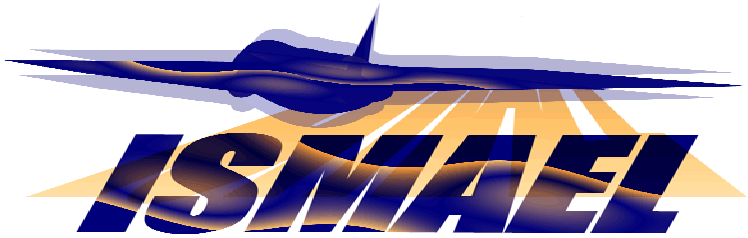

Intelligent Surveillance and Management Functions for Airfield Applications Based on Low Cost Magnetic Field Detectors

Publishable Executive Summary

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4	Centre for Research and Technology Hellas	ITI-CERTH	Greece
5	HiTec- Vereinigung High Tech Marketing	HITEC	Austria
6	Fraport AG	Fraport	Germany
7	Advantage Technical Consulting	ADVANTAGE	United Kingdom
8	European Research and Project Office GmbH	EURICE	Germany

General objectives

The main objective of ISMAEL is the development of an alternative system for surface movement surveillance at airports and thus to improve safety and efficiency of ground movements. A new detector based on magnetic sensor technology will be developed for use within Advanced Surface Movement Guidance and Control Systems (A-SMGCS) at major international airports or as cost-effective alternative to Surface Movement Radar at smaller airports.

In order to understand the needs and demands of operational users of such systems, ISMAEL captures the requirements for an effective and usable system from a technical, economic and legal point of view and identifies relevant user groups. Appropriate hardware prototypes for magnetic field detectors will be developed and their function will be optimised through laboratory and field trials. ISMAEL will develop and apply complex algorithms for the detection and identification of vehicles and to measure speed and direction. Furthermore it will be examined whether the developed detector module can be successfully integrated into complete systems for airport applications by developing a solid concept for combining the detector output with other information sources like radar and flight data etc. In this context the potential benefits of the new technology for enhancements of existing systems as well as for new systems are also explored. By means of practical experiments and trials in real airport environments it will be investigated if the new detector technology is able to satisfy the

identified user requirements and it will be determined where further work or investigation of the system is required.

In this context a socio-economic evaluation of the system's impacts on users and society in general will be carried out including an analysis of users' acceptance, of relevant regulatory issues and of costs and benefits in particular for smaller regional airports. A detailed market analysis will deliver the basis for improvements of the detector system and its further development towards a marketable product. For those purpose market opportunities, adoption barriers, and competitive pressures will be identified and different operational scenarios set up. To provide for valid implementation and marketing strategies the technical and economic potential with respect to the most promising applications will be considered putting special emphasis on safety related applications. The ISMAEL project and its results will be made transparent to both experts and the general public by means of extensive dissemination activities of all partners. Main objective is a real communication policy at the same time coherent, consistent, and finalised with respect to identified user groups, standardisation bodies, and other relevant stakeholders.

Work progress and results achieved

Within the second period of the project the development of aircraft detection system based on magnetic field detector and sensor data fusion (SDF) server is the most important task. Concept design on realising defined airport applications and system demonstration activities are also focuses of this period.

In the first project period, potential user groups/stakeholders for ISMAEL were derived. The user needs and performance requirements for the range of possible applications in airport traffic control were captured and analysed. Applications with real potential added value resulting from magnetic sensor detection were identified as Runway Incursion Protection, Gate Management and Airport Surveillance (either as a stand alone solution in smaller airports or as part of an integrated A-SMGCS suite at larger airports).

In this context, to assure an easy integration of the ISMAEL system in the airport environment it is vital to specify the system in accordance with the relevant conditions and regulations.

Based on the experiences obtained from the first two generations of sensor head, the detector based on third generation-C-Series has been developed in this project period. This design has several improvements which avoid shortcomings in the last generations. It uses a processor with DSP (Digital Signal Processor) functionality. The sensor head has – just like A- and B-Series - three equal channels for the three-dimensional detection of earth field changes. The three-axis-signal is sampled and mathematically filtered inside the controller. Different filtering techniques are used to filter out frequencies. The detector's firmware reacts on changes of the sum of the (unsigned) magnitudes of the three axes and currently signals on demand the binary states "Field disturbed" and "Field not disturbed" via RS485. 27 PCB were assembled and soldered.

