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STUDIES AND TESTS OF MICRO AERIAL VEHICLE DURING FLIGHT

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Abstract

The article presents the results of flight tests of an unmanned flying device based on a model Micro Air Vehicle (MAV). The airplane was used during experimental studies. In the article, on-board equipment of micro-plane used in the study has been shown. Furthermore, the process of integrating all of the avionics equipment with MAV has been described. During the flight test, all parameters of microaircraft flight such as air and cruising speeds, altitude, air route, angles of tilt, slope angle, deviation angle, tilting speed, slope speed, deviation speed, etc. were recorded. During the study, the behaviour of micro-aircraft in various phases of flight such as autonomous take off, landing, programmable flight to the specific points of the air route was checked. In addition, the action of specified fail safe features of micro airplane operating in the case of a failure (e.g. in the case of low voltage of power package, loss of GPS signal, loss of communication with the ground station, etc.) is determined. The graphs of some flight parameters and figures of flight routes as well as flight profiles during the programmable flight have been presented. The researches allow for the verification of the integration process of micro-aircraft with on-board systems and they also allow for evaluation of its functional characteristics in further studies such as formation flights and bypassing the obstacles.

Keywords: *Micro Air Vehicle, flight tests*

1. Introduction

Micro Air Vehicle (MAV) is a small aircraft, light and inexpensive unmanned flying vehicle for direct, over the hill reconnaissance. The focus is on fixed wing, forward thrust airplane since the ability to negotiate strong opposing winds is required.

Several prototypes of fixed wing MAVs were built and they achieved good range and endurance performance. These characteristics, the data first be tested by analytical methods, runs simulations, and finally verifies its characteristics during flight.

Research on the fly is a special breed of flight, during which examines the characteristics and behaviour of micro air vehicle to detect and diagnose any abnormalities in terms of stability, steering, load and performance, stall and spin characteristics, vibration, compliance, etc.

2. Flight tests

Flight-testing is an ultimate method validating results. MAV used in flight tests was almost identical to the wind and water tunnel model applied. Aircraft structure was based on the carbon torsion box in the nose part of the wing and ribs covered by flexible membrane in the remaining part of the wing (see Fig. 1). This structure was selected because of greater flow stability. Electric motor MEGA Acn 16/7/8 with Jes18-3P Advance controller and APC 5.7x3 propeller were selected for propulsion of the airplane. Motor was supplied from Li-poly batteries with capacity of 1250 mAh. Separate Li-poly battery was applied to supply the experimental equipment. PRP-J5 data acquisition system was used to conduct measurements together with a set of accelerometers and differential pressure velocity sensor. Fig. 1 shows the airplane before the test.

Experiments with large angles of attack began after initial airworthiness testing.

Fig. 1. The MAV before flight tests

The aircraft was fully controllable when performing this manoeuvre. As can be expected, aircraft is stable and controllable. Both lift and drag influence the load factor measured orthogonal to the fuselage, so it increases due to the drag increase if lift remains at least constant. Therefore, presented result proves that the investigated airplane is capable of coping with angles of attack greater than 32. Lack of any tendency to autorotational roll or spin and full controllability during experiment support this statement.

3. The control system automatically Micropilot

The control system automatically Micropilot MP2128 is currently the most widely used, mass-produced autopilot for small flying objects. The relatively low weight and broad configuration possibilities allow the use of this system for flight vehicles of different classes and different sizes. With the company's offer, Micropilot Canadian Company selected the most extensive system of heli MP2128 version (also adapted to carry hovering).

Micropilot systems are supplied as modules in a standard OEM (running electronic circuit boards) and cabling components. At the customer's responsibility to make connections, casings and install and integrate an entire system from the airframe.

Micropilot systems are covered by the law of dual use (Class ECCN 9A991 for systems with programmed flight path), and require an export license. In practice, this procedure several months waiting for permission to purchase and restrictions on use of the system (it cannot be exported from the country and you cannot resell).

