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“Avoid Aircraft Accidents” – EU FP7 Collaborative Project Proposal with participation Miklos Zrinyi National Defense University

Abstract. This paper is initiated by ongoing collaborative project proposal for EU FP7 made by ten participants from six countries. By our concept and objectives: many aircraft accidents still occur that could have been easily avoided. Causes of critical accident are classified in four main groups by the safety boards: Weather, Equipment, Systems and Human. The Hungarian research group, created from members of MZ NDU, Institute of Aviation and Air Defense and Institute of Informatics and Communication is deeply interested in success of project. By this paper we would like to inform and the same time call the experts, enthusiastic peoples to support us with their ideas, suggestions and proposals.

Keywords: Avoid, aircraft accident, automatic, aircraft health monitoring system, pilot skills.

Introduction

According to statistics many accidents, especially of small aircraft and less skilled pilots, are produced by the inadequate pilot reaction to a weather, equipment or system problem. The main cause is not the pilot itself, but avoiding the fatal consequence is only possible if the pilot is expert enough. The project will divided two main parts as increasing knowledge about root causes of accidents and derive the best practices, requirements for the avionics and procedures for pilots, and also proposing the new ICADS concept, which will function as “virtual copilot”, surveillance the aircraft health and nearby airspace. As a human copilot, the ICADS will offer advises to the pilot on aircraft operations, like new routes, proper reactions to malfunctioning or maneuvers suitable for avoiding external hazards. [1]

Notice: further in this paper we will use and cite part of [1] project proposal often – without sign. The reason is the proposal was written by collective effort – in side Hungarian participants – but could not be familiar with large audience of other MZNDU members.

Progress beyond the state-of-the-art[1]

From its origins on late 1970s, avionics systems have increasingly evolved, especially in last years with the introduction of new aircraft like Airbus A380 or Boeing 787 Dreamliner. Mechanical, electromechanical and hydraulic control systems are decreasing in number while electronic systems are substituting them. Gauge based cockpits have evolved now to glass cockpit. Federated architectures move to Integrated Modular Avionics (IMA) architectures. And the main target of all these improvements is to improve aircraft safety.

Avionics components include voice communications, data communications, navigation information, collision avoidance alerts, health monitoring and maintenance logs, and the most advanced ones, the Flight Control Systems (FCS). A number of sensors are spread on board but also out of the aircraft to capture the required information. And an increasing number of displays that compose the cockpit are the interface of those systems with the pilot. The main cockpit components on a large aircraft are: EFIS (Electronic Flight Instrument System), which provides aircraft position (horizontal and vertical), time and speed; EICAS / ECAM, that Monitors engines and aircraft mechanical parts; And several awareness systems about weather (NEXRAD), airplanes in the airspace (TCAS / TPAS alerts), traffic on runways: AMASS, and terrain: GPWS / TAWS. Also a large number of proposals on new avionics and new concepts have been proposed to improve safety and pilot's awareness.

Most small aircraft usually flight only on VFR conditions. Avionics present on these aircraft are simple and cheap, most of the times limited just to the mandatory magnetic compass, barometric altimeter, anemometer and chronometer. When flight is done on controlled airspace, aeronautic radio and transponder might also be present.

Figure 1. Mandatory instruments for VFR[2]

In recent years the reduction of prices on GPS based navigators has produced the incorporation of these systems. Garmin AereaTM or GPSMAPR are examples of last GPS portable equipments for aircraft. For less than three thousand euros they provide the position of the aircraft in an aerial 3D map, and also the vertical profile of the terrain and its obstacles with awareness in case of few separations. Also real time weather information, or air traffic alerts are included in the most expensive portable navigators.

