ABSTRACTS – INVITED SPEAKERS

International Committee on Global Navigation Satellite Systems (ICG): Coordination and Cooperation

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Following the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in 1999, the United Nations General Assembly endorsed the "Vienna Declaration: Space Millennium for Human Development." The Vienna Declaration called for action to improve the efficiency and security of transport, search and rescue, geodesy and other activities by promoting the enhancement of, universal access to and compatibility among, space-based navigation and positioning systems. In response to that call, in 2001, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) established the Action Team on Global Navigation Satellite Systems (GNSS) to carry out those actions under the chairmanship of the United States of America and Italy.

The Action Team on GNSS, consisting of 38 member States and 15 inter-governmental and non-governmental organizations, recommended that an International Committee on GNSS (ICG) be established to promote the use of GNSS infrastructure on a global basis and to facilitate exchange of information. COPUOS included this recommendation in the Plan of Action proposed in its report to the United Nations General Assembly on the review of the implementation of the recommendations of UNISPACE III.

From 2005 to 2008 the International Committee on Global Navigation Satellite Systems (ICG) held three annual meetings to review and discuss matters relating to global navigation satellite systems (GNSS) and their applications. The ICG work plan includes compatibility and interoperability; enhancement of performance of GNSS services; information dissemination and capacity building; interaction with national and regional authorities and relevant international organizations; and coordination.

The United Nations Office for Outer Space Affairs, as the Executive Secretariat of the ICG develops a wide range of activities focusing on capacity building, specifically, in deploying instruments for the international space weather initiative (ISWI), with emphasis on establishment and/or operation of ground-based worldwide instrument arrays with GPS onboard, and utilizing regional reference frames that support sustainable development, particularly in developing nations.

GPS Modernization: GPS IIIA – On the Road to the Future

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The GPS modernization program is currently underway bringing new capabilities to positioning, navigation, and timing users throughout the world. In May 2008, the U.S. Air Force awarded a contract to Lockheed Martin Space Systems to develop the next generation of GPS satellites, the GPS IIIA.

The GPS IIIA program recently completed a highly successful Preliminary Design Review and is scheduled to undergo a Critical Design Review in Fall of 2010. The fist launch of a GPS IIIA satellite is projected for 2014 in support of both normal constellation sustainment and continuing the implementation of the GPS modernization program.

Beginning in 2014, the GPS IIIA satellites will broadcast the new fourth civil signal, called L1C, in addition to the second and third civil signals as well as the military M-code signal. Significantly, the signals from GPS IIIA will be both compatible and interoperable with the Open Service broadcast from the European Galileo system.

This presentation will update the conference on the current status and capabilities of the GPS IIIA program.

KEYWORDS: Satellite navigation; GPS; modernization; L1C; interoperable.

ABSTRACTS – ORAL PRESENTATIONS

Or 01

Certification of safety critical galileo applications

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The Institute of Flight Guidance (IFF) of the Technische Universität Braunschweig has been and still is involved in multiple research activities in the field of satellite navigation. One special research area is the applicability of Global Navigation Satellite Systems (GNSS) for safety critical purposes. Today's GNSS GPS and GLONASS are not able to provide the needed performance for many possible safety critical applications. One advantage of the future European GNSS Galileo compared to existing systems will be its guaranteed performance and promised certifyability. This will provide the basis for certifying safety critical GNSS applications.

The IFF has been partner in the European GALCERT project. Funded by the Galileo Supervisor Agency (GSA) it was aimed at developing a Green paper for the certification of the Galileo Signal in Space (SIS). Currently, the IFF is partner in the GAUSS project bringing together research and industry partners in the field of certification for safety critical GNSS applications. While GALCERT focused on the System Galileo and its Signal in Space, the base of any applications to come, GAUSS as follow-up project explicitly focuses on the application itself. It aims at developing a harmonized trans-modal certification process for safety critical Galileo applications for all domains of transportation.

This paper illustrates the ongoing research work of the IFF in the area of certification of safety critical GNSS applications. It focuses on the progress made in the development of a certification process applicable for multiple transport domains including aviation, railway and road and with small adjustments also maritime. The paper also exhibits the chosen bottom-up methodology moving from domain specific to a general transmodal process.

Or 02

Latest developments on the payload in-orbit testing of galileo iov spacecraft

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This paper describes the infrastructure and the functions of the Galileo In-Orbit Validation (IOV) In-Orbit Test (IOT) System. This is then followed by a detailed review of the main technical challenges posed by the IOT activity and how the IOV IOT System has been specifically designed to meet them.

The IOV phase covers the launch and characterisation in orbit of four satellites, allowing the system to be properly evaluated before full system deployment. The four Galileo IOV satellites will be launched in pairs and the IOT campaign will be held to ensure that they have survived the launch without damage and their performance is consistent with that measured during ground test.

Inmarsat is responsible for implementing and operating the Galileo Payload IOT System, which will be located at the ESA Redu earth station and expected to be 35 days long. The functions of the IOT System include RF transmit measurements at C-Band and UHF-Band, RF receive measurements at L-Band, as well as measurements carried out by dedicated Navigation Test Equipment. Inmarsat will deploy a fully automated IOT Measurement System and three main antennas at Redu: a high gain L-Band receive-only antenna for receiving satellite downlink signals, a C-Band transmit antenna for sending navigation messages and a UHF transmit antenna for up-linking S&R test signals to the satellite. During IOT the satellites will be under the control of DLR.

The IOT System will face design challenges dictated by technical and operational requirements

that are uncommon for IOT purposes of conventional geosynchronous satellites:

1) Tracking the Galileo Satellites
2) The Challenges of the IOT Timeline
3) Measuring On-Board Clocks Accuracy and Stability
4) Assessing the Quality of Navigation Signals by real-time analysis and post-processing.

The results obtained during the IOV IOT campaigns will represent a benchmark throughout the satellite operational life and will constitute a reference basis across the entire constellation.

Or 03

The status and significance of eloran

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Global Navigation Satellite Systems (GNSS), in particular GPS, are likely to form the core Positioning Navigation and Timing (PNT) technology for e Navigation. All GNSS are vulnerable to interference, because the signals, measured at the surface of the earth, are very weak. These systems are susceptible to non intentional interference as well as jamming, resulting in the possible denial of the service over large geographical areas. The result of such interference could be the complete failure of the mariner's GNSS receiver and the many systems that use GNSS as the PNT input. Possibly worse, would be the presentation to the mariner of hazardously misleading information.

Recent delays in deployment and replenishment of GNSS have increased concerns about the security of PNT and underlined the need for a reliable backup with dissimilar failure modes.

eLoran is the only credible and cost-effective alternative that, in the time available, can deliver e-Navigation's urgently needed benefits of safety and security at sea and protection of the marine environment. e-Navigation will allow all nations to protect and enhance their coastal assets, for example by implementing motorways of the sea, providing for aquaculture and maritime national parks, within the context of a considered maritime policy and orderly geo-spatial planning.

Although the infrastructure for eLoran exists in large parts of the Northern hemisphere, providing coverage of 70% of the world's major ports, the future of this important system has been uncertain. This paper provides up to date information on the status of eLoran in North America, Europe, Russia and the Far East and sets out the measures needed to ensure that the security of PNT for e-Navigation is guaranteed for the future.

Or 04

Group repetition interval selection and core eLoran service capacity

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According to the eLoran Definition Document issued by the International Loran Association, eLoran will be divided into Core Service Provision components and Application Service Provision components. Core service provision includes eLoran transmitters and their associated monitoring and control infrastructure. Application service provision includes that infrastructure required to support the application requirements of specific user segments.
The accuracy, integrity, availability and continuity performance of eLoran core service provision depends on the number of eLoran transmitters within a coverage area. Recent developments in new technology transmitters has created the potential for cost effective improvements in eLoran coverage. However, with each additional transmitter installed more Cross-Rate Interference (CRI) is added to the radio environment within which eLoran stations are expected to operate.

This extra interference increases the attendant integrity risk upon signal reception. CRI is inherent to the eLoran system and cannot be prevented. Nevertheless, its effect can be mitigated by judicious choice of the Group Repetition Intervals (GRIs) within which the stations transmit and by advanced receiver signal processing techniques.
We have developed a set of Matlab tools, which implement a GRI selection technique based on methods sanctioned by the International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) for the establishment of new Loran-C chains. We have also extended the techniques by developing a number of updates that take into account the modernization of Loran-C to the eLoran standard.
In this paper we explore the effect of CRI on the positioning performance of an eLoran receiver, and assess the effectiveness of modern receiver CRI mitigation techniques. The resulting models are integrated into an updated GRI selection method and are used to analyse the capacity within the European region to accommodate new eLoran stations.

Or 05

LORAN for vehicle and pedestrian tracking: a viable back-up to GPS?
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The past decade has seen renewed interest in the maintenance and development of the terrestrial LORAN navigation system for airborne, marine and land navigation. The increasing use of GPS in safety-related civil applications is raising demand for a viable back-up system to mitigate GPS's vulnerabilities, in particular its sensitivity to interference and jamming. On land, proposed applications for LORAN include providing enhanced accuracy in areas with poor GPS propagation, for example in deep urban canyons or inside dense buildings, and vehicle tracking in scenarios where GPS jamming is likely.

This paper provides a study of the achievable performance of LORAN for land-based applications, and in particular for vehicle and pedestrian tracking. The principal sources of error in LORAN measurements are first reviewed from a theoretical standpoint, including the effects of terrain, and multi-path propagation from buildings and power lines. Potential mitigations for these errors are then discussed, including methods for the efficient calculation of additional secondary factors (ASFs) in urban environments.

The results of an experimental measurement campaign in the UK are then presented. Measurements have been made with a CrossRate eLGPS1110 combined GPS/eLORAN receiver using dual H-field antennas. LORAN measurements have been made in a variety of environments, including dense urban, rural and indoor settings. A variety of methods for ASF computation are tested and the resulting measurement accuracy and availability is compared with that of a modern high-sensitivity GPS receiver based on the SiRFstarIII chipset.

Finally, consideration is given to possible enhancements to the accuracy of LORAN through the combination of LORAN measurements with other data such as inertial sensors and knowledge of road locations in a vehicle tracking scenario. In particular, results from the use of a particle filtering algorithm for real-time probabilistic data fusion are presented.

Or 06

Interference Detection and Analysis in the Field of GNSS Verification
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A constant growing number of applications based on satellite navigation systems especially safety critical ones like airplane landing require highest precision and robustness of the positioning solution also available under rough conditions. In order to provide sufficient quality of service the positioning performance of the satellite navigation system is a main key factor. Accurate and comprehensive interference measurements of unwanted and possible perturbing emissions and a clear separation of the different sources are necessary since they can degrade the performance and integrity of safety critical applications.

A main challenge in these kinds of measurements is the determination of the interference source. These could be external terrestrial interference like ground based navaids as the Distance Measuring Equipment (DME) or Tactical Air Navigation (TACAN), TV-Stations and radio operators which affect the signal quality due to their high output power levels and continuous operation. Another source of potential interference is caused by other satellites which transmit their signals in adjacent or even the same frequency bands. Beside the determination of the interference source also the information of the specific form and occupied bandwidth of this measured interference is essential.
Starting in 2005 the DLR Institute of Communications and Navigation established an independent monitoring station for the analysis of GNSS signals. A 30 meter antenna located at Weilheim, Germany is the core element of this facility. An absolute calibrated setup with this 30m antenna allows very precise measurements on a single navigation satellite. Using this facility it is also possible to measure and analyse potential interference very detailed. This paper gives an overview of the used setup and will present the results of an extensive interference measurement campaign in the L-Band, the most interesting frequency band for satellite navigation at the moment.

Or 07

Narrowband interference mitigation in a software GPS receiver
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In this paper, we present some practical methods of mitigating narrowband interference in a software GPS receiver. One significant source of such interference is the 14.318 MHz oscillator generating the system clock in most personal computers. This frequency has a harmonic at about 400 kHz from the GPS L1 centre frequency, which can interfere with the carrier tracking loops of a GPS receiver. An obvious way of removing the interference would be to use a narrow notch filter, but running such a filter in a software based receiver is not practical because it requires a lot of CPU resources. Instead, we implement a method of actually tracking the interference signal and using the output of the tracking loops to remove the signal from the actual IF data. First we find the signal with a simple FFT-based search method, and then we track the signal with a phase locked loop (PLL). After identifying the frequency and phase of the interference using the PLL, the interference can be removed from the IF data either pre- or post-correlation by adding an identical signal with the opposite phase. We investigate both of these methods. Pre-correlation removal from the raw IF data is attractive because it allows interference removal without modifying the actual GPS signal processing software. We analyze methods to remove the correct amount of interference signal from the raw data without introducing disturbing artifacts. However, pre-correlation removal is quite CPU-intensive. A less intensive way is to remove the interfering signal after correlation. In this case a replica of the interfering signal is also correlated, and the results are subtracted from the correlator outputs. In this paper, we present initial results on the performance of the two described methods. The Fastrax Software GPS has been used as a test bed for these methods.

Or 08

On the advcanced simulation of distortions for navigation, landing and radar systems - modern methods, cases and results
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Modern navigation, landing, radar and communication systems rely on the physics of antennas and propagation and signal processing. Their electrical performance is determined by the intended radiation and by the scattering of distorting objects and of the terrain, so-called multipath. New buildings and the development of airports or the sustainment of the electrical performance of the systems have to be simulated in advance before these new objects are built or appear by adequate means in a sufficiently accurate and reliable way according to state-of-the-art SOA principles. The realistic scattering analysis and the realistic signal processing are an integral part of the system simulations which have to result in the system parameter, e.g. the (monopulse) angle or range error or false target in case of ATC-radar. The modeling of the

antennas, the environment, the distorting objects and of the system are the basic steps of the simulation process. All the modeled objects are electrically large 3D-objects in much varying distances to the system antennas, whereas the field point is in electrically very large distances. The applied modern numerical methods have to be adequately selected and mutually adjusted to the structure of the 3D-model and the terrain aspects for system simulations often in a hybrid way by applying the combination of the most modern SOA-methods. Numerical feasibility aspects are discussed, such as the demanding computer time and storage. It is shown that the detailed 3D-model plays a decisive role to get the sufficiently correct system answer. Validating comparisons of measurements and simulations for complex cases are presented showing a remarkable agreement. Typical practical examples to be discussed are shown below which can be analyzed by the developed integrated system simulation scheme, such as the new A380 on airports, wind turbines en-route or other examples such as towers or hangars on airports and high voltage lines.

Or 09

Soldier and first responder RF-positioning in indoor environments

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High accuracy radio positioning systems for soldiers and first responders operating in indoor environments is a challenging problem due to multipath propagation. The purpose of the paper is to evaluate algorithms for radio positioning where a radio transmitter is placed on a soldier operating inside a building, a scenario where GPS fails to deliver sufficient accuracy. The radio signal experiences heavy multipath propagation inside typical buildings and by utilizing bandwidths of 10 to 30 MHz it is difficult to resolve the direct signal component from the multipath components. The algorithms will be evaluated both by simulation and using data from real experiments. In particular, we are interested in evaluating how the wave propagation in different types of buildings affects the accuracy of the estimated positions.

The basic positioning algorithm used is based on time of arrival (TOA) and/or time difference of arrival techniques (TDOA) techniques. These algorithms etimate the time of arrival or time difference of arrival of the direct line of sight signal. However, in the considered application the direct signal component is difficult to detect due to the multipath signal propagation. The characteristics of the multipath propagation will be studied for different building materials, modulation frequencies and signal bandwidths. The results will be used to determine which type of algorithm is best suited to estimate the position of the transmitter.

The experimental setup consists of four USRP-2 units. USRP-2 (Universal Software Radio Peripheral) unit is a simple, relatively cheap hardware platform that can be used to quickly realize a test waveform in a software radio. Moreover, the USRP unit can be used together with the freely available open source software package GNU-radio. The advantage with this system, except for the low price, is its flexibility to quickly evaluate RF-positioning systems. Thus, the system is appropriate for small research projects

Or 10

WLAN Positioning on Mobile Phone

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Many of the recent mobile phones have integrated WLAN module which could be utilized for positioning applications without any additional accessories, thus such devices are good candidates for personal positioning. WLAN positioning methods are mainly based on signal strength measurements but there are several approaches how the measurements are exploited like e.g. cell ID, trilateration, and fingerprinting.

In this paper, a WLAN positioning on a mobile device is described. The positioning method is based on WLAN signal strength measurements with fingerprinting approach, where the position is obtained with the aid of radio map stored in a database. We used two position estimation

methods - Maximum Likelihood (ML) and Minimization of Expected Error (MEE). The requirement for the implemented algorithms was that their computational load should be light enough due to limited computing capacity of mobile devices.

We report the computational load, power consumption, and positioning accuracy of fingerprinting based on ML and MEE estimate. The computational load was measured with Nokia Energy Profiler application. The power consumption was measured by running the algorithms until the charge of battery was reduced below the minimum operating voltage. Related to this, we were also interested in the effect of the WLAN positioning on the other programs running on phone and vice versa.

Preliminary results show that a modern mobile phone has sufficient resources to perform computations for both ML and MEE fairly well. When executing positioning with only a small fingerprint database and Energy Profiler the peak value of the load is about 10%. The accuracy depends on the methods used in collection of calibration data but it seems that it is possible to achieve average error (distance between true and estimated location) of 3 meters. The main concerns in our experiments are related to sampling rate as the WLAN API in the OS is not defined for signal processing applications

Or 11

Symbolic 3D WiFi indoor positioning system: A deployment and performance evaluation tool

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In many location based applications there is no real need for accuracy, but rather for reliability. For example, the fact to know someone is in a specific room, corridor or office is often sufficient. This is the basis of the symbolic approach that gives a positioning in terms of rooms (or group of rooms). Developed algorithms have then a clear target: to provide high reliability in a typical 3D environment, together with real time indicators of both accuracy and reliability. The WLAN symbolic system has also been designed in order to provide a positioning without any calibration phase and that still works even in "real telecommunication environments", i.e. with a reduced set of Access Points (it still works with only one Access Point, although the accuracy of the positioning is then really poor). In addition, the symbolic approach is scalable and easy to adapt to particular needs such as an increased accuracy in specific areas or positioning in a complex 3D building. We developed a tool that allows a user to evaluate the positioning performance of its WiFi network, using the symbolic method. Default values of the various parameters allow a straight forward approach, although a reduced set of initial measurements (a "not more than five minutes" calibration) is bound to provide a better positioning estimation. This tool is also useful in improving the WLAN network deployment for positioning purposes in helping to find the best locations of the Access Points. In addition, it helps in defining the location of a new added Access Point that will improve the positioning. The tool is fully presented and described in the paper and allows the deployment and evaluation of the symbolic positioning in all environments by any user.

