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PROCCEDINGS | **10 - 13 September 2007**

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COMPUTER SCIENCE AND AUTOMATION

COMPUTER SCIENCE MEETS AUTOMATION

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Preface

Dear Participants,

Confronted with the ever-increasing complexity of technical processes and the growing demands on their efficiency, security and flexibility, the scientific world needs to establish new methods of engineering design and new methods of systems operation. The factors likely to affect the design of the smart systems of the future will doubtless include the following:

- As computational costs decrease, it will be possible to apply more complex algorithms, even in real time. These algorithms will take into account system nonlinearities or provide online optimisation of the system's performance.
- New fields of application will be addressed. Interest is now being expressed, beyond that in "classical" technical systems and processes, in environmental systems or medical and bioengineering applications.
- The boundaries between software and hardware design are being eroded. New design methods will include co-design of software and hardware and even of sensor and actuator components.
- Automation will not only replace human operators but will assist, support and supervise humans so that their work is safe and even more effective.
- Networked systems or swarms will be crucial, requiring improvement of the communication within them and study of how their behaviour can be made globally consistent.
- The issues of security and safety, not only during the operation of systems but also in the course of their design, will continue to increase in importance.

The title "Computer Science meets Automation", borne by the 52nd International Scientific Colloquium (IWK) at the Technische Universität Ilmenau, Germany, expresses the desire of scientists and engineers to rise to these challenges, cooperating closely on innovative methods in the two disciplines of computer science and automation.

The IWK has a long tradition going back as far as 1953. In the years before 1989, a major function of the colloquium was to bring together scientists from both sides of the Iron Curtain. Naturally, bonds were also deepened between the countries from the East. Today, the objective of the colloquium is still to bring researchers together. They come from the eastern and western member states of the European Union, and, indeed, from all over the world. All who wish to share their ideas on the points where "Computer Science meets Automation" are addressed by this colloquium at the Technische Universität Ilmenau.

All the University's Faculties have joined forces to ensure that nothing is left out. Control engineering, information science, cybernetics, communication technology and systems engineering – for all of these and their applications (ranging from biological systems to heavy engineering), the issues are being covered.

Together with all the organizers I should like to thank you for your contributions to the conference, ensuring, as they do, a most interesting colloquium programme of an interdisciplinary nature.
I am looking forward to an inspiring colloquium. It promises to be a fine platform for you to present your research, to address new concepts and to meet colleagues in Ilmenau.

Professor Peter Scharff
Rector, TU Ilmenau

Professor Christoph Ament
Head of Organisation

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M. Arredondo / A. Cormack

SeeTrack: Situation Awareness Tool for Heterogeneous Vehicles

INTRODUCTION

SeeTrack is a mission planning, monitoring and post processing tool for rapid on-site analysis and data fusion of sensor data, including sidescan, imaging sonar, and video. It is a highly modular, equipment-agnostic system and is designed to perform on both notebook and desktop environments. It has been successfully deployed on numerous surveys, military exercises, and scientific experiments.

SeeTrack is platform and manufacturer independent, currently supporting a variety of underwater vehicles (e.g. Remus, OEX, Hugin, Morpheus, Gavia, Autosub, RAUVER) and sensor suites; including a number of sidescan and imaging sonars from different vendors (e.g. Marine Sonics, Klein, Didson), video, CTD, bathymetric and navigation sensors (INS/DVL, LBL, USBL, GPS). It runs on Windows compatible notebooks or desktop computers.

SeeTrack supports concurrent data visualization and processing of the various vehicle data products in an intuitive, easy to use fashion. Crucially, the system exhibits rapid operation, with data import and processing times which are orders of magnitude faster than other commercial systems, suiting in-stride operational needs.

In this paper we present SeeTrack's design concepts and some of its main features, which make it the ideal tool for situation awareness of heterogeneous vehicles.

