Introduction

Currently, substantial resources are being spent on the investigation of intelligent robots both in the civilian and in the military spheres. During the Second World War, Germany already performed the mass-production of robot-aircrafts which were up to the technical level of the time (V1). After the mapping of the investigation and use of the robots we can conclude that in many cases similar devices were already used with much success. The joint characteristic of them is that they are distantly operated (Goliat), so the life of the operator is not directly damaged.

In peace time the above devices are often used in the mapping of the disaster places and in the actions of life-saving and recovery of goods. In the past, there are many examples on use of the robots or half-automatic devices with distant operation.

Because of the rapid progress of computerisation we could conclude that in the near future there will be a significant progress in the area of robotics. Currently, there are both tehnical and theoretical bases for this.

Currently we can definetely see that the technical progress is not the only condition for the expansion of robot devices. Every country which deals with the development and operation of robots usually meets the notable problem of clarification of the legal and safe operation of existing devices!

The question of safe operation is conspiciosly the most urgent in the case of the robot-aircrafts, but the similar problems have been already conceived in the cases of the other distantly operated or autonomic devices.

In connection with the operation of robot-aircrafts the following questions are on the forefront and waiting for resolution:

- The excise and prevention of the secondary damage which could be caused during the operation because of the errors in the system (material and individual damage of the third person)
- **The operation of the aircrafts which are not operated by the pilots in the free** (with no special restrictions) **airspaces**.

In order to decrease the occurent damages or injuries, the current practice is to restrict the area of operation. But this restriction deprives the operator of the aircraft which is being operated without a pilot from the significant benefit of the above devices, because henceforward these

devices cannot be used in the space above the dangerouse plants, industrial areas or densly peopled settlements. **One of the accentuated areas of the investigation is the question of the significant decrease of the risk of the damage which could be caused by the aircrafts without pilots.**

The question of the space use is also an unresolved question. In case of the long-distance robot aircrafts we should take into account that the flying devices could also use the air space with the different classifications (controlled and uncontrolled) which is being used by civilian planes.

Currently, in order to use the controlled air space the robot aircraft should have an answering signal device (transponder), and also should have a flight plan which was approved by the aeronautic authorities. At the same time, it is not clear by what way this robot aircraft is going to respond to the commands of the aeronautic transport supervisor body, or rather by what way the „justification of the command" could be done.

In case of the uncontrolled air space use, the situation is more difficult, because according to the the relative regulations, the pilot must observe the air transport traffic and must change the flying parameters according to the actual situation. **In this case the basic problem is that the pilot does not know that** in the airspace which is used by him **he could meet the aircraft without a pilot**.

In order to resolve operation problems, international forums are trying to answer these questions.

From those countries or organisations which are dealing with the development work, the **expectation is a quick development and effective testing of** the prototypes which could satisfy the demands in the best way. During development work, there is a necessity in the use of such new building technology which could assure a quick and cheap production of the prototypes. The unflexibility of many production organisations was caused by the fact that the huge costs of the production technology which was took over from the „traditional" technology of the aicraft building does not make it possible to build numerous operable prototypes. **Significant changes i**n this field **could bring an introduction of the cheap, quick and flexible production technologies for the building of prototypes.**

The computerisation systems of the military aircrafts are being more and more developed. These systems could perform almost all pilot functions, so the pilots have more time to deal with the other tasks during the flight (such as to retrice and to destruct the objects and to deal with the other possible military tasks). The automatization of the aircrafts already reached that level, when the individuality of the pilot obstracts the total use of all abilities of the aircraft (because

the structure if the aircraft could bear more strain then the human organism). **The international and local trends** both in research and in expansion show that in the near future the traditional (operated by pilot) **aircrafts will be substituted by the robot-aircrafts.**

Research hypotheses

My research was dealing mainly with the autonomic and half-autonomic devices. Naturally, I did not undertake analysis of the whole area because of the time and size restructions. My research was centralised on the aircrafts which are operated without a pilot, but I tried to propose such solutions which could be uniformly used for the direction of other devices (such as water and overland ones).

