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ANALYZES OF MODERN PROBLEMS IN RADIO ALTIMETER SYSTEM AND ITS SOLUTION METHODS

АНАЛИЗ СОВРЕМЕННЫХ ПРОБЛЕМ СИСТЕМЫ РАДИОВЫСОТОМЕРОВ И МЕТОДОВ ИХ РЕШЕНИЯ

РАДИО АЛТИМЕТРЛЕР ЖҮЙЕСІНІҢ ҚАЗІРГІ ЗАМАНУ МӘСЕЛЕЛЕРІН ТАЛДАУ ЖӘНЕ ОЛАРДЫ ШЕШУ ӘДІСТЕРІ

Аннотация. В данной статье проведены исследования современных проблем самолетных радиовысотомеров малых высот и предложен новый метод диагностики для решения существующих проблем. Показано, что на основе использования нового метода диагностики может быть реализован контроль корректности работы системы радиовысотомеров и, как следствие этого, принятие на борту мер для устранения ложных показаний системы, тем самим обеспечение безопасности полетов за счет повышения достоверности информации получаемой от системы радиовысотомеров. Основными преимуществами предлагаемого метода диагностики является то, что его можно проводить как в полете, так и в наземном обслуживании, а также применять без контакта с радиовысотомерной аппаратурой самолета.

Ключевые слова: безопасность полетов, корректная работа, радиовысотомерная система, современные проблемы, автономный метод диагностики.

Аңдатпа. Бұл мақалада төмен биіктіктегі әуе кемелерінің радиобиіктік өлшегіштерінің заманауи мәселелері зерттеледі және бар мәселелерді шешудің жаңа диагностикалық әдісі ұсынылады. Жаңа диагностикалық әдісті қолдану негізінде радиобиіктік өлшегіш жүйесінің дұрыс жұмысын бақылауға және соның нәтижесінде жүйенің жалған көрсеткіштерін жою үшін бортта шаралар қабылдауға, сол арқылы ұшу қауіпсіздігін қамтамасыз етуге болатыны көрсетілген. радиобиіктік өлшегіш жүйесімен алынған ақпараттың сенімділігін арттыру арқылы. Ұсынылып отырған диагностика әдісінің негізгі артықшылығы оның ұшу кезінде де, жерде жұмыс істеу кезінде де жүзеге асырылуы, сондай-ақ әуе кемесінің радиобиіктік өлшегіш жабдығымен байланыссыз пайдаланылуы болып табылады.

Түйін сөздер: ұшу қауіпсіздігі, дұрыс жұмыс, радиобиіктік өлшегіш жүйесі, заманауи мәселелер, автономды диагностикалық әдіс.

Abstract. The modern problems of low-altitude aircraft radio altimeters is researched and a new diagnostic method is proposed to solve existing problems in this article. It is shown that controlling the correct operation of the radio altimeter system can be carry out based on the use of a new diagnostic method. As a result, it is possible to take measures to eliminate false readings of the system on board and thereby to ensure flight safety by increasing the reliability of information received from the radio altimeter system. The main advantages of the proposed diagnostic method are that it can be carried out both in flight and in ground service, and also can be applied without contact in radio altimeter system of the aircraft.

Keywords: Flight Safety, correct operation, radio altimeter system, modern problems, autonomous diagnostic method.

Introduction. Our scientific researches determine that in recent years, there have been happened emergence of the errors and malfunctions in this system and consequently, the flight safety level has decreased. The existing problems of radio altimeter system has been analyzed and many diagnostic methods belongs to this system have been investigated solving system problems. In this article, is considered implementation of proposed autonomous diagnostic method based on the controlling to value changes of the operating electrical parameters of the radio altimeter system. The purpose of the new self-diagnostic method is ensuring the correct and reliable operation of this system by performing accurately diagnostic the aircraft radio altimeter system and, thereby is increasing flight safety.