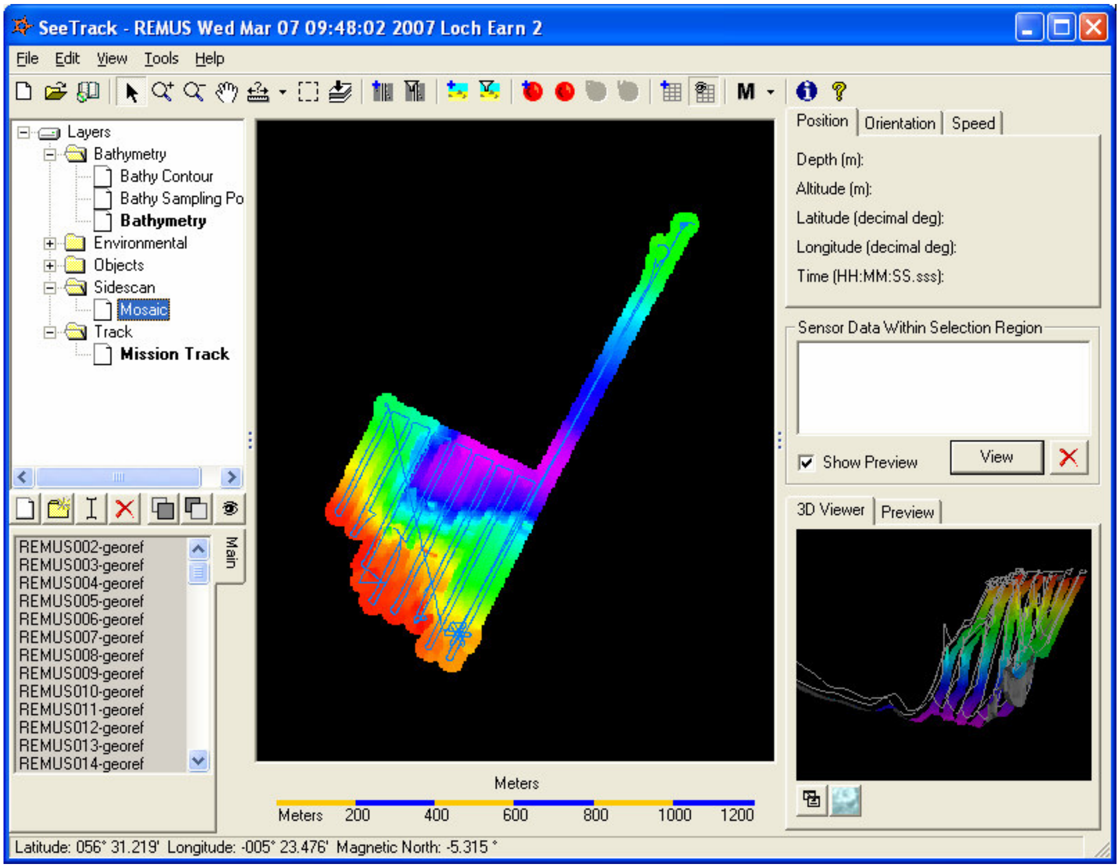

Figure 1 SeeTrack's main window.

DESIGN

SeeTrack has been designed around three main concepts:

1. SeeTrack uses a modular, hot-swap plug-in architecture. The free SeeTrack SDK allows for different vendors of vehicle platforms/sensors to create drivers that allow SeeTrack to import, visualize and analyze vehicle/sensor data. In the same way the SDK allows for the development of plug-ins for processing data (e.g. Seafloor classification, mine detection in sidescan sonar).
2. SeeTrack is designed as a geographical information system (GIS); that is, it allows the geo-location of vehicle and sensor data, which is crucial for mission planning, monitoring and analysis. Furthermore, working on a GIS allows users to import legacy data from other sources (e.g. charts, contacts, locations of interest, satellite images, etc.) For military personnel, working on a GIS allows them to identify potential targets for reacquisition and data fusion.
3. SeeTrack has been developed from the start as an operational tool. It has a very easy to use interface and displays the data in a friendly way. Users can access

data from any mission, process them and export the results to external systems (e.g. MEDAL and MINTACS) in only a few clicks. Finally, SeeTrack capabilities are well adapted to the needs of the user as it only requires a standard laptop to run.

CAPABILITIES

SeeTrack offers several key advantages compared to other software systems:

1. It integrates multiple sensors in one common geo-referenced environment, allowing users to run missions more efficiently. For example, sidescan sonar interpretation is enhanced as three dimensional navigation of the vehicle is available. Another example of the advantages of a common environment is the use of video data to confirm detections of mines made in the sidescan sonar.