Or 12

E-navigation - applications and benefits

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This paper will explore some of the potential applications for e-Navigation and in each case identify the technological advances required, concentrating on radio navigation and communication systems. The benefits will also be discussed in terms of improved safety and protection of the environment as well as efficiency and security.

The applications considered here include virtual aids to navigation, collision avoidance, navigation information systems and passage planning.

The purpose of the Virtual AtoN System is to provide a near-instantaneous warning to the mariner of a new danger, such as a wreck, obstruction or floating debris. This warning must be provided in a form that can be received, interpreted and displayed by any class of vessel in the required operational area and carrying appropriate equipment.

Collision avoidance is best performed using a number of different methods together, including radar, the Automatic Identification System (AIS) and visual checking. No single method should be trusted as the sole source of data to avoid collisions. Radar will detect almost all obstacles, but is affected by weather conditions with the potential effect of clutter. AIS is less affected by weather, but cannot detect some vessels and most obstacles. Used together, these techniques can form a powerful set of tools to assist in collision avoidance.

Intelligent information systems can provide the mariner with the relevant data to plan and execute a voyage. Searching for information based on location, application and context will reduce the risk of overloading and confusing the user and help to ensure that the important data is not overlooked.

These applications exemplify the concept of e-Navigation and demonstrate its potential benefits.

Or 13

Reliability and availability on onboard AIS information

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Today UAIS has been under full operation on ocean-going vessels all over the world. For example, this system was set up on all domestic vessels of over 500 GT last July. Under the present situation, the antenna heights of the system became lower than what they used to be because smaller vessels installed the AIS system. On the other hand, some troubles of AIS data reception are reported because Class-A is going to be enforced completely. But the reliability on this system and helpfulness for seafarers are not researched sufficiently. So the authors surveyed the reliability of the system and examined how seafarers can make full use of it. Firstly, some on-board experiments were excuted on three types of vessels who have the different heights of antennas in order to survey their reception conditions. The following results were obtained from the experiments. 1. The reception rate of the AIS signal loss under the situation as follows: (1) In case that there are interference objects between own vessel and another vessel, (2) In case of multi pass, and (3) In case that a radio wave collision occur in the same slot. 2. The performance of reception greatly depends on the heights of antenna. Especially the tendencies of the effects were appeared in small vessel or lower antenna. Secondly, some questionnaire surveys were conducted for domestic seafarers who sail in congested areas in order to investigate how they can use the system effectively. The survey showed that about half of the respondents used the AIS stand-alone, and another half used it overlaying on the ARPA or ECDIS. The following opinions were obtained from the questionaire survey : (1) AIS is useful system for safe navigation of vessels, (2) there are some differences in perception between the seafarers who use only AIS stand-alone and those who use overlaying techniques, and (3) there are some concerns about the reliability of AIS data.

Or 14

3D panoramic stereo imaging system for maritime search and rescue (SAR) simulator

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Maritime search and rescue (SAR) is a complex and arduous mission. Seafarers need to face a variety of complex marine weather and sea state, and use the limited time to search and rescue the objects. Many research efforts have been dedicated to optimizing SAR planning. However seafarers often were still not able to successfully rescue the objects even though they found out the objects due to the lack of the operating experience. Therefore the capacity to train seafarers within a SAR simulator presents a critical need for Maritime Safety Department. Currently, many

SAR simulators appear to be widely in use by seafarers in training for the purpose of repeatedly practicing rescue procedures.

3D visual system is a key technique in these SAR simulators. However, the simulators still remain with mono 3D visual system so that they cannot simulate the realistic SAR scene. In order to better enhance the sense of immersion, a superior strategy would be first to build a 3D panoramic stereo imaging system that precisely yields the SAR stereo scene, and then integrate the bridge system into the simulator. This approach is addressed in this work. This paper presents a complete framework for building a 3D panoramic stereo imaging system in maritime search and rescue simulators. The implementation employs the panoramic stereoscopic projection method. Specifically, the automatic geometry calibration and image blending method is developed to map the 3D stereo scene onto 360 degree cylinder display screen and seamlessly blend the overlapped regions between projection images. The approach successfully builds a 3D panoramic stereo imaging system with which SAR simulators can be improved to obtain a strong sense of immersion. Furthermore, 3D virtual scenes with various rescue scenarios are simulated, such as adverse sea state, ship flooding, ship fire, ship sinking etc.

Or 15

Mapping the regional ionospheric TEC using a spherical cap harmonic model and IGS products in high latitudes and the arctic region

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The need for accurate GNSS positioning is nowadays necessary even in high latitudes and the arctic areas. One of the most dominant error sources in GNSS applications is the ionosphere and its free electrons. The ionosphere in the arctic regions is, however, hard to be modeled by conventional ionosphere models due to two facts: on the one hand, the ionosphere in the arctic regions is affected more strongly by the activity of the Sun and the geomagnetic field; and on the other hand, the conventional ionosphere models based on geodetic coordinates have asynchronous dimensional resolution, especially in the area close to the pole.

This paper presents a novel spherical cap harmonic model for mapping the arctic regional ionospheric TEC values in a spherical cap coordinate frame. Utilizing a series of IGS products, including e.g. the precise orbits of the satellites, the satellite and receiver differential code bias, and the TEC values from the global ionosphere mapping (GIM) model, a set of dual-frequency GPS data from IGS stations in high latitudes is processed and used to map the arctic regional TEC values with the spherical cap harmonic model and the conventional polynomial model. Together with the global GIM model from IGS, the TEC mapping accuracies from these three sources are compared. The comparison results show that the spherical cap harmonic model has a slightly improved TEC mapping accuracy with smoother residual distribution in both temporal and spatial domains for the arctic region.

Or 16

High resolution GNSS tomography for water vapour retrieval and quasi real-time heavy precipitation forecast

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Recent flood events in Switzerland and across Europe have pointed out several deficiencies in the planning and prediction methods used for flood risk mitigation. With an enhanced tomographic approach we exploit the GNSS measurements in view of forecast of heavy precipitation and hazard mitigation. In mountainous regions it is of utmost importance to be able to make predictions at a spatial resolution at least of the dimension of the catchments. Therefore, one goal of the presented research is to reach a spatial resolution of the water vapour retrieval of the order of 1 - 5 km in quasi real-time analysis. To reach these goals we newly formulated the tomographic approach using parameterization and filtering which lead to

an enhanced spatio-temporal resolution is GNSS water vapour tomography. The spatial parameterization of the voxels allows to continuously describing the three-dimensional field of wet refractivity. The tomographic inversion is formulated as Kalman filter with parameterised voxels in ellipsoidal coordinates. This is a clear enhancement, compared to the tomographic approaches realized in Cartesian coordinate systems, which are not adequate in cases of large areas of investigation. The Kalman-filter formulation allows all the measurements (ray path delays) to be taken into account sequentially. Analyses based on simulated and real observations and validations of the high resolution tomography were carried out in the Swiss Alps (canton Valais). Results from GPS tomography were compared to more than 30 weather balloon soundings at 6 sites within the project area.
The parameterised approach revealed superior performance regarding accuracy and quality compared to the usual constant voxel approach. A short summary of the developed algorithms, and results will be presented, and advantages and disadvantages of the new algorithms will be discussed. Results from GPS test campaigns in the Swiss Alps will be presented.

Or 17

Real time computation of precipitable water vapour using global positioning system - data quality improvement
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Global Positioning System (GPS) is a satellite based navigation system, designed to provide instantaneous position, velocity and time information on the surface of the Earth at any time in any weather condition. GPS radio waves are delayed due to the ionosphere and troposphere. It has been found that tropospheric delay is due to the composition of gases and water vapor present in the troposphere. The total water vapor content can be determined by using the GPS data and formulating suitable model of the troposphere, which in turn can be used for monitoring the flood, short-term weather forecast, and various atmospheric studies.

The integrated total water vapor content can be computed from the zenith equivalent total path delay affecting the radio signal propagation in the troposphere. The zenith total delay (ZTD) will be decomposed in to the zenith wet delay (ZWD) and zenith hydrostatic delay (ZHD). The ZWD is found out by subtracting ZHD, from zenith total delay. ZHD is computed by using suitable atmospheric model. ZWD can be converted in to precipitable water vapor (PWV). The objective of this study was to precisely estimate the ZTD, ZHD, ZWD and PWV using GPS with Global Pressure and Temperature (GPT) and Observed Pressure and Temperature (OPT) and compare with Radiosonde PWV. The objective was also to study the effect of updating station coordinates using GAMIT GLOBK on the accuracy of zenith delay and PWV estimates. A technical paper on the work will be submitted after receiving the acceptance notification.

Key words: Global Positioning System, Meteorological Parameters, Zenith Wet Delay, Zenith Hydrostatic Delay, Zenith Total Delay, Precipitable Water Vapor.

Or 18

High performance Galileo E5 correlator design
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The Galileo E5 signal is the most precision civil navigation signal which is currently transmitted by Giove satellites and which will be available in the near future for regular navigation. The excellent performance of this signal was reached by AltBOC modulation, which was specially designed for high precision range measurement and which is featured by extremely wide bandwidth. The paper compares various signal processing methods of the E5 signal from a simple one based on the separate signal component processing to an optimal one based on the processing of the whole signal power.

The philosophy of the optimal processing method is firstly described on a simple example which is QPSK modulated navigation signal by the pilot and data signal. The correlator for QPSK

modulation usually processes these two orthogonal components separately but the simultaneous processing of such signal is also possible. The problem of the second approach is signal replica generation because of its dependency on the navigation message. The correlator therefore must generate two replicas for both data bits hypotheses and select correct hypothesis on the end of the integration.

AltBOC modulation is more complicated than QPSK one. We can unambiguously generate the replica of part of the signal which depends on the ranging codes only. The replica of in phase component modulated by the navigation messages and auxiliary envelope correcting signal cannot by unambiguously generated due to their dependency on the navigation messages.

The optimal signal processing of E5 employing all signal power was evaluated by generalization of second QPSK processing method.

The last part of this paper deals with the implementation of the proposed optimal E5 signal processing to the software GNSS receiver. The test results on live Giove A and Giove B signals are also presented.

Or 19

Chi-Square Distribution Matching in Unambiguous Sine-BOC and Multiplexed-BOC Acquisition

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Multiplexed Binary-Offset-Carrier (MBOC) modulated signals are the main candidates for the future Galileo Open Services (OS) and modernized GPS L1C signals. Sine-BOC and MBOC-modulated signals have a narrower main lobe of their ACFs, compared to the BPSK-modulated signal. This feature is known to improve the accuracy in the delay tracking process. However, additional peaks and some gaps or deep 'fades' appear within +/- 1 chip interval around the maximum correlation peak, due to sine and multiplexed BOC modulation. As a result, the ACF becomes ambiguous. In order to avoid the ambiguities of the absolute value of ACF, several unambiguous or 'BPSK like' acquisition techniques have been proposed: Betz and Fishman (B&F), Martin and Heiries (M&H) and Unsuppressed Adjacent Lobes (UAL) methods. The purpose of this paper is to model theoretically, via chi-square distributions, the test statistics of both unambiguous sine BOC-and MBOC-modulated signals and to present a chi-square based analysis for the above-mentioned unambiguous. The parameter distribution fitting is based on simulations and Kullback-Leibler divergence criterion, and the resulting theoretical model is compared with the simulation results, in terms of detection probabilities. The deterioration factors for modeling the variance and the non-centrality parameters in the acquisition process are estimated here for both sine BOC(1,1) and MBOC modulations and for all 4 acquisition methods: one ambiguous (the classical one) and 3 unambiguous (B&F, M&H and UAL). The underlying theoretical model of M&H and UAL unambiguous acquisition methods has never been addressed in the literature so far to the best of the authors' knowledge. Also, the analysis of chi-square based statistical model of B&F method has been limited only to sine BOC cases so far, while our paper deals also with MBOC cases. The references, figures and detailed results are to be included in the final paper.

Or 20

Universal front end for software gnss receiver

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The development of GNSS systems and implementation of a new wideband navigation signals require innovative approach to the software receiver front end design. The ideal front end is very versatile and is able to process signals of any L band GNSS navigation frequency. Other main features of the receiver analog front end are a low noise figure, a high selectivity, a wide dynamic range and a low intermodulation distortion. The front end of the software radio should be configurable by software. These contradictory requirements were solved by a direct

conversion receiver. The paper deals with the design of the complete analog signal processing chain, i.e. antenna, LNA, RF filters and configurable receiver, for civil GPS and open Galileo signals. The frequency demultiplexing of the GNSS signals is complicated in this case due to the frequency proximity of the GPS L2 and Galileo E5 signals. A conventional diplexer therefore cannot be used and the signal has to be split by a standard power splitter. The high attenuation of the power splitter must be compensated by the wideband high dynamic LNA. The split signal is then processed in a bank of filters with coaxial resonators tuned on frequencies L1 (E1), L2, E5 (L5). The filtered signal is passed into the configurable L band direct conversion receiver with programmable bandwidth in range from 8 to 80 MHz. The extreme dynamic range of the receiver blocks before the frequency filtering is required to prevent penetration of high power signals of terrestrial communication systems which transmit in an adjacent part of frequency spectrum. Disadvantage of such solution is high power consumption of the LNA (1 Watt in our case).

Or 21

Barometer-aided road grade estimation

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In accurate land vehicle navigation, it is crucial to have uninterrupted navigation solution. The solution must be available also during satellite navigation outages, which may occur, e.g., in urban canyons and tunnels. Inertial navigation system (INS), including three accelerometers and three gyros can be used to propagate the position estimate during the outages. As gyros are the most expensive components of INS, reduced inertial systems with only one gyro have been proposed in recent navigation literature. The underlying assumption is that changes in pitch and roll are limited when the unit is installed to a road vehicle. However, in this case any change in the road grade induces errors to the position solution, as gravity component cannot be estimated in the local-level frame.

In this paper, we propose a reduced inertial system, where the road grade is estimated with the aid of accurate barometer and, therefore, aid the measurements of the accelerometers. We describe our field test navigation system consists of accurate differential GPS (DGPS), one horizontal gyro, three accelerometers, and an accurate MEMS barometer in a normal passenger car. We carried out field tests with a passenger car on steep hills to find the limitations of the reduced INS, and to see how the inclusion of barometer changes the situation. A 20 Hz DGPS navigation solution was used as a reference and error in longitudinal distance as a function of outage time was used as the accuracy measure. The results show that barometer can identify the change of the road grade but there is notable accumulation of error due to positive feedback in the speed estimation loop.

Or 22

Mobile multi sensor geo-context and attention tracking system for window-shoppers in urban environments

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In order to seamlessly evaluate consumer behavior and their attention during an urban shopping scenario, it is essential being able to identify the subject's line of sight as well as its position in an exact manner. For determining the user's attention, the line of sight is intersected with a virtual 3D city model.

This approach requires the location determination not to deviate more than 1 meter from the subject's actual position. In an urban scenario, absolute satellite positioning alone would not provide that necessary accuracy. As a consequence, various methods to improve the location determination are combined.

In the first step, the absolute position information obtained from satellite is enhanced with information provided by a cellular network. This includes a rough estimate of the user's position

(in order to accelerate the satellite locking process) and triangulation with various base stations (aGPS).

Next, differential methods are used. This is done by utilizing already existing correction signals, like EGNOS, WAAS or MSAS (depending on location) on the one hand and by introducing own reference points for which the position was determined in advance on the other.

Finally, data collected by an inertial measurement system consisting of acceleration and motion sensors is combined with orientation information of a digital compass and an eye tracker. With this data, the most probable direction of motion can be derived.

The various tech solutions for this multi-sensor approach which evolved in the last several years became more and more sophisticated in matters of sensitivity, energy efficiency and portability. This makes it possible to create a personal user tracking system covering all types of data previously mentioned.

In this paper, the combination method of the various pieces of sensor data and the subsequent improvement of position, spatial orientation and line of sight determination accuracy are presented.

Or 23

Development of a smart phone based 3D personal navigation and LBS system

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GNSS applications in mobile phones are now dominating the GNSS market. 3D personal navigation in a smart phone will bring new experiences to the mobile phone users and enlarge the scope of mobile applications. The Finnish Geodetic Institute, Tampere University of Technology, Chinese Academy of Surveying and Mapping, Shanghai Institute of Technical Physics and Shanghai Ubiquitous Navigation Technology are now developing a 3D personal navigation and LBS service that will be demonstrated in the world exposition in Shanghai in 2010. The project will deliver an entire 3D personal navigation solution consisting of a 3D-city model for the EXPO area in Shanghai; a multi-sensor positioning solution for both indoor/outdoor environments, and a freely downloadable handset-software based on the Nokia Series 60 platform for exploring the 3D personal navigation and location-based services. With the project deliverables, the mobile users, who have a Nokia phone based on the series 60 platform, will be able to conveniently experience the 3D personal navigation service during the World Exposition in Shanghai in 2010. This paper presents the challenges in developing such a system including real-time 3D visualization in the mobile phone, semi-automation generation of 3D city models and approaching a seamless indoor/outdoor positioning solution based on multiple MEMS sensors, GNSS, and wireless LAN.