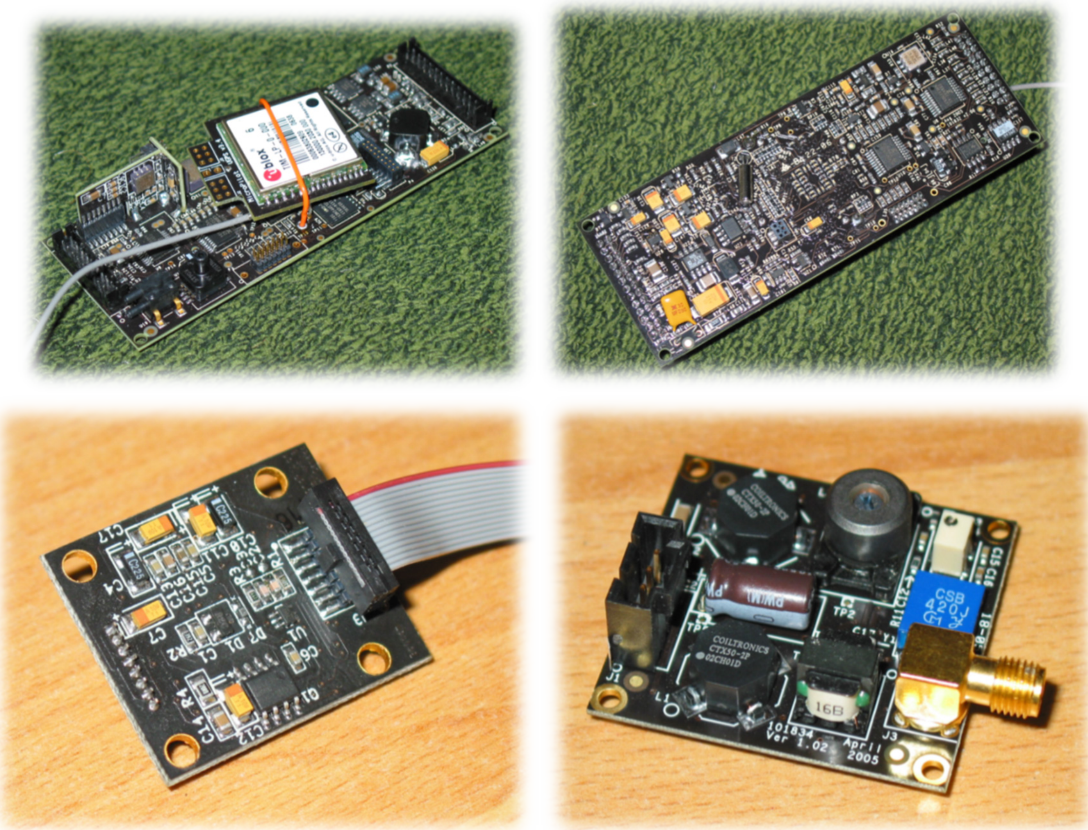

Fig. 2. Micropilot system components: a base plate, the plate probes of magnetic and ultrasonic altimeter plate

Research on the fly performed using the Horizon software package, which was supported by additional software integration and utilization of the system. These are programs for the analysis of registration records flight data for testing individual modules and simulation packages. A valuable advantage Micropilot product is constant updating of the programs and software source files modified based on feedback from users around the world.