[1] Part of 1.2. chapter of proposal - describing very deeply the background of general aviation completed by authors S. Fassois, G. Notarstefano and others.
[2] Figure (1.4.) from AAA-ICADS proposal

Some projects which started for large aircraft, like the tunnel-in-the-sky system proposed by Delf [http://www.tudelft.nl], have been adapted for small aircraft. This project in particular developed the Delphins Synthetic Vision system to display a tunnel for secure navigation approaching to an airport. A similar concept is what the project AAA targets, but focused on aircraft which is already or very close to a hazard. The project extends the state of the art in several technologies and research areas, since the hazard causes and consequences can be diverse:

State of the art and advances in Aircraft Health Monitoring

In flight vehicles, where failures may result in loss of life or loss of a high-value asset, safety and reliability are the two principal goals to be achieved. The designer of avionics and associated aircraft systems must ensure that each such critical device has the capability of providing its function without significant interruptions, for maintaining the operability of the general system and, accordingly, the aircraft airworthiness. This mission is even more crucial, given the non-ideal operational environment of avionics (vibrations, humidity, electrical transients and so on), and their complexity which sometimes results in design or implementation faults. For this purpose, specific modules are designed to diagnose (that is, detect and identify) faults in avionics and critical systems, and provide help (in form of the flight control reconfiguration) for supporting the operational level of the overall system. Additionally, all major avionics and aircraft systems are designed to provide fault-tolerant operation, meaning that they may sustain a certain degree of fault occurrence while still functioning acceptably.

This diagnostic and fault-tolerant framework is implemented for critical actuators, sensors and digital avionics via the physical redundancy principle, that is, the introduction of parallel hardware devices performing the same action. Hence, if one of the devices is affected by fault(s) it is easily detected (via comparison with the rest of them) and its output can be disregarded. Note that, especially for avionics, emphasis is given on producing the necessary signals from dissimilar redundant computers. Thus, situations with failures which could affect near simultaneously copies of a specific redundant computer due to a single cause (a situation referred to as common mode failure-CMF) can not happen. Nevertheless, the hardware multiplication has its limits due to cost and added complexity. Hence the physical redundancy strategies may ideally, be complemented by novel FDI and reconfiguration schemes based upon the principle of analytical redundancy. This stipulates the effective use of available measured signals along with decision-making algorithms, in order to cost-effectively deliver diagnostic results, without additional hardware. The intensive research conducted over the past years on the creation of analytical redundancy (supported by various NASA grants or European Commission projects), has resulted in several relevant schemes.

One class of such schemes is based on the Interactive Multiple Model (IMM) [2], the Multiple Model Switching and Tuning (MMST) [3] or Neural Network (NN) based [3] principles: In all schemes, specific dynamics are represented in healthy and various faulty states of the examined aircraft system via either Kalman filters (IMM), linear adaptive models (MMST), decentralized neural networks [4] and so on. Measuring the deviation between the “current” dynamics and those described by each one of the health state-related models, ensure detection of the system’s health state (and reconfiguration for the MMST and NN based schemes). Other relevant schemes are based on the modeling of relationships among specific available flight data (attitude signals, angle-of-attack and so on) via stochastic nonlinear models with constant [5] of time-dependent [6] coefficients. These relationships are valid only for an aircraft in nominal (healthy) state, meaning that when single or multiple faults occur, changes are induced in these relationships. Then, in-flight comparisons of the nominal and the current aircraft dynamics provide fault-related information, which is statistically evaluated for FDI purposes. Finally, nonparametric schemes (that is, not based on modeling of aircraft system dynamics) have also been proposed, often for the detection of sensor abrupt faults [7]. Such schemes process sensor signals (Angle-of-Attack in [6]) by non-stationary removal, outlier removal, whitening and so on via suitably estimated filters. Hence, any fault-related information is exposed and may be assessed via statistical decision-making or threshold strategies.

State of the art in Sensing Technologies

Electro Optical (EO) and Infra Red (IR) sensors are used in all types of aircraft and helicopters for the surveillance. In recent years they were incorporated in the “sense and avoid“ systems of the military aircraft. These systems are powerful but they require on board complicated FPGA electronic devices and they are too heavy for the small aircraft. In the period of several years increasing air traffic is expected to be pushing the safety separation distances on common aerospace in Europe. In order to provide the safe operations of all demanding aircraft in this new environment it is necessary to increase of their outside sensing capability. Several important new EO/IR devices that have been developed in recent years may be used for this purpose. NASA Langley Research Centre developed a visualization method that is projecting on the screen inside the pilot helmet images from the camera that is installed in the aircraft nose. The system is designed in such a way that does not overload pilots with information, undercutting their “situation awareness” by giving them too much to track. Many light weight gyro-stabilized EO/IR sensors with pan, tilt remote control are commercially available and have been proven in flight. Also light weight laser range finder devices have been developed and are commercially available. In the project we will investigate the best configuration for a good image capture and later process.