Or 24

A ground-based real-time demonstration of the NASA TDRSS Augmentation Service for Satellites (TASS)

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NASA is in the demonstration stages of a new service that will provide GPS global differential corrections to Earth satellites enabling decimeter-level orbit determination accuracy onboard, in real-time. The TDRSS Augmentation Service for Satellites (TASS) is broadcasting NASA's global differential GPS (GDGPS) corrections over the S-band multiple access channel of NASA's

Tracking and Data Relay Satellite System (TDRSS). The GDGPS system has been used to demonstrate real-time decimeter-level positioning on ground and air platforms. Because there is not yet an effective means to get the GDGPS corrections to a space platform, after-the-fact analyses using actual GPS data from BlackJack receivers onboard the CHAMP, SAC-C, GRACE, and Jason spacecraft coupled with the GDGPS corrections have been performed. The analyses demonstrate that it will be possible to achieve decimeter and, in some cases, sub-decimeter-level positioning in real-time onboard an Earth-orbiting satellite carrying a TASS-enabled GPS receiver.

While TASS is ultimately intended for use on an Earth-orbiting platform, during this demonstration phase, we are performing real-time ground-based static and mobile positioning tests of a user in the system. Engineers from JPL have modified an IGOR dual-frequency BlackJack GPS space receiver to acquire and track the S-Band signal from TDRSS. The modified BlackJack tracks the TASS signal and extracts the GDGPS correction message for use by JPL's Real-Time GIPSY (RTG) precise positioning software. To accommodate the ground-based testing, the RTG software residing on the BlackJack has been modified from the precise orbit determination algorithm, as was previously demonstrated without GDGPS corrections on the SAC-C satellite in 2002, to a point positioning algorithm for use in static, mobile, and aircraft applications. In this paper, we will describe the TASS user-end test setup and show results from ground-based static and mobile testing.

Or 25

Deformation source modelling of a probable magma intrusion in the Fogo/Congro area (S. Miguel Island, Azores)

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GPS is nowadays an essential tool for understanding crustal deformation in volcanic regions. The monitoring of volcanic activity is particularly important in populated regions, such as the Azores islands. As the result of such monitoring in the S. Miguel Island, we present a case study of a probable siliceous magma intrusion, inferred from the velocity field obtained from the analysis of GPS data spanning the period 2000.0 – 2007.7. The magma inflow has contributed to an important 3D deformation pattern over central S. Miguel Island, in the vicinity of Fogo composite volcano, placed in the boundary between Nubia and Eurasia stable tectonic plates, east of Middle Atlantic Ridge. The horizontal deformation shows a clear outward radial pattern whereas the vertical component shows stepwise inflation/deflation episodes along the intrusion processes. The best simple source deformation modelling of the 3D displacement field points out for a cigar-like shape intruded magma body, with a 110 m radius and a depth of 600 m (height of top and bottom of 1800 m and 2400 m, respectively). This intrusion has contributed to a widespread seismic swarm, correlated in magnitude, time, and space with the deformation field. The very high ratio of the seismic moment (calculated based on the seismic magnitude of registered events) to the magma injection geodetic moment (based on the volume change estimations using the Mogi model) give evidences of an important stress regime prior to the onset of the intrusion, afterwards triggered by the uprising magma. Moreover, underestimation of intrusion volume and very high magma viscosity could also be considered as causes for the high moment ratio. These results give important clues for understanding of the source mechanisms of magma intrusion for the Azores volcanic systems and contribute for risk mitigation in S. Miguel Island, far significant for society.

Or 26

Advantages of combined GPS and GLONASS PPP - experiences based on G2 a new service from Fugro

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A new combined GPS and GLONASS precise orbit and clock service named G2 is presented in this paper. It is the first real-time GLONASS Precise Point Positioning (PPP) service ever to be launched. The addition of GLONASS gives a total of about 50 GNSS satellites and is a significant improvement to navigation availability and reliability. The objective of this paper is to present the system, analyse the performance and show field results demonstrating the advantage of combining GPS and GLONASS.

The system presentation goes through all elements of the complete navigation solution: including the global reference station network; the real-time collection of GNSS data; the calculation process of precise orbits and clocks for both GPS and GLONASS; the PPP data distribution over geostationary satellites for global coverage, and finally the GNSS receiver solution at the user end. Detailed accuracy analysis and statistics for the real-time orbits and clocks compared to IGS final products for both GPS and GLONASS are presented. Real-time positioning results are shown: from both benign and challenging environments and from both static and dynamic positioning. Even results from GLONASS-only precise orbit and clock real-time navigation are presented showing the full potential of GLONASS.

The results presented in this paper represent a significant step forward in PPP GNSS research and development. The system's horizontal positioning accuracy is at the decimetre level. GLONASS improves the availability and reliability of the solution. This is expected when increasing the number of satellites in the constellation with 60 percent from about 31 to 50 satellites. The outcome of the development of the G2 real-time combined GPS and GLONASS PPP service is truly a next generation GNSS augmentation system.

Or 27

A reduced search space maximum likelihood delay estimator for mitigating multipath effects in satellite-based positioning

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Multipath is one of the dominant error sources in global navigation satellite systems, such as the Global Positioning System or the future European satellite navigation system, Galileo. The reception of multipath may create a bias into the time delay estimate of the delay lock loop of a conventional navigation receiver, which eventually leads to an error in the receiver's position estimate. In order to mitigate the impact of multipath on navigation receivers, the multipath problem has been approached from several directions, including the development of novel signal processing techniques. In this paper, we propose a maximum likelihood based algorithm, namely the Reduced Search Space Maximum Likelihood (RSSML) delay estimator, which is capable of mitigating the multipath effects in moderate-to-high carrier-to-noise-ratios. The proposed RSSML attempts to compensate the multipath error contribution by estimating the multipath parameters along with the line-of-sight signal. The elaborate description of the RSSML will be presented in the full paper. The multipath performance of other state-of-the-art delay tracking methods previously studied for Binary Phase Shift Keying (BPSK) and Sine Binary Offset Carrier (SinBOC) modulated signals, is also analyzed here, together with the new Multiplexed BOC (MBOC) modulation. Simulations are carried out in closely space multipath scenarios for two-path Rayleigh fading channel model. The simulation results to be included in the final paper show that the RSSML achieves the best multipath mitigation performance in root-mean-square-error sense for all three different modulated signals (i.e., BPSK, SinBOC(1,1) and MBOC), compared with four other multipath delay estimation techniques, namely the Narrow Correlator, the High Resolution Correlator, the Teager-Kaiser estimator and the Peak Tracking estimator. The simulation results along with its interpretation will be presented in the full paper.

Or 28

Analytical model for GNSS receiver implementation losses

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GNSS receivers suffer losses in signal-to-noise ratio (SNR) due to bandlimiting, quantization, and sampling. Previous research into such losses has included: (1) low-fidelity analytical models that predict SNR loss values with many simplifying assumptions, (2) extensive simulation campaigns that provide useful loss values, but only for a limited set of receiver configurations and without providing much insight into the various loss mechanisms.

This paper presents an analytical model for GNSS receiver losses applicable to a wide variety of hardware configurations. The model addresses digitization of the received signal by a uniform quantizer with an arbitrary (even or odd) integer number of output levels. It also addresses the distinction in incurred losses depending on whether analog-to-digital conversion is mechanized at baseband or at an intermediate frequency (IF).

As observed in the previous literature, losses are dependent on the desired signal modulation type. Furthermore, different losses are incurred for the three components of the received signal considered: (1)desired GNSS signal, (2) noise, and (3) Gaussian non-white interference (e.g., inter-/intra-system interference from a number of GNSS signals of the same or different modulation type). The analytical formulation provides insight into how implementation losses result from a combination of attenuation of the desired signal, and attenuation and/or enhancement of the noise/interference

Or 29

Estimation of the complex far-field of an antenna array using live GNSS signals and the equivalent electric current method

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When using antenna arrays with GNSS receivers both the gain and the phase of the far-field radiation pattern may be distorted due to coupling effects. This problem can often be solved in the design process of the antenna or by measurements in a measurement range. This is, however, not always possible and it is then necessary to characterize the antenna using live measurements. In this paper the equivalent electric current method is used to estimate the gain and phase of the far-field of an antenna array for a GPS receiver. In the method, the complex far-field pattern of an antenna is estimated using the distribution of the electric current, which is described using suitable basis functions. This approach can be used even if the relative position of the antenna elements is not known accurately. Of interest in antenna arrays is the difference in gain and phase between the different antenna elements in the array and knowledge of the absolute values are therefore of minor interest. For a GPS antenna array, the measurements are therefore obtained by using one antenna element as the reference and slaving all other channels' code and tracking loops to this channel. The orientation of the antenna array with respect to the satellite constellation is here assumed to be known a priori from other sensors. Since the location of each satellite is known the whole problem is then reduced to a linear system of equations which can be solved using for example the least squares method. Data was collected using a 7-element GPS antenna array and processed using a software receiver. The radiation pattern of each antenna element was then estimated using the equivalent electric current method. These results as well as a comparison of the accuracy of the estimated far-field pattern of the antenna elements under different multipath conditions will be presented.

Or 30

Stability analysis of strapdown seeker scale factor error and line of sight rate

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An inertial measurement unit (IMU) consisting of three gyroscopes and three accelerometers is utilized to carry out guidance performance in a short range ground to ground missile system. To improve the accuracy of trajectory, a seeker is applied and this seeker measurement is provided to a PNG law. A Strapdown seeker has advantages compared to a gimbaled seeker in terms of

size and FOV limit. If the strapdown seeker output is combined with the output of an inertial sensor, the potential for instability exists if the scale factors AND gain of the two sensors are not equal. Because the strapdown seeker provides LOS angles from body to target in a body frame, for PNG, the LOS angles need to be changed to their rates in the inertial frame. This paper presents the method of a LOS rate derivation from image plane values of the output of the strapdown seeker and analyzes the effects of the instability generated by the scale factor errors of the strapdown seeker and inertial sensor. The proposed derivation of LOS rate and analysis of the effect of scale factor error are verified by a simple but realistic navigation and guidance control simulation. When we assume the threshold of the miss-distance is within 10meters, results are satisfied within the threshold with 0.5% scale factor error. When we assume the threshold of the miss-distance is within 2meters, results are satisfied with 0.45% scale factor error. Through the simulation, we can find the effect of scale factor error, and this paper suggests further work towards a solution to this instability. Reference number(8) "Line of Sight Rate Estimation and Linearizing Control of an Imaging Seeker in a Tactical Missile Guided by Proportional Navigation",IEEE, Jacques Waldmann. "Strapdown Sensors and Seeker Based Guidance Filter Design",ICCAS, Joongsup Yun. "A Robust Horizontal LOS Rate Estimator for 2-Axes Gimbaled Seeker",IEEE, Won-Sang Ra and Ick-Ho Whang Support:ADD(Agency for Defense Development), ASRI

Or 31

Ultra-tight integration of an IMU with GPS/GLONASS
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Whereas there has been much interest in ultra-tight GPS/INS integration in the last number of years, there has been little work done on expanding this application to the revitalized GLONASS system or, indeed, for the modernized GPS signals. The availability of GLONASS signals is at an all time high, providing a significant improvement in signal availability, even in more challenging environments. For instance, there are typically five or more GLONASS satellites in view over Calgary at any given moment. This increase in satellite availability can have a significant impact on receiver operation, both in providing an improved geometry and an increased likelihood of line-of-sight signal availability.

In this research a software receiver is used to process GPS and GLONASS signals in an ultra-tight configuration. Real data has been collected in open sky, under foliage and in urban/suburban areas using synchronized RF front-ends and different qualities of IMU. The performance of GPS/INS and GLONASS/INS integration will be compared and the benefits of dual system integration will be evaluated. Not only does this represent the first known integration of this type (to the authors' knowledge), results will provide a direct assessment of the benefit associated with an improved satellite geometry (relative to GPS alone) and will therefore have application to the integration of other systems such as Galileo and Compass. Performance comparisons will be made at the tracking level, through the analysis of lock indicators and tracking jitter, at the measurement level, and at the navigation level. Particular emphasis will be given to carrier phase tracking. Time permitting, the analysis of this work will be extended to include the impact of ultra-tight GPS/GLONASS INS integration on the availability and accuracy of an RTK position solution.

Or 32

Real-time attitude determination system based on GPS carrier phase measurements and aided by low-cost inertial sensors for high dynamic applications
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This paper explores a low-cost GNSS attitude determination solution based on L1 GPS receivers with the aiding of MEMS gyroscopes. The proposed approach resolves integer ambiguity on-the-fly using single frequency carrier phase measurements overcoming the problems of reliability, availability and performance present in high dynamic environments in common low-cost GNSS

attitude systems.
For high-precision GPS-based attitude determination, reliable integer ambiguities resolution has been a critical issue being performance and computational efficiency of the ambiguity search process its main concern. Single-epoch approaches have shown low success rates when carrier phase observations are affected by multipath, residual atmospheric effects, unfavourable satellite geometry, etc. On the other hand, works in LEO satellite applications, where the effect of the aforementioned errors is reduced, have shown the advantages of this approach.
In the proposed solution not only a fast IAR method is evaluated, but also a high frequency gyro rate data integration procedure is considered. To fit with the fast integer ambiguity resolution requirement, a search space reduction from 3D to 2D is accomplished by a one-epoch algorithm based on a Gram-Schmidt orthogonalization. The subsequent Attitude Estimation is performed by means of Davenport's q-method. In addition, improvements in reliability, availability and performance in high dynamic conditions are achieved by fusing gyros rate data in an ad-hoc extended Kalman filter.
In order to evaluate the performance of the proposed navigation system suitable for real-time high dynamic applications, several tests and simulations have been accomplished. Detailed analysis of the viability of the method is presented.

Or 33

Preliminary simulation results of a deeply coupled GNSS/INS system for high dynamics

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Current research is conducted on the field of Kalman filter based signal tracking that includes inertial sensors. The navigation process and the signal tracking process are performed simultaneously which is also called deeply coupled GPS/INS integration. The signal tracking process is supported by the trajectory dynamics measured by an inertial navigation system. This enables new possibilities in designing the base band processor including GPS/INS integration. The measured tracking error used in the Kalman filter measurement step is basically a measurement averaged over the predetection integration time. Discriminator values resulting from correlator outputs in general describe an average tracking result. For increasing the predetection integration time a systematically correct description of the measurement is necessary. In existing deeply coupled GPS/INS systems these averaged measurements are used as punctual values which produces systematic errors especially visible in high dynamics. The proposed deeply coupled GPS/INS integration system uses these averaged values in an adequate measurement step. By imitating the approach of time differenced carrier phase measurements, a measurement formulation was found that accounts for the systematic problem. In this formulation the trajectory dynamics is modelled in the measurement step. The accuracy of the navigation process in high-acceleration environments up to 35g is significantly increased and the velocity error in the simulation is lower than 5cm/s. Finally an approximation is made to avoid an increased processing load. The loss in accuracy is insignificant. By reformulating the measurement step of the deeply coupled GPS/INS system it was adapted to correctly account for the averaged measurement values. This results in a decreased velocity error especially in high dynamic environments. The predetection integration time in the baseband processor can be extended without suffering from dynamic stress in the measurement step.

Or 34

Indoor carrier phase measurements through GNSS transmitters - Theory and first experimental results

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The repeater indoor positioning system is based on the use of GNSS so-called repeaters in order to provide GNSS availability indoors through the way of an amplification of the signals received on an outdoor (typically on the roof) antenna. The complete system, already described in previous conferences, uses four repeaters in order to provide a full 3D 1 to 2 meter accuracy indoor positioning. The measurements, at the receiver end, are the pseudo-ranges at the

instant of transition from one repeater to the next, the transmission being achieved through a sequential scheme (only one repeater transmitting at any given time). This approach implements a sort of "time differential" approach that provides such a good positioning accuracy. Unfortunately, it is not possible to improve this accuracy since the sequential scheme does not allow for carrier phase measurements. The pseudolite system allows such measurements but has the problems of synchronisation (not present in the case of repeaters since we are using the GNSS constellation time) and near-far.

A new idea rose up: the repealites (a shortcut between repeater and pseudolite). We still use an identical signal transmitted from all the so-called repealites but which is slightly delayed for each transmitter. The correlation function, at the receiver end, now shows N primary peaks in the case of N transmitting repealites. Interference problems and near-far effects have been addressed in previous papers and we are now interested in the positioning resulting accuracy through carrier phase measurements. The multipath problem, very acute indoors, is dealt with through the use of the SMICL (Short Multipath Insensitive Code Loop) design. Ambiguity resolution and resulting accuracies are presented through both the theoretical and experimental aspects.

Or 35

Ultra-precise positioning sensor for sport applications

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Starting in 2006, the Schulich School of Engineering, through its PLAN Group has developed and tested, in collaboration with Alpine Canada Alpin, the governing body for ski racing in Canada, an ultra-precise, ultra-light sensor, namely the Elite Athlete Training Sensor, to support the Canadian Alpine Ski Team during training. The GNSS-based sensor has proven to operate very well under a variety of conditions and its application is now being expanded to other sports. This paper will describe the sensor components, assembly, mode of operation, technical specifications and performance. The positioning and motion components displayed to athletes and instructors for performance evaluation are presented using real data collected on ski slopes in the Canadian Rockies.

Or 36

A software receiver phase lock loop analysis and design to implement adaptive phase tracking using a finite impulse response loop filter

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Starting from the early 90's, software defined radio (SDR) technology has gained growing attention in the telecommunication community, because it is flexible enough to emulate a wide range of radio devices.
A SDR Global Navigation Satellite System (GNSS) receiver is a useful tool in a research environment, because it allows to gain access to every single block of the receiver, to remove it and to substitute it with a new block. In this paper we will consider one of the most important functional blocks of a GNSS receiver, the phase lock loop (PLL), providing an original approach to the design of a second order adaptive PLL.
In literature it is possible to identify mainly two criteria to the second order digital PLL design. The first criterion is based upon analog PLL theory: analysis and design are led in the s domain, while the z domain filter parameters are obtained by means of the bilinear transform. The main drawback of such a method is represented by the use of the bilinear transform, which is not a good approximation at high frequencies. The second criterion leads analysis and design in the z domain but it aims to obtain the same impulse response of a second order analog PLL.
In this paper our goal is to analyse and design a simple and original fully digital PLL that fits the requirements of a GNSS receiver, starting from the constraint of bandwidth and making the transient duration minimum.
In our design we decided to implement a finite impulse response (FIR) loop filter, which results

in a more reactive PLL with respect to the one that implements an infinite impulse response (IIR) loop filter. In fact, the transient of our system is significantly shorter than the one of a PLL that implements an IIR loop filter, the bandwidth being equal.
As a further goal, we worked out a simple way to make our PLL adaptive. We implemented a look up table method in order to change the system bandwidth dynamically and accordingly to the system noise, keeping the transient minimum.

