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RUNNING UNMANNED AERIAL VEHICLES IN HUNGARY

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Abstract
Flight tests proved that it is cost effective to use commercial modelling components for building UAVs used by the military. First it may look like we are building an aerial vehicle using toy parts, but nowadays' manufacturing is well-developed, and by applying adequate quality control system, air safety will be ensured. This study was realized through the assistance of the European Union, with the co-financing of the European Social Fund. It enjoys the support of "Critical Infrastructure Protection Research TÁMOP-4.2.1.B-11/2/KMR-2011-0001".

Subordinated plan: „Data integration

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NEW SZÉCHENYI PLAN

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1. INTRODUCTION

The Hungarian Defence Forces (HDF) use radio-controlled (RC) aircraft models during the training of their infantry and air-defence units. The aircraft models imitate enemy aircraft on tracking exercises and live-fire manoeuvres.

The models 'GÓLIÁT', 'METEOR-1', 'METEOR-2' and 'METEOR-3' were conventional radio-controlled types. The requirements of the 'MISTRAL' short range air-defence missile system acquired in 1999 for HDF showed the path along which the necessary modifications (infrared-emitter, Lüneberg-lens) of the 'METEOR-3' model had to be made. It was soon proved that conventional radio-controlled models can not provide the operational radius for the exercises.

Fig.1.

Originally, to increase the operational radius of the model, 2 operators flew it. The first controlled the take-off and flew the model to the area of operation, where the second took over and controlled the flight along the track. This method required a high level of cooperation between the operators, and also it endangered the safety of the second operator who had to stay in the area of operation. In order to eliminate the disadvantages of this procedure, a GPS-based control system was fitted on the model, which was named 'METEOR-3M' – Fig.1. – and made a successful debut in 2005 at a live-fire exercise.

The target model was under continuous development to meet the requirements placed by the air-defence units. Based on the previously successful control system, an autonomous and re-usable target aerial vehicle was built. It was the 'METEOR-3MA' TUAV (target unmanned aerial vehicle). – Fig.2.

Fig.2.

2. FIRST STEPS

The METEOR family stepped into a new age after the development of the new type of air-targets. The auto pilot system made possible to reach 40-50 km range without visual contact. [1]

However the real success was not the application of the autonomous system, but the TUAV's adaptation to national and international legislation.

According to risk analysis, because of the autonomous flight mode and the increased speed (250 km/h), the TUAV became a danger source of such a degree, that a reliable and safe operational method had to be developed – or an already existing method had to be taken over.

Based on the National Aviation Authority's (NAA) statement, the TUAV can not be fitted into the model category because of its flight capabilities and size. It stands closer to airplanes, so we have to apply aviation rules when flying the TUAV. This high-level quality assurance system helps to keep the aviation incidents at low-level.

When experts talk about the development of UAS they usually think about the UAV with ground equipment. In our opinion however, the running of UAS contains the legislation background too, as well as the airworthiness-, radio equipment- and radio frequency certificates, the approved flight plans, the training of the operator teams, all of which are approved by the NAA.

3. QUALITY CONTROL OF MATERIALS AND COMPONENTS

Air safety is maintained by application of legislative measures. For the sake of safe operation of passenger airliners we have to keep up a high-level – and expensive – quality control system. However, UAS manufactures could only sell their products if they keep the costs down.

High-level quality control and low costs are expectations of a contradictory kind, so there is a need for urgent compromise.

According to comparative analysis, Hungary can operate Class-1 (below 150 kg) and Class-2 (150-600 kg) types of UAS. [1]

A competitive procurement price for the UAS can only be provided if the manufacture purchases some components of the aircraft and/or the system from civil market. Servos, motors and batteries used by modellers are an obvious solution. [2] However, running UAS requires aviation safety at the same level as running any other aircraft. So after the basic requirements of UAV air targets were determined for achieving success at tracking exercises, the commercial components that are acceptable for military purposes were chosen. But if we want successful and safe operation we have to develop a control system what can provide fool-proof running.

During production the control methods have to cover all subsystems (hardware), and control needs to be carried out repeatedly despite the compulsory periodical check-ups of the UAV. This way the condition of the UAV can be followed and we can find hidden quality problems. During the periodical check-ups the endurance tests of the wings, the fuselage and the surface controls are carried out over and over again.

We did not discover any faults of the autopilot system that could cause air incidents during the test period. If we use commercial modelling components (servo, electrical motor) we have to check their lifespan rate and also check the survival characteristic of the fuselage. We have scanned metal gear servos for 100+ hours, whether they will be able to work in extreme weather conditions or not.

The main requirements of the air frame would be low cost of the material, short production time, simple production technology and good survival characteristics. The optimal testing environment is not always available when we are operating Class-1 type of UAV, so the airframe could easily be subject to damage during landing. If we choose an airframe type that is resistant to mechanical impacts we can greatly reduce the chances of irreversible damage. Experiments with delta-winged aircraft and blended-wing-bodies proved that these types of airframes have the characteristics which cover the above stated requirements of UAVs'.

