SMALL UAVS

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TAt the present time the UAVs have become the one of the most developing branch of the aviation. The situation in UAV sphere is very often equate with the early age of flying. In-process vision of the European union have assigned to this sphere an attribute as the „ industry of 21st. century“

K e y w o r d s. uav, quadcopter, glider, navigation

1 INTRODUCTION

Within the scope of department of aviation technical study there is underway the project of small UAVs. It's ambition is to involve into the project also the other departments, to find the space for their participation and development.
One to the next important goal is to motivate students to study technical disciplines. The last but not least, there is the space for commercialization of the overall project and for an expansion of manufacturing UAVs through the cooperation between the Faculty of aeronautics and commercial companies.

The mentioned goals is possible to divide into several levels :

- constuctional l.
- electronic l.
- aplication l.

The constructional level
On this level there are solved a problems related with the framework of the UAV , the arrangment of its parts and the choice of materials. We put the accent on using the new technologies of manufacture, materials and using the programs instruments CAD to design the frameworks of vehicles. The final outcome will be the projection of constructional arrangement of UAV in CAD system Pro/Engineering with the accent on choice of material, shape, gripping of engines, rigidity of the framework. Śimultaneously there is inevitable to deal with proposition and manufacture of the suitable propellers for quadcopters.

The electronic level
The object of this level is the summary of problems ralated with controlling of the vehicle, its stabilization and automatic control. That level is relatively large, because of necessity of solution plenty of the next particular integrated systems, which consists of systems for stabilization, navigation of the flying vehicle with numbers of sensors, control of power units and with senzorial part designed for performance of the tasks.

The aplication level
On this final level there are solved the problems about the efficiency of designed vehicles. It is virtually a group of activities, where is possibly to use the UAV. It is counted with using the cameras, infra-camera, variety of chemical sensors and sensors of physical quantities. The next potentialities are to use the UAVs as a baseband repeaters and to transport some material.
Within the scope of solving of UAVs, there were created 2 systems of UAV. The first on the platform of fixed wing and the second as the quadcopter.

2 UAV WITH THE FIXED WING

UAV with the fixed wing is a 4-channel model of the glider with the wingspan 1,9 m. It is made from EPP. It is delivered with built-in electric motor and the controller. The model is controlling in 3 axis by 4 pieces of 9g servos. The aeroplane was inevitable to add by receiver, it works at frequency 35Mhz of air modelling band.

The glider specification:

- lenght 1210 mm
- wingspan 1960 mm
- wing area 38,40 dm^2
- flight weight 960g
- wing load 25g/ dm^2
- power drive AC brushless engine

The automatic flight control of the vehicle is perform by the autopilot of Ardupilot type.

Ardupilot

Ardupilot is the autopilot based on the platform of the Arduino. It is designed for the planes with fixed wing. It is capable automatically stabilize the flight and performs the GPS navigation along the programmed way. There is possible to plug-in 4 input channels (throttle, rudder, airelons, elevator). For the purpose of the autopilot control there is plugged only 3 channels to control throttle, elevator and airelons. It allows to control the roll, pitch and direction of the glider. There are a thermopile sensors to stabilize in horizontal flight. It is the method, the position of plane is determined on the principle of measuring the differences of temperatures of the backround. As the extention of it there is mounted also a board for measuring the air speed and barometric height. It concurrently provides the switch-over of GPS modul with a controler processor. The data transmission is performs through the X-bee modules, they work at 2,4 GHz .

The master modes of the autopilot:

- manual – the control is directly from the radio without stabilization
- stabilization – the control is from the radio with stabilization, released sticks = automatic holding of height and flight mode.
- control type A – almost the autonomous mode with holding the height. The model follows the adjusted course, keeps the height and speed.
- control type B – almost the autonomous mode without speed stabilization. The model follows the adjusted course but the speed is under manual control.
- auto mode – the model follows the adjusted GPS track points. RTL (Return To Launch) – the model is able to automatic flies to point of start. When it reach this point it take up the flying in circles around this point.
- waiting – the model circles around actual position. It is possible to enter to the control at any moment.

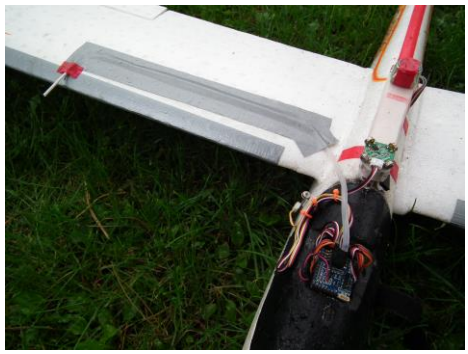

Figure. 1: Detail on the part of the autopilot

Ardupilot configuration

For the hardware of autopilot there is availiable a firmware, it is necessary to adjust for concrete type of the plane. We need to set up the speed of rotation around control axis, flap angles, height of returning to place of start, ballance of GPS signal. Entire program is created in Wiring language, on which is build the Arduino platform.

