DESIGN OF MINI UAV AIRCRAFT PLATFORM FUSELAGE

Peter Mrva - Jozef Páleš

Article about diploma thesis which handle conceptual design of unmanned aerial vehicle parts, engineering of fuselage construction and manufacturing technology of composite hull components. Solves basic fuselage design based on similarity with choosed wing airfoil folowed by aerodynamical simulation, constructional solutions and strenght analysys. Involves introductory landing gear project, propulsion system and control system. Handles technological instructions for preparation and manufacturing process of composite hull components.

K e y w o r d s: UAV, fuselage, polars of wing, promechanics

1 INTRODUCTION

Simplified definition of an unmanned air vehicle is an aircraft without human crew; the crew is replaced by computer and communication equipment. In fact, it's really difficult device, unmanned from its origin, without any place for crew. The vehicle is a part of entire unmanned control of UAV according to its control system. Onboard equipment may consists of many devices for monitoring, for example high resolution CCD camera for infrared, daylight and/or low visibility conditions, meteorological or tracking sensors, even devices to marking targets and missile guidance. Communication devices incorporate radio weaves receiver and transmitter and ensure bidirectional communication and data transfer with ground station or compatible portable equipment. There are many tasks that can be performed by UAV; these tasks include extreme dangerous conditions or exceed time of effective human crew attention, or tasks required precision control over human possibilities. Civilian purposes for using UAV can include aerial photographing, agriculture purposes, securing national borders, chemical reconnaissance, fire patrolling, inspection of electrical wiring, meteorological reconnaissance, etc.

Figure 1 Fulmar UAV

System, which is important for operation of UAV, consists of the one or more UAVs, ground control station, required optional onboard equipment, communication equipment, ground support, optional secure, guidance and surveillance devices. Ground control station allows receive and display wide range data from UAV and guidance.

Military purposes can be combat reconnaissance and patrolling, guidance for artillery and missiles, radio-electronic warfare, and etc. My thesis describes overview of commercial UAV, design my own vehicle, its calculations and manufacturing of composite airframe.

2. COMERCIAL UAVS OVERWIEV

2.1 Fulmar

The air teledetection system based on small UAVs, with its own flight control system with detection of the normal and infrared images in real time. Also consists of a drain catapult, ground control station and landing net. Fulmar (Figure 1) is flying wing of innovative design. It provides good stability, good value of resistance to uplift, which ensures low fuel consumption and the high flight endurance. High aerodynamic efficiency allows the use of a wide range of speeds and climbs rates. Composite materials used are unusually resistant and provide maximum protection to UAV. The design allows the airplane to overcome multiple load size + /-6g in all axes. The airplane is also designed to land on the sea on an inflatable platform. The Fulmar is easy to use as take-off, flight and landing are fully automatic and easily programmed with GPS - 3D control points using a ground control station. Ground station also serves to control the movement and focus onboard camera, which is partially stabilized gyro stabilizer and partly by ground reference points.

Table 1 Tecnical parameters of Fulmar UAV

Wingspan [mm]	3100
Lenght [mm]	1230
MTOW [kg]	19
Operational radius [km]	800
Endurance [h]	8
Cruise speed [km/h]	60-150
Ceiling [m]	3400
Payload [kg]	8

2.2 Aerosonde

The UAV developed by same name Australian company, for civil, military and scientific purposes. Conceptually, the airplane (Figure 2) designed as a double hull construction with a gondola and tail shape of an inverted letter V. The drive provides piston engine craft modified Enya R120 in a pushing arrangement with the performance of 1.74 horsepower. Takeoff is secured by a catapult or discharge from the roof of a moving car. The landing is then made into a safety net or landing straight to the bottom of the hull. With a minimum payload can reach up to 30 hours endurance at 5 kg of fuel consumption. Maximum payload can reach up to 5.3 kg with a maximum takeoff weight of 14 kg. For maximum battery life is optimal flight speed 120 km / h.

Avionics equipment consists of starting from a moving vehicle or classic way. Landing can be made under the terms of the area of the airport or a parachute. With a minimum payload can reach up to 30 hours endurance at 5 kg of fuel consumption. Maximum payload can reach up to 5.3 kg with a maximum takeoff weight of 14 kg. For maximum battery life is optimal flight speed 120 km / h. Avionics equipment consists of a transmitter of the primary data channel transmitting at 300 Mhz UHF waves, the secondary data channel transmitter for sending frequencies of 300 or 1300 MHz, tertiary on vertical transmitter sending data at frequencies from 4.4 to 4.9 GHz, accurate GPS system, position lights, infrared anti-collision lights, backup battery, a three-axis magnetometer, a laser altimeter.