Modern problems and diagnostic methods of the aircraft radio altimeter system. The aircraft radio altimeter system is one of the most important systems for flight safety. On-board and ground aircraft equipments are installed on the basis of radio technical principles. As it is known, receivers and transmitters is especially important in the operation of radio navigation systems used in aircraft.

According to the results of our scientific researches, there have been failures and cases of erroneous decisions in the aircraft radio altimeter system lately.

The radio altimeter system provides altitude information to the aircraft systems and is important for the proper operation of these systems, these systems include: TAWS (TERRAIN Awareness and Warning System), FULL AUTOMATIC LANDING, Manual landing, Takeoff (Auto Pilot, Flight Control Laws, Autothrottle), COCKPIT DISPLAY (Primary and vertical), WIND SHEAR SURVEILLANCE, TCAS (Traffic Alert and Collision Avoidance System), COCKPIT ALERT AND WARNING and it is shown in Figure 1.

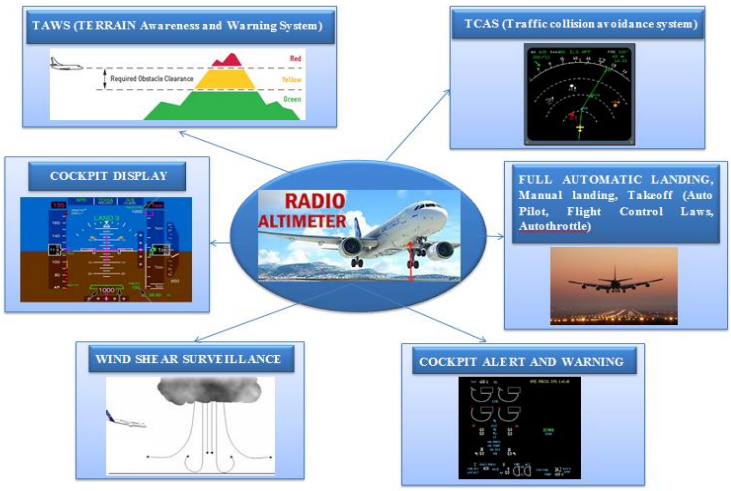

Figure 1. Radioaltimeter usage in aviation

Analyzing of the radio altimeter system modern problems [1]:

On February 25, 2009, an accident of Boeing-737-800 Tekirdag passenger aircraft a belonging to Turkish Airlines (THY) occurred as a result of a malfunction of the radio altimeter when landed in Amsterdam, the Netherlands. The autopilot system caused the aircraft to stall position on the basis of information received from the faulty radio altimeter system, and the flight crews couldn't quickly estimate this situation. It was found out that this malfunction was repeated twice in the last eight flights of Boeing 737-800 aircraft with TC-JGE registration number.

This type of the radio altimeter malfunction has also been detected in other aircrafts. Royal Dutch Airlines aircrafts have also been found to malfunctions of the altimeter in the last years.

"On April 7, 2009, the radio altimeter of the Boeing 737-800 aircraft belonging to Qantas Airlines which was flying from Hobart to Sydney, incorrectly reported flight altitude to the aircraft systems when landed on the runway. Consequently, EGPWS system of the aircraft warned pilots, and after the warning, the autopilot system of this aircraft whose flight altitude was reduced 10 ft, had been malfunction.

The Antonov 72 aircraft operated by Kazakhstan crashed on December 25, 2012 and the accident was caused by a malfunction of the autopilot and radio altimeter systems.

On September 11, 2018, an Instrument landing System (ILS) malfunctioned on an Air India flight carrying 370 passengers between New Delhi and New York. Announcing the incident, Air India said that the radio altimeter of the aircraft were faulty which could not operate the TCAS and ILS.

The aircraft navigation systems operate between frequency values of 4.2 and 4.4 GHz according to international law and, use of the C-band for 5G technology is allowed between 3.7 and 3.98 GHz in the United States.