State of the art and advances in Automate Reactions

The great development of electronic devices assisting pilots in aircraft guidance in the last fifty years has tremendously increased the aircraft capabilities and safety. Still, very many unpredictable “unpredictable disturbances” may interfere with the aircraft system and cause accidents. In order to prevent such unpredictable events and even more to be able of reacting to them it is crucial to have automatic procedures to assist the pilot and (maybe in a not so far future) help or substitute him in recovering the aircraft.

For this purpose computer aided engineering (CAE) becomes a key tool to perform testing on virtual aircrafts in order to explore the dynamic capabilities of an aircraft before building a real prototype. The possibility of testing solutions on virtual prototypes allows a great reduction of costs and time to market. Using virtual prototypes it is possible to test the aircraft capabilities at their limit conditions by exploring the trajectories that the aircraft can perform.

In order to perform this kind of analysis, advanced control algorithms must be developed that are able to autonomously fly aircraft. The literature on flight control is quite vast, see [8] for a survey, however most of it concentrates on how to control low level actuators in order to have desired high level control commands (e.g. angle of attack or roll angle). Theoretical and numerical techniques have been proposed and studied in the last years to design control laws for non-stationary maneuvering of aircraft, [9][10], and in some cases they have been tested on real test-beds [11][12].

A different point of view that will be considered in this project is the design of control strategies to explore the dynamic capabilities of the aircraft. In other words, the purpose of designing control strategies is not just to fly an aircraft, but to understand what maneuvers, in particular most aggressive ones, it can perform. An important contribution to explore maneuvering capabilities of flight vehicles comes from optimal control. Numerically robust techniques to solve optimal control problem have been developed in recent years [13] and have been applied to simplified planar models of aircraft to study their dynamics capabilities even in the presence of input and state constraints [14].

Concept and objectives[3]

Many aircraft accidents still occur that should or could have been easily avoided. This happens in spite of the multiple advances in structures, technologies, ATC automation and tight safety regulations. The accidents and fatalities are timidly having a regressive chart and this behavior is even better if we consider the increasing number of flights scheduled today in the airspace (increasing rate of 5% every year). Some of these accidents (15%) are originated by non scheduled flights, mainly domestic flights belonging to small airliners, private jets or training flights.

Classification of the most critical accidents, as done by the safety boards, results in four main groups: Weather, Equipment, Systems and Human:

- Bad weather conditions affect:

Visibility (heavy clouds, fog, rain)
Flight stability (severe winds and turbulence)
Runway slippery conditions (rain, fog, ice)
On board electronic systems (lightning, storms)

[3] Part of 1.1 chapter from AAA-ICADS proposal

- Equipment hazard are given when:
  Old, malfunctioned, improper, unsatisfying, missing
  New assembled or installed if short testing or not enough training
  Inadequate (sensors, means of warning, redundancy)
  Improper maintenance
- System failures include:
  Engine(s), fuel
  Actuators, structure, hydraulic (landing gear, flaps)
  Avionics (flight management system, sensors), electrical subsystems
- Human errors, as main cause, are:
  Pilots
  Health problems
  Incorrect understanding and reaction
  Slow reaction

The human reaction is decisive in many incidents caused by the former three causes. The pilots long training and their strict physical and psychological tests are the best guaranties for the aircraft safety in hazard conditions. Pilot's caution is assumed to avoid bad weather conditions, pilot's expertise and intuition for overcoming equipments malfunctioning, pilot's wisdom to understand systems failures. But many accidents, especially of **small aircraft** and **less skilled pilots** are produced by the inadequate pilot reaction to a weather, equipment or system problem. The main cause is not the pilot itself. But avoiding the fatal consequence is only possible if the pilot is expert enough.

This project will address small aircraft defined as light aircraft that would be certified with the CS23 regulation. This include some light jets (as the Cessna Citation Mustang, the Eclipse 500, the Embraer Phenom 100 or the Spectrum the independence S.33), some turboprops (as the Partenavia P68C or the Cessna Caravan) and some propeller driven aircraft (as the Cessna 350).