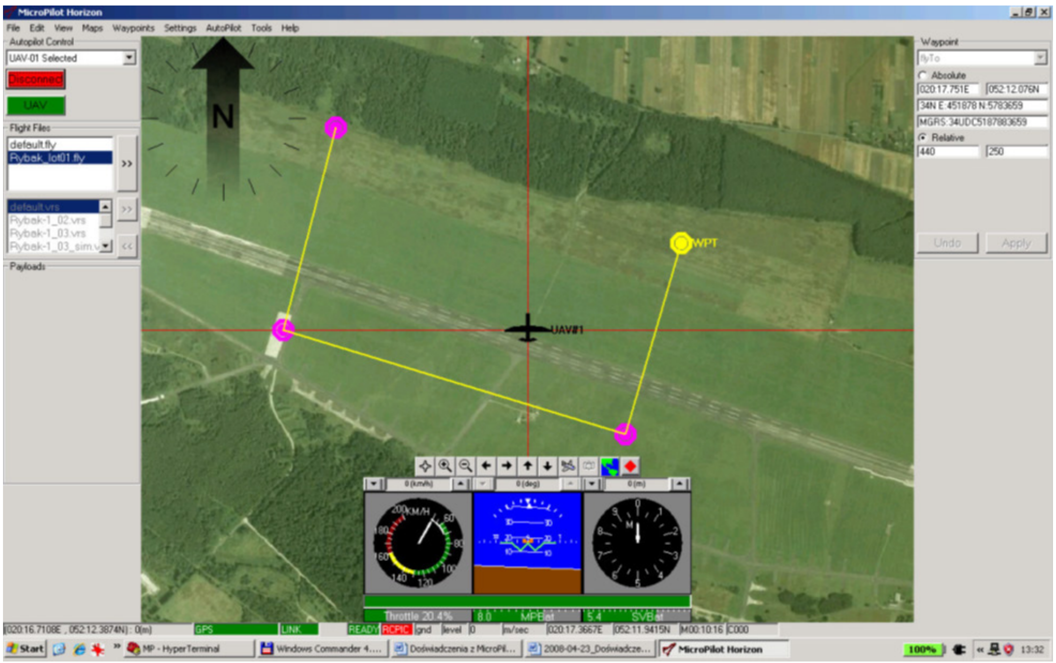

Fig. 3. Screenshot of mission control program

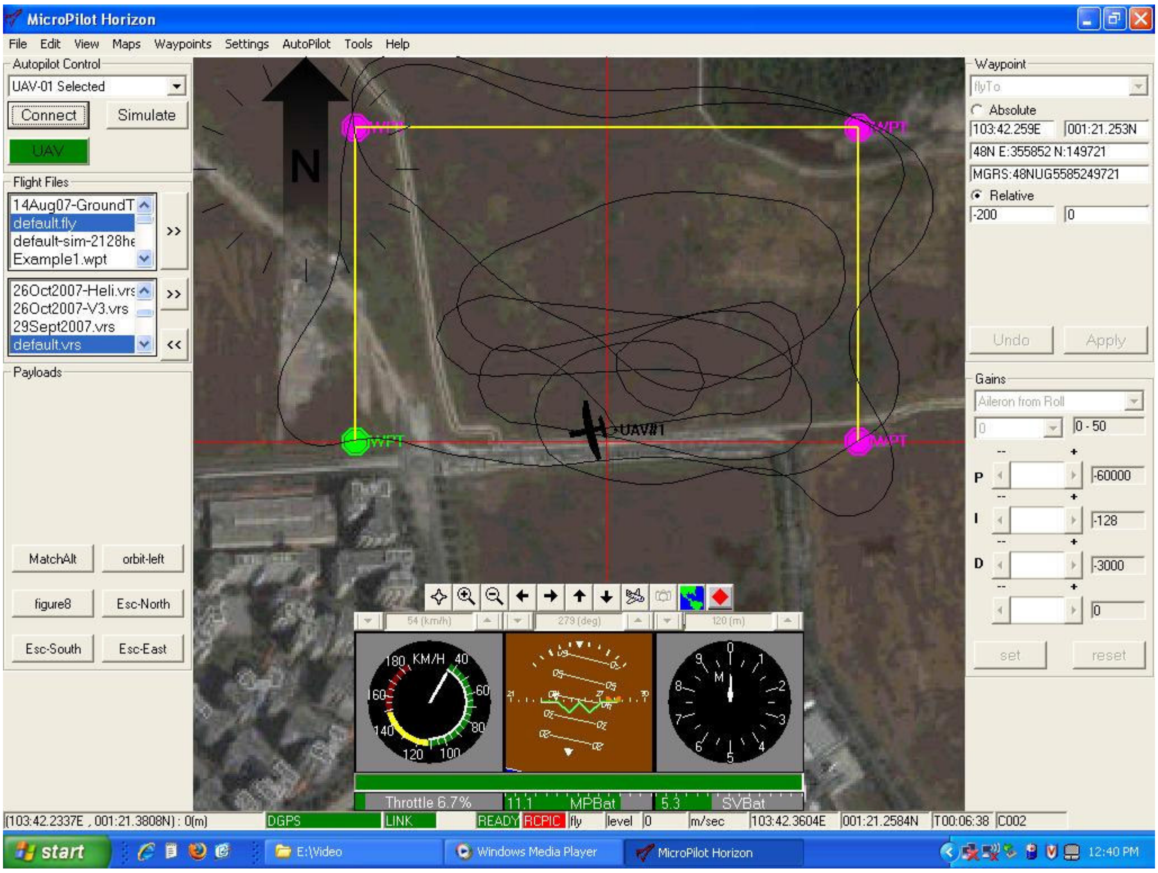

Fig. 4. Mission planning on the computer screen with the flight path

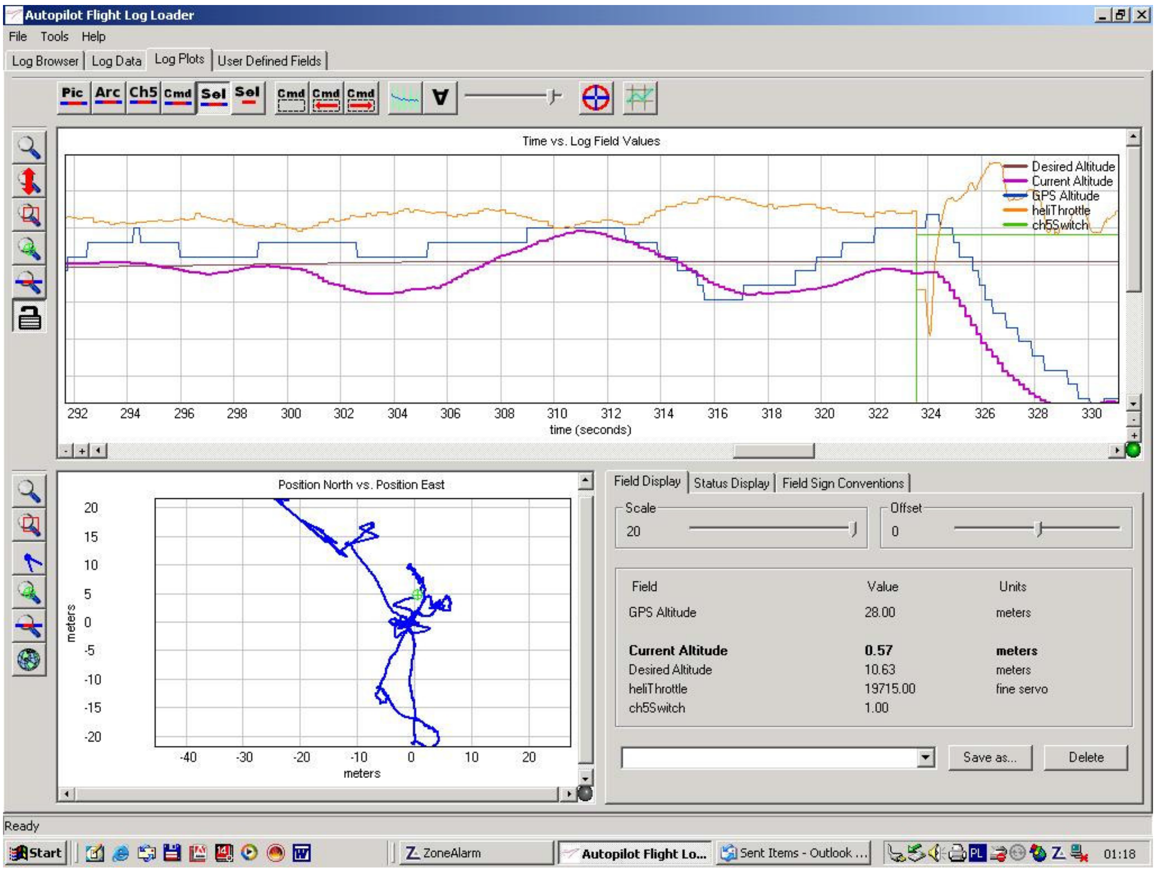

Fig. 5. Examples records flight data

Fig. 6. Examples of photographs made from the deck MAV, transferred to the computer screen mission planning way radio

4. Analysis of results

Some results from flight test data recorder are presented in the Fig. 7-15.