The Aerospace Vehicle Systems Institute (AVSI) conducted a study simulating the worst-case 5G signal emission and its impact on the aircraft systems. It was concluded that there may be significant differences in the receiver operation of the radio altimeters belonging to different manufacturers in this researh.

So that, some radioa ltimeters are equipped with radio receivers supplied on the basis of better filters to provide protection against counterfeit emissions, others are affected by signals coming from outside the 4.2 to 4.4 GHz frequency.

A protection band was established between the 5G spectrum and the spectrum that aircraft avionics systems operate. Boeing company offer was to ban the use of 5G technology in the 4.1-4.2 GHz frequency range. Thus, the frequency band that formed to prevent the generation of interference signals, was defined as an interval of 220 MHz between 3.98 GHz and 4.2 GHz which is the maximum frequency value of 5G and is shown in Figure 2 [2].

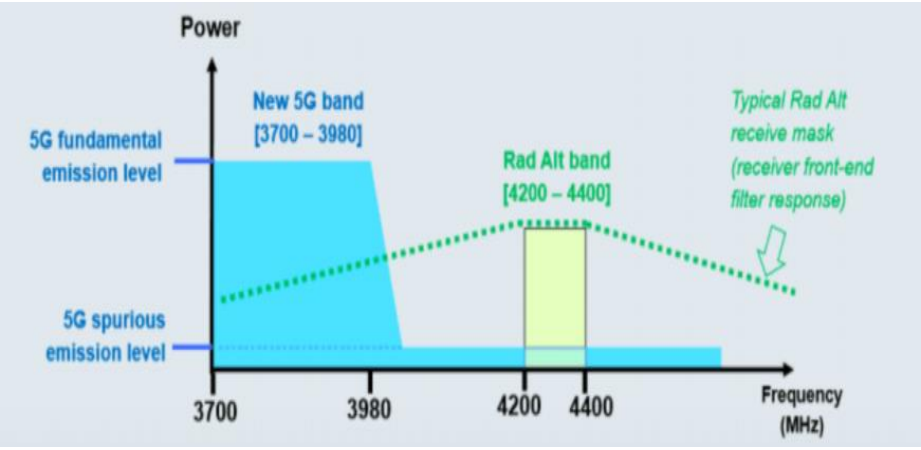

Figure 2. Frequency band of the radio altimeter and 5 G

Loss of altitude data and transmission of incorrect altitude data to the system, were observed in this system as a result interference of 5G signals to the radio altimeter. The FAA says, it is important to continue testing for sensitivity to 5G interference signals and to investigate innovations that could reduce the effects of interference signals.

Such errors brought about deactivate flights of the Boeing 737 Max aircraft for about two years in 2019 and accidents.

The FAA has released SAIB (Special Airworthiness Information Bulletin) according to dangereous situation that interference signal resulting from 5G transmitters and other technological processes can be caused malfunctions in aircraft systems which is important in flight safety. It is reported here: "Radio altimeters and aircraft manufacturers together with the federal authorities should evaluate the characteristics of aircraft altitudes and test the sensitivity of altimeters to 5G interference signals and investigate innovations that may reduce the effects of interference signals." [3].

The FAA has issued a notification stating that was identified faults caused by 5G on many automated systems of the Boeing 787. The radio altimeter are an essential part of the Boeing 787 descent system. It was stated that the interference signal generated by the application of 5G will cause the aircraft increased landing distance and additional movement on the runway.

Also, radio altimeter of the Cessna Caravan which operates at 4.3 GHz, had been malfunctioned by a 5G network that broadcasts from the C-band (4-8 GHz).

Helicopter Association International held a seminar on the effects of 5G and, one of its representatives who developed an altimeter for many aircraft at Honeywell Aerospace, Seth Frick said that: Based on the Honeywell 5G test was found errors in measuring altimeters due to emergence of noisy situation.

In 2020, the Telecommunications and Information Department was informed that allow of the 5G operation in the specified frequency band will caused to problems in flight safety.