Figure 2 Aerosonde UAV

Table 2 Tecnical parameters of Aerosonde

Wingspan [mm]	2900
Lenght [mm]	2100
MTOW [kg]	14
Operational radius [km]	?
Endurance[h]	30
Cruise speed [km/h]	110-150
Ceiling [m]	4500
Payload [kg]	5

2.3 Manta/Mamok

Unmanned system Mamok was developed in the TANDEM program, announced by the Ministry of Industry and Trade of the Czech Republic. It is a modernized version of the tactical unmanned reconnaissance suite that provides same parameters on less take-off weight as already established complete UAV Sojka III. The basis for the UAV MANTA (Figure 3), equipped with nose type landing gear with the possibility of starting from a moving vehicle or classic way. Landing can be made under the terms of the area of the airport or a parachute. Flight time of this aeroplane is more than 3 hours on flight conditions corresponded with Sojka III. Like its predecessor the MANTA at take-off weight of 62 kg user can carry equipment weighing 15 kg. Data logging is carried on board for high-capacity SD card. The design consists of a composite airframe parts. Since this is a relatively new project, access to information about the system are extremely limited.

Figure 3 Manta UAV

Table 3 Tecnical parameters of Manta

Wingspan [mm]	4400
Lenght [mm]	2500
MTOW [kg]	62
Operational radius	60
Endurance [h]	3,5
Cruise speed [km/h]	180
Ceiling [m]	3500
Payload [kg]	10 - 15

3 The basic hull design

The basic hull shape follows shape of selected profile Eppler 375 (Figure 4), largely because of its favorable coefficient of resistance to its internal usable area and also because of a slight curvature of the lower part of the profile which the hull is intended for installing of CCD camera aperture.

Figure 4 Basic shape of fuselage. 1-fuselage, 2-airfoil eppler 375

One of the basic requirements for hull design was to achieve the optimal ratio of shape complexity of the structure to its good aerodynamic properties. Another requirement was to allow maximum use of internal fuselage spaces for placing of payload which should to have as much as possible shape of blocks, because this way internal space can be most effective and easiest to fill in electronic equipment, which is most often in shape of the blocks. From these basic requirements results hull shape, which is derived from basic geometrical bodies such as the block, which is the basis for the lower torso and cylinder, which is the basic shape of the upper torso. The main purpose of the design of the hull of the geometric solids to the whole body was going through the back of smoothly into a cylindrical shape, respectively, to the back of passing smoothly into the shape of a propeller spinner in order to minimize the resistance of the material due to the bypassing of air turbulence. The bearing surface of the wings is chosen so that the wing was going down as much as possible to contour the body and did not increase the resistance so unnecessarily shaped structures. Interference resistance between the wing, fuselage and tail rounded edges is minimized at the transition. The front part of the body from the tip to the location of the wing (Figure 5) is intended as a useful storage space for on-board camera and electronic equipment.

Central part of the hull below the heart is reserved for the placement of integral fuselage fuel tank with a capacity of about 4 to 5 liters of fuel. The center of gravity and fuel tank will be located space for servo control equipment tail surfaces and throttle carburetor powerplant. In the rear of the fuselage will be on the vertical motor mount located on the drive unit located foursome rubber silent block.

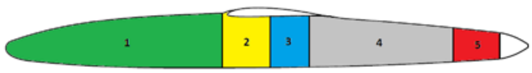

Figure 5 Basic dividing of fuselage to main sections

3 DETAILED AERODYNAMIC ANALYSIS

This was done using relatively simple program to simulate the air flow XFLR5. In the environment of this program was created by a simplified three-dimensional model of the aircraft fuselage and wing was added. Because the program XFLR5 does not feature for separate analysis of the aerodynamic body, a separate analysis was made for wing and tail, second analysis was made for the body with a built-in wing and tail surfaces. The resulting coefficients of the body are then obtained by plotting the coefficients of each analysis are displayed in polar and polar wing aircraft (Figure 7) Aerodynamic coefficients results are all for angle of attack 0 ˚