In particular we will target those aircraft certified to operate with a single pilot. The minimum requirement for this pilot is to hold a Private Pilot License (PPL), while for commercial operations the pilots must have at least the Commercial Pilot License (CPL) and for many aerial works usually they hold an Instrument Rating (IR) qualification, which allows the flight on Instrumental Meteorological Conditions (IMC). An airline qualified pilot, which holds an Airline Transport Pilot License (ATPL), will usually go through all these licences before obtaining the required flight hours and experience, complementing them with a Multi Crew Cooperation course (MCC).

For our project we will consider as less skilled pilots to those that are in “The Killing Zone” as defined by Paul A. Craig in his book “How and Why Pilots Die”. This is, the pilots with less experience which have a total number of flight hours in the range of 50 to 350 hours. At the moment of obtaining a PPL the pilot may have 50 to 60 flight hours. For the CPL the pilot must have 200 hours of flight time, crediting 100 hours as pilot-in-command, 20 hours of cross-country flight, 10 hours of instrument instruction and 5 hours of night flight time. The IR requires at least 50 hours of cross-country flight time as pilot-in-command and the theoretical knowledge of the pilot will be increased with instrument navigation courses. All of these general aviation licensed pilots can be inside the "Killing Zone". The skills of these recently qualified pilots are far from the skills of a pilot with an ATPL with the 1500 hours required to obtain the license.

And these less skilled pilots are flying in small aircraft usually without a copilot. Moreover, their aircraft usually are less equipped than commercial airline planes. Also, the aerodromes they use have not always long, wide, and well lit runways. Finally, small aircraft have less range, thus the number of takeoffs and landings per flight hour are higher than in commercial aviation. Since takeoff and landing are more hazardous than cross country flight, they are more exposed to risk. These are also general reason why these pilots do have higher rate of fatal accidents (see figure below) and why we propose a new supporting device which might be useful to help them to deal with non nominal situations.

The approach of the Avoid Aircraft Accidents Innovative Capabilities and Automatic Diagnostic Systems (AAAICADS) project is to propose a new innovative onboard capability, similar to a "virtual copilot", to help less skilled pilots in hazard situations. The functions of the "virtual copilot", which we name ICADS, are to Automate Diagnostic on aircraft health and on nearby airspace to notify possible hazard in advance. As a human copilot, the ICADS will offer also some advises on the aircraft operation, like new routes, proper reactions to malfunctioning or maneuvers suitable for avoiding external hazards.

The project focuses on small size aircraft operating in nonscheduled flights facing unforeseen situations and has a "double layer" approach:

LAYER 1: Increase of knowledge

Research about the root cause paradigm and the pilot responses to derive conclusions on best practices, requirements for the avionics and procedures for pilots.

The foreseen activities starting from (input) historical data and with the active participation of pilots are:

- Filtering accidents to be specific for flight operation of small size aircraft operating in nonscheduled flights
- Deriving one root cause by fault tree analysis. Name the failed avionics "component", the incorrect maneuvers, the weather condition, etc.
- Creating similar situations in a flight simulator facility.
- Analyzing of pilots reaction in the simulator and classification of their consequences

LAYER 2: New ICADS concept proposal

Research and proposal of a new automate system capable of detecting a possible failure situation before it appears and advise the pilot within a failure flight mode. A criticality analysis of both functions and of their effect will derive the safety requirements.

The specific activities of this layer are:

- Proposing new automatic diagnostic systems for small aircraft (low weight, low cost) which, based in virtual sensor concept, EO/IR sensors, and voice radio, will provide the pilot with continuous health monitoring of structure and awareness of air space.
- Exploring aircraft capabilities to identify safe regions of operation via trajectory optimization in case of failure
- Propose new automation capabilities for future implementation in the area of accident avoidance, supporting less skilled pilots to manage unforeseen situation

In particular, we want to provide strategies, tools and instruments to prevent novel pilots of failures or hazards in advance and to promptly advise him/her with the proper reaction to the failure as a copilot will do if were there. Major technical objectives to be targeted are:

- Assessment of new means adequate to prevent small aircraft accidents
- Propose new operations or procedures for certain type of accidents
- Add failure early detection systems suitable for small aircraft, based on the detection of strange behavior (tendency) of the aircraft
- Study Human Machine Interaction (HMI) issues: coordination between pilot's actions and responsibility and automatic advisories.