2. Its open architecture allows to plug-in processing modules, which can be developed by SeeByte or by third party. SeeByte plug-ins like the Computer Aided Detection and Computer Aided Classification of mines (CAD/CAC) and the Seafloor Classification have proven very successful in different sonars.

   SeeByte's CAD/CAC [1] uses a model-based approach, where both the sonar process and the physical parameters of the objects being searched for are considered during the analysis process. This provides several appealing properties. First, as AUV computational capabilities improve, the models can be continuously adapted to include more realistic information and simulations, resulting in improved performances. Second, contrary to the currently favored feature-based CAD/CAC systems which provide a 'black-box' solution, it is possible to determine why the model has provided a given solution. Last, the CAD/CAC is not sonar or platform specific and may be easily ported to access data from different sonars including emergent Synthetic Aperture Sonar (SAS) technologies.

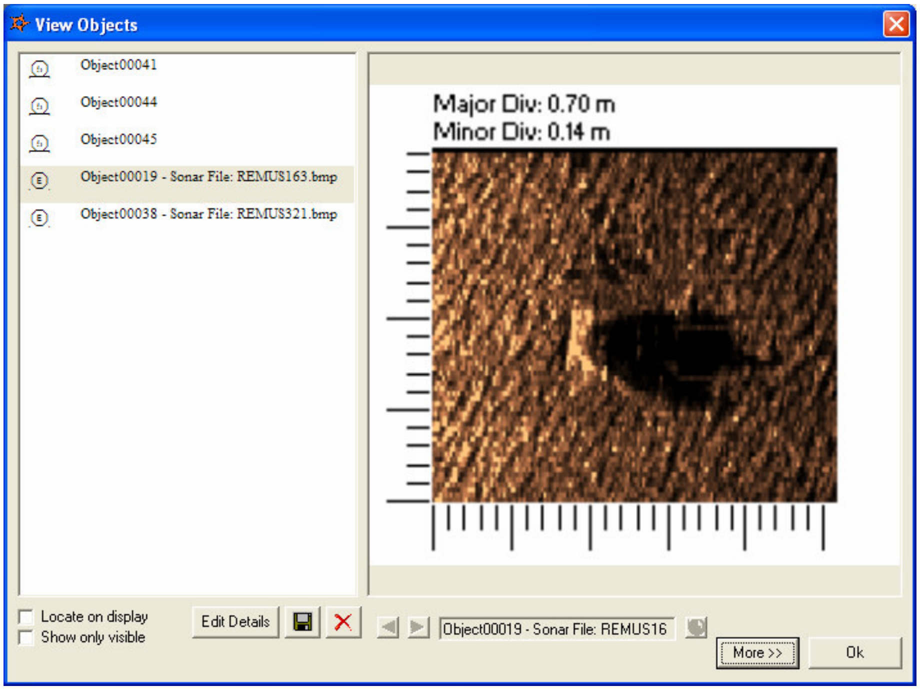

Figure 2 SeeByte's CAD/CAC has been successfully tested on different sidescan sonars.

In terms of navigation processing, SeeTrack can post-process navigation for error correction using an Extended Kalman Filtering with smoothing, ensuring better estimates of true locations of objects on the seabed and a high quality mosaicing of sonar and video data.

The latest addition to the repertoire of SeeTrack add-ins is the Performance Analysis and Training Tool (PATT) [2], which allows the evaluation of Mine Detection and Classification models. PATT uses an augmented reality approach: a mine simulator and sonar renderer model places ground truthed mine objects into real sonar data; a seafloor classification module is used in conjunction to classify the survey region into areas according to mine huntability. These two modules combined allow the evaluation of Automatic Target Recognition (ATR) algorithms in a large variety of scenarios. From the evaluation, Mine Counter Measure (MCM) missions may be planned to maximize the probability of mine clearance. Furthermore, ‘what-if’ scenarios (increasing sonar resolution, altering AUV trajectory) may also be considered and the results used to impact future MCM operations.

3. The system has the ability to perform fast and accurate mission analysis on a portable, low-cost platform enabling on-site mission assessment and decision

making. For example, a typical two hours REMUS mission with CTD data display and sidescan geo-referencing takes approximately 15 minutes.

