VOICE INFORMATION ON THE ACTUAL ALTITUDE OF THE HELICOPTER

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This artice focuses on the possibility of a simple modernization of the helicopter Mi - 8 of the supplement to the information of the actual amount of radio altimeter RV -5 helicopter in which they are located. On possible security risks associated with helicopter flight at low altitudes and during flight and landing in dissected terrain. The practical part of the article discusses about facilities used for building versions of the product. For reporting is used, on amounts to the microprocessors, Arduino UNO supplementary by there to Adafruit wave shield. Their mutual communication and process functionality and description are followed by a description of the measurements made and the method of integration of the product into the radio altimeter.

Keywords: helicopter, radio altimeter Arduino, Adafruit wave shield

Introduction

In the world there are currently hundreds of small-scale aircraft manufactures, looking for the appropriate application of their products on the use of small aircraft in the air traffic so that the economic costs of each system are minimal, but with higher efficient operations and activities. Since avionics is going through a phase of integrating their systems, this task is not easy in the present. Looking elsewhere one finds the options that can be found in exploring potential opportunities in the field of patents, which are aimed at simplifying these systems in the field of avionics.

One such option is the search for multifunctional systems based on understanding of their operation and principles. An example is the on-board altimeter, where measurement is one task measurement and it is improved with a further assistance function. Increasing the efficiency of these widely used systems in small aircraft, radio altimeters can also be used to increase safety of a flight. This is done by attaching other features that clearly contributes to the safety of flight such as the repeated signaling of altitude. The existence of such systems is already known, but these systems are integrated into the systems avionics computers, so it is very difficult to implement them on a small aircraft or helicopter. The helicopter chosen by the author as an object implementation is made more difficult by the activity of management of helicopter piloting multiplied by constant offsets generated aerodynamic forces. This means that fixing the so-called hanging (offsets) if not controlled by autopilot is a complex process. The helicopter is machine adapted to carry out not only transport but also aerial work, so constant orientation in high space is very important for a pilot; therefore any change induced cyclic control, causes a large change in the space below.

One of the problems with which the pilot aboard the helicopter meets is the stabilization of the rotor in different conditions in carrying out aerial work, or during his flight during the implementation of these works.

The present Helicopter Mi 8/17 on his board uses a radio altimeter type RV (Russian production) in which the vast majority of A - 037 as the variant, which can vary according to the approved documents under the applicable EASA, ISO, and TSO certificates. However, if we take into account that the principle of measuring the height of each variant is similar, it is possible to carry out a technical implementation which will promote helicopter assistance function to the next stage.

One possible solution is to add a voice instrument into the altimeter circuitry so that the model would be able to report real terrain clearance in real time to the pilot's headphones. These devices would be beneficial, since dozens of helicopters operating in the Slovak Republic do not have such options available.

The author sets the goal to create a technical feasible design to such a system for the altimeter type RV and theoretically analyze the issue of helicopter flight at low altitudes. In laboratory Faculty of Aeronautics, the avionics department used the altimeter RV - 5, which will used to simulate the present implementation system.

Theoretical analysis of selected topics

The topic of vocal information on the real altitude of a helicopter is the current view of the management of small airborne aircraft, carrying out flight activities at low altitudes. Of course briefing the pilots in general is secondary information, but it draws attention to the area in which the craft is operating. The issue of helicopter flight at low altitudes and its subsequent maneuvers for landing form a separate issue for the successful piloting of the machine. Pilot's visual attention must be drawn to multiple aspects of the flight, which increases the possibility of overlooking one of the important indicators for landing. This topic was chosen to expand awareness on the piloting helicopters, its flying skills and qualities. In the thesis, I would like to contribute to the improvement and simplification of landing operations of helicopters Mi-8 and Mi-8MTV flying in low altitude. To enrich and improve systems for helicopters in which an inexpensive device will help to improve and increase

flight safety helicopters, which have not been equipped with more complicated and expensive equipment. The proposed device is intended to provide helicopter pilots with voice information of the real height based on data from the altimeter, allowing the pilot to concentrate on the landing maneuver or other indicators necessary for flight and landing.