The FAA has approved five altimeter models that will be compatible with 5G. The aircrafts models which is equipped the cleaned radio altimeter include: Boeing 717, 737, 747, 757, 767, 777, 787, MD-10/-11; all Airbus A300, A310, A319, A320, A330, A340, A350 and A380 models; and some Embraer 170 and 190 regional jets.

The radio altimeter system self-test is started with the TEST button on the receiver / transmitter to solve this sytems problems by ground service and air / ground discrete prevents self-testing in flight. When the self-test is started manually from the front panel, the LRU (line-replaceable unit) status indicator is turns red light during 2 seconds turns green light during 2 seconds and then turns OFF for the next test. XMIT and REC LEDs becomes red light during 4 seconds. The green LRU STATUS or red LRU STATUS lights appear on the test results. The red XMIT or REC LED FAIL status indicator comes on when there is a problem with the antenna system. If there is an error during the last four flights, a red LRU STATUS FAIL light is observed during the self-test [4].

ALT-8000 equipment is also used to test the radio altimeter system and this equipment provides a radio frequency-based altitude simulation that can be easily installed for rapid testing, or a direct connection to the LRU to troubleshooting additional problems. The wide color touch screen displays parametric measurements and allows the creation of detailed profiles to imtate the real aircraft situations. ALT-8000 radio frequency connections are shown in Figure 3 [5].

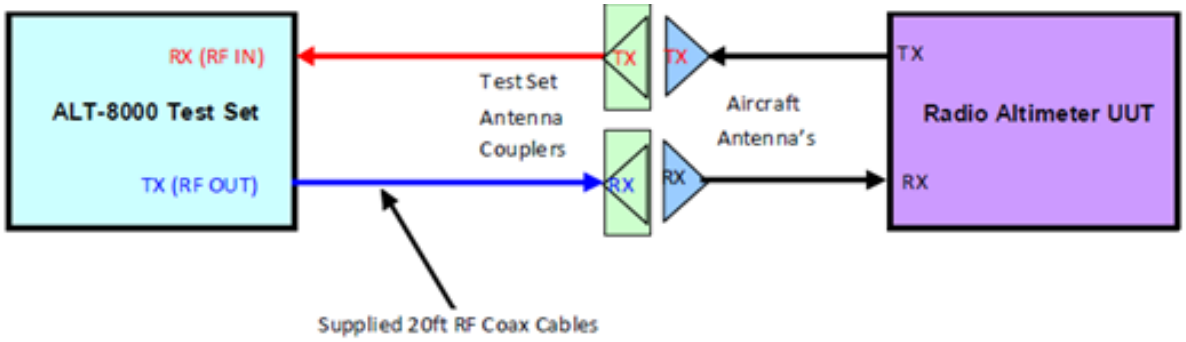

Figure 3. ALT-8000 radio frequency connections

Proposal of an autonomous diagnostic methods for the aircraft radio altimeter systems. A new diagnostic method, its algorithm and structural scheme is intended to be developed which prevents possible malfunctions or errors in the aircraft radio altimeter system in this article.

The results obtained on the basis of scientific research show that it is possible to carry out autonomous diagnostics of the system by monitoring operation modes of the aircraft radio altimeter system according to the current. The main purpose of the article is to ensure the correct operation of the radio altimeter system by non-contact control in accordance with the increase and decrease of the operate current value of the system [6,7,8].

The data obtained by monitoring the electrical parameters of the radio altimeter transmitter antenna with sensor 1 and its 115 V source bus of the receiver/transmitter with sensor 2 is evaluated in an autonomous diagnostic computer and, the correct data is provided for the reveiver/transmitter operation. Hall sensor and Rogowski coil are intended as sensor 1 and sensor 2 in structural scheme of the autonomous diagnostic method that is shown in Figure 4. Our scientific research shows that high-frequency circuits require the use of a Rogowski coil.