Methodology

The work plan has been divided in 7 Work Packages (WP) as shown in figure 1.5, that extend during 36 months. There is one Management WP which corresponds also with the General Assembly Board and a Dissemination WP. The other 5 WP are devoted to research and Development (RTD).

The temporal planning starts with an assessment work package (WP2) that studies the last decade accidents occurred to small aircraft, analyses the pilot reactions during accidents, and looks for the root causes and list the critical items of accidents. Even more, the "by-book" pilot actions are assessed in the environment of the "state-of-the-art" technology and equipment. Then a representative list of accident scenarios will be prepared in WP2 to be used as a test-bed of later WP.

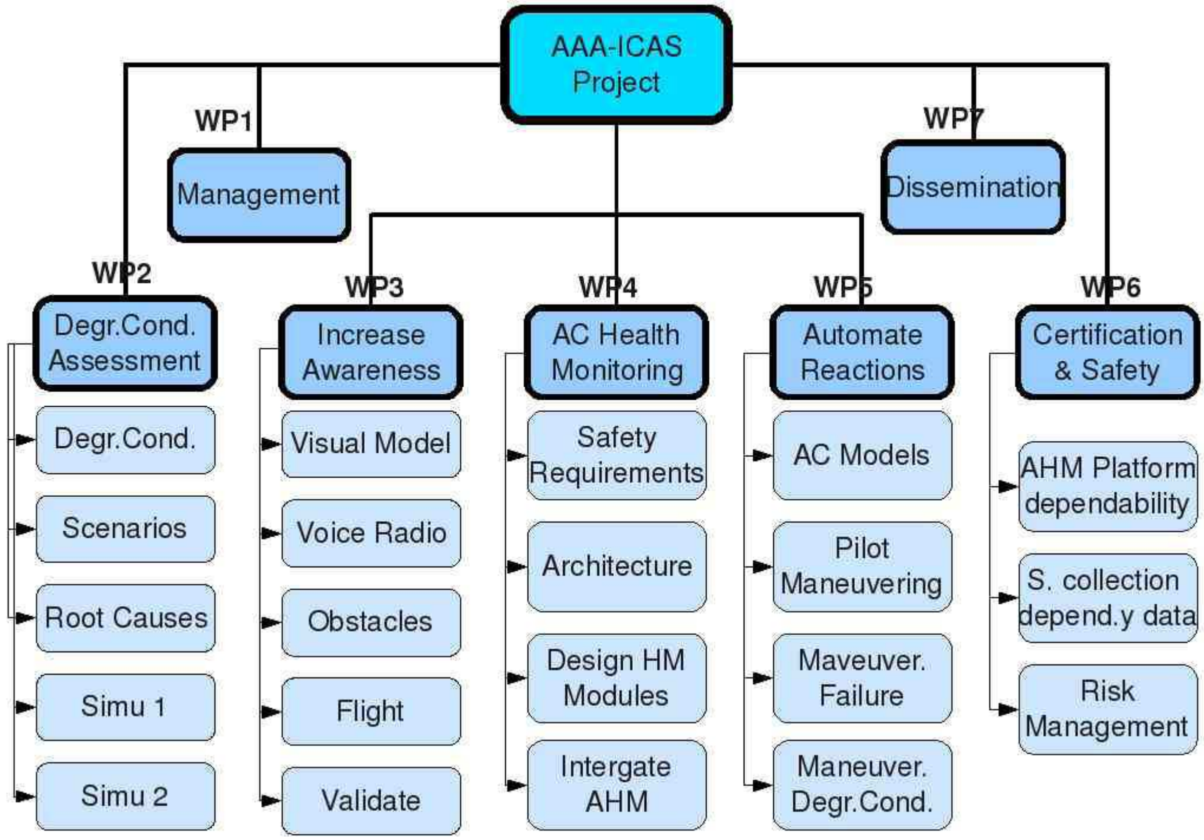

Figure 2. Work packages[4]

New methods and solutions are on WP3, 4 and 5: WP3 will obtain environmental data by real flights and will propose new image processing algorithm and transmission protocols for increasing awareness of pilots; The development of an integral Aircraft Health Monitoring (AHM) platform on WP4 is expected to influence at least the signal availability and the modular framework of current avionic systems; And WP5 will study the limits of maneuverability in case of downgrade conditions from a general description of the aircraft aerodynamic model, to better advise the pilots in hazard situations.