My research and development work was determinated by the following hypotheses:

- Currently, those robot aircrafts which are the part of the system or are just before the setting into the system are very expensive, but their area of use is a very type-specific.
- **The appropriate elaboration of governing principles and methods could decrease techological costs during the development work.** Therefore, the starting costs of developed robot aircrafts could be decreased, and this could give opportunities for their use in a broader area.
- The handling of the modern control systems (robot systems) is a very complex task, it should reflect the governing principles of the age and demands highly qualified operators. At the same time, in many military areas there could be request for the cheap and commonly operated aircrafts, so the operators with the middle level of qualification or even one person could deal with the local tasks (for example, with the local reconnaissance). **The working out an operating system with the „users and personnel" approach will speed up the practical use of the robot aircrafts.** But all this at the same time fulfil the conditions which are necessary for the piloting of the aircraft whilst in contrast with the traditional systems, the operating surface is common, the system and structure of data input reflects the user's approach, and not a technical one.
- The use of robot aircrafts is a risky thing. The damage which could be caused by the possible breakdown depends on the damaged area (for example, if robot aircraft slams to the dangerous industrial region or plant or densly peopled area etc), and also on the size of the aicraft and its construction. **The special drive train could decrease the operational risk of the robot aircrafts.**

The main aims of the research

For the better transparency and for the easier manageability of my research I have defined the main aims which I would like to achieve. While definition of the aims is not determinating their successful achievement, however, during my research it helped me several times to determine the current state of my research and stage of my progress.

In my research I have determined to reach the following aims:

- To define those correspondences of mechanics, aerodinamics and flying technique in view of which it will be possible to design the most adequate flying robot constructions.
- To define those translate functions, which could finely fit in the possibilities (capacities) of the modern computerisation, and at the same time posess the appropriate regulative characteristics.
- To design and to achieve a complex unit which is directed by robot and which could be used is in a flexible way in the different small-sized territorial and aeronautic vehicles.
- To define the building technology of such a robot aircraft, by the help of which it will be possible to create the test aircrafts in a cheap and quick way and so thus make their research and expansion easier.
- To design and to build such a aircraft without pilot, which in the case of its damage does not cause sufficient propetry damage or human injuries.
- In order to justify the principles and relationships which were defined by me, I aimed to build several aircrafts without pilot for the demonstration purposes to make possible the demonstration of their different novel abilities (for example, cost-saving aeronautic reconnaissance, quick analysis, sending of consignment with highly precise dispatch, etc).

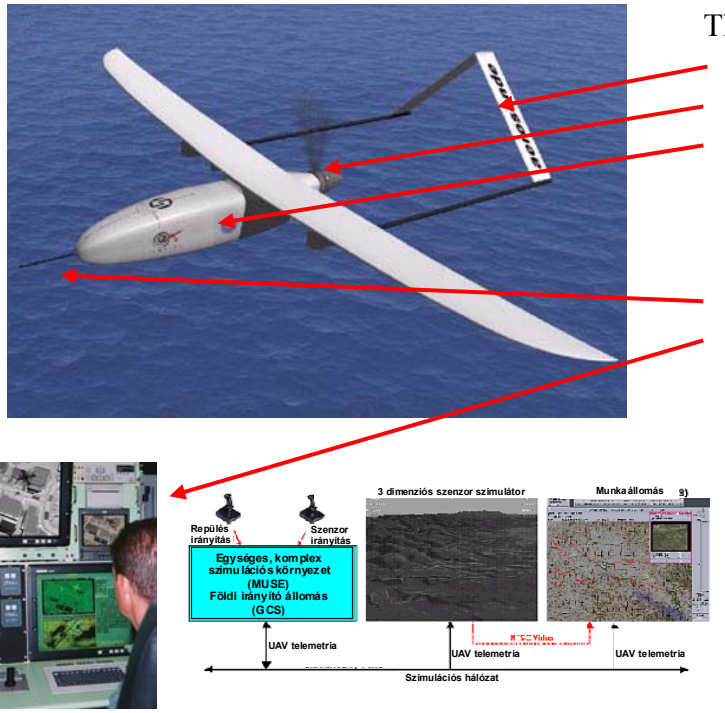
Methods of research

In order to achieve the objects which I propose to myself, I used the following main research methods which are listed below:

- **I have compiled the Academic plan** in such a way, that the mandatory and optional subjects and research seminars assist me in a best way to achieve my academic aims.
- **I have studied** those chapters of the appropriate foreign and inland specific literature which are relaltive to my theme, the newly issued publications, monographs and also the results and references of the newest research.
- **I took part** in the **international and home forums and conferences,** where I delivered lectures, and in addition have gained experience and colloquyed with other researchers and designers.

