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Robotics Methods Implementation in Aircraft Maintenance Technologies

New technological approaches to diagnosing the state of aeronautical engineering objects based on the use of robotic systems are considered. The results of the introduction of innovative robotic technologies at various stages of aircraft maintenance are analysed.

Aircraft maintenance is the effort required to keep equipment running and functioning like new. Unplanned aircraft downtime due to equipment failure is one of the major problems for the aviation industry, resulting in billions of dollars in losses every year. Maintenance is an important aspect of improving productivity by reducing such downtime and maintaining airworthiness.

The aircraft cannot fly with malfunctions; they must be repaired before takeoff. This is a rather complex and time-consuming task. On the way to solving it, it is necessary to find such innovative technologies, with the help of engineering and technical personnel, they will be able to significantly reduce the cost of performing MRO, as well as minimize downtime of the aircraft fleet.

This work aims to expand the investigated question by using unmanned aerial vehicles in various types of aircraft maintenance, as well as pre-flight and post-flight visual inspection of aircraft. Pre-flight inspection procedures are performed by certified aircraft maintenance personnel or crew members prior to flight. The process is the same for all categories of aircraft, but its implementation differs for certain specific types of aircraft. The result should be a reduction in the number of possible failures caused by the human factor affecting operational safety. An equally important fact is the desired minimization of the time required for all types of inspections and maintenance (Fig. 1), which will improve the final indicator of their effectiveness.

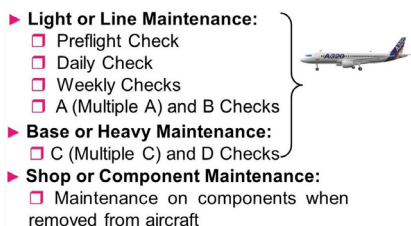


Fig. 1. Types of maintenance

In this area of research, the articles "Use of unmanned aerial vehicles in aircraft maintenance" [1] and "Unmanned aerial vehicles and their use for aircraft inspection" [2] have been published. Aviation has certain legal regulations and standards that must be strictly observed. Procedures related to aircraft periodic

inspections and checks are carried out during aircraft operation by certified organizations, always under the supervision of the Continuing Airworthiness Management Organization (CAMO). According to Commission Regulation (EU) no. 965/2012, establishing the technical requirements and administrative procedures related to air transport in accordance with the Regulation of the European Parliament and Council Regulation (EC) No 216/2008, are aircraft operators and at the same time hold an air operator certificate (AOC). Airlines are required to implement an in-service management system with operational management of security risks throughout the entire operation process (Safety Management System - SMS). In addition, airlines must conduct their own scheduled pre-flight checks before each flight. As the industry focuses on new technologies in line with the principles of Industry 4.0, certified maintenance organizations (MROs) and continuing airworthiness management organizations (CAMOs) should follow suit and use “smart technologies” [3]. The collective response of maintenance and aviation industry organizations has led to the creation of the "Smart Hangar" (fig. 1) concept, which allows CAMOs and MROs to operate with a higher degree of accountability when human errors are detected [4].



Fig. 2. Smart Hangar concept for MRO

All innovation in the aerospace sector is based on efficiency, although different parts of the sector attach importance to it. For maintenance and repair, efficiency is related to the most effective use of the aircraft in the service of its owner. In practice, making sure that he earns money for the maximum possible part of his working life. The innovation in MRO is to speed up the process and return the aircraft to active service in the air as soon as possible. The advent of drones has definitely brought a big change to this branch of the aviation industry. Drones can reduce costs and significantly reduce the time spent on maintenance.

Drones are becoming a major trend in the inspection environment for visual assessment due to their small size and remote control capabilities. Technological

improvements have a huge impact on the commercial applicability of drones. Aircraft inspection drones are equipped with auxiliaries such as mirrors, endoscopes, lenses, and fiber optic devices to provide increased safety and ease of service during aircraft inspections.

The benefits that drones provide are numerous. Automating and speeding up the defect detection process allows maintenance and repair professionals to pinpoint potential damage that can be visually inspected at a later stage. Drones are most useful for visual inspection of aircraft that may have been damaged by lightning. In addition, another useful aspect is scheduled maintenance of fuselages and other parts that may require minor repairs. Another use for drones is the delivery of spare parts, which can help reduce the time spent by M&E personnel in the hangar, ultimately leading to more efficient repairs.