A key result of WP3, 4 and 5 is to anticipate the new levels of safety required in a world of rapidly growing air transportation and to translate them into tangible, cost-effective

Technological applications to be integrated in the aircraft of the near future. Simple as it may sound, this result requires a thorough reconsideration of the chain of events involving design, development and integration process. WP6 will deal with the safety assessment and certification process of the new proposed concepts on avionics systems.

Finally, WP7 will lead the Dissemination of the work done. Since most of the work is research done at Universities and research centers, the Dissemination will be mainly done at conferences and scientific publications. Of course, WP7 will manage the web site and the Deliverables.

[4] Fig. (1.5) from AAA-ICADS project proposal

Relation of Partner Expertise

1 The role of project coordinator is upon the Technical University of Catalonia (**UPC**), a institution with huge experience in European projects participation and coordination, being last year the seventh European institution regarding its participation in the FP7. In the year 2008 UPC has obtained participation in 29 new projects (6 as coordinator) with a total budget of 7.9M euros. The administrative department (the CTT) is composed by 20 professionals on project management who deal with 144 projects during last year. The role of UPC in the project is to leader the project, which UPC has large demonstrated experience. In the technical part, UPC will be involved in all work packages except for the certification one, with major involvement in WP3 about awareness increasing.

2 IAI is leading the central project work package (WP2: Degradated Conditions Assessment). In this work package the specific accidental situations are going to be selected and reconstructed in a flight simulator. The expertise of an enterprise for this WP will lead to a realistic and practical approach, in particular for demonstrating results on a simulator. The exploration of new automated systems should be directly an important result to exploit for IAI and its industry partners. IAI has also an active participation in WP4 and WP6, and in Dissemination.

3 In the project **IAS** will lead the working package on awareness (WP3). This topic fits into the department of navigation and control systems, where microcontroller based systems are designed and manufactured using FPGA platforms for real time. Software development for on board camera images recognition and their integration with data from on board avionic and sensors systems is the main target of this work package, expertise on which they have from their current projects on UAS and sense&avoid techniques. The IAS facilities, located next to the civilian airport, with access to the runway and stateoftheart equipment will be used to obtain real flight images of conflicts to be processed on WP3. IAS is also actively involucrated in WP4 and in Dissemination.

4 The **PATRAS** participants are expert on structural health monitoring systems for diagnosing and in the project they are leading the WP4, where an aircraft health monitoring will be proposed for small aircraft using novel virtual sensors techniques. They will be also involved in WP5 since they also have interest in re configuration systems following a damage; And on WP2 to investigate the causes of degradated conditions for reducing accidents.

5 The Italian Aerospace Research Center (**CIRA**) specific competencies joining the project are on automated systems reliability and certification acceptance. This topic is covered by WP6, which CIRA leaders. CIRA will also be involved all the other RTD work packages, since certification issues attain to all proposed concepts, but will mainly participate also in the WP2, where fault tree analysis will be applied to accident data base to obtain the root causes of accidents.

6 CRANFIELD University has a large experience on the generation, dissemination and application of knowledge in engineering, applied science and manufacturing. In the project the lead WP7 on

Dissemation and will also participate in WP2 and WP6 on the causes and consequences of the developed technology.

7 The **NDU** is a Hungarian University at Budapest with a large history on military formation. The research group that joins this project is working on airframe design, and its onboard sensors. And in the project they will join mainly WP4 proposing health monitoring sensors which adequate to small aircraft.

8 **ENAC** represents National Aviation Authorities in the project, and will contribute in WP2 to the inventory of accidents and incidents, but will collaborate mainly in WP6, commiting the Risk Assessment activities for the use of proposed systems. They will contribute to build Safety requirements and Certification specification, assessing innovative components shortcomings and deriving mitigation to shortcomings. The project will enforce the recommendations issued by the National Flight Safety Agency.