- **I have gained knowledge** about experience, theory and practic results in respect to the foreign robot aircrafts.
- **I have consulted** with the potential inland users and measured and summarize their requests and ideas.
- **I have initiated consultations** with the researchers and specialists of the specific and narrower areas of the theme.
- **I have done serviceable search** in the libraries and also on databases which could be found on the internet.
- **I have systematized** all knowledge which was gained during my previous career as a researcher and as an active pilot.
- **I have made simulised modeling,** and on the base of the results I have prepared my experimental devices.
- **I made experiments** in order to clarify and to **punctualize some partial tasks.**

My research theme covers a complex system. During development of the several sub-systems it is essential to know the whole system. Picture 1 shows the draft parts of the robot aircraft systems. The names of the main parts which are shown on this picture are conform with the terms and phrazing of the special literature and of this dissertation.



The general structure of the robot aircraft

- Air frame
- Engine
- Board electronics
  - Flying safety equipment
  - Navigation
  - Communication
- Telemetria
- Direction from the ground
  - Pilot
  - Exploration and appraising
  - Flight direction

Picture 1: The general structure of the robot aircraft

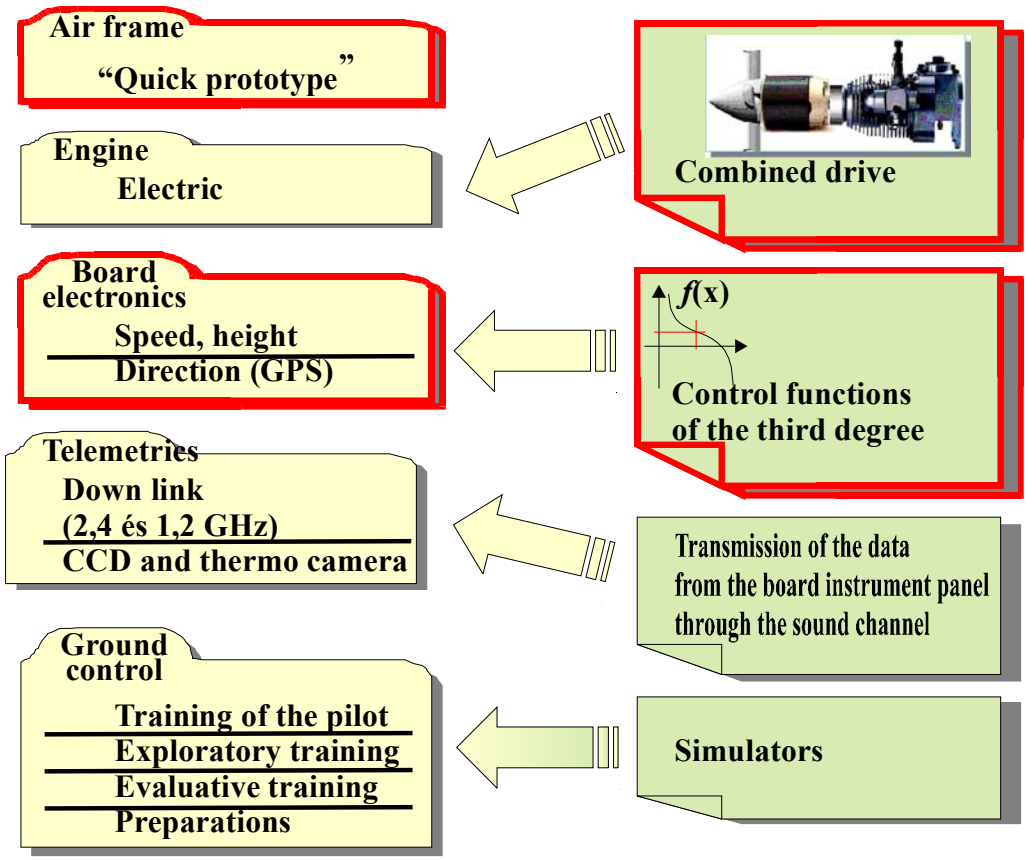
Picture 2. gives us an outline of those areas which were surveyed by me in details. On the picture I marked **by red frame** those areas in which I have produced **new academic results** during my research.

I have regularly published the partial results of my research in the professional journals. Also, I have regularly conducted lectures about my work and about the results of it on the international and native professional forums and conferences. I used the responses and reflections to my lectures and publications during appraisal of my results.

The frames of my research and structure of dissertation

Because of the restriction in the size, my dissertation deals with those most important principles and relationships which are definetely necessary for the unambiguous definition of my conclusions.

The theme which I have chosen, touchs several related fields and each of them could be an individual subject of dissertation. Because of the size restriction – albeit I deal with several themes very narrowly – I could only mention certain areas.



Picture 2: The main areas of my research, emphasing the areas of the new academic results

Preparations

This dissertation is divided into four mair chapters.