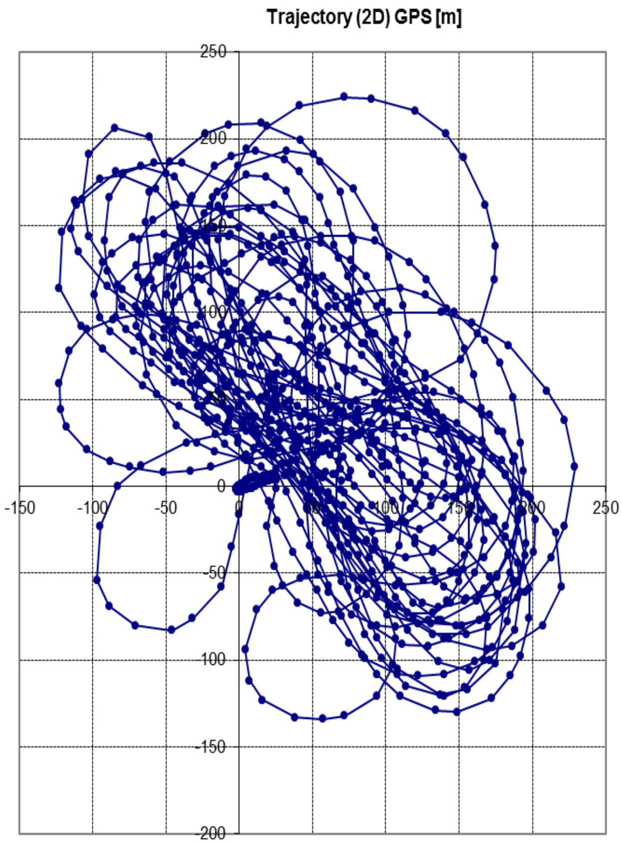

Fig. 7. Trajectory of flight

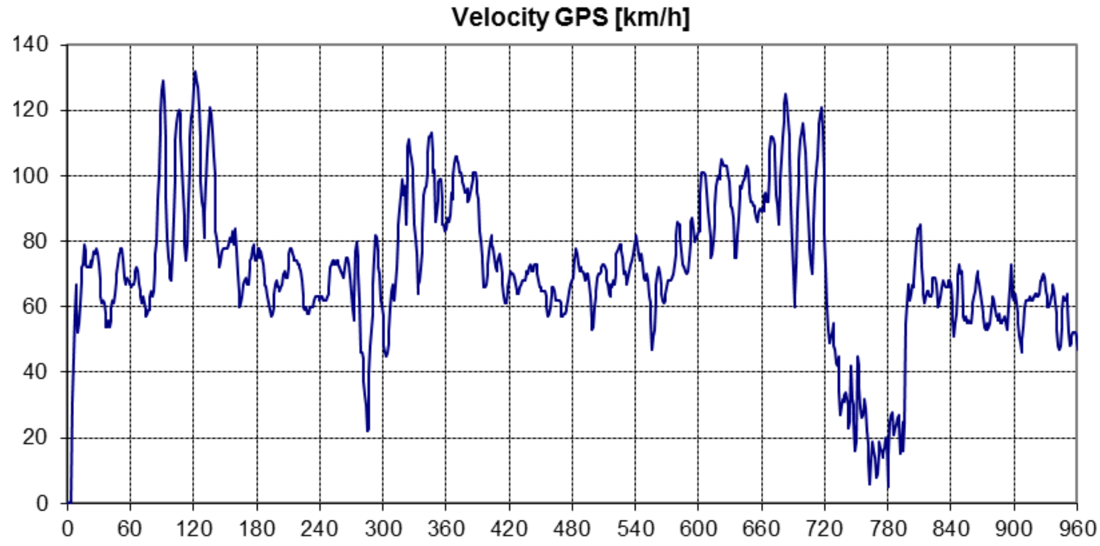

Fig. 8. Ground speed

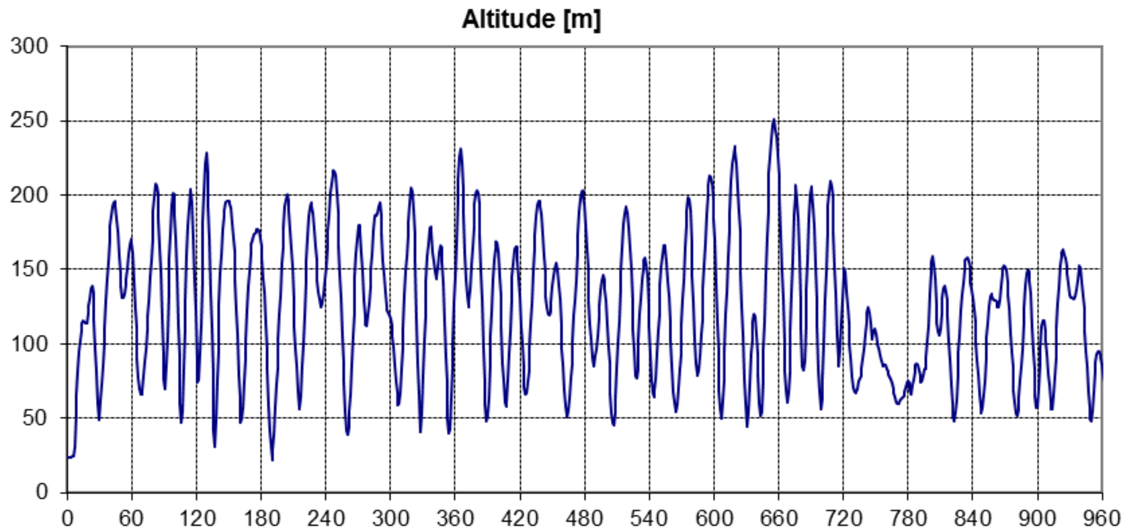

Fig. 9. MAV altitude during flight

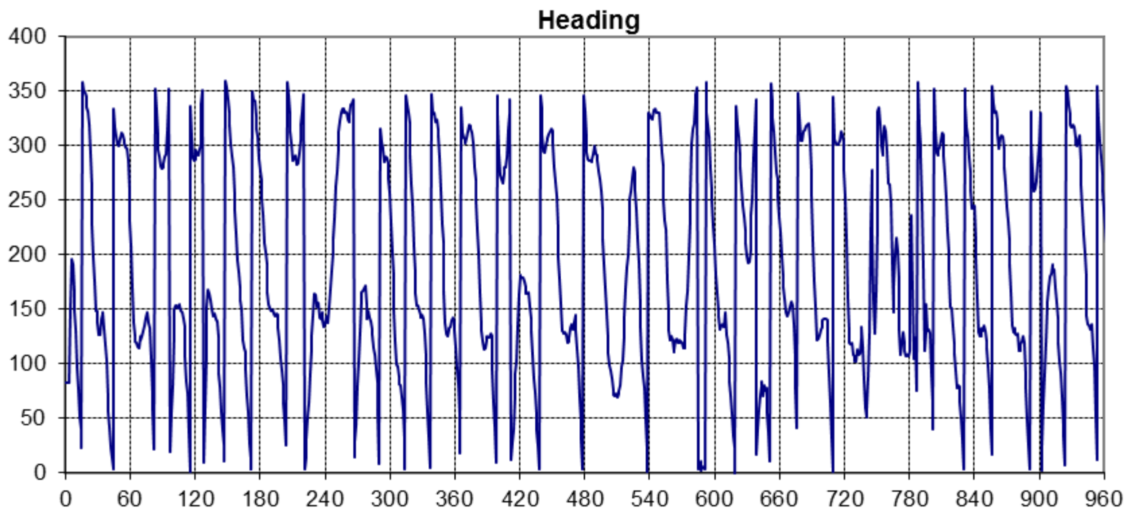

Fig. 10. Heading