In addition, development of sensor head focuses in solving problems, which were found during former sensor head tests. Especially, the output shift of the sensor head caused by the temperature coefficient of the resistance of the complete sensor and by the change of its sensitivity to magnetic fields has been discovered. The most promising approach to this problem is a local compensation of the magnetic field at the sensor's position. This compensation was realised via a control loop. In this setup, there is a compensation coil which can produce a magnetic field reverse to the external magnetic field through adjusting the current through the coil. The magnetic sensing elements always work in zero magnetic field conditions which avoid the temperature shift caused influence.

After the first samples of the detector module based on C-series sensor head were available, laboratory tests of detector modules were carried out. All devices reacted on commands sent via the bus as expected. Apart from sensitivity, noise level and the temperature behaviour were tested. The analogue signal corresponds to the final digital output of the detector linearly in a defined magnetic field range. The C-series provides a lower noise level over the full frequency span than B-series. As the frequency response of the B-series in the range to 100Hz is nearly flat, the C-series has a slope in the stop band of more than -30dB/decade. Thereby environmental noise will be damped. In the temperature range between -40°C and 85°C, the C-series sensor head has a stable output. This characteristic makes the C-series based detector suitable for all weather applications and tests.

In the first project period, five pieces of B-series sensor head prototypes were installed at Taxiway of Saarbruecken airport. Field tests have been applied to passing by aircraft including Boeing 737, Fokker 50, Cessna 525 Citation Jet, ATR 42, etc. As of end of 2005, 136 magnetic profiles of 60 individual aircraft and 27 types and relevant subtypes of aircraft have been recorded. Under current test setup, all tested aircraft can be detected by sensor head prototypes in the middle of taxiway. One database, which contains signals from all tested aircraft, is under construction. These data will be further analysed. Test results on same aircraft but in different time prove the reproducing ability of the sensor head.

As detector module based on C-series sensor head became available, the array at Saarbruecken airport was modified in order to test those new detectors. In January 2006, three detectors based on C-series sensor head have been applied to replace the B-series sensor head.

Within this project period the interface of SDF server to the magnetic detectors was developed and the MHT (Multiple Hypothesis Tracking) tracker was integrated. Furthermore, modifications and improvements were made to the graphical user interface. The system was successfully tested at the laboratory, where tests of various scenarios were conducted. Furthermore, the Data Transmission Unit was also developed, enabling the transmission of data via UDP/IP (User Datagram Protocol/Internet Protocol) communication. The data is coded in ASTERIX Cat10 format, a standard developed by EUROCONTROL for the exchange of radar data, but extendable to any kind of surveillance data. Finally, for the evaluation of the SDF, a software package, called Test Analysis Client, for statistical analysis was designed and is under development.

To achieve the three defined airport applications, detector locations have been defined at both test sites -Frankfurt airport and Thessaloniki airport. Detector position and numbers have been optimised based on detector features as well as airport application requirement. Communication aspects among detectors and server have been defined and the first system level tests have proven the successful communication among these components. Detailed installation plans for both sites have been produced to assure practicability for both, demonstration and assessment. At Frankfurt airport the gate B46 has been chosen for detecting the aircraft parking situation. Meanwhile taxiway S will be used for runway incursion protection and airport surveillance. Existing cable tubes have been examined and can be used to hold the cables for the detector. At Thessaloniki airport, the installation of eight magnetic detectors along the centerline of taxiway A was decided. The distance between the magnetic detectors was decided to be 30 meters, apart from the last detector (beyond the stop line) that will be installed 20 meters away from the previous one for better monitoring of the stop line. The installation of detectors as well as the installation of the required cabling was started and completed in October, 2005. All cables from magnetic detectors end at a small building near the taxiway A, where communication cables already exist and are available to be used for transferring the signal to the tower. The central SDF server computer was installed at the tower and connected with magnetic detectors network. Currently, first tests are executed with the established detector arrays at Thessaloniki airport to validate the expected performance. Additional tests with a different detectors configuration at Frankfurt airport will also be conducted providing more information about the functionality of magnetic detectors.