Assistance systems and on-board information system helicopter

Aircraft complex is formed in-vehicle systems that provide reliable operation for the aircraft to achieve the desired functions directed to aviation. The basic function of each agent is flying ability to independently move in the airspace. To do this adequately adapted aerial performance systems, such as leaf area and power unit. Based on this, it is necessary to control the system.
In the area of security of communication, navigation and warning alarm messages can be understood as information system -board the aircraft. On the basis that you create a realistic picture of modern aircraft Fig.1

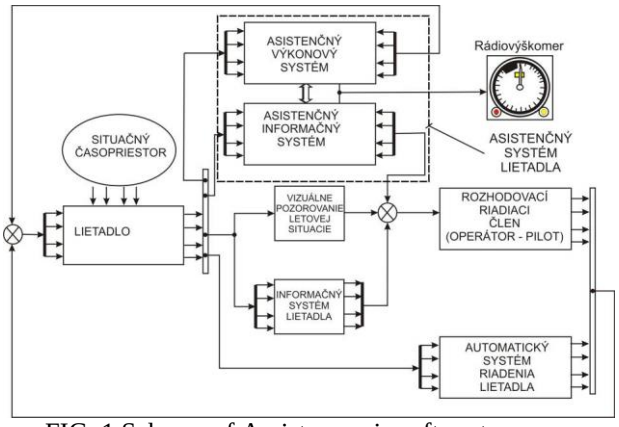

FIG. 1 Scheme of Assistance aircraft systems

Assistance system is used to ensure the safety of surgical procedures and the management system makes it impossible to complete wrong decisions of operators.

Each designated system in itself is a subsystem that has a warning to output information about its internal state (fault-free condition), or the external condition (alarm - warning - prediction condition).

Assistance alarm systems fall into this category and are deployed on board the aircraft. They allow for alerting the crew to dangerous situations during flight. In the past years these information and assistance systems were equipped in almost all of the work management space for pilots. The sorting for them can be seen in the picture below.

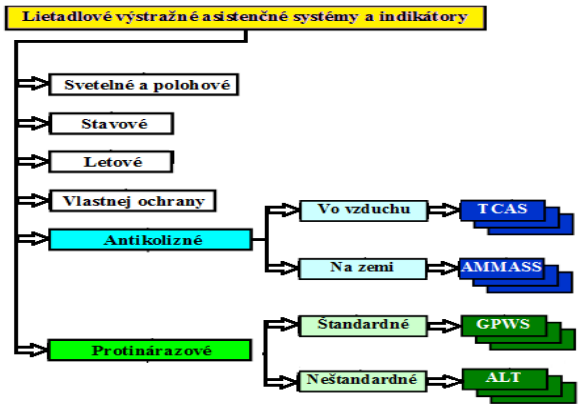

FIG. 2 Distribution of airborne warning systems

Alarm warning (anti-collision) systems are designed to warn the aircraft crew before the possible emergence of a collision with another object flying in the air, and to avoid collision of aircraft moving on the tarmac. The systems allows for situational awareness of the pilot proposing alternative solutions for collision avoidance.

Warning bump (from precipitation) systems are designed to alert the pilot before the aircraft reaches dangerous approaches to the ground, as well as early warning for low- flying aircraft before terrain obstacles .

Onboard aircraft Information System

Onboard aircraft information System (PIS) is characterized by digitizing output information from aircraft systems into image information system, which can be presented in the form of electromechanical information or command indicators, and electronic imaging systems.

Example, it is possible in Fig. 3 to show the projected flight path information from the real flight path of the physical object (aircraft) until the normal selected flight path is corrected.

Interpreted information is offered to the pilot – as is the aircraft's response to the immediate situational status. The PIS processes the pilots outputs – controlled by the helicopter operators as they are illustratively shown in FIG. 3

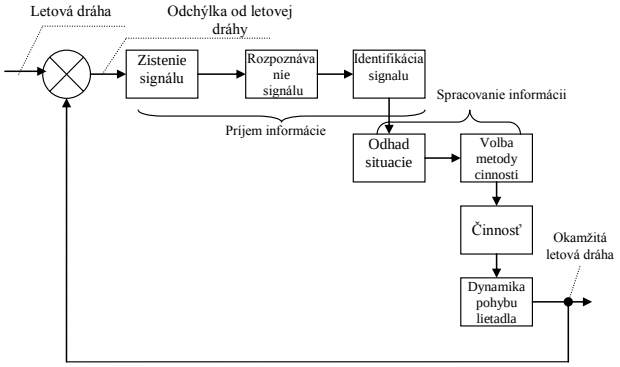

FIG. 3 Information helicopter flight system and treatment process

- It is possible to include this activity pilot operation, created by a subsequent sequence of operations:
- receiving information (signal detection, recognition, and determination of its meaning)
- estimate of the number of elements with data ISL and the experience of a pilot - operator whose output is based on the admission of control algorithm
- Practical implementation - addressing flight situation
- check the results of management action.