Or 37

A novel software defined receiver architecture
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Software defined receivers (SDR) is an increasingly important tool within the GNSS research community as the high level of flexibility offer a significant advantage over traditional hardware implementations. Over the last decade, software receivers have been used to investigate techniques as diverse as bistatic radar (additional correlators), multipath mitigation techniques, GPS/INS integration and array processing.
Mentioned above is only a few examples of features that could be required of an SDR, other include support for new signals (Galileo, GPS L5), multiple data file formats, high sensitivity and support for very long data sets. The large number of available features should ideally be coupled with program simplicity (such that other people can understand the program) and efficiency. This paper discusses these issues and proposes several solutions such as generalized data buffers (that is trivial to extend for new data formats) and a unified tracking structure (regardless of signal modulation). Examples are given using a Matlab implementation based on the Borre/Akos book "A Software-Defined GPS and Galileo Receiver", however with significant modifications. Where critical, Java are used to increase performance while maintaining cross platform compatibility. Near real-time operation is available under optimal circumstances, and the receiver currently supports GPS C/A, GPS P and Giove-A signals.

Or 38

Phase lock loop false lock avoidance in presence of global navigation satellite system signal
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Phase lock loops (PLL), together with delay lock loops (DLL), represent the core of a global navigation satellite system (GNSS) receiver. Once the DLL has wiped out the code from the signal, in absence of bit transitions, the signal is reduced to a pure sinusoid and the PLL is demanded to track the phase of this sinusoidal carrier. If the PLL fails to lock the carrier phase, the receiver will not work properly. Such a phenomenon might happen if the signal is too noisy or if the signal autocorrelation function shows a spike higher than the correct one. In the former case the PLL will just fail lock, while the latter case will be the one of false lock. False Lock maybe be experienced when the receiver is in motion. In fact in this case the acquisition engine developed in a software receiver might not operate with an ideal autocorrelation function, but with a distorted version due to effect like Multipath, Channel Fading or interferences and consequently with a tracking initialization outside the Pull-In range. We collected some data in motion and we processed it with our software receiver and other software receivers, experiencing that after the coarse frequency acquisition and the fine frequency tuning by means of a frequency lock loop (FLL), a PLL would work in a false lock state. The result is that the navigation data could not be decoded due to a residual 500Hz carrier. In this work we analyse why and when the false lock state happens, and suggest a method to avoid it. Our method to avoid false lock was successfully tested in our software receiver. After the acquisition stage and the fine tuning, in our receiver there are three PLL stages. One of them is centred on the frequency generated by the FLL, while the other two are centred at Â±500Hz. In this way it is possible to compare the outputs of the PLLs and to determine the correct phase to track, discarding the two PLLs centred in the wrong frequencies.

Or 39

An adaptive multi-sensor positioning system for personal navigation
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Navigation applications are becoming standard features in more and more commercially available devices. Locating a mobile user is however still a very challenging task, especially in GNSS degraded areas such as urban canyons and indoors. A seamless indoor/outdoor positioning solution requires utilizing additional technologies in parallel to satellite navigation due to satellite signals being often unattainable in for example deep indoors. MEMS sensors, such as accelerometers, gyros and barometers are being widely suggested for augmentation to GNSS. Combining such sensor provided information loosely to GNSS positioning is, nevertheless, very demanding and plenty of adaptability is needed in order to obtain sufficient positioning accuracy and acceptable service availability.

Difficult signal environments of most mobile applications typically contain significant sources of disturbance. In poor signal areas, GNSS signals have typically greater noise levels and the measurements might be affected by multipath propagation or cross-correlation. The measurements from MEMS sensors, e.g. a digital compass, can also be significantly disturbed by any object bearing magnetic perturbation, for example an elevator. Therefore, outlier monitoring and error detection are essential. In addition, environment awareness is crucial when adapting filter coefficients and outlier rejection limits according to location and application. This paper presents a multi-sensor positioning system that includes a high-degree of adaptability; environment detection for adaptive filter coefficient steering and measurement rejection. The system analyzed includes a commercial GPS receiver, an accelerometer, and a digital compass, and the measurements from the different sources are combined in a master Kalman filter. Test results are presented of the adaptive system and the shown performance demonstrates the usefulness of the adaptive multi-sensor usage with respect to a standalone GPS solution.

Or 40

Application of air data in bridging of GPS-outages
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The Institute of Aerospace Systems (ILR) at Technische Universität Braunschweig, Germany develops autonomously operating Mini Aerial Vehicles. Reliable and precise navigation data is essential for automated aerial vehicles. For this purpose a low cost inertial measurement unit (IMU) was tightly coupled with a low cost receiver for the Global Positioning System (GPS). A navigation Kalman filter has been designed to obtain a stable and accurate navigation solution with the low cost sensors. This low cost navigation system was successfully implemented and resulted in excellent performance.

For this accurate navigation solution the GPS aiding is essential due to the use of heavily drifting inertial sensors. This drifting behaviour is typical for the used micro-electro-mechanical systems. Thus in case of GPS signal loss the quality of the navigation solution decreases after a short time. The aim of the presented research is to find additional sources of information to aid the drifting inertial navigation data in case of GPS outages. Air data measurements like angle of attack, side slip angle and wind velocities provide potentially useful data to bridge GPS unavailability. Thus, first a methodology of air data aiding will be introduced. Afterwards, the applicability and accompanying limitations of the presented method will be shown by the use of real measurement data.

In order to evaluate the presented methodology and its performance, measurements from the institute's meteorological mini-UAV "M^2AV" will be used. This well-proven Carolo T200 type aircraft with a total wingspan of 2 metres is equipped with sensors for the measurement of wind vector, temperature and air humidity and thus allows the computation of the needed air data.

Or 41

Collaborative navigation in GPS-impeded environments using dynamic sensor network and inter-nodal RF ranging

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In GPS-challenged environments, using the traditional GPS approach, users may be denied the ability to navigate. However, collectively, the network of GPS users may be able to receive sufficient satellite signals, augmented by intra-network ranging measurements, to form a collaborative position determination. Such a network of receivers represents a spatially diverse distributed aperture, which may be capable of obtaining gain and interference mitigation. Further mitigation is possible if selected users (nodes) use an antenna array rather than a single-element antenna. In addition to utilizing distributed GPS aperture, RF ranging measurement among the network nodes is used to support collaborative navigation. The challenge here is to select nodes which can receive GPS signals reliably, further enhanced by the distributed GPS aperture, to serve as pseudo-satellites for the purpose of positioning all the nodes in the network. A recursive mechanism is used to select these nodes, while inter-nodal RF ranging becomes an important enabling technology.
The key components of such network system are (1) inter-nodal ranging sub-system (each user can be considered as a node of a dynamic network), (2) optimal network configuration, (3) time synchronization, (4) optimum distributed GPS aperture size for a given number of nodes, (5) communication sub-system, and (6) selection of pseudo-satellites.
This paper presents the concept and algorithmic development of new techniques for robust GPS positioning in a dynamic sensor network using a distributed GPS aperture and RF ranging signals among the network nodes. The objective is to develop an algorithm, which will provide an optimum navigation solution for all the network users for which a navigation solution is possible. The performance assessment, based initially on simulations, will demonstrate the ability of a networked group of GPS receivers to operate under adverse conditions, in which an individual receiver would be impaired.

Or 42

SENECA: Italian programme for GNSS introduction in civil aviation

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EGNOS is going to be certified for Civil Aviation, but, beside the core positioning service, a set of additional services would be useful for the air traffic controllers and other involved actors to fully exploit the capabilities provided by the GNSS introduction in civil aviation.
In 2009 the Italian Space Agency (ASI) and the Italian company for Air Navigation Services (ENAV) started the contract to develop the programme "SatEllite Navigation sErvices for Civil Aviation" (SENECA) which is being implemented by an industrial team which includes Telespazio S.p.A. (coordinator), Thales Alenia Space Italia S.p.A.; Selex Sistemi Integrati S.p.A. and Ingegneria dei Sistemi S.p.A. The programme aims to introduce EGNOS services in the frame of Italian air traffic management, support the development and demonstrations of innovative civil aviation GNSS applications and prepare the transition towards Galileo. The final system will be a platform including the following assets:
•National Monitoring System providing real-time status and prediction of RNP availability figures, fitted on specific ATC sector/route computed from 5 local GNSS monitoring stations, and GNSS NOTAM over National Air Space.
•GNSS Services experimentation centre which will acquire and store raw and pre-processed data, provide an upgraded GNSS simulator and test bed for studying positioning and integrity interoperation modes, data analysis tool and a fleet management application focused on apron operations.
•Flight Procedure Validation Platform for design, verification and validation of GNSS flight procedures
•GNSS Signal Platform including: SIS Verification Platform, NavCom Platform for ATS/AOC

applications, a paseudolite based Airport Local Components, an helicopter NavCom Simulator for Civil Defence applications and a study on UAV systems for civil applications.
The paper presents the platforms and the services that will be installed and demonstrated in an Italian airport.

Or 43

A methodology of estimating safe minimum route spacing for RNAV-approved aircraft
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RNAV road map was made by Japan Civil Aviation Bureau for effective utilization of area navigation (RNAV). Following the road map, RNAV routes have been implemented in Japan. Annex 11 to the Convention on International Civil Aviation describes that any significant safety-related changes to the ATC system shall only be effected after a safety assessment has demonstrated that an acceptable level of safety will be met.
For the sake of carrying out the safety assessment required in Annex 11, the estimation of the safe minimum route spacing for RNAV routes was needed for implementation of RNAV parallel route. For considering route spacing, lateral overlap probability for target aircraft is required to calculate by estimating the distribution of lateral navigational errors (cross-track deviations). This paper describes a method of estimating lateral overlap probability for area navigation (RNAV) approved aircraft. Radar track data of aircraft which flew on a Kagoshima RNAV standard terminal arrival route (STAR) were collected for six months for the purpose of analyzing the cross-track deviations for RNAV-approved aircraft. A distribution of cross-track deviations was estimated using this data set. Then a probability distribution model of it was found. The lateral overlap probability was estimated using the empirical distribution and its deformation. Collision risk was estimated by collision risk formula using the estimate of lateral overlap probability together with other given parameters.
As a result, in the case that the population of aircraft with poor navigation performance, which barely meets 95 % containment requirement, is assumed to be 10 percent, estimates of minimum route spacing are 8 NM for RNAV1 routes and 32 NM for RNAV5 routes, respectively.

Or 44

Analysis of performances of nioraim algorithm implementation in a gnss monitoring system: verification of raim availability in various phases of flight
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Many studies have been conducted on RAIM to use satellite navigation in those fields where the requirement of the integrity availability is very strict. Many algorithms have been proposed: the NIORAIM is one of the most promising. NIORAIM uses non-uniform weights applied to the pseudo-range measurements of satellites involved in the position solution to improve RAIM availability. NIORAIM lowers the integrity levels, improving integrity availability at the cost of a slight degradation of accuracy of the position solution.
A paper previously presented by the authors at the ENC-GNSS 2009 Conference, described a particular iterative search method used to determine "ad hoc" weights. Such method computes the values of the integrity levels following a worst-case philosophy for integrity monitoring; each value corresponds to the largest of the integrity limits computed using a mathematical technique which uses a numerical integration of the bivariate Gaussian density function so that the probability within the missed detection region is exactly equal to the specified allowable rate.
The simulations showed a remarkable improvement of integrity availability reached with NIORAIM compared to another RAIM algorithm in the APV-I and APV-II phases of flight.
This paper shows the implementation approach of the NIORAIM algorithm in a real system at present used to monitor SBAS service for ATC applications. This system is able to acquire the GNSS SIS using a commercial receiver and process them, providing real time protection levels and integrity information.
The performances of the NIORAIM algorithm are compared to those achieved both by the model and by another RAIM algorithm in order to assess the effectiveness of this new algorithm in a real time system.

The results show a substantial improvement in the protection levels values computed with NIORAIM in each considered phase of flight at the cost of a slight degradation of accuracy so fully confirming the theoretical expectations.

Or 45

A Norwegian Satellite for AIS Observations in the High North.
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The Automatic Identification System (AIS) for maritime vessels is basically an anti-collision system for vessels at sea. The vessels are broadcasting AIS messages on two channels in the maritime VHF band to neighboring vessels for collision avoidance, and to shore stations for vessel traffic services (VTS). The AIS messages can also be received by a VHF receiver in space for maritime activity monitoring of ocean areas not covered by AIS base stations. Careful modeling of the space based AIS detection probability has been performed, with particular emphasis on observation of Norwegian ocean areas in the High North (and High South). Based on the results from this modeling Norway is now building its first AIS satellite (AISSat-1). The Norwegian Coastal Administration will process and distribute the AIS data to relevant authorities and users. The AISSat-1 satellite is based on a low cost high-performance nano-satellite platform (20x20x20cm) with full 3D attitude control. The platform is built by University of Toronto Space Flight Laboratory (UTIAS/SFL), Canada. The AIS receiver is a software defined radio build by Kongsberg Seatex (KSX), Trondheim, Norway. The presentation will in some detail discuss the AIS modeling, mission architecture, satellite platform, payload, and data distribution on ground.

Or 46

Space based technologies for operational pollution monitoring and detection and identification of vessels
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Kongsberg Satellite Services (KSAT) is a world leading provider of integrated space based information for operational purposes. The main focus is on marine services derived from satellite Synthetic Aperture Radar (SAR) data integrated with additional information. The satellites applied today include the European ENVISAT and the Canadian RADARSAT. KSAT utilises the company's ground segment facilities in Tromsø, Svalbard, Grimstad and Troll (Antarctica), to obtain global access to the data.
Use of satellite data for oil spill has been operational for years. KSAT is responsible for a consortium providing the pan-European satellite based oil spill detection under a contract with the European Maritime Safety Agency (EMSA). The service integrates information from satellites with additional geo-referenced information and source identification from fixed installation databases or AIS. KSAT is also serving other operational customers including the offshore oil industry and global institutional users. Examples from the service operations will be given in the presentation.
Detection, tracking and identification of vessel is another priority area. This service relates to the oil spill detection service wrt detection and identification of the polluting source. The service provides vessel positions detected in satellite images, integrated with identity information from land or satellite based AIS (Automatic Identification System). By combining the satellite based information with the other systems, non-reporting vessels can be identified and reported. Targeted users include agencies responsible for homeland protection, maritime security and integrity, fisheries protection, environmental protection, oil and gas companies, shipping companies. The service will be presented, and examples related to the piracy situation in the Gulf of Aden and along the Coast of Somalia will be given.

Or 47

A research on an automatic navigation system basing on radar and ais data
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Safety of navigation is always a matter of concern as marine accidence, if it might occur, may result in not only loss of human lives but also catastrophic damages to the environment. A deal of efforts have been made to ensure the navigation safety in parallel with satisfying the economic demands. The aim of this research is to construct an Automatic Navigation System to reduce the workload of navigator while taking maneuver, together with ensuring the safety and efficiency of navigation, basing on the available supporting equipments, including Radar/ARPA and AIS. The system should be able to solve the following tasks:
- Continuously be on watch to detect any possible arising risk of collision on the intended route.
- Conduct real-time calculation of the shortest route to be clear from any dangers, together with maintaining in proximity of the plan route.
- Automatically handle the own ship to keep the intended track while keeping on watching for possible risk of collision with coming targets.
Risk of collision is predicted for the route, basing of Subjective Judgment (SJ) value and Bumper Model criteria, using own ship data and data of targets received from radar and AIS. If the passage is unsafe, a dynamic programming would be used to generate the shortest route for own ship, that satisfies the above-mentioned criteria, taking into account the own ship maneuverability. Once the route has been generated, an automatic tracking control program is applied to ensure that the ship closely follows the passing schedule. For this purpose, Optimal Control could be referred, in which an adaptively linearized state space model of ship dynamics and a suitable cost-function are used in the Riccati equation to determine the control input.
The art of the system is that collision avoiding route for the ship will be calculated and realized continuously in an automatic manner, from the departure to the destination along the planned route.

Or 48

A Project to use the GNSS in a rail safety application
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The economic and environmental advantages of the train, mainly considering the congestion of the road traffic and the consequent pollution, are universally known: the railways are continuously pushed to provide more services with a better quality in order to attract as much people as possible: this is a big challenge of the next few years. One of the key factors to face this challenge is the use of train control systems able to ensure a more efficient running, improving in this way the efficiency and effectiveness of the "rail system"; such control-command systems, normally in place on high-density traffic lines, do not exist on the regional lines: their low traffic cannot justify the necessary investments so their management systems are over-aged and often based on manual procedures, unable to support the improvement of traffic required from the growing mobility needs. The GNSS (Global Navigation Satellite Systems) can represent an essential infrastructure to support this challenging goal, considering that the "train position" is a vital information but very expensive to acquire, because the requested ground installations: on the contrary, a GNSS train location can provide accurate positioning data without any trackside device. The experience of the railways is quite good in GNSS 'commercial' applications but nearly inexistent where "trains management" is involved, considering the high safety level required and the consequent needs in terms of integrity and accuracy of the "data" to be processed and used in order to fulfil the general principle "to avoid, in any context and condition, any risk of collision". Actually the incoming of reliable satellite location functions, today GPS + EGNOS and tomorrow GALILEO, is making this technique useful also for safety relevant applications, such as train control and management, at least for this specific kind of lines where low density traffic has to be managed.

Or 49

DGPS and inter-vehicle UWB ranging for improved relative vehicle positioning

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Vehicle navigation is an important component of intelligent transportation systems, with many current systems relying on the Global Positioning System (GPS) to obtain vehicle position and heading information. While an unaided GPS position coupled with a digital map is effective for locating vehicles and providing driving directions, the accuracy of this kind of solution, which is on the order of five to ten metres, is insufficient for many mission-critical applications including autonomous and semi-autonomous operation. Furthermore, accuracy of 5-10 m may not always be possible in urban/suburban and tree-covered environments.