The consortium investigates the possible interface of ISMAEL system with other A-SMGCS systems, where the data from the SDF server will be correlated with radar and flight plan data or with data from other surveillance sensors (e.g. SMR (Surface Movement Radar)). Working on this direction, the SDF server has been developed to provide output in ASTERIX Cat.10 format, which is a standard for the exchange of radar data.

During the first half of the reporting period the Assessment Plan was updated with respect to the remarks of the Annual Review Meeting. The main activity in technical categories was the coordination between WP 5 and WP 3 (“Detector and System Development”) and WP 4 (“System Demonstration and Optimisation”) concerning the technical assessment especially at Frankfurt Airport.

Within this project period the estimation and analysis of the market potentials for ISMAEL’s magnetic sensing solution was completed as planned. First steps of analysis with respect to identifying market opportunities as well as potential barriers for the future market introduction of the ISMAEL solution on the part of the users, airport operators, and other relevant stakeholders of the aviation community, have been taken.

Also standardisation activities were started. First steps consisted in a documentation search regarding relevant standards and regulations. Particular attention has been paid to existing and emerging international standards for A-SMGCS.

The dissemination task of ISMAEL makes the activities of the project transparent to both experts and the general public. Besides several papers and articles in national and international

journals, magazines, and online publications, the following dissemination activities shall be further highlighted: 1)The German TV station 3SAT has produced a short documentary about the ISMAEL project, which was presented in the framework of "nano", a popular scientific serial, on November 10, 2005. 2) ISMAEL submitted and presented in the '5th European Congress and Exhibition on Intelligent Transport Systems and Services', JISSA conference, the fourteenth eChallenges, the e-2005 Conference and the ITSC '05 – 8th International IEEE Conference on Intelligent Transportation Systems.

Following the success of the first Cluster Meeting, the project officers of ISMAEL, AIRNET, and SAFE-AIRPORT, three projects funded within the scope of the "eSafety of Road and Air Transport" action line of FP6, organised another cluster meeting that should give the three participating projects the opportunity to identify and explore potential opportunities for cooperation in more detail. As a result, an integrative approach that takes up the individual strengths of each project approach in and integrates it them into a complete architecture was identified as promising future roadmap. The common goal should be the exploitation of multiple sensors to generate an accurate and reliable surveillance network at affordable cost.

A subsequent cluster meeting to specify a common concertation agenda was held in Toulouse. A joint presentation of the three airport projects has been prepared and published on the IST website of the EC, and a joint cluster web portal has been put online http://www.airport-safety-cluster.com. The main focus of this platform is to increase the visibility of European research and development activities in the field of traffic safety at airports. Synergy potentials, joint activities, upcoming events, and common exploitation potentials are presented to keep interested parties informed and attract potential clustering candidates. In addition, plans for a joint STREP or IP for FP7 exist aiming at developing a common integrated system based on the complementary underlying technological approaches of the three cluster projects.

Expected end results and intentions for use and impact

A steady increase of air traffic over the last decades has led to the situation that many major airports are working at their capacity limits. Efficient measures are required to overcome the resulting delays and to cope with the projected traffic volume in the future. ISMAEL responses to these emerging needs with the following expected results:

- The addition of new, comparatively low-cost passive sensing technology to SMGCS
- A SMGCS solution for regional and smaller airports
- A candidate contributor to existing SMGCS solutions by adding a new technology module to survey otherwise hardly controllable airport areas, e.g. blind areas of SMR coverage, or where active sensors are not sufficient and reliable, since not all aircraft and vehicles are equipped and there is no fall back in case of failure.

Intentions for use and impact

According to the main philosophy in aviation: “safety first”, this project contributes to this objective by enhancing situation awareness to the control personnel. ISMAEL will provide precise and accurate surface surveillance irrespective of visibility, which will be of great help for keeping the airport management in a safe situation at small or middle-size airports. The ISMAEL product can also be used as point surveillance which works as one input to a multisensor A-SMGCS at a major airport – fixed point surveillance independent of other systems at critical locations such as runway stop bars. A worldwide market is accessible in more than 80 countries, each with at least 5 airports with a need for SMGCS in various levels of complexity. Large project integrators and airport development companies will be interested in the technology, once its usability and reliability has been proven.