2. Definícia výšok používaných na palube

The aircraft, to be maneuvered in space needs to meet some basic principles of navigation. To meet the navigation conditions, it is necessary to know its location, which is realized in the form of outputs from on-board navigation systems such as VOR / JUSTICE, ADF, INS and the altimeter to us uniquely determines the vertical position within the airspace presented by the actual height above the ground. Since the on-board altimeter performs its function orientation above the ground and as such is limited to its design range, there should be another device that can measure the distance outside the measured parameters. A device such as this is a barometric altimeter. Other sources of height include global or satellite systems.

Definition of height above ground: the actual (real) height above the ground, measured with airborne radio altimeter based on the temporal change in the send and receive signals on board.

Flight height measured and monitored, according to the task and the type of flight. Height above sea level, which is related to the sea surface, is also called the absolute height.

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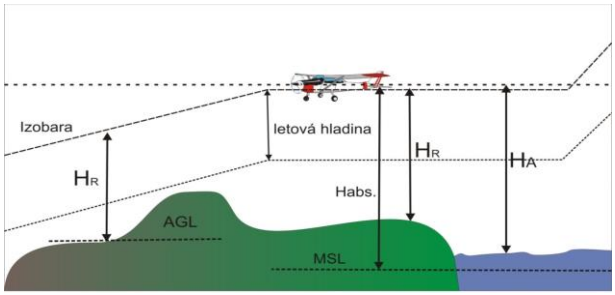

FIG. Showing 4 heights

Height above just flown country called relative height. The absolute height is the importance of the pilot fly over the mountains, which are indicated on the map with its height above sea level. To land without external visibility we need to know the exact height above the ground, i.e. relative height Hr.

There are several known definitions of height:

- Indicated altitude - information on the altimeter when the altimeter is set to the local barometric pressure at surface sea level.
- The absolute height - height of the aircraft above the terrain over which it is flying. It is measured in meters above ground level (AGL).
- The actual - actual height above mean sea level. It is indicated altitude corrected for non-standard temperature and pressure.

3. Altimeters and its role on board the helicopter

Knowing the elevation above which the aircraft is flying is the primary source of information for the pilot to comply with the prescribed elevation, and if possible to avoid collision with terrain. As the main information for the pilot the flight altitude is used for comparison with the overflown terrain map data, thereby undertaking a. an initial check against collision with terrain. This amount as a safe altitude (OCA) (Obstacle clearance altitude) or obstacle clearance (OCH) (Obstacle clearance height) is set in aeronautical charts, and also provides the aeronautical authorities of the countries over which the aircraft operates during flight.

The pilot is authorized to establish minimum flight altitudes on lines for which they wish to operate flights. These amounts may not be lower than those imposed by the Authority of the States overflown, unless they expressly allow a lower altitude flight (ATC commands). Determination of minimum height above ground is also based on assumptions of accuracy and reliability indications of altimeters, terrain characteristics (topography), weather conditions (frequent weather changes), and other constraints of the country.

With this information the pilot establishes the minimum and hazardous terrain clearance and decision altitude before landing. Dangerous height (DH) above ground level (AGL), which is provided by the radio altimeter input to TAWS systems. This height is crucial for take-off and landing maneuvers, and when approaching the aircraft to the airport.

FIG. 5 height indicator

RH decision height is the height before landing aircraft (helicopter) established by the pilot determined on the basis of the runway and the parameters of the aircraft. This amount is the final height when the pilot prior to the landing may perform an circular maneuver or landing for example with engine(s) failure.
The low range radio altimeter type is designed to measure the actual amount of the aircraft above the ground. Indication of altitude is transferred to:

• Pilot's altitude indicator
• In automatic flight control system SAU.
In addition to tasks above, the indicated height indicator, altimeter, also performs the following tasks:

A. Posting altitude data in the form of a DC voltage of positive polarity, where the size of the measured voltage is proportional to the amount
b. Broadcasting of data exceeding of a preselected elevation level flight,
c. Broadcasting of serviceable altimeter data.

4. Progress of measuring the output voltages

In the initial implementation of measurement were considered measuring tensions with information about the amount of the blocked indicator. After technical - theoretical analysis, this information may be inaccurate; therefore, one must consider altimeter errors. One of them is instrumental error. Another factor is the delay which may cause a deficiency reaction time to the given information. After practical laboratory tests, the theoretical conclusion that the best place to measure and obtain data information would be given to the SAU (autopilot), where the voltage magnitude of its value information corresponding to the input connection to the voice instrument with which one can count as Realization components.

FIG. 6 Laboratory workplace RV-5 to determine the amount of real output voltages

The implementation to achieve sufficient voltage parameter, the point of joining the bloc altimeter No.8, W1 terminals was reached.