For many applications, however, the absolute position (e.g. on what road/street are you located?) is not as important as the relative positions of nearby vehicles (e.g. how close are the neighboring vehicles and are they in the same lane?). This is needed, for example, to avoid collisions. Differential GPS (DGPS) has been successfully used for relative positioning in the past, but it still suffers from reduced accuracy or unavailability in degraded environments. To help improve performance, especially in these degraded areas, this paper investigates the integration of ultra-wideband (UWB) ranging transceivers with DGPS pseudorange data. UWB is a new radio technology that allows for precise (cm- to dm-level) short distance (<300 m) ranging. By combining the UWB range measurements with DGPS data, the relative positioning accuracy and reliability are both improved. In particular, since UWB can directly measure the inter-vehicle range, the relative position solution is improved in the direction most critical to safety.

The paper first presents the mathematical models for integrating DGPS and UWB. Then, using data collected on multiple vehicles under a variety of operational environments, the relative positioning accuracy improvement relative to DGPS alone is demonstrated. The statistical reliability of the integrated system is also assessed.

Or 50

Design of a GNSS kinematic slot car test track

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Measurements of objects in a kinematic mode often require logging of the objects accurate positions at any given instance of time. This paper describes the considerations and preliminary results for a slot car track for GNSS kinematic test campaigns,

The track has been made of 31 pieces of 16 mm. chipboard/particle board and consists of straight plates as well as 45, 90, and 180 degree turn plates to a maximum total length of 27 m. On each plate two slots separated by 10 cm. have been routed with 1/10 mm. accuracy and position sensors based on opto couplers have been positioned at least every 20 cm.

A logging system, using input from a GPS receiver and the signals from the position sensors, has been implemented in a microcontroller in order to synchronize the position of each car to GPS time. A mount has been developed to fit a normal slot car, to hold the antenna phase center at a fixed location on the car directly above the trigger for the position sensors, and to hold the GNSS equipment.

The advantages for the designed test track include
- Portability, the track can be assembled anywhere
- Flexibility, different tracks can be assembled to provide different shapes and lengths
- Absolute accuracy, the position is given in absolute coordinates at the sub cm. level
- Two lanes, for making test with two moving objects at the same time
- GPS synchronization, the positions of the car refer to GPS time
- Independent position logging, the position is calculated independent of the equipment on the car
- Statistics, the car is travelling in the exact same slot, providing a good statistical foundation for data analysis by repeated rounds

Outdoor kinematic tests will be performed and presented to verify the obtainable position

accuracy and the functionality of the system. Also preliminary precise point positioning kinematic tests in different kind of measuring environment will be performed and presented.

Or 51

Improving ionospheric correction models at high latitudes by means of long-term groundbased measurements on Svalbard

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GNSS performance at high latitudes is influenced by the highly variable ionosphere. Correction procedures such as two-frequency solutions may not provide accurate positions at the required level during severe ionospheric disturbances. In addition, common augmentation solutions are often not available in the Arctic. Here ionospheric models might be used for fore- or nowcasting (in addition to post-processing). However, these models are often not sufficient at high latitudes, mostly due to large grid size or little input into these empirical models from groundbased or in-situ measurements. In order to improve the quality of these models, long-term groundbased measurements from a variety of instruments on Svalbard (78°N) can be utilized. We present an overview of the instrument park on Svalbard and first results of comparisons between measurements and different models.

Or 52

New developments in the SWEPOS network

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During the last years the SWEPOS network of permanent GNSS reference stations has slowly approached the stage when all of the Swedish land territory is covered by a centimeter level positioning service. The last part of Sweden to be covered by a dense network of permanent stations is in the extreme North. In this area a dense network of reference stations was for long seen as uneconomical. However the problems with land subsidance caused by the large iron mines in Kiruna and Malmberget made an extension of SWEPOS in the area necessary.

The project - RTK Malmfälten - with the task to establish 20 new SWEPOS stations in the extreme North of Sweden has also introduced new features in the SWEPOS network. Because the mining industry will be an important user, support for machine guidance applications is planned from the beginning. Permanent GNSS reference stations from Sweden, Norway and Finland will co-operate to cover the project area.

Other projects for the development of SWEPOS e.g. CLOSE are also briefly presented.

Or 53

Egnos performance in northern latitudes

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In 2007 EGNOS RIMS stations were established at the Norwegian island of Jan Mayen, at 71 degrees N, and at the Svalbard groups of islands at 78 degrees N. The RIMS station at Svalbard became operational in December 2007, and the RIMS station at Jan Mayen became operational in October 2008.

As part of the EPINOL project (EGNOS Performance in Northern Latitudes) demonstration activities were carried out to investigate the change in EGNOS performance at high latitudes after the two new RIMS stations became operational. With this paper we describe the data

collection, the processing and analyses of the data, and we show the improvement obtained in EGNOS accuracy, availability and continuity after introduction of the two new RIMS stations.

Data from nine permanent GNSS stations in Norway were used, along with data collected at two vessels travelling the Norwegian Sea and parts of the Barents Sea. Data was selected from a number of days where all EGNOS RIMS stations in the northern part of Europe were operational and the ionospheric activity was low.

The data was analysed to obtain the EGNOS performance. For derivation of accuracy, reference trajectories for the vessels were calculated using high accuracy carrier phase data collected at the vessels. EGNOS positioning was then carried out with and without the new RIMS. For the processing with the new RIMS the real broadcasted EGNOS messages were used. For the processing without the new RIMS special EGNOS data generated by the EGNOS Performance Assessment and Check-Out Facility (PACF). This data was based on an EGNOS CPF processing carried out in a replay mode, where data from the RIMS stations at Jan Mayen and Svalbard were removed.

It was hereby possible to directly compare the EGNOS performance with and without the new RIMS under the exact same conditions. The results show that when introducing the EPINOL RIMS improvements in EGNOS performance are seen, especially in the area between between 63° and 77° North in Norway.

Or 54

Satellite compass in the practice

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Satellite compass is a specific, multiantenna GPS receiver which apart from the standard functions enable to measure the angles of the orientation of the ship's hull in 3D. In the past decade this device became very popular although it has only a few approvals of classification institutions. The big interest to it is stimulated mainly because of low price, but additionally the absence of any exploitation problems. It permit to suppose that such compasses can soon become recognized as the standard.
In the paper the practical observations from the use of two different types of satellite compasses will be referred. In the report the practical experiences from the use of two different types of satellite compasses will be referred, as well as the analysis of observed errors. Authors anticipated that behavior of satellite compass is not comparable to any gyro or magnetic compasses which are in fact something natural and which is a result of completely different mechanism of action. These suppositons are fully approved.
The special attention during the investigation has been paid for changeability of heading error in the time. Two specific phenomena in errors of such devices could be specified. First one is a typical noise which appears as high frequency errors. The second one is very low frequency errors with period of some hours. Both of them are no related to known characteristic of quality of observations in satellite measurements. This is a consequence of fact, that satellite compass consists of two separate channels: traditional code receiver and additional phase receiver. So at the moment average navigator has an orientation about the present accuracy of GPS position on the basis of HDOP for example. In case of using the satellite compass he has no information about the quality of heading measurements. In authors opinion it is important to provide them some kind of indicator of that.

Or 55

Strategic application of two axes velocities information for ship maneuvering

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Today, SDME (Speed and Distance Measurement Equipment), which presents the two axes velocities OG to ship master and/or pilot, such as Doppler SONAR, etc. is made the best possible

use of safety docking to dolphin or berth for VLCC, etc. Recently it is also developing to assist maneuvering in approaching to dolphin or berth using high accuracy D-GPS or RTK-GPS which needs communication to base-station, etc., and now the new technology on GPS, which calls VI-GPS and presents very high accuracy velocities stand-alone or without communication to base-station, is coming to apply onboard. One of authors also presented the trade-off between accuracy and response in application of docking velocity onboard. Meanwhile, recently it is often taken to dock not only to berth but also to navigating vessel such as VLCC which calls STS operation (Ship To Ship). In STS, it is taken on open-sea and/or deep sea, so it is sometime difficult to use Doppler SONAR (2 axes SOG) and it increases that the turbulences such as current and/or wind affect ship maneuvering. The measuring current and wind onboard is necessary to make a good solution for the latter problem, but it is very difficult to measure current onboard. In this paper, the new algorithm is proposed, and the modeled onboard experiments and the results are presented. The new algorithm is able to present the current onboard at real time according to measure high accuracy 2 axes SOG, ship's maneuvering data onboard without STW (Speed Through Water). It is indeed difficult to get 2 axes STWs onboard, because of the poor performance of EM-Log and high cost of Doppler SONAR, and it is coming easy to get 2 axes SOGs and other maneuvering parameters such as propeller RPM, rudder angle, heading, ROT, wind, etc. The authors evaluated the application of new system using the maneuvering data onboard experimentation, and it will be applicable to docking and/or STS operation to make not only good safety but also efficient maneuvering.

Or 56

Simulation method of range detection of marine navigation radars

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The wide-spread opinion is that sea navigation radar is assigned for detection of objects on water surface, determination of the objects' coordinates and, on a large or limited scale, realization of anti-collision functions. An important matter becomes also a possibility of using radar in carrying out salvage activities connected with searching castaways at sea and training on target the salvage crews. Determination of castaways' location coordinates in such circumstances may be performed basing on the methods as follows:

- the active one - with active response - radar is operating as a receiver and interpreter of electromagnetic pulses which are sent by a transmitter of castaways' salvage kit (radar transponder) released with radar sounding pulses;

- the active one - with passive response - radar is sending and receiving its own pulses reflected from ship hulls (their remains) of watercrafts which experienced disaster, radar reflectors which rescue boats and life rafts should be equipped with.

A character of effects producing physical properties of a majority of the sea environment factors, as well as of their permutations, is fluctuating, not determined and random. In consequences it causes a change of radio waves' propagation (attenuation of signals) and passive type disturbances. The disturbing signal, together with an effective signal reflected from the detected object affects the radar receiver's input. A result of such an action is similar to raising a level of input noise of the receiver's circuits and, at the same time, its own noise coefficient.

Deliberations included in the paper are aimed at presenting the assumptions of the simulatory method of determination of an influence of the factors, connected with technical navigation radar parameters and conditions of carrying out radio-locative observations, on its maximum detecting distance, in relation to detection probability for the case of the active method with passive response.

Or 57

A study on evaluation of container truck interface systems efficiency in the semi-automated container terminal

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Along with the appearance of a super large containership, the port environment of the world is rapidly changing into the 'hub and spoke' type. To keep up with this trend, major ports all over the world are making every effort to improve their productivity and to build an automated container terminal, so that they will be able to become a hub port. In an effort to improve the productivity of horizontal layout-typed yard automation system, this study has analyzed the kiosk-based truck recognition method and the RFID-based truck recognition method. In particular, this study has tried to find out how these recognition methods affect the efficiency of Container Terminal Yard Work, the core work of semi-automated container terminal. To this end, this study has analyzed and compared the work process of both the kiosk-based system and the newly developed RFID-based system, and also has collected the real data of these systems. Finally, this study has made a simulation of these two systems by using the simulation software ARENA As a result of our simulation tests, we have found that the RFID-based truck interface system is much better than the kiosk-based truck interface system in terms of the turnaround time, traveling time, ATC's total work hours, and waiting time of the outside trucks.

Or 58

Satellite navigation supporting disabled people: the NADIA project

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The NADIA (NAvigation for DIsability Applications) Project responded to the call for proposal of the Italian Space Agency (ASI) concerning the "Satellite Navigation Applications for Disabled Citizens". Thales Alenia Space Italia is the Prime Contractor and unique interface to ASI, leading a mixed team composed by Industries, University and User associations.

The main objective of the Project was to provide the Target Users (blinds and disabled on wheelchair) with the possibility to experience end-to-end solutions and prototype products able to guarantee their mobility in secure and safe conditions. The developed architecture is primarly based on satellite navigation technologies, opportunely hybridized with other technologies (RFID, INMS, MEMS, etc..) and supported by communications capabilities and strategies.

As full citizens, people with disabilities have equal rights and are entitled to dignity, equal treatment, independent living and full participation in society: the possibility to move in autonomy allows the active inclusion in the society. There are two key aspects that affect the mobility of a person in a given environment: the locomotion ability and the capability to perceive different elements in the environment.
Starting with the identification of the user needs and requirements, the project went through the specification of the system and the system demonstrator. A demonstration phase, carried out by the users, equipped with "ad hoc" hybrid terminals was the way to achieve different important goals. The navigation capabilities have been demonstrated both in outdoor and in indoor scenarios. All the current and future solutions are useful only if integrated with the different layers of the civil society as Public Administrations, users Associations, etc. because even if the technology development can provide very efficient, innovative and useful tools, only this integration will lead to an universal design for a real inclusion.

Or 59

Distributed fault detection for precise and robust local positioning

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This contribution deals with the distributed fault detection of a time difference of arrival (TDOA) local positioning system, known as the LPM. The LPM system is based on several base stations

(BS)s surrounding the measurement field at well-known positions, a reference transponder (RT) - also at a well-known position – to provide a common time base and a measurement transponder (MT) which position is to be estimated. For the position estimation process the pseudoranges are determined by measuring the difference between the signal of the RT and MT by each of the BSs and hence a position estimate of the MT can be delivered by e.g. an extended Kalman filter (EKF) estimator. For precise and robust positioning it is of utmost importance to detect faulty measurements before they are able to perturb the position solution. Numerous concepts exist to make the EKF resistant against false measurements - e.g. robust Kalman filtering -, but all of them struggle with the nonlinearity of the position estimation equation. In this paper, an input estimator (IE) is derived for monitoring the pseudoranges directly. In the LPM system, they exhibit a significant drift, which stems from the incoherent clock of the oscillators in the RT, MT and BS. This drift can be modelled by a constant velocity (CV) model and predicted by a linear Kalman filter at each BS. A chi-squared test is then used for data evaluation purposes of each measurement separately before the measurement data is fused to calculate a position solution. The main advantage of this approach is that the problem of fault detection is completely decoupled from the position estimation problem and therefore much easier to handle. Furthermore, the linearity of the model allows the application of highly robust estimators like the least median square (LMS) estimator in the initialisation phase of the Kalman filter. Finally the applicability of the presented algorithm is demonstrated on real measurement data.

Or 60

Partial IMU\GPS integration in car navigation like robot

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Global Positioning System (GPS) alone is incapable of providing continuous and reliable positioning, because of its inherent dependency on external electromagnetic signals. Inertial Navigation (INS) is the implementation of inertial sensors to determine the position and orientation of a vehicle. The availability of low cost Micro-Electro-Mechanical-System (MEMS) inertial sensors is now making it feasible to develop INS using an inertial measurement unit (IMU). INS has unbounded error growth since the error accumulates at each step. Usually, GPS and INS are integrated with a loosely coupled scheme. With the development of low-cost, MEMS inertial sensors and GPS technology, integrated INS/GPS systems are beginning to meet the growing demands of lower cost, smaller size, and seamless navigation solutions for land vehicles. Although MEMS inertial sensors are very inexpensive compared to conventional sensors, their cost (especially MEMS gyros) is still not acceptable for many low-end civilian applications (for example, commercial car navigation or personal location systems). An efficient way to reduce the expense of these systems is to reduce the number of gyros and accelerometers, therefore, to use a partial IMU (ParIMU) configuration. For land vehicular use, the most important gyroscope is the vertical gyro that senses the heading of the vehicle and two horizontal accelerometers for determining the velocity of the vehicle.
This paper introduces a simplified 2-D navigation algorithm using (ParIMU)\GPS integration which is a reliable and effective navigation algorithm in land vehicle navigation application. The data fusion process is done with an extended Kalman filter. The primary piece of equipment used was a MEMS-based Crista IMU (from Cloud Cap Technology Inc.) and a Garmin18 PC GPS (which is both a receiver and antenna). In order to perform numerical simulations, MATLAB software has been developed.

Or 61

EfficienSea - e-Navigation

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We will make a presentation of the EfficienSea project, which is an EU project lead by DaMSA with participation from 6 Baltic Sea Region countries, represented by 17 different partners. The countries are: Sweden, Norway, Finland, Poland, Estonia and Denmark. The budget is 8 mill Euros. The timeframe is 2009-2011, but this might be extended due to EU has classified it as a

strategic project. EfficienSea consists of 4 thematic work packages, where wp4, e-Navigation is the largest.

In short terms we will in the following describe how we work with e-Navigation and where we want to go. This will be elaborated in our final presentation. To identify the possible future e-Navigation services we have made three parallel approaches:

1. Gathering information on International organisations, projects and foras' work on e-Navigation.

2. Performed simulations at Chalmers University in order to analyze how work is conducted today in the pre e-Navigation era.

3. Performed a Mock-Up and presented this in workshops for the users, industry and organisations.

The Mock-Up will be presented at the congress as well as user feedback and results from the simulation.

Having identified potential e-Navigation services through the process outlined above, we will implement these for a number of test users. The test users will gain experience with the services through regular usage during the project. It is the intension to channel these early experiences with potential e-Navigation services into the overall e-Navigation process in the major international organisations, such as IMO and IALA. This way we hope to influence the decisions taken by the major authorities and facilitate decisions to be made based on actual experience and facts.

We intend to create a unique e-Navigation test bed in the project's region as part of the European Union's strategy for the Baltic region. This testbed will be placed in the Sound and perhaps another in the outskirts of Gdansk.