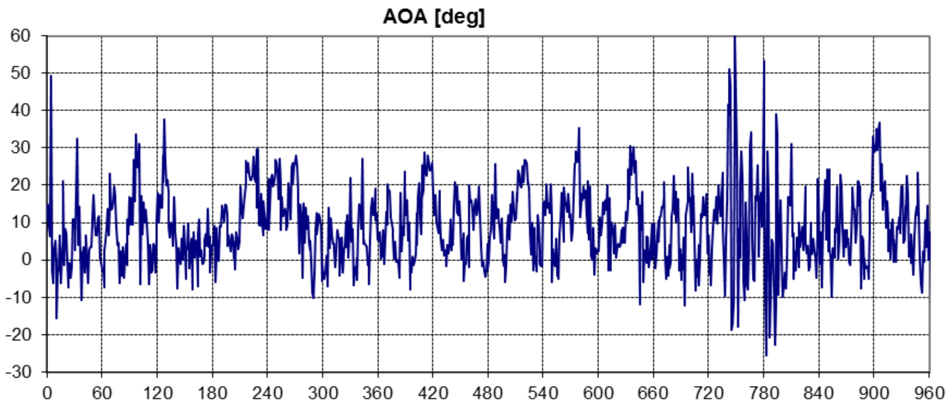

Fig. 11. Changes in AOA during flight

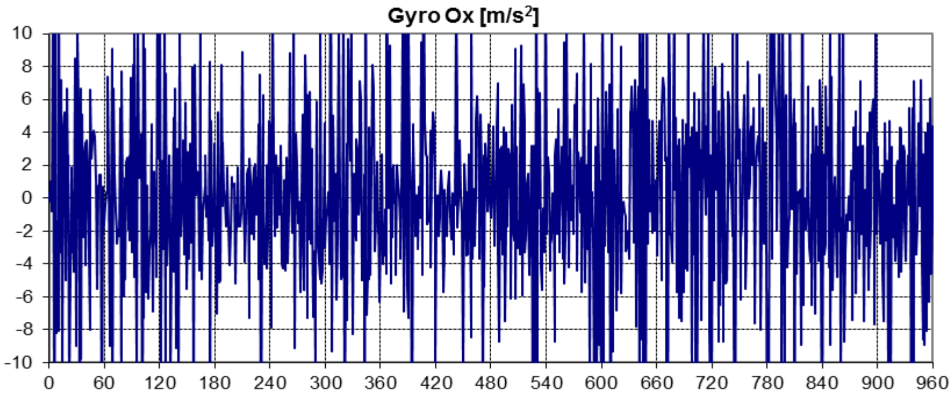

Fig. 12. GYRO acceleration Ox direction

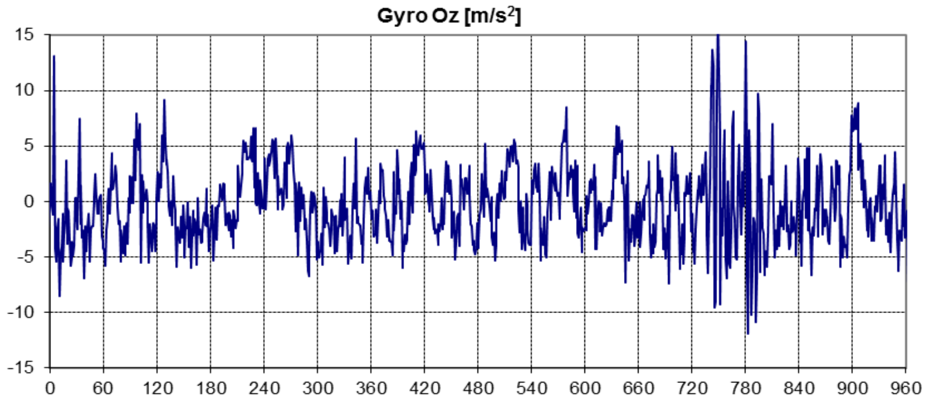

Fig. 13. GYRO acceleration Oz direction