The Arduino is the platform for the creation of electronic prototypes. It is spreaded under the free licence. Virtually it is the connection of hardware, in the concrete processors of family Atmel with Wiring language. This language is simple and designed to create programs for microprocessors Atmel without knowledge about machine routines.

An interface is written in Java language, it means it is multiplatform. The programming going still in the same way, without reference to operating system.

The function of autopilot is commmanded by switches on the RC transmitter. After the turn on the feeding it started the verification of the state of all systems. The GPS receiver is activated and the actual positions is written into the memory. Take off is carry out by the hand launch and subsequently works the stabilization to the horizontal flight. After that it is possible to activate all modes of the autopilot.

3 QUADCOPTER

Quadcopter is the flying vehicle which is able to fly by the 4 propellers. Basically the front and the rear propellers rotate in clockwise. The right and the left propeller rotate counter clockwise. In hover, all propellers rotate at equivalent rpm. The outcome is the balanced angular momentum and quadcopter stability in the air. If we want quadcoter to do some manoeuver, it must lose its stability. It works by the rpm changing of each propeller and it caused the change of the resultant moment,which causes on quadcopter.To guarantee the stable flight is necessary to know the movement of quadcopter in the space. It is usually providing by the IMU sensors. IMU uses the data from sensors and then calculates the desirable value of rpm for each engine-propeller. IMU also provides the compensation of movement caused by external interference, for instance the wind correction. The computer is programmed with an open-source software. The effective payload is cca 0,5kg with a 20 minutes endurance.
The structure of quadcopter:

Figure. 2: Quadcopter during test flight

- **Flight computer** – is designed to stabilize and control the quadcopter. The core of computer is procesor AVR ATMEGA644, tacted at 20Mhz. It contains from 3 gyro made by Analog Devices ADXRS 610 and 3-axis accelerometer LIS344ALH. To measure the flight level and its stabilization there is the senzor of barometric pressure MPX4115A.
- **Flight-course computer** – is the extension of the flight computer. The using of datas from GPS microBlox and 3-axis magnetometer MK3Mag it performs the navigation of quadcopter. It is able to performs the flight follows the track and correct the deviation caused by wind. It also subserves the function of full-automatic flights and to return to the starting-point.
- **Drive unit** – includes the controller, it is designed to transformation DC voltage to three-phase rotating field for the supply of the brushless engine. The power of the one engine is 200W. The rpm of the engine are controled by the controller, they comunicate with flight computer via I2C bus.

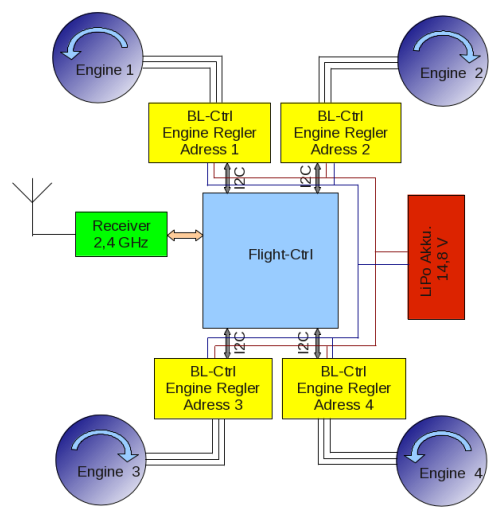

Figure. 3: Quadcopter block diagram

Control and programing

Quadcopter is possible to control by the radio transmitter, it usually works at 2,4GHz. The way of control is similar as the control of RC helicopter. In addition quadcopter is able to do full-autonomous flight follows the track.

The programming is performed by the aplication MK tool, by the the help of it, we can load and set the input data into to the flight computer, flight-course computer and to the controllers of each

engine. This utility is designed for debugging of PID regulator for the flight computer and programming of the complex flight and for the monitoring the parameters via datalink. Datalink works at 868MHz.

5 CONCLUSION

Described by means of their individual parts included in the theses of students. The aim is to include all Department of Aerospace faculty through the development and manufacture of UAVs. The result of the system to be able to perform different tasks aerial survey, with minimal intervention by a human operator in process control equipment.

BIBLIOGRAPHY

[1] Gonda, P.: Monitoring the magnetic field around high-voltage lines, Dissertation thesis, 2010
[2] www.mikrokopter.de
[3] www.diydrones.com

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