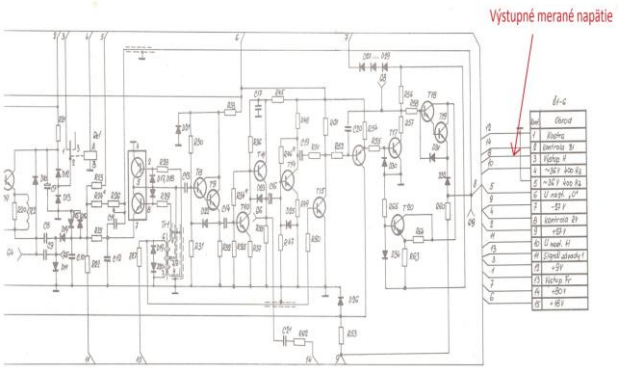

FIG. 7 Schematic representation of the RH-5 and BI-5 blocks.

On the basis of knowledge fundamentals RV-5 measurements were made, which justified the correctness of the wiring system. In laboratory conditions were measured and evaluated, signals necessary for the effective implementation of voice instrument. Since several measurements on the RV-5 were achieved, the figures acceded to the involvement of the RV itself, having been complied with required parameters to measure it. Adjusting the connection circuit included in the BI part of the RV included a simple multi-meter with the accuracy required to obtain adequate measurement values .

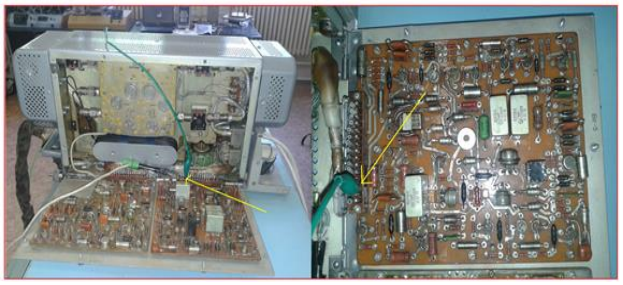

FIG. 8 Selected parts of the real circuit boards in an RV - 5

5. Implementation involvements and the program for the voice instrument

Voltage measuring height was chosen microcontroller Arduino UNO, one of the freely available platform for electrical modeling based on a simple and flexible user software and hardware. Arduino platform module contains a microprocessor and its own development environment that uses the language C++. The modules are based on microprocessors from Atmel. Adruino can be

powered via USB connection or with an external power supply which is automatically selected. External power can come from AC - DC adapter or battery.

FIG. 9 Microcontroller Arduino UNO

As a complementary add-on the Arduino platform is capable for the purpose of playing music files designed Adafruit wave shield device that can play back uncompressed audio files of any length with the volume up to 22 KHz, 12 bit. It has on-board DAC filter and high-quality output. Audio files are read from SD / MMC card. The volume can be adjusted using the potentiometer on the board using the control dial. Adafruit Wave Shield comes with Arduino library for easy use. It can play any uncompressed 22 kHz, 12 bit, mono Wave (. Wav) files of any size.

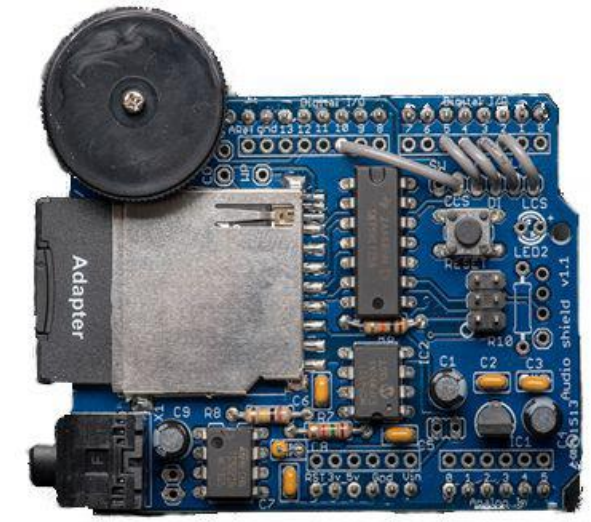

FIG. 10 Adafruit Wave Shield

The requirements to measure in the laboratory the radio station connects to KPRV-5 , which contains the device I-5 and K-5th These devices are used to control and adjust radio altimeters RV-5 and RV-5R . Power is supplied from the mains 115V frequency of 400 Hz and a network of DC 27V, a DC power requirement of 45 watts and AC 40 VA. This arrangement allows for:

• Check the signal voltage safety (27 V network), 18 V stab (power block), 115 V (net) with a maximum error of ± 5 %;