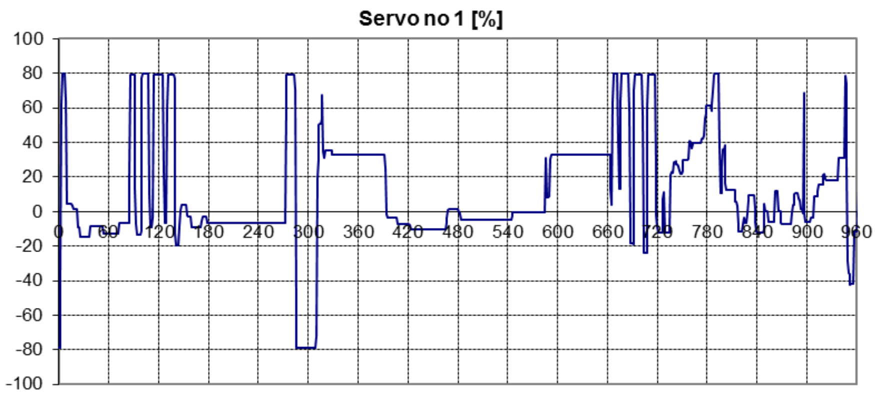

Fig. 14. Servo motion

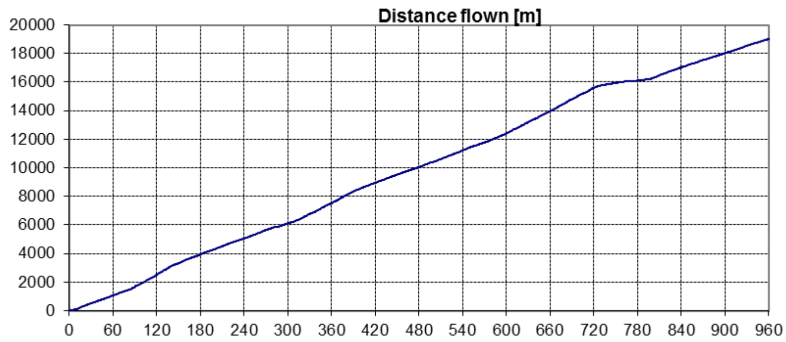

Fig. 15. Distance flown

Figures 12-15 are showing 16 minutes flight of MAV.

5. Conclusions

It can be stated, that results of tests confirmed, that vehicle is stable and controllable. The flow distance was above 19 km. It can be observed rapidly changing flight parameters, caused by wind (5 m/sec), and atmospheric turbulence.

Used software is effective and allows for full analysis of the flight.

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