Drones have been proven to reduce inspection time by 80-90%. The unmanned aerial vehicle is supposed to detect any structural damage to the aircraft as well as assess the quality of paintwork, markings and signs of lightning strike, which significantly saves time and resources during inspection and overall maintenance time. Their reliability is of great importance for aircraft, as any deviation can cause the aircraft to fail, which can sometimes be fatal. Fast and error-free inspection is what lays the groundwork for the growing number of unmanned aerial vehicles for aircraft inspection in the aviation industry.

For decades, the process of inspecting aircraft has been the same. With the advent of drones, we can say that a small revolution has taken place. The accelerated development of new technologies made it possible to significantly speed up this process and make it even more reliable.

The number of UAVs around the world is increasing, as are the number of areas of human activity in which UAVs are used professionally. They are present in all areas of human life and are an integral part of the equipment of law enforcement agencies and rescue units, photogrammetry, transport, construction, industry, scientific research, logistics, in addition, young people can play with them. Technologies evolve and change as their use grows. At the same time, the relevant legislation on safe use must correspond to technical progress. This area should be protected by European and national legislation in such a way as not to restrict freedom.

Recently, Intel and Airbus began a collaboration to further improve this process. Intel supplies UAVs equipped with video recorders that allow them to record images or data that can be used to create entire 3D models of Airbus aircraft. Airbus Aerial, a subsidiary of Airbus S.A.S., provides equipment inspection services to various sectors of the aviation industry. There are other similar companies operating in this market, such as France's Ubisense S.A.S, MRO Drone Ltd from Great Britain and Canard Drones from Spain. Recently, they have developed special procedures to provide airport and aircraft screening solutions.

A decisive factor for the use of UAVs in an aircraft control and management system is the software and subsequent applications for data evaluation. Systems such as Smart Hangar require complex access to individual systems and applications to ensure its operation. The article "Use of Unmanned Aerial Vehicles in Aircraft Maintenance" [1] discusses Model Based Software Development (MDS) (Fig. 3). It is based on automatic code generation at a high level of system specification

requirements and can be used to provide specific functionality to the system as a whole. Such an approach can be used, for example, to enforce safety rules for autonomous systems, to determine and optimize system transverse properties such as resource energy balance, synchronization and safety, or to coordinate the behavior of multiple UAVs in a multi-unit system.

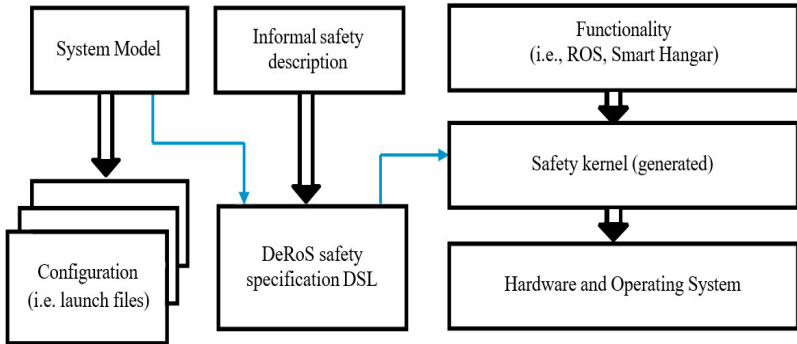


Fig. 3. UAV software platform for MDSD

Thus, analyzing the situation that has developed regarding the introduction of methods and means of robotics in modern aircraft maintenance technologies, we can draw the following conclusions:

1. The aircraft maintenance system has undergone revolutionary changes over the past decade due to the introduction of innovative software of the latest robotic tools and methods from the application into the MRO technological cycles.
2. Such innovations affected not only pre-flight and post-flight inspections as part of operational maintenance in the conditions of aircraft location outside the hangars of aviation technical bases (Fig. 4-5), but also extended to the area of basic maintenance and repair (Fig. 6-7).



Fig. 4



Fig. 5



Fig. 6



Fig. 7

3. Innovations have touched not only the improvement of MRO production facilities, but also the improvement of diagnostic tools, methods and technologies.

All this together provides a significant increase in the productivity and efficiency of MRO, as well as reducing airline fleet downtime and maintaining a high level of airworthiness.

References

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