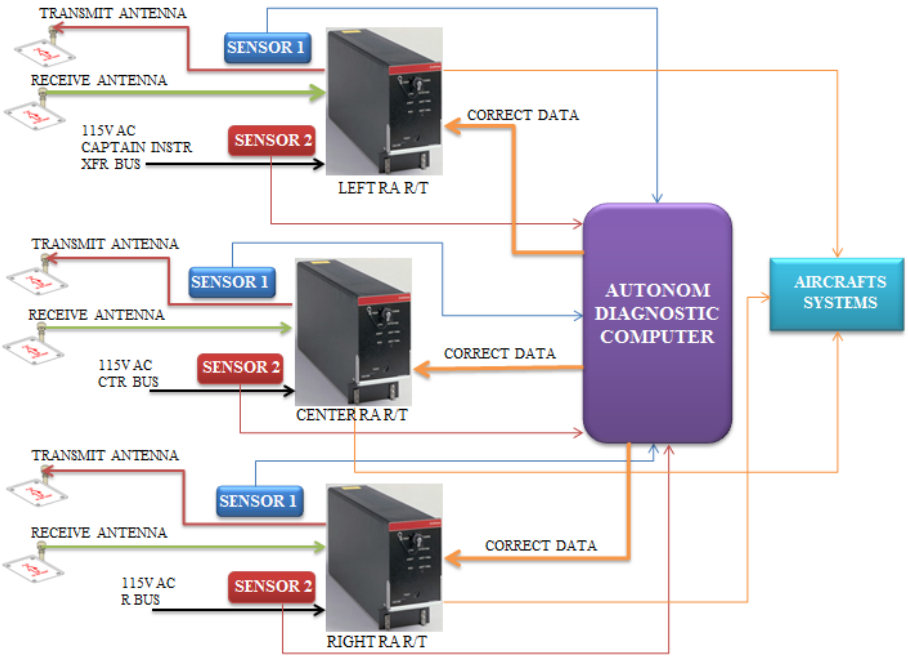

Figure 4. Structural scheme of the autonomous diagnostic method.

One of the main advantages of the proposed a new diagnostic method is that diagnostic of this system can be carried out with contactless during the flight and ground service.

Conclusion. The article analyzes the aircraft radio altimeter modern problems and existing diagnostic methods applied in this system and a new diagnostic method is proposed for the radio

altmeter system. Contactless installiation on board and diagnostic of the aircraft radio altimeter system in flight is the main advantages of a new monitoring method-autonomous diagnostic.

Based on the correct diagnosis of the aircraft radialtimeter system, can be ensured and improved the accurate and reliable operation of the radio altimeter system.

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СОЗДАНИЕ МНОГОФУНКЦИОНАЛЬНОЙ ЛОГИСТИЧЕСКОЙ СЕТИ С ПОМОЩЬЮ ОБЪЕДИНЕНИЯ ЦИФРОВЫХ ПЛАТФОРМ И ОБЛАКА

САНДЫҚ ПЛАТФОРМАЛАР МЕН БҰЛТТАРДЫ БІРІКТІРУ АРҚЫЛЫ КӨП ФУНКЦИЯЛЫ ЛОГИСТИКАЛЫҚ ЖЕЛІ ҚҰРУ

CREATING A MULTIFUNCTIONAL LOGISTICS NETWORK BY COMBINING DIGITAL PLATFORMS AND THE CLOUD

Аннотация. В данной статье представлен результат внедрения взаимодополняемых цифровых технологий, а именно платформенных и облачных технологий и какие же возможности станут реальными. Благодаря новому принципу внедрения инновационных цифровых технологий будут производиться транспортные процессы. Сначала отечественный рынок сможет конструировать новые цифровые сервисы, далее – создание или комплексирование инфраструктуры, необходимой для их обеспечения. В работе особое внимание уделено синергии платформенных и облачных технологий, актуальности облачных