Or 62

A study on planned route and navigation information by AIS -safety and efficiency assessment in Osaka Bay

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The marine traffic density of Osaka bay with Hanshin port that is under redevelopment is expected to increase. In the bay, vessels into/out from Hanshin-port pass Akashi-kaikyo or Kitan-kaikyo(Tomogashima-suido). In addition, many fishing boats are around fishing area in Osaka bay. Therefore, vessels should avoid approaching fishing boats, net and other obstructions in addition to other ships. For safety in Osaka bay, vessels receive supporting information by VHF telephone and fax etc. Recently, obligatory vessels to install AIS can communicate with each other or AIS base station. If those ships are shared with all navigation information, collision risk will be reduced. In this paper, first, planned route that is safe and minimum time route calculated from navigation information received by AIS are obtained. Second, using actual information in Osaka-bay, possibility to improve a traffic environment in Osaka-bay that all vessels navigate on the planned route are inspected. The planned route that is to avoid collision with other ship or obstructions (fishing net etc) is calculated by Dynamic Programming. An actual navigated ship route was made from AIS information that observed by AIS receiver on coast of Osaka bay. Each ship's planned route is calculated basing on other vessel's planned route, speed, current position and other information (fishing net etc). Other ships are assumed to navigate accurately on their planned route. Using this method, the possibility to improve efficiency of marine traffic in Osaka-bay was suggested.

ABSTRACTS – POSTER PRESENTATIONS

P 01

The implementation of the EGNOS system to APV-I precision approach in Mielec - Polish work package APV-I and HEDGE implementation

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The implementation of the EGNOS system to APV-I precision approach operations, according to ICAO requirements in Annex 10. This need many analysis accuracy, integrity, continuity and availability SIS (Signal in Space) to define useful and certification EGNOS like SBAS (Satellite Based Augmentation System) in aviation, especially in landing. Also, the project will try to exploit the excellent accuracy performances of EGNOS to analyse the implementation of GLS (GNSS Landing System) approaches (Cat I-like approached using SBAS, with a decision height of 200 ft), Che³m Town located near Polish-Ukrainian border is also at the east border of planned EGNOS coverage for ECAC states. In this place there is a navigation center with EGNOS and EUPOS receivers. The starting of the project is close to October 2008. According to current EGNOS programme schedule, the project activities will be done with EGNOS system v2.2, which is the version released for civil aviation certification. Therefore, the project will allow to demonstrate the feasibility of the EGNOS certifiable version for civil applications. Other project that we will present in our article is HEDGE (Helicopters Deploy GNSS in Europe). The project objectives are to achieve the following by the end of the project:
• To develop the helicopter SOAP (SBAS Offshore Approach Procedure) procedure (and necessary avionics) and then to successfully demonstrate it to the user community.
• To develop helicopter PINS (Point in Space) procedures for mountain rescue and HEMS (Helicopter Emergency Medical Services), and to then successfully demonstrate them to the user community.
• To demonstrate EGNOS (European Geostationary Navigation Overlay Service) APV (approach with vertical guidance) approaches to general aviation in Spain, and Poland.

P 02

Performance analysis of GPS L5 signal processing board for GNSS ground sensor station

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The GPS L5 signal added newly in the GPS modernization plan was designed to improve the accuracy and availability for civilian users. In Korea, ETRI is developing technologies of GNSS ground infrastructure and next generation search and rescue beacon from 2007 up to 2010. We are going to develop hardware board per signal frequency for the development of the high performance GNSS receiver which monitors not only GPS but also Galileo system. In this paper, we are focusing to performance of the GPS L5 signal processing board. The hardware board receives IF signal of RF/IF Front-end and process IF signal in the ADC, FPGA, and DSP for baseband process. And the performance of GPS L5 signal processing is verified by compare accuracy, sensitivity, TTFF with ETRI specification for the spirent simulator and a few real signals.

P 03

GPS kinetic short-distance baseline estimation from RINEX files under matlab environment

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A Baseline consists of a pair of stations for which simultaneous GPS data have been collected and it's useful in many kinds of application, such as attitude determination. In this paper, RINEX navigation files and observation files from two kinematic GPS receivers are adopted as basic data to get the epoch-by-epoch short-distance baseline estimation. Three methods are used. The first one is using simultaneous observations of C/A pseudoranges to compute the epoch-by-epoch positions of the two GPS receivers, and then the baseline between the two antennas is estimated by subtracting one from another. The variation of the baseline length is between±0.35m. The second one is also using simultaneous observations of C/A pseudoranges, but we only compute the positions of the rover receiver and then the baseline is estimated from the epoch-by-epoch difference of pseudoranges. The level of the variation is the same with the first method. The third one is using simultaneous observations of carrier phase. We use Lambda method to fix the integer ambiguities. The variation of the baseline length is between ±3mm, which is much better than the other two methods. Here in this paper, detailed Matlab codes are provided to perform GPS kinetic short-distance baseline estimation from RINEX file under Matlab environment. First, the fundamental principle of baseline estimation from two antennas is introduced. And 3 kinds of methods of baseline estimation are presented. Second, the RINEX file and the definition of the GPS observables, including Time, Pseudorange, Phase, Doppler, are described. And two examples of snapshot for GPS Observation Data File and GPS Navigation Message File are illustrated. Third, system flow charts of the 3 kinds of baseline estimation methods are described in detail. Fourth, results of data processing and compare of the 3 kinds of methods are showed and plotted. Finally, summary and conclusion are provided.

P 04

GPS single point positioning and velocity computation from RINEX File under Matlab environment

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Although GPS position and velocity are standard output for many receivers, writing your own code under computer environment is much more important when simulation and post processing are needed while conducting pure study and research work. Matlab is an efficient tool to do this kind of job. Although there are existing public Matlab codes for positioning from RINEX file as a kind of illustration under optimum conditions, velocity computation is never calculated. Here in this paper, more detailed Matlab codes are provided to perform GPS single point positioning and velocity computation from RINEX file under Matlab environment. Factors that affect the accuracy of the computation, such as satellite selection, ionosphere correction, satellite clock error calculation and correction, troposphere correction, Earth rotation correction, are all considered in order to obtain better position and velocity results.

In this paper, first, single point positioning and velocity computation are introduced. Second, the RINEX file and the definition of the GPS observables, including Time, Pseudorange, Phase, Doppler, are described. And two examples of snapshot for GPS Observation Data File and GPS Navigation Message File are illustrated. Third, a system flow chart of the position and velocity computation is described in detail. Fourth, results of data processing are showed and plotted. Finally, summary and conclusion are provided.

P 05

GIS data base for air pollution in urban area

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Air pollution is a major problem in developed and developing countries. It causes respiratory diseases and chronic illness.
the amounts of pollutants are measured at ground stations. Based on these measurements,spatial distribution of air pollution is estimated and visualize using interpolation method which gives an approximate picture of the distribution of Common air pollutants, which include carbon monoxide, nitrogen oxide, sulphur dioxide, lead and Total Suspended Particulates (TSP), the latter being the most widespread and the most serious for human health. The major sources of air pollutants in Baghdad are weather conditions and through man-made activities,

particularly industrial manufacturing and motor vehicle operation activities.
This research focuses on the mapping of dispersion of Baghdad air pollution using high resolution satellite remote sensing images and ground station data. spatial distribution map in respect of air pollution using ERDAS software for image processing, while Arc View GIS soft wear include Spatial analyst and surface analyst techniques, Were used for combination ,intersection ,overlaying analysis and presentation.
Such a spatial distribution map can give city planners a much more effective visual perspective of the spatial variations in city air quality than can tabular data from point samples, and this can lead to faster decision making about which areas represent the greatest risks and are therefore most in need of intervention measure.
The results showing, the Both human activities and natural environmental processes are sources of air pollution in Baghdad city and the levels of this pollutant are above WHO recommended levels in most parts of the City, indicating a need for a regular air quality monitoring and management system.

P 06

Gps-glonass performance assessment with weighted solution
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For navigational purpose a widespread metric to evaluate the quality of a satellite constellation is GDOP.
GDOP has only geometric value, for its inherent assumption that all satellite pseudorange measurement errors are independent with the same statistics. These hypotheses are not realistic, because certain measurements are noisier than others and atmospheric measurements errors are highly correlated for satellites at the same elevation angles. Using a realistic measure error model,an appropriate measurements covariance matrix can be computed and a Weighted-GDOP can be defined. It is an extension of GDOP concept and is a more effective metric for measurement selection. A similar extension can be made on the geometric RAIM availability, that is the geometric limit to the RAIM applicability. GPS stand-alone does not provide good performance in all environments or in every application.
GPS civil service provides suitable performance only in situations of good electromagnetic visibility; the fixing becomes difficult in environments like mountainous or urban areas.In these situations GPS could supply only inaccurate positioning or even could be not able to provide fixes, owing to bad geometry or lack of minimum number of visible SV. Otherwise the SPS of GPS is inadequate for critical safety applications like aircraft takeoff or landing, characterized by severe requirements.
To solve the GPS gap the integration with other systems is necessary. In this paper we focus on the integration GPS-GLONASS to validate the use of satellite navigation in critical applications or difficult environments. GPS and GLONASS are very similar, but their differences must be considered to obtain a realistic assessment of their integration performance. Particularly measurement error models are slightly different. GPS one is well-established in literature, while the GLONASS one is obtained experimentally. A simulation software has been developed in MATLAB to analyze the effectiveness of the GPS-GLONASS integration

P 07

Optimization and design of observational plan of local GPS network
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GPS, the result of the last decade of 20-th century, is a developed, powerful and applicable system for positioning in all levels of precision with high velocity and low cost. To achieve high precision positioning with GPS, there should be simultaneously dual frequency carrier phase observables in static and relative methods for all or almost of independents baselines. Since optimization of the precision is final goal, the highest precision isn't concerned but the optimized precision is concerned. So in optimization process, observation of all baselines results in observation of minimum baselines so that postulated precisions are satisfied. The network that used to confirming the validity and correctness and efficiency of method is the network that

contains 8 points which established for preparation of the desired results. In this study, it was shown that we can be eliminated the 30% of all baselines from the observational plan of GPS network without having a significantly negative effect on network precision, it means at least 30% decrease of the project cost. Optimization must be used in accordance the project goal, then it is possible to eliminate higher than 30% of baselines.

P 08

A stochastic sigma model for glonass satellite pseudorange

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The GLONASS is a satellite positioning system able to provide unlimited number of air, marine, and any other type of users with all-weather three-dimensional positioning, velocity measuring and timing anywhere in the world or near-earth space.
The sharp recovery of the Russian satellite programme shows that is better to rely on consolidated technology and well functioning such as the GLONASS despite the clamour raised by the draft European Galileo Civil satellite system its delay and all the problems raised.
A GLONASS receiver performs passive measurements of pseudoranges and pseudorange rate of at least four GLONASS satellites as well as receives and processes navigation messages contained within navigation signals of the satellites. The navigation message describes position of the satellites both in space and in time. Combined processing of the measurements and the navigation messages of the 4 (3) GLONASS satellites allows user to determine 3 (2) position coordinates, 3 (2) velocity vector constituents, and to refer user time scale to the National one.
The purpose of this work is to create a stochastic model for pseudorange variances of GLONASS satellites able to provide an estimation of pseudorange measures variance. This evaluation is made to each satellite as a function of height and azimuth alone and independently of the place where is considered the user. To achieve this goal we developed a software tool MATLAB able to create a GLONASS sky from the broadcast ephemeris.
In order to validate the sigma stationary stochastic model the results are compared with the same obtained from measures really carried out. There was therefore the need to extract from a Mixed observation RINEXE file all the measured pseudorange. Starting from the well noted receiver position and from the computed satellite coordinate it was obtained the geometric range which is compared with the observable pseudorange in order to achieve the pseudorange variance used as reference.

P 09

Daily gps total electron content (tec) variation over the Kingdom of Saudi Arabia

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Ionosphere, upper layer of atmosphere, is a dispersive medium for radio waves implying that the refractive index is a function of frequency and total electron content (TEC). TEC has strong diurnal variation in addition to monthly, seasonal, solar cycle variations and small and large scale irregularities. Dual frequency GPS receivers can recover TEC and its variation in various time scales. We here investigate daily TEC variation over the Kingdom fitting to a regional GPS network. The regional network consists of six local stations in the Kingdom and nine International GNSS Service (IGS) stations around the Kingdom. GPS measurements, acquired for ten days in April 2009 at the network points, were processed in daily basis by using the Bernese 5.0 GPS processing software and IGS products. Snapshots at two hour interval of the function-based ionosphere models are developed using the geometry free GPS observables in regional scale. The developed ionosphere models are analyzed for daily TEC variation and compared with IGS-GIMs as well.

P 10

Interpolation of TEC for a regional operational ionosphere model

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GNSS satellite signals are affected while being transmitted through the ionosphere. This effect is mainly a function of the amount of free electrons along the signal path which is measured as the total electron content (TEC).

Residual ionospheric effects in the position and navigation solutions do affect GNSS users, especially at high latitudes. The Norwegian Mapping Authority therefore initiated development of a regional ionosphere model based on the SATREF network of permanent GNSS reference stations.

The SATREF Ionosphere Model is based on estimation of TEC in ionosphere piece points (IPP) from dual frequency GPS observations collected in the GNSS stations. The estimated vertical TEC values at the IPPs are then used as the basis for a spatial ionosphere model.

The spatial model is grid based, and interpolation of the TEC from the ionosphere pierce points to the grid points is based on an interpolation scheme combining ordinary kriging and inverse distance dependent weighting.

This paper initially reviews the general problem of spatial interpolation, followed by a theoretical description of ordinary kriging supplemented with a discussion on the algorithms selected and implemented for estimation of the semivariogram and for the ordinary kriging performed in the Norwegian ionosphere model.

To further enhance the reliability of the operational model, the kriging algorithms are supplemented by interpolation based on inverse distance dependent weighting which is more robust, especially in the presence of data gabs and in the boundary areas of the model. This algorithm is described and discussed along with the decision scheme used for automatic switching between the two interpolation algorithms.

The discussions are supported by examples and test results, and finally an overall evaluation of the nested interpolation method is provided.

P 11

A study on acquisition performance of Galileo E5 signal processing in ML 506 platform

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The signal processing in GNSS receivers can be roughly divided into two successive stages: a signal acquisition and a signal tracking. The purpose of the signal acquisition is to obtain the signal parameters estimation which is closed enough to the true parameters and smooth transition to the signal tracking can be accomplished. The tracking stage produced the signal parameters estimation continuously in time and under dynamic signal parameters changing. The signal tracking is based on keeping the received signal and locally generated signal replica in synchronization, i.e. the system drives the replica generation to minimize the errors of estimated parameters. The only new investigation needed for AltBOC signal tracking task consist in signal delay synchronization. The typical choice for DLL discriminator is a power early-late type. Its discriminator function can be described as follows (since the I&D output signals vary slowly in time the explicit time dependence is omitted) Tracking loop is based on E-L time discriminator (DLL) which assesses CCF between receiver signal and complex conjugant replica of the complete Galileo E5 signal.

The AltBOC CCF has significant dependency on data bits sequences in both the received signal and the generated replica which are carried on E5aI and E5bI AltBOC input components. The bits disagreement in the received signal and the locally generated replica has a negative effect on the CCF maximum height and therefore also on the tracking performance.

Test results for GIOVE-A Satellite are shown as following table.

Deviation of the code tracking noise [m] 0.202 @40dB-Hz app
Standard deviation of the carrier phase noise [mm] 2.828 @40dB-Hz app

P 12

Dual-element diversity antenna for gps / galileo receivers
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Evolution of handheld GPS/Galileo receivers has made it an essential part of most of the communication devices including mobile terminals. Antenna is an important element of these receivers. Theoretically, the GPS antennas should have good Right Hand Circular Polarisation in order to receive the incoming signal efficiently. However, this requirement is hard to fulfil nowadays due to the size and space limitations of handheld receivers. It paves the way to explore other options to enhance the antenna performance while maintaining relatively small size of which diversity is more efficient choice.

A number of GPS antenna solutions are reported in literature taking into account the antenna diversity enhancements [2]. However, this gap in the GPS market still needs more ideas. This paper presents a novel antenna for the GPS/Galileo applications. The antenna is designed using CST Microwave Studio® package and tested in Antenna Lab at QMUL. The antenna is fed by a microstrip line with a substrate of 100x50mm and having dielectric permittivity of 3. The radiating element is a combination of monopole and loop structure. Ground plane size is only 18x80mm. The radiating element consists of 11 loops of 23.2x2mm. The antenna resonates at 1575.42MHz with an impedance bandwidth of 107MHz covering the frequencies from 1520.2MHz to 1627.5MHz for an S11 level better than -10dB. The simulated gain of the antenna is found to be 2.31dBi and is linearly polarized. Vigorous design modifications are then considered to enhance the antenna performance employing antenna diversity. Effectiveness of diversity is analysed in terms of diversity gain. The results indicate that the proposed antenna is a viable solution for the GPS/Galileo receivers.

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[2]Gao, Y., Chen, X. and Parini, C.G., "Study of Diversity Antennas for Galileo/GPS Receivers", ENC-GNSS 08, April 200

P 13

Implementing a software snap-shot receiver for mobile phones
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In the recent years personal navigation using GPS receivers experienced a boom, making navigation equipment affordable for everybody. snap-shot positioning is an effective solution for consumer applications where there is no need for a continuous navigation solution, e.g. location based services (LBS) or the E-112 and E-911 respectively. Within this paper a practical implementation of a snap-shot software receiver for mobile devices is presented.
The software architecture is very flexible so that it can process arbitrary signals from multiple systems just by defining reference codes. The platform used for the snap-shot receiver implementation is a current smart phone with an XScale Processor with MMX2 technology. Using assistance data, the snap shot receiver can reduce the Doppler search space for acquiring the signals. For the acquisition a circular FFT with coherent or additional non-coherent correlation is used. The implementation uses a fixed point FFT with optimized assembler code. This ensures fast processing utilizing integer instructions with reasonable accuracy losses. As the measurements for snap shot positioning are approximated code-phases from the acquisition instead of pseudoranges from a steady state tracking loop, it is necessary to refine the code-phase measurements. From the calculated correlation values an improved code phase estimate with a reduced multipath bias is obtained through the combination of correlation values at distinct code-phase offsets around the assumed correlation peak.
For the validation of the proposed mobile snap-shot receiver it has been assessed using real and

simulated IF samples from GPS C/A and Galileo E1-B/C signals. Performance measures of the acquisition module will be discussed, e.g. accuracy and processing time/load, depending on front-end bandwidth and sampling rate. Moreover the position accuracy from the snap-shot positioning will be investigated in different scenarios for GPS, Galileo and combined for both signals.