In the first chapter the main features of the modern aircrafts without pilot are described together with the background which is sufficient for their development and operation. The aim of such description is to point out those development and research areas which are currently situated on the known borders of this theme.

In the second chapter I made a detailed analysis of the theoretical questions for constructions of the robot aircrafts. **I worked out a quick building technology for the prototypes of the robot aircrafts.** The aim of analysis was to find those main aerodynamical characteristics and methods of prototype production which ensure that the kite structure would fit in a best way into the ability of electronics to stabilize the flight and to follow the air-route.

In the third chapter by the experimental **measurements I determine the accuracy, trustiness and use conditions of the GPS device** which is used in the robot system on board**.** The aim of the expriments was to design and to build the robot pilot system.

In the fourth chapter I show the robot system which was worked out by me. With the help of experiments I justified the proper work of the separate units of the system and show the prospective course of the further development.

I do not consider my research as finished with the writing of this dissertation. During my research work I have found many areas where after further testing and experiments new results could be born. Currently, the practical use of the robot aircrafts shows a constantly rising tendency that is why I will proceed with my work to find those directions which could help to develop, to build and to use robot aircrafts in our country.

New academic results

During my research work I have successed to achieve the goals which I set before myself in the beginning.

According to my intentions I have systemazed those areas of knowledge which are essentially necessary for the designing of the small-size flying constructions.

I have pointed out those characteristics which are significant from the point of flying technique (for example, predisposition to the swing, stability, controlability, etc.), and unfluence heir phisical grounds and possible methods of their impacts.

I have worked out and used during research process such building technlogy of the aircraft which makes possible a cheap and quick production of these devices. With the help of it was possible for me to perform ny experiments with the favorable effectiveness.

I have elaborated a robot pilot unit which could ensure the autonomical direction, characteristics of which are in conformity with the points of my initial reserarch intentions.

I justified by numerous experiments that my robot system is capable of autonomical direction of the aeronautic and ground vehicles.

After completing my research and development work, I consider the folowing results as a new academic achievements:

- **I have created and justified by experiments one such universal directive unit which could equally autonomically direct both ground, water and auronautic robot vehicles. Its further advantage is a modular construction, to which, thorough the standartly adjusted surfaces, the further accessory systems could be added (the tachometer, altimeter, inertial stabiliser, accelerometer, gyro, etc.).**

- **I have created and justified by experiments such functions of the third degree ((6), (7), (8)) with the help of which real time directions could be performed. The advantage of those functions which were determinated by me is that they do not contain composition of functions, and their interpretation range is continuous, so in comparison with the traditional resolutions their adaptation is safer. Those functions of the third degree which were used by me, decreased the possibility of the hidden mistakes in the system, and therefore they could be regarded as a safer and more dependable control devices**

- **I have elaborated the building technology of such a „quick prototype"** with the help of which it could be possible, in comparison with the already known methods, to build or to re-build experimental robot aircrafts more effectively. **This building technology, which was suggested by me could be used as cost-saving and in a beneficial manner in every such development task when we should perform the comparison of the several experimental models.**

- **I have defined and justified by experiments those principles which could be used to decrease significantly those property and personal damage which are caused by the disabled robot aircrafts.**

Conclusions

The results which were achieved during my research work justified that my research hypotheses are sound and topical. On every special forum and during the talks with the potential users it turned out that there are practical possibilities of use of the small-size robot aircrafts.

I have also performed fire-drill practice and also watched the fire expansion with demonstration purposes under the guidance of professional firemen. The experience which was gained from these experiments was regarded as a successful and perspective both by the supervising authority and by the further professional forums.

On base of the above I regard my research work as a a successful one.

Proposals and recommendations

During my work I have drawn some possibilities and resolution recommendaitons which are touching the areas of my reasearch but which are not included into this work because of the time and size restrictions.

1. **I recommend the creation of the home research and development centre t**he main task of which will be the development of the small-sized robot aicrafts. The principles of the development should be determined by the potential users such as Hungarian Army, Fire Service, Service of the Defence against Disasters and other important strategical enterprises such as National Electrical Service, Water Service etc.
2. **I recommend to organise a robot aicraft supplier unit,** the task of which will be to satisfy demands connected with those robot aircrafts which are operated by it. Such supplier service could be for example a constant auronautic observation of the protection dams during the dangerous flood periods of the year, or in case of the extensive fires it could be a constant observation of the their expansion or their extinguishing, etc.
3. **I also recommend the use of the part of this dissertation „A cost-saving construction of the air frame-structure of the experimental robot aircraft" as a supplementary teaching material** with a special respect to the future training of the the personnel of the robot aircrafts.