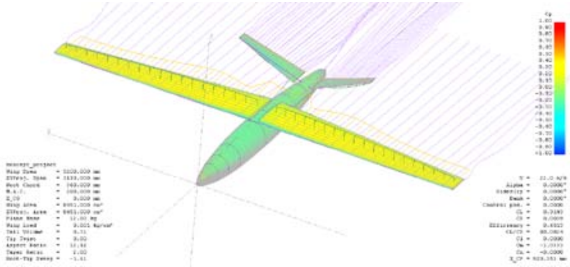

Figure 6 Aircraft aerodynamical analysis in program XFLR5

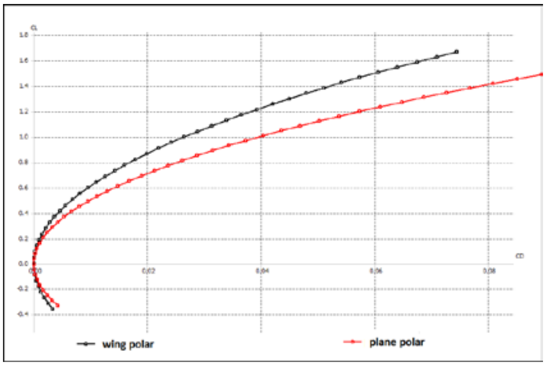

Figure 1 Polars of wing and plane

4 STRESS ANALYSIS OF FUSELAGE

For the purpose of strength controls the body was used for the environment-mechanical (Figure 8). Stress analysis executed on hull shell loaded in key places loaded from the forces of gravity of the main components of the airplane and its on-board equipment. These forces were multiplied times the load of the turnover value of 10 of flight envelope and a safety factor of 1.5.

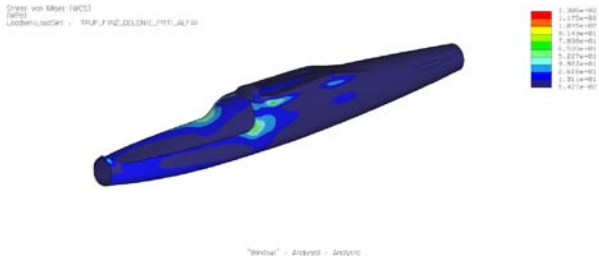

Figure 8 Fuselage stress test in Pro-mechanica

In the figure above are clearly visible maximum stress values shown in green. These will be the production of locally reinforced with carbon fibers.

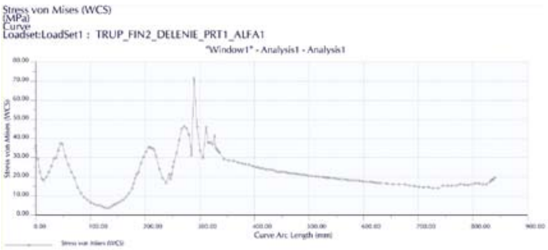

Figure 9 Graph of maximum fuselage stress

The maximum stress value displayed on the graph (Figure 9) is more than five times lower than the breaking strength of the material and, therefore, we conclude that the structure is strong enough.

Figure 10 Final 3D model of designed UAV

Figure 11 Final 3D model and construcion team

5 CONCLUSION

Unmanned aerial vehicles are in recent years rapidly growing part of the aviation industry. This fact is mainly due to wide possibilities of their use. This article brought overview of unmanned airplane designation concept and detailed design of the hull. Theoretical results were later completed by a practical implementation as a physical realization of project by building real size prototype. Most of the tasks set at the beginning of the project was met by a form of what was in those circumstances can be achieved. However, there is still room for improvement by optimizing the structure of its parts or the design and production of the remaining parts of the airborne equipment. Designed airplane (Figure 10) will be subjected to full completion of the running tests and then flight testing. After installation on-board avionics and payload of weight two kilograms, airplane will have a maximum takeoff weight twelve kilograms, including fuel range between twelve to thirteen pounds. In this configuration should be capable with reliable navigation system, flight within five hundred miles or achieve operating radius two hundred and fifty kilometers with flight endurance up to five hours. I believe that the UAV with such parameters is very well usable for humanitarian purposes.

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AUTHOR'S ADRESS

doc. Ing. Peter Mrva, CSc. Department of Aerospace Engineering, Faculty of Aeronautics, Technical University, Košice, email address: Peter.Mrva@tuke.sk

Bc. Jozef Páleš – student of Faculty of Aeronautics, Technical University, Košice, jozef.pales@centrum.sk

Reviewer: Ing. Jozef Judičák, PhD.