P 14

Inertial Navigation System with MEMS-ESG and Automated Sun Altitude Measuring System using Web-Camera

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In 2007, Micro Electro Mechanical Systems (MEMS) Electro-statically Gyro (ESG) was introduced by TOKYO KEIKI Co. Ltd Japan. The accuracy of this sensor has been dramatically improved compared with vibration types. For example, instability has been improved 10 times more than the vibration types. The MEMS-ESG could detect the relative angles as accurate as GPS compass in short term use. Using this sensor, basic research for the Inertial Navigation System (INS) was tested. It is examined the accuracy as INS for using on a small ship. Because the MEMS INS has problem of errors increasing with time, normally a complement system is used. Since our one of objective is not using the GPS, other complement system is concerned. A celestial navigation system is one of the possibilities for this purpose. Traditionally, the celestial navigation has been carried out by hand on the ships. However, the system would need to update automatically to make an integrated system with MEMS INS. Therefore a Web camera with a CMOS(Complementary Oxide Silicon) sensor is used in this research. Although CMOS is not as accurate as CCD(Charge-coupled device), it has got many benefits, especially its cost, high-speed read out and power consumption. Recently CMOS accuracy is much improved. In the past research, the sun movement was detected 5□f14□h per pixels and 2□f16□h per pixels for the altitude and direction respectively. However CMOS cameras are needed much effort with calibrations. In addition to that, the time with digital image processing would be the problem for the update. Therefore a camera platform has been developed. It is able to turn the camera system towards the sun. Using the platform, it is able to minimize the use of image sensor range and calibration would be much easer. The analysis shows that the accuracy improvement and increasing digital image processing speed comparing only CMOS cameras.

ABSTRACTS – ALTERNATE PRESENTATIONS

Alt 01

A simplex network rtk implementation via communication satellites

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Network based RTK (NRTK) has been developed in recent years. It utilizes the measurements from an array of continuously operating reference stations to create local precise error corrections, which can effectively mitigate the distance-dependent errors and achieving centimetre-level solutions in real-time. Comparing to traditional single Reference Station based RTK positioning it can provide much greater reliability and mobility. A two-way communication link is required in the NRTK implementation, usually via commercial cell phone networks. Due to the server and channel capacity, the two-way service is limited when adopted in mass market applications. As well as the good quality (correctness and completeness) of the transmission, wide coverage is required, which cannot always be satisfied by the current commercial cell phone network services.

The Satcoms in Support of Transport on European Roads (SISTER) project promotes the integration of satellite communications with GALILEO to enable mass market take-up by road transport applications. This project is supported by the European Commission under the 6th

Framework Programme (FP6) for Research and Development. One of its objectives is the implementation of an enhanced, Europe-wide, communication satellite-based RTK solution, and its subsequent optimization. In contrast to the cell phone network based two-way communication, a communication satellite based one-way broadcast is proposed to deliver the RTK corrections. A parameter-based model is investigated for the pursuing of an efficient transmission bandwidth and a wide coverage. The approach to achieve such an effective model will involve the integration of current models for the troposphere and ionosphere, and also a mathematical representation of the correction residuals. The broadcast mechanism makes the RTK service available to an unlimited number of users, and helps to improve the service coverage to Europe wide, especially in remote areas.

Alt 02

L5 - The New GPS Signal

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The constant development in the field of global satellite navigation systems opened the door for a new type of safety critical applications. To meet the challenging requirements which include precision of the positioning solutions as well as robustness of the service new technologies have to be implemented in developing and modernized satellite navigation systems.
In early spring this year a next important step in GPS modernization took place. With GPS IIR-20(M) a new satellite was added to the actual constellation which carries an L5 demo payload. This satellite transmitted the first GPS L5 signals from a Medium Earth Orbit in space after its launch. Since L5 is claiming to be a GPS "Safety of Life" signal which intends to increase precision and robustness of the navigation solution due to mitigation of ionospheric refraction errors and by an enhanced signal design which includes a higher signal strength and advanced code structure compared to the existing GPS civil signal.
Starting in September 2005 the DLR Institute of Communications and Navigation established an independent monitoring station for the analysis of GNSS signals. The core element of this facility is a 30 meter deep space antenna located at DLR Groundstation at Weilheim, Germany. The use of this antenna which is characterized by its high gain and small beamwidth and the absolute calibration of the whole measurement setup including also the 30m antenna allow very precise and absolute calibrated measurements on a single navigation satellite.
The paper gives a brief overview of DLRs GNSS verification facility. This includes a description of the measurement setup and the performed calibrations on all components. Afterwards a detailed analysis of the transmitted L5 signal is presented. Signal imperfections like spectral asymmetries or distortions are discussed and evaluated using different signal representations like spectra, constellation diagrams, sample analysis and correlation functions.

Alt 03

Study of a sdr galileo—gps receiver

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In the last decade, the SDR concept applied to GNSS has been widley exploited; the flexibility of a software approach allows fast implementation of both GPS and Galileo signals and modulations. The aim of this paper is to develope a single frequency Galileo—GPS SDR receiver. The features and modulations of the Galileo signal are briefly listed; the differences with GPS signals are then highlighted. A full description of the observations on the B channel of the E1 frequency signal is then presented, along with some results. Then the navigation data and the tracking outputs of both GPS and GIOVE satellites are used for positioning: the results highlight complete compatibility of the 2 navigation systems. The "pilot" C channel's signal is then acquired and tracked, using a coherent integration: the results presented show an expected enhance of the C/N_0, allowing its use to develope high-sensitive receivers.

Alt 04

E-navigation - iala's contribution
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E-navigation is an IMO initiative, but is supported by several other international organisations. Members of IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities) are responsible for marine aids to navigation throughout the world, including Vessel Traffic Services. The systems provided by IALA members will form essential components of e-navigation. This paper describes the progress achieved in areas such as user requirements, positioning, navigation and timing, communications and shore-side architecture. The approach taken in the work so far, the next steps and planned timetable for IALA contributions will be set out and some projections made about the likely significance of the developments for safety of navigation and the protection of the environment.

Alt 05

Dilution of precision and interference level on a compatible receiver within a combined GPS/Galileo scenario: A comparative study and conclusions
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Within this article, the author develops on the possibility to use, for a given navigation receiver simultaneously tracking GPS and Galileo satellites, higher antenna elevation masking angles while keeping the performance shown with unique GPS or Galileo constellations. This measure, not treated in the present literature as per the author's knowledge, is observed to reduce (in certain scenarios) the vulnerability to ground-based non-navigation interference sources, and to multipath in urban canyons.

In a first developing stage, the GNSS-induced interference power levels on the target receiver are determined (as a function of the masking angle) for a range of characteristic user types. In all cases, signal characteristics are selected compliant with the relevant ICDs and the spectral separation coefficients (SSC) between navigation signals are estimated following a novel approach (see [Ref. 1], from the same author) that exploits the frequential pseudo-periodicity observed on the SSC pattern versus the relative Doppler frequency shift due to the finite duration of spreading codes.

Secondly, the satellite visibility and Dilution of Precision for GPS, Galileo and combined GPS/Galileo constellations are statistically determined for arbitrary user positions, also as a function of the masking angle.

At this point, a trade-off is reported, as high masking values provide improved rejection against GNSS and ground-based non-GNSS interferences, but degraded satellite geometry (high Dilution of Precision), and hence reduced accuracy/precision of the determined Power-Velocity-Time solution.

A further step is then taken to conclude on the applicability of the proposed measure especially (but not only) for low cost mass-market navigation receivers.

[Ref. 1] Fernandez-Prim D. et al., 'Determination of the spectral separation between signals and its effect on the GNSS receiver performance. A more pragmatic approach'., ION GNSS 2008, September 2008, Savanah, Georgia (USA).

Alt 06

Is spoofing a real threat for integrated navigation systems?
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In today's world many navigation systems depend on GNSS signals. It is crucial to analyze the susceptibilities of these GNSS signals. Main threats for GNSS signals are: interference, jamming and spoofing. In this paper we are going to analyze the spoofing. First we are going to explore how spoofing can be done. The basic spoofing is done by deceiving the GNNS receiver such that it tracks the spoofer instead of a real satellite. In order to do this spoofer stamps the GNSS signals as if the signal is originated from the satellite. If the spoofer signal is strong enough a standard GNSS receiver would fail to make a good position measurement. Analytically we will argue that spoofing is not a real threat, if the navigation system is integrated with inertial sensors. In this case the spoofer needs to track the GNSS receiver platform in order to spoof the receiver otherwise it would not be effective and the spoofer signals can easily be rejected. We will calculate a effective deceiving radius for the spoofer which is only a few hundred meters.

Alt 07

GNSS transmitter based indoor positioning systems - Deployment rules in real buildings

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Indoor positioning appears to be a real challenging topic and many techniques have been proposed these last ten years, ranging from High-Sensitivity GNSS to sensor networks, through Assisted-GNSS or WLAN based approaches. No ultimate solution seems yet to provide the answer to the problem, probably crucial to Location Based Services, of continuity of the availability of the positioning from outdoors (where GNSS are such good candidates) to indoors. Current works are mainly oriented towards hybridisation techniques.

The repeater approach is based on the use of GNSS so-called repeaters in order to provide GNSS availability indoors through the way of an amplification of the signals received by an outdoor antenna (typically located on the roof). The complete system, already presented in previous conferences, uses four repeaters in order to provide a full 3D 1 to 2 meter accuracy positioning, indoors. The measurements, performed at the receiver end, are the pseudo-ranges at the instant of transition from one repeater to the next, the transmission being achieved through a sequential scheme (only one repeater transmitting at any given time).

Since regulations tend to be provided (ECC reports on maximum transmitted power allowed) for both repeaters and pseudolites, we carried out indoor propagation simulations, for real environments, in order to define realistic deployments of both systems. Different buildings have been considered and modelled. Coverage and positioning accuracy results are presented for various hypotheses: full 3D (3D positioning all over the building), 2.5D (2D positioning all over the building and 3D provided only where floor level changes are possible, i.e. near the stairs and near the lifts) and only 2D (assuming the floor level is available through another mean). The number of repeaters/pseudolites required for a complete coverage of the buildings is also given and commented (the specific case of the Institut Telecom campus in France is analysed).

Alt 08

Indoor positioning with foot-mounted inertial sensors and UWB

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A personnel positioning system should be light-weight, small, relatively inexpensive and power efficient, and still provide meter-level accuracy during indoor operations. MEMS-based inertial sensors (tri-axial accelerometers and gyros) fulfills these requirements, but their inherently large errors (e.g. bias drift) only allows for (non-aided) navigation during a short time interval before the positioning errors become unacceptably large. However, by mounting the IMU on the foot it is possible to utilize the fact that the foot, and IMU, at regular time intervals is at stand-still (i.e. the so-called stance phase). Hence, during the stance phase the velocity of the IMU is

zero and this information can be utilized as input to the Kalman filter, allowing the sensor fusion filter to estimate and compensate for sensor bias errors. This zero-velocity update (ZUPT) procedure occurs approximately once every second during regular walking, and can effectively reduce the position errors; however, they cannot be completely eliminated since the heading error is only weakly observable from the zero-velocity information. One key to success for a foot-mounted INS is the ability to reliably declare a stance phase during a multitude of realistic movements, such as walking, sprinting, duck-walking, side-stepping, stair-climbing and crawling.

In this work we have evaluated different stance phase detection approaches on IMU data collected during several indoor measurement campaigns, with emphasis on their reliability during different movements and their effect on the resulting position error. Furthermore, UWB transceivers have been utilized to estimate the range between two soldiers moving through a building, each equipped with a foot-mounted IMU. The positioning performance using different sensor fusion approaches is compared, e.g. sharing position and range estimates and corresponding uncertainties, or combining IMU measurements and UWB-ranges into a single sensor fusion filter.

Alt 09

Detection of the rescue target in the marine casualty based on visual attention mechanism

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In the case that a marine casualty occurs, the detection of the rescue target such as life rafts is surely required to carry out the prompt rescue of human life. However, the detection of the small rescue targets such as life rafts or shipwreck survivors depends on the visual search by man as yet. Since human eyes can not keep focusing on the sea surface during the long searching period, the evelopment of searching support system using image or video processing techniques in place of the human eyes is indeed required.
But there are still some problems of these mentioned techniques for detection of the rescue target. One is the detection accuracy, that is, a very small target corresponds to only several pixels in the image or video data must be detected in the wide views over the sea. Object detection methods using radar can not find such small target. Moreover, the ratio S/N between the target and the background (sea surface) decreases due to the sunshine reflections, cloud shadows and white crested waves, which could result in false detection or miss detection. The other is the processing speed, that is, huge image data must be analyzed in a real time manner. Application of conventional image processing techniques cannot attain the purpose owing to the reasons above.
A two-step scheme based on visual attention mechanism is proposed in this paper to detect dim targets in visual image sequences. In the first stage, an efficient method is applied to extract the potential regions using color information; in the next stage, the true targets are detected from these regions by advanced visual properties. The proposed approach can reduce the computation complexity, while the algorithm's performance is not traded off.

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Alt 10

Estimation of the maneuverability under external disturbance

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From the view point of safe navigation, it is very important for ship officers to understand the maneuvering performance of handling ship. As the judgment index of the maneuverability of the

ship, there is the tactical diameter, the advance and the transfer, etc., obtained from the turning test, and there is also the maneuverability index (Nomoto' T & K) obtained from the ordinary graphical analysis of the zig-zag test. Fundamentally, it is preferable that these tests are done without the influence of the external disturbance under the condition in the still water. However, in general it is difficult to carry out these tests under such condition, and the various indexes of maneuverability are estimated by using several experimental results. By the way, the attempt to estimate the maneuverability index online is being done in recent years. In this method, the simple linear maneuvering model (T-K model) is transformed into the integral equation, and the online parameter (T&K) estimation is performed by the IIR (Infinite Impulse Response) filter. The estimated parameter is very stable; therefore the method is a powerful tool for online identification of the continuous system. On the other hand, in general the large sea area is necessary for the zig-zag test. So, the method of estimating the maneuverability index without examining zig-zag test for the high speed ship is groped for. As one of the example of such study, the methodology of the estimation of the maneuverability index based on the AutoRegressive(AR) model using the data of the turning test is developed. However, in this methodology the relativity of the AR coefficient and the maneuverability index is not clear. To solve this problem, the self-organizing state space modeling procedure is introduced in this study. We have confirmed to be able to estimate not only the maneuverability index but also the tactical diameter etc. from the data of the turning test under external disturbance.

Alt 11

New offshore vertical reference frame from satellite altimetry (DNSC08MSS)
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Satellite altimetry can be used to derive an offshore vertical reference surface for offshore GPS navigation as satellite altimetery and GPS are conveniently given in the same reference frame. This way satellite altimetry can be used to provide a harmonized global vertical reference surface.

A global mean sea surface called DNSC08MSS have been derived from the physically observed time-averaged height of the ocean's surface derived from a total of 8 different satellites and a total of 8 different satellite missions like i.e., the T/P, ERS, ENVISAT and ICESAT.

Extensive comparison with GPS leveled coastal tide gauges around Britain and Norway indicates that a vertical reference surface from satellite altimetry is accurate of around 10 cm. In the open ocean the accuracy is believed to be on the 5-8 cm level.

Using DNSC08MSS as an offshore vertical reference surface, instantaneous sea surface height can be obtained for real-time positioning to high accuracy by adding the time-varying height signal from tides and wind.

Accurate knowledge of the vertical position of the marine vessels in a fixed system becomes increasingly important in the future where also the relative position of the ship becomes better.

Alt 12

Near real time monitoring of global ionosphere with gound based GPS data
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Because of the dispersive nature of microwaves in ionosphere region, dual frequency GPS observation can be used to get precise total electron content along the signal path. As the reference stations become world-wide distributed and real time data stream is being built now days, GPS become a convenient and valid way to monitor global or regional ionosphere climate. For the target of real time monitoring of ionosphere variation, a way to combine sphere harmonic function and Kalman filter is developed. The goal of this work is illustrate the Tec change on global scope but not the ionosphere layer structure or profile of specified location. So the 2D method on the assumption of ionosphere slab shell is used. Consider that Sphere harmonic function method have been used widely in geodesy and proved to be a valid method for ionosphere monitoring which develop by CODE for providing daily global TEC map. Also Kalman filter could provide a common solution to real time data processing. Then we take these

two methods to solve the real time monitoring of global ionosphere. Using this method, near real time global TEC map can be drawn for atmosphere related research. Still this method estimate DCB on line could avoid mistakes caused by station or satellite receiver fluctuation or other environmental effect. Both the final DCB and TEC result show good coincident with IGS and some short time change also can be caught by this method. The result also shows that the ionosphere irregularity caused by magnetic storm or other reason can be caught in near real time.

Alt 13

Stance phase detection for constrained inertial navigation in pedestrian navigation systems - a algorithm evaluation

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Due to the integrative nature of inertial navigation systems, amplifying the sensor errors, their position error grows proportional to the cube of operating time. Therefore, with currently available ultra low-cost inertial sensors, free inertial navigation is only feasible for time periods in the range of a few seconds. However, by imposing constraints on the navigation solution, based upon information about the system dynamics, the devastating cubic error drift can be broken. A commonly used type of information to combat the error drift is knowledge about when the system is in a stationary phase, i.e., has zero velocity.

The usage of zero velocity updates (ZUPTs) is especially appealing for constraining foot mounted inertial navigation systems, since during ordinary walking conditions the foot returns to a stationary condition on a regular basis. Indeed this approach has shown some promising results; resulting in systems where the position error grows proportional to the number of steps of the user. However, to use ZUPTs to constrain the navigation solution the time epochs when the foot is stationary must be identified. Accordingly a range of algorithms has been proposed for detecting stationary epochs based upon the inertial sensor data. However, the proposed algorithms are generally derived in an ad-hoc manner and the literature lacks a profound study of the characteristics and performance of the detectors.

Therefore, to analysis the detectors and accesses their performance, data from a foot mounted IMU together with reference data from two switches mounted beneath the foot, has been collected. The collected datasets, reflecting different walking conditions, have been processed using, the most widely used stance phase detection algorithms. The performance of the different detectors has then been calculated in terms of the probability of correctly detecting the stationary phase versus the probability of a false detection.