• The control signal on the basis of the amount of DC voltage 0-10 m with a maximum error of 0.2 mA 10-750 ms error of ± 2 %;

• Check the measuring tract band radio altimeter heights measured at several points using a constant frequency;
• Height adjustment range measuring heights;
• Check amplitude control circuit radio altimeter;
• Control circuit for turning on radio altimeter;
• beep "radio altimeter check ";
• Display of error-free fault signal. Signal dangerous heights;
• Check the audio signal parameters;
• RF signal delay of 36-40 m with a maximum error of ± 0.5 m using the device K-5;
• Checking the sensitivity of radio altimeter with a maximum error of ± 3d

Attaching the voice altimeter instrument to RV-5

For measuring voltage proportional height the chosen block was measuring BI-5 due to the output voltage varying from 0-40 V, which will then be restricted to enter the platform at maximum extent devices to 5 V due to adruino. After opening the right side and the radio altimeter disclosure block height measurements BI-5 is connected to the Arduino pin number 3, which is proportional to the current amount. The second pin is grounded. Using your KVRV-5 I-5, the simulation gradually increased from 0 to 100 meters, 100 meters where the boundary has reached the maximum allowable values for 5V input to the Arduino microcontroller higher voltages; which are filtered using a 4.7 V Zener diode to ensure the functionality and to prevent damage to the microcontroller. The measured voltage corresponding to the altitude data are shown in Table. 1 in the previous chapter.

Voltage waveforms were measured ten times with the deviation from the values listed in the table as ± 0.18 V, the resulting variation may be due to uncertainty of measurement error in the readings of the amount of equipment KVRV5-I5, resulting deviations are almost negligible, but it is considered and treated by the Arduino microprocessor. Deviation values and voltage waveforms are shown in Figure. 11

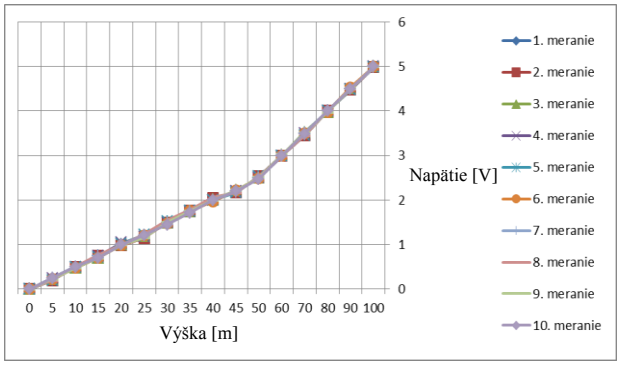

FIG. 11 Graph of the output voltage height adjustment

Program features of the voice instrument

For program functionality the WavHC.h library was used, this library contains default use pins. Sound system compatible with Arduino library and also with WaveUtil.h, both libraries ensure correct operation of the module that connects to the Adafruit Wave Shield. Analog pin 1 is used for sensing the voltage measurement unit of radio altimeter BI-5. At the very beginning, the program will start diagnosing the correct functioning of the card. In the first step, the control card will test the memory load of the Arduino. If there is insufficient free memory, the program will not run and illuminates Fault in the form of lit LEDs connected to digital pin 14. In the next stage the card tests the accuracy of the formatting FAT16/FAT32, if there is incorrect formatting LED connected to pin 14 starts flashing at intervals of 1 s. Following testing of the memory card the program passes to an endless cycle and using an analog pin 1 reads the value from the A / D converter and converted to a voltage. Loaded voltage is compared with predefined values stored in the program, which were measured in the laboratory. If the value of the read voltage corresponds to a predefined value a function is performed by the copying the desired file with information about the amount. This function first tests whether the file has triggered the desired format and whether or not it is damaged. On File Fault the LED on pine 14 starts flashing every 4 seconds. With the correct file format the playing will commence. After playing the file the function is terminated and the program returns to the beginning of the cycle.

This simple voice instrument could be used to increase safety during helicopter flights with radio altimeter type RV when the pilot's attention should be more focused on the observation of the surrounding rugged terrain. This additional equipment is easy to construct and inexpensive, so it would be an appropriate assistance system to the information systems radio altimeter.

References

[1] The helicopter Mi - 8 power and special Equipment (Operation) Ministry of National Defense, Praha 1972
[2] The radio altimeter RV - 5 (description and operation): Ministry of National Defense, Prague 1977
[3]http://store.arduino.cc/index.php?main_page=product_info&cPath=11&products_id=195
[4] https://www.adafruit.com/products/94
[5] P. Kurdel , Dissertation thesis : the altimeter Information and assistance systems of the helicopter, Kosice 2010

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