4. AIR INCIDENTS – TRAINING OF STAFF

Operation experiences proved that air incidents usually happen because of the human component of the system (operator personnel). The most common problems are:

- lack of operator training
- missing pre-flight checks
- overconfidence in abilities
- lack of identification of possible dangerous circumstances (e.g. weather).

The operators' continuous training ensures that air incidents will be kept at low level, and even an UAV with poorer characteristics can be operated by professionals. [3]

Class-1 type aircraft's payload is extremely limited. If we need to mount parachutes or airbags for ensuring safer landing, the payload will become even smaller. Highly-trained operators are the guarantee of efficient running and safe landings and there will be no need for extra landing systems. We should consider however the circumstances of using UAVs in operational theatres, where controlled landings could be compromised because of enemy fire.

The NAA has approved a training syllabus for the operating staff. During both the academic and practical training the emergency procedures has to be emphasized. These procedures includes avoiding dangerous approach, or flying a UAV with limited control capabilities (e.g. because of system failure). Learning these emergency procedures is extremely important for operators working close to, or behind enemy lines.

5. CLOSED AIRSPACE – IS IT SAFE?

According to current Hungarian legislation, UAVs allowed to fly only in closed airspace. When we carried out test flights with the METEOR-3MA TUAV, we had the opportunity of flying in closed and in restricted airspace too. Based on our experiences, the closed airspace distributed in NOTAMs does not provide real safety for the UAV. There was precedent of an aircraft violating the restricted airspace, and this type of dangerous approach can easily be missed be the pilot of the other aircraft.

It is essential that future UAVs should be equipped with an appliance that warns the pilot on board the aircraft that violates restricted airspace. A cheap (although payload-limiting) solution could be mounting flashlights on the airframe of the UAVs, and placing observers all along the borders of the training airspace. But it is just a temporary solution. In order to achieve efficient and flexible operation, further development is necessary to avoid dangerous approaches and violation of restricted airspace.

6. OPERATORS

In the early years (METEOR-1, METEOR-2) the UAVs were controlled by 2 operators. Depending on the nature of the task (complexity), one of them flew the UAV, and the other carried out the special task (e.g. timing the dropping of infrared emitters with parachutes).

At the moment 2 operators are the minimum requirement of safe operation. The operators decide the necessary measures to be taken during the flight, based on information provided by computerized data. If observers are also present, they follow the UAV's flight with binoculars and make sure that no aircraft violates the airspace.

The so popular FPV (First Person View) system allows the operator to fly the UAV as if he was on board, like a pilot of any aircraft.

In order to keep the costs low and the operation fool-proof, a similar video system was mounted on the TUAV. This equipment informs the operators about the actual position of the UAV, so in the case of autopilot failure or loss of telemetric connection, this secondary system is able to provide enough flight information for the operator to recover the UAV.

7. RADIO FREQUENCIES

The necessary data transmission to control the UAV is ensured by radio waves. If we examine the propagation of radio waves, we will find that the frequencies in the chart below (Fig.3.) ensure the best connection between the UAV and the control centre.[4]

Name	Frequency
VHF (Very High Frequency)	30 MHz-300 MHz
UHF (Ultra High Frequency)	300 MHz-3 GHz
C-band	4-8 GHz
X-band	8-12 GHz
Ku-band	12-18 GHz

Fig.3.

This wide interval however can not be used as it is, according to current legislation.[5] We have to separate ground-based static, ground-based mobile and aeronautical mobile radio service. According to legislation only those frequencies can be used which are still free, and not issued to anybody. Most of the frequencies are reserved for air traffic and telecom systems, thus our powers are greatly limited.

Military frequencies used by NATO countries provide communication for military UAS. But civilian UAS are not authorized to use these frequencies; they soon will need their own frequencies in order to operate safely. An alternative could be the frequency band used by radio amateurs.

8. CONCLUSIONS

We can state that good quality commercial parts are suitable for building UAVs. But in order to keep up air safety it is inevitable to develop quality control methods to reduce the probability of air incidents.

Recommended conditions of fool-proof operation of UAS:

- Determination of the maximum load-bearing capacity of the chosen parts; based on this figure the working load can be also determined.
- Examination of the lifespan of the chosen parts. When their lifespan expires or they brake down, they should be replaced because repairing them is not cost effective.
- Pre-flight system checks are to be carried out before each take off.
- Periodic inspection of the airframe and electronic systems is also recommended.
- Proper basic training and consecutive training courses for the operators.
- Maximum respect of all of the regulations.

Basic rules of flight planning:

- Do not fly above populated areas in order to minimize secondary incidents.
- Bear in mind the topography of the area where UAV tracks are planned, to avoid crashing, and to ensure continuous communication between the operator and the UAV.
- Fuel capacity determines flight range, but it depends on weather conditions too.

Motto:
High level of competence both theoretical and professional, a way of life according to regulations, and respect for military code and technological discipline are the principles of air safety.

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