SEETRACK AS GREX'S USER INTERFACE

The main object of the European Project GREX [3] is to create a conceptual framework and middleware systems to coordinate a swarm of diverse, heterogeneous physical objects (underwater vehicles) working in cooperation to achieve a well defined practical goal (e.g. search of hydrothermal vents) in an optimized manner.

SeeTrack provides the ideal software tool for the mission planning, monitoring and analysis of missions performed in the context of GREX. Planning of tasks for the heterogeneous vehicles can be performed using SeeTrack's friendly mission planning interface, which allows for simple point and click planning over charts or satellite images. During mission execution, live position and data from the vehicles can be displayed via Ocean-Shell messages [4]. Data can then be loaded and displayed in SeeTrack for post-mission analysis, so that success of the mission and quality of the data gathered can be evaluated.

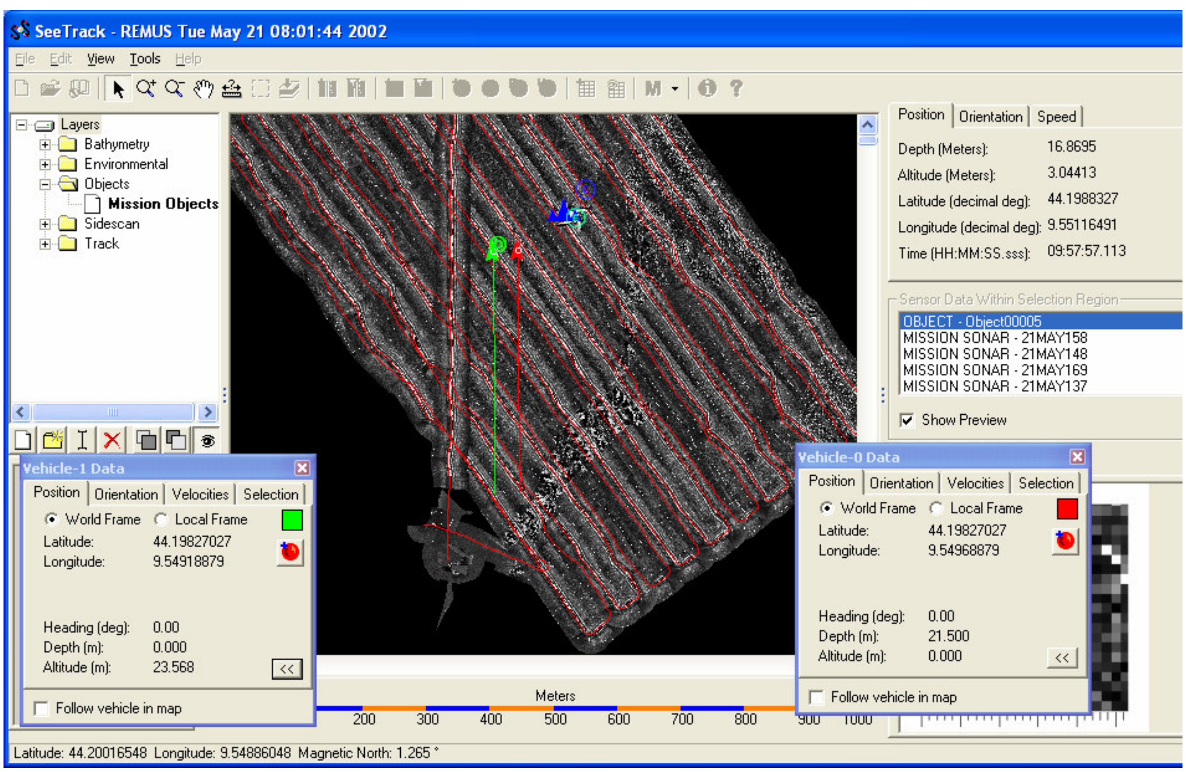

Figure 3 Live position and data from vehicles is displayed in SeeTrack using Ocean-Shell messages.

SUMMARY

The use of multiple sensors and vehicle platforms for AUV operations brings the need for a single interface to plan, monitor, analyze and report all the data products, regardless of the platform used to acquire the data. SeeTrack provides a system that enables this functionality and interoperability in a common application.

This paper has presented SeeTrack's design concepts and some of its main features, which make it the more suitable software tool for the situational awareness of heterogeneous underwater vehicles.

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