9 The **UNILE** group has expertise in the area of control engineering and robotics, involved in modeling and control of dynamical and embedded systems. They will leader WP5 on automated reactions and maneuver advisory based on exploring dynamic capabilities of aerial vehicles. By means of control and optimization theory, they suggest stable maneuvers when a fault diagnosis activates. UNILE will also participate in the rest of work packages except on the certification, with major involvement in the WP3 and WP4.

10 The **COPAC** represent end users and their main task in the project is to help in the assessment of accident reconstruct in the simulator and on flying the simulator in the hazard situations, all inside WP2. Also contributions expected from pilots is their feedback about the use of novel devices and their cockpit displays for awareness and maneuver advisory.

Hungarian participants and they role in AAA-ICADS project

The “Miklos Zrinyi” National Defense University takes part in project with members of Institute of Aviation and Air Defense, Institute of Informatics and Communication of „Janos Bolyai” Military Technical Faculty.

Brief description of the organization:

“Miklos Zrinyi” National Defense University (MZ NDU) was established in 1996 when two military academies integrated, and later the military technical academy also joined this institution. It has 2 faculties: Military Science Faculty and Military Technical Faculty. It is the only military institution in Hungary where officers’ training takes place. MZ NDU is an independent legal institution directly subordinate to the Minister of defense. It is located in Budapest and Szolnok. The University has many scientific researches on the fields of military technology such as defense electronics, aviation, and unmanned aerial vehicles. These research activities include basic and applied researches, tentative developing, technological transfer and those participants who are involved in the field of technological innovation, their professional knowledge, publications and achievements thanks to the researches made in cooperation with universities and other external institutes.

Main tasks attributed in the project

WP1 – Management – project steering, management and coordination

WP3 – Increase of Awareness – participating in tasks on visual models and models of obstacles

WP4 – Design of health monitoring platform – concepts of operation and development of HM modules

WP6 – Certification and safety – supervision of dependability data

Previous experience relevant to those tasks

The faculty of Electronic Warfare has been publishing academic writings and been organizing scientific conferences like the Robot Warfare conference. The Institute of Aviation and Air Defense continuously publishes academic writings (Aeronautics Announcements online journal), organizes scientific conferences every year in April on the occasion of the day of Aviation and Astronautics. The MZ NDU was an active partner in the European Union launched UAVNET project. The UAVNET focused on the technical research and development of unmanned aircraft to be used in civil aviation in European airspace, dealt with flight safety and economic issues of usage, and to form regulatory provisions for their application. The MZ NDU held a numerous lectures and was a host of meeting in Budapest. At the MZ NDU Military Technical and Military Science PhD School there are ten PhD students after dissertation whose topics are directly connected to the issues of unmanned aviation.

Short profile of the staff members/key experts

Prof. Dr. Imre Makkay engineer colonel retired holds a CSc on Military Sciences. He is working as a teacher since 1987 for MZ NDU. Actual job is professor at IAAD Department of Onboard Devices and leading a research and development group directed to Advanced Wildlife Monitoring and Control at Airport/Airfield Areas.

Dr. Laszlo. Vanya engineer lt. colonel holds on PhD on Military Sciences. He is working as associate professor and head of Institute of Informatics and Communication and Information Operations and Electronic Warfare Department. He is leading a research and development group directed to Advanced Electronic Warfare Devices.

Dr. Laszlo. Kovacs engineer major holds on PhD on Military Sciences. He is working as a teacher since 2002 for MZ NDU. Actual job is associate professor at Information Operations and Electronic Warfare Department of Institute of Informatics and Communication – besides them he is leading a research and development group directed to Advanced Information Operation Technology and Strategy.

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Concluding remarks

The "Miklos Zrinyi" National Defense University takes part in EU7 project with very strong and honorable partners. However the proposal in stage of evaluation the great work was done before issue the document. We appreciate all participants first of all the UPC members for co-operative team-work, professionalism and toughness. We have learned a lot in this joint effort and hope for further collective activity.

Author – who is novice in general aviation – expresses his acknowledgement for opportunity to take part in this project, also for assistance and support of University's colleagues.

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