Alt 14

Using the autonomous GPS receiver for real time, precise time keeping

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Even if mainly focused to the provision of global spatial coordinate information, GNSS constellations are also a precious source to derive and distribute precise time, time interval and frequency information.
The question is how to increase accuracy and precision of time keeping, in order to encounter the needs and requirements of new potential user domains, potentially using simple (mass-market) devices.
An analysis was carried out in order to verify which algorithms seem promising, allowing especially to increase real-time processing precision, without providing any external support to the receiver. The techniques proposed to improve the equipment clock offset accuracy estimation have been developed according to a principle: avoiding to adopt corrections/measurements from any other external device.
The terminal may know or even not know its exact coordinates: experimented algorithms are "autonomous", treating as input only internal receiver observables (code range and carrier

phase).
A high precision can be achieved through the fusion of pseudorange observables with the "factor-1000-more-precise" carrier range measurements, without attempting to solve for the well known initial ambiguities – a step that is precluded, when using only L1/L2 frequencies and no DGPS/RTK support.
The pursued approach is a "porting" to the time determination problem of the algorithm known as "phase connected" computation, already known and nominally experimented to determine the orbit state of satellites equipped with navigation receivers.
Additional aspects are treated and implemented for processing real navigation data, that include smoothing of code range and efficient autonomous algorithms to grant for absence of dangerous 2cycle slips" and to exclude "measurement outliers".
The overall strategy adopted implements a kinematic, sequential least squares filter/smoother compatible with real time application.

Alt 15

Analysis of positions time series of GPS-DORIS collocated station
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We assess the signal characteristics in weekly solution time series of residual coordinates for 15 GPS and DORIS collocation sites, using the Singular Spectrum Analysis (SSA) to extract their trends and periodic components and the Allan variance to characterise their noise.

The obtained results show that the applications of SSA on the three position components (north, east and vertical) permits to better extract their trend and periodic components. However, after a trend and periodic components have been removed, the Allan variance analysis shows that the GPS noise characteristics of all three components is combination of white plus flicker noise with a level of few mm increases in the order east, north and vertical directions. While the DORIS time series have white noise with a level of few cm.

Alt 17

Design and implementation of a low-cost integrated navigation system for marine applications
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In this paper we present the design and the implementation of an integrated navigation system (INS), based on low cost MEMS inertial sensors, for marine applications. The idea is to extend and adapt most of the innovative solutions developed in the high-cost aeronautical scenario to the marine context, trying to solve the trade-off between admissible costs and performances. In particular, the low sensor quality will be compensated by the use of a certain sensor redundancy, sophisticated sensor fusion techniques and computationally efficient algorithms. Note that the correct estimation of the attitude is a crucial point for fast boats, since it can allow, in the very next future, the use of active control strategies to minimize fuel consumption and maximize navigation comfort. The work described in the paper is part of the so called MEMSIP Project, aimed to the implementation and the construction of the platform prototype, and it is carried on in partnership between the University of Naples "Federico II" and Axitude srl, a supplier of avionic instrumentation. The main features of the platform can be summarized as:

1. Loosely-coupled architecture scheme. This sensor fusion scheme, based on a Kalman Filter, integrates inertial sensors with the complimentary measures obtained through GPS and three-axial magnetometer, allowing to cope with low cost MEMS sensors inaccuracies.

2. Cost-effective parallel embedded architecture based on three ARM processors. The front end processor performs filtering and compensation tasks while two parallel processor compute, respectively, navigation and integration algorithms.

3. Two-speed inertial navigation algorithm. The tasks necessary for the computation of the kinematic model embedded into the INS structure are executed by using different frequencies in order to reduce the computational burden.

Experimental results in a real marine scenario show the effectiveness of the prototype.

Alt 18

Multi-planner operation planning system and method of container terminal

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Container Vessel is becoming larger and faster thanks to the rapid growth of global trade and development of technology. Recently 12,500TEU vessel ordered by Maersk is constructed and being serviced and moreover, 15,000 TEU vessel is expected to be ordered in near future.
Every nations in north-east Asia are facing strong competition to be logistics hub to get the initiatives of logistics in response to the rapid change of logistics environment according to the globalization of economy and major ports in this region also are trying to catch big shipping line for their survival.
Considering above circumstances of the advent of ultra-large container vessel and spoke-and-hub strategy, it is inevitably necessary to make a fast and accurate vessel job(working) in the terminal in order to be a leading port To meet this objective, current vessel planning system has to be improved innovatively.
However the research about improvement of algorithm and system for vessel operation has been studied until now butthe research related to the concept of operation system and technologies which adopt new type of operation is not accomplished so much.
In vessel operation system used in current container terminal, one planner make a loading/discharging plan so it takes about 5 hours for the planning in case of 1,000 TEU container.
If the time of planning is long, it comes to be low-quality of working plan, as a result, the productivity of terminal will go bad including re-handling of container, increased density of yard utilization.
Therefore, this thesis propose multi distributed vessel planning system which enables multi loading/discharging planning with several planner simultaneously for faster and more accurate than existing planning and enhances quality of planning through information sharing among planners. Also this thesis uses simulation through Arena to verify the efficiency of this multi-distributed vessel planning system.

Alt 20

Optimized information management for positioning services: a comprehensive approach for making the right choices

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An extensive array of different positioning services, with exceptionally wide ranges of technologies and functionalities, is currently available for implementation. In order to analyze and evaluate the options, a new multidimensional approach is suggested. The result of which would be the ability to attain the best recommendation for the currently available positioning technologies for applications. This specialized and customized analysis combines state of the art tools from the IT-branch for architecture development (Information Exchange Requirements), interoperability methods like the Enterprise Architecture framework (NATO-NAF) and international specifications for geo-data summarized in metadata-standards (e.g. ISO 19115). Each makes a vital and essential contribution to having and choosing the best system or system combinations. This new comprehensive method defines an evaluation process, which would result in an optimized (and thereby cost-efficient) information management examination tailored for positioning service applications. Based on the receiving system requirements this analytical process would generate the aggregated information requirements for a potential

position technology like accuracy and estimated regular error, robustness, signal repetition, certification or data encryption. Furthermore, local and regional variations like the system coverage, the environmental influences or limitations and the type of positioning would be evaluated based on a predefined concept of operations. The assessment should also include the potential total service costs for the user, customer support of the various technologies (updates or signal monitoring) as well as the type of protocol implemented in order to achieve an optimal IT-Integration. The resulting information requirements summary would have to be cross-checked with implemented geo-metadata and would result in a logic suggestion of the proper positioning technology (or mix) to be implemented.

Alt 21

Outline design of navigational information system that systematized lookout

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This paper describes an outline design of navigational information system that systematized lookout by image processing. Constructing procedure for navigational information system involves the following sequential steps, "System Conception", "Requirement Definition", and "Outline Design". In the step of "System Conception", we show that marine accidents are mostly caused by collisions between ships. The primary cause is insufficient lookout. In order to prevent marine collision accident, a lookout system that supports the navigator is essential. We defined the items required for constructing such system. In the step of "Requirement Definition", we propose a logical model of the new system by specifying the constraints and defining the scope of the system. We proved that it is necessary to add lookout function in navigational information system. We also show that it is important to integrate and fuse the information of AIS, radar, and lookout for preventing the collision of ships. In the step of "Outline Design", we explain the system structure. The structure was created according to object-oriented approach. And we describe the function of each sub-system and explain the hardware configuration and network configuration of the system.

Alt 22

Monte Carlo analysis of low-cost imu's on a graphics processor

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Evaluating low-cost Inertial Measurement Units (IMU) for purposes of Inertial Navigation Systems (INS) is a processing intensive process. The non-deterministic or stochastic error components of the IMU's output signal requires multiple simulation runs to properly evaluate the IMU's performance when applied as input to an INS. The Graphics Processor Unit (GPU) makes use of stream processing, which allows simultaneous execution of the same algorithm on multiple data sets. Monte Carlo techniques are applied to create trajectories for multiple possible outputs of the INS based on stochastically varying inputs from the IMU.

The processing power of the GPU allows simultaneous Monte Carlo analysis of several IMU's. Each IMU however requires a sensor error model, which entails calibration of each IMU to obtain numerical values for the main error sources of low-cost IMU's namely scale factor, non-orthogonality, bias, random walk and white noise. Three low-cost MEMS IMU's were calibrated to obtain numerical values for their sensor error models. Simultaneous Monte Carlo analysis of each of the IMU's is then done on the GPU with a resulting circular error probability plot. The circular error probability indicates the accuracy and precision of each IMU relative to a reference trajectory and the other IMU's trajectories.

The analysis process requires intensive processing and can take up to 6 hours to analyse one IMU's performance in 1000 Monte Carlo runs. Using the GPU however resulted in simultaneous analysis of three IMU's in as little as 5 minutes for 1000 Monte Carlo runs.

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Operational implementation of EGNOS in Aviation in Europe

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The most important objective for the utilization of the EGNOS system in aviation is to achieve the complete operational implementation in daily revenue operations. The main activities in Europe has to focus has on supporting the end users of identified niche markets. Aiming at supporting the introduction of EGNOS and Galileo services in the aviation market, the GIANT project for the "GNSS Introduction in the Aviation Sector" was born in 2005 and successfully ended in October 2008. The Project main objective was to show economic and operational benefits to end users while demonstrating that the required safety levels are maintained or improved to the responsible authorities. The project (www.gnss-giant.com) paid special attention to how GNSS systems particularly meet the needs of regional airlines, general aviation and helicopter operators and special effort within the project was devoted to the Flight Demonstrations in two of these domains. The project successfully promoted and trialled the introduction of EGNOS-based LPV applications in the area of Regional Aviation, helicopter HEMS (Medical) operations and North Sea Oil Rigs operations, with special focus and effort devoted to the flight demonstrations with the CRJ200. After the successful completion of the GIANT Project, the European GNSS Supervisory Authority (GSA) awarded a contract (GIANT-2 Project) under the first Call of the Galileo 7th Framework Programme, for the continuation of these activities in other three key identified niche markets for the EGNOS-based LPV approaches, namely: Corporate Aviation, General Aviation and SAR Helicopters. This paper will present the results of GIANT in the different domains covered by the project and the outcomes and foreseen activities in the GIANT-2 project that started in January 2009 and will end in 2011.

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Evaluation results of multilateration at Narita International Airport

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The multilateration is a new surveillance system which has been introduced for air traffic control in recent years. This paper describes evaluation results of performance tests for the multilateration conducted at Narita international airport for airport surface surveillance. Increasing aviation demand has brought expansions of major airports. As a result, the airport layout and operations become more and more complicated. Providing accurate and highly reliable surveillance information to air traffic controllers is an essential requirement, in order to ensure safe and smooth operations in this situation. And this requirement needs to introduce a sophisticated surveillance system, such as the multilateration. The multilateration detects signals of SSR transponder (Secondary Surveillance Radar), and measures a target position by the TDOA technique (Time Difference Of Arrival). To achieve high performance in the multilateration, the most important thing is an appropriate antenna allocation. In the evaluation tests, decrease in performance by signal interference occurred at the apron area especially. This paper points out problems associated with the inappropreate antenna allocation in the evaluation tests. In addition, this paper provides an improvement idea for the antenna allocation to mitigate the decrease in performance. The evaluation results indicated that the improvement idea is effective to resolve the problems.

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Arctic observing system for navigation in ice regions

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An Arctic Regional Ocean Observing System (Arctic ROOS) has been established by a group of 14 institutions from nine European countries working actively with ocean observation and modelling systems for the Arctic Ocean and adjacent seas. There is an increasing demand for information about ocean, sea ice and atmosphere at high northern latitudes to support navigation and operation in Arctic waters. Arctic ROOS will promote, develop and maintain operational monitoring and forecasting of ocean circulation, water masses, ocean surface conditions, sea ice and biological/chemical constituents. This information can only be achieved by close integration of data from in situ observations (ships, moorings, buoys, floats), remote sensing (satellite, aircraft, land based), and from numerical model simulations. Of particular importance is use of satellite radar images (Synthetic Aperture Radar) that can map details of the ice cover independent of light and weather conditions. During the International Polar Year (IPY) there are enhanced observational efforts of the Arctic and sub-Arctic seas, with testing and implementation of new satellite monitoring systems and in situ instruments and platforms for data collection and data transmission. Many of these systems are developed and operated by support from EU projects, in particular MyOcean, as well as other projects contributing to the implementation of GMES and GEOSS. One of the goals of Arctic ROOS is to contribute to the legacy of IPY, maintaining cost-effective and useful observing systems after the end of IPY. The members of Arctic GOOS are data providers running operational services and research programmes collecting ocean and sea ice data and value-added products for dissemination to different user groups. Data dissemination of Arctic ROOS will follow the guidelines of EU (INSPIRE Directive) and the GEOSS Data Sharing Principles. More information about Arctic ROOS is found at www.arctic-roos.org.

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Effectiveness of estimated environmental stress value monitor

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In the congested waters of the world collisions continue to occur despite the ability to track vessel movements by the Automatic Identification System and the exchange of information between ship and shore station via the Vessel Traffic Service. A Radar/ARPA is carried on board to detect other ships around one's own ship and to show information regarding potential collision. Accidents happen because information given to mariners pertains only to the moment and not to the future. It is difficult to make navigational adjustments according to the future movements of other ships in congested water. Older information support systems also deal only with the present conditions in the area. They do not indicate the degree of difficulty in ship-handling which will be imposed on mariners in the immediate future. In this paper, we developed a new information support system to quantitatively determine the estimated environmental stress value imposed on mariners when moving from one problem area to the next area. In addition, the system has been developed to help mariners understand their present and future navigation situations visually. The system shows the difficulty of ship-handling due to other ships. The monitor consists of transition of difficulty when the course of own ship is assumed to be maintained, and transition of difficulty when it is assumed to change. Therefore, decision making to avoid other ships becomes easier by use of this system. To evaluate the effectiveness of the system, experiments using a ship-handling simulator were done. One group used the Radar/ARPA to get information for avoidance. The other used the new system. Results reveal that mariners can be guided more easily in congested water using the system. This fact makes use of an estimated environmental stress value monitor in conjunction with a bridge simulator an effective teaching tool. And, we believe that the system will become a useful support system on board to reduce accidents at the sea.

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On numerical navigation for a ship under simulation of tidal current and wind over the sea in coastal water

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The numerical forecasting of tidal current or wind over coastal water are important for the effects to the sailing ship. The numerical simulation of tidal currents was carried out at Osaka Bay in Japan. The detail tidal current was calculated using POM (Princeton Oceanography Model). The numerical results of tidal currents was compared with the calculated ones by the tidal harmonic coefficients of the tidal table at the locations in the bay. Comparing the numerical and calculated results, both results are agreement very well. The numerical simulation of wind over the sea in the same bay was carried out. The detail distribution of wind on the sea was calculated using MM5 model (the 5th generation Meso-scale Model). The numerical simulation of wind was compared with the observed result at the atmospheric center of Japan. The numerical navigation of a ship was carried out under simulation of tidal current using the ship maneuverability theory of MMG.
The final object of this simulation of numerical navigation for a ship is to develop the weather routing for navigation of a small vessel in relatively narrow coastal water. Many studies on ship navigation for large transoceanic vessels have been conducted as the weather routing. However, not many studies on the weather routing for navigation of a small vessel, have been conducted. In fact, even in short-distance navigation, the cumulative sailing time will be large enough to deserve a great economical consideration. Furthermore, because of the diminishing petroleum oil reserves and the development of powerful high-speed engines, it is likely that the cost of fuel will be very high in the near future. As the first step for this final object, the effects of the tidal current or the wind on a ship□fs maneuverability by numerical simulations were examined. Comparing the simulated rhumb lines of a ship with the dead reckoning tracks, it was recognized that the effects of tidal current or wind on the sailing ship were large.

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Modelling of domain spanning terminologies for GNSS-positioning systems by means of ontology-based system-engineering

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This paper presents a new approach for specification modeling of GNSS-Positioning Systems by means of ontology-based-System Engineering. The objective is to afford safety-critical railway applications based on GNSS-positioning. The latter shall be realized by giving requirements-engineering of railway transportation domain the possibility to formulate their needs in their own terminology but to translate them to a common physically-based terminology afterwards. This physically-based terminology shall be used by developers of GNSS-positioning systems (e.g. receivers) to meet the appliers demands from the railways. The main problems may be stated as follows:
1. A common syntax and semantic for description of terminologies
2. Method to define and formulate interfaces between domain-specific and GNSS terminology
3. Definition of common physically-based terminology, compatible to GNSS specifications.
Each traffic mode, as railway, automotive and aviation, holds its specific terminology to specify requirements concerning e.g. accuracy and availability of positioning. At railway transportation there exist different standards exactly specifying the needs and requirements to positioning for their safety-related applications. Furthermore the upcoming Galileo-System is presently specified using terminology from aviation-technology. Considering these transportation domains there is a lack of interfaces between the respective terminologies to enable the developers of GNSS positioning systems to fulfill the appliers' specifications.
To overcome these problems due to different terminologies, here an approach is presented which is based on UML as a method for describing terminologies, ontological formalisms and the relations between different terms. As result this paper demonstrates accordingly modeled terminologies of rail and aviation domains and their linguistic interfaces which shall be the basis for further development of a physically-based common terminology.

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Compensation of time alignment error in heterogeneous GPS receivers

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Commercial GPS receivers extensively utilize low-quality oscillators such as Temperature Compensated Crystal Oscillators (TCXO) and Ovenized Crystal Oscillators (OCXO). As widely known, if a crystal oscillator is utilized as the time reference of a GPS receiver, the resulting clock bias error grows fast. To prevent the clock error becoming too large, clock steering mechanisms are usually utilized in commercial GPS receivers. Since the clock steering mechanism is different from one manufacturer to another manufacturer, time alignment errors arises inevitably if heterogeneous GPS receivers are utilized in differential positioning or differential time transfer. This paper investigates the how the different clock steering mechanisms can affect the position estimates in differential positioning and proposes a solution to eliminate the effects of the time alignment error.