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Evaluation of robotics and drone usage for improvement the MRO process in aviation industry

An analysis of the application of a variety of robotic solutions to improve and speed up the inspection and maintenance of aircraft as a tool was carried out. Perspective of interaction between technologies and unmanned systems is considered.

The detailed inspection during aircraft and its components can take a large commercial aircraft out of operation for days at a time, but the different uses for drones and robots can help speed up the inspection. The downtime due to lengthy inspection process costs airlines a lot of money. Every checks or tasks periodically performed on airframe systems, structure, power plant and aircraft components in purpose of ensuring reliability of components and detecting or preventing any fault which could affect the airworthiness of the aircraft means that paying passengers are not in the air.

Today's development of uses for drones and robotics the aviation industry as a tool allows to effectively solve such tasks that are required to restore or maintain an aircraft's functional systems, components and structures in an airworthy condition with minimal cost. Maintenance, repair, and overhaul (MRO) companies are using a variety of robotic solutions to speed up the inspection and repair of aircraft.

One of the more time-consuming tasks faced by aircraft MRO companies is inspecting the exterior of an aircraft to assess its required maintenance needs. Such inspections are required during not only scheduled maintenance checks but also for specific maintenance if the aircraft receives accidental damage or is suspected of being damaged. This could occur while the aircraft is in the air (lightning, bird strikes etc.), during take-off and landing (FOD on the runway and hard/overweight landing) and while stationary (collision with ground equipment or accidental collisions with other aircraft).

If any of these events should happen, then the aircraft must be taken out of service and inspected for damage. To conduct an inspection, maintenance staff have to set up gantries or utilize special lifting equipment to get themselves up to the level of the fuselage and wings and then move about the aircraft to inspect each part. This is often a complicated and lengthy process and sometimes even dangerous for the human technicians health and safety due to the risk of injury through falling.

The main specific ways that robotics and drones are already improving the MRO in aviation industry are the following:

One of the more time-consuming tasks faced by aircraft MRO companies is inspecting the exterior of an aircraft. One alternative way of looking at the outside of an aircraft is in robotic systems which can inspect aircraft much quicker and more easily than a human could. This approach can greatly reduce inspection times, enabling skilled personnel to manage more complex tasks and reducing the cost of the overall MRO process. In 2011 a type of drone called the RISER (Remote Intelligent Survey

Equipment for Radiation) was developed to check for contamination when the Fukushima nuclear reactor melted down. The modern version of this drone is Remote Automated Plane Inspection & Dissemination (RAPID). A RAPID drone can be programmed to fly around an aircraft's exterior, while scanning with a high-resolution camera that can detect defects as small as one square millimeter. As an example, a RAPID drone can do inspection an Airbus A320 exterior in as little as 30 minutes, while human technicians have to take 24 hours to fully inspect it. Airbus developed its own MRO inspection drone, the Airbus' Advanced Inspection Drone. Designed for use inside a hangar, the drone is fitted with an integral visual camera, a laser-based obstacle detection sensor, flight planner software and an Airbus' aircraft inspection software analysis tool.

If an airplane needs to be repainted, it's an incredibly labor-intensive job and also dangerous to the human staff. This issue is solved by usage of Large Aircraft Robotic Paint Stripping (LARPS) system in the 1990s to carry out stripping and repainting works remotely. This robotic applications shortened maintenance times and made the tasks much safer. Lufthansa Technik (LHT) has developed CAIRE (Composite Adaptable Inspection and Repair), an automated milling robot which can repair carbon-fibre reinforced polymers on airframe. The robot can remove any damaged material and produce repair layers, which are manually inserted, glued and cured.

Swiss company SR Technics has invented a climbing robot for aircraft inspection. It can be equipped with infrared or ultrasound scanners that can detect defects invisible to the human eye. A similar version of climbing robot (Vortex) is developed by Cranfield University in the UK. Its wheels use a suction cup system to drive around the entire exterior of an aircraft. New Zealand-based Invert Robotics has developed a robot which employs a patented suction mechanism enabling it to cling to the outside of an aircraft at any angle, including being upside down (Fig.1). This robot is equipped with an inspection camera which can record and transmit video images to engineers on the ground and can be fitted with additional sensors for ultra-sound and thermo graphic testing.

Fig.1. Invert Robotics robot

Robotic solutions are also being used to improve engine inspections and repairs. Aerospace company Rolls-Royce has developed a camera system (SWARM) with a camera on the end of a long, flexible tube which can be inserted into the interior of an engine to take a look around inspection. The system is designed to use robots to inspect and service difficult-to-reach part of engines while they are still attached to

aircraft. These included a remote-controlled boreblending machine, fibre network 'periscope' cameras permanently embedded within the engine, snake robots which could be inserted into an engine to conduct patch repairs and micro walking camera 'beetles' which could conduct a visual inspection of the interior of a combustion chamber The main goal of this robotic tech is to eliminate the need to detach and disassemble an engine for a simple inspection.

Another advantage of using robots for MRO inspections is that they can access to spaces within aircraft structures without the need to dismantle them – the function of non-destructive inspection (NDI).

Properly adjusted a MSG-3-based maintenance programs use wide variety of different On-board systems fitted with a multitude of sensors monitoring the health of aircraft functional systems to detect and predict faults while aircraft are in flight and send messages to their destination airports. Airbus uses its Aircraft Maintenance Analysis (Airman) system to predict defects before they occur.

Aviation operators are obliged to implement maintenance programs including management of safety risks in whole process of aircraft operation (Safety Management System - SMS). One of the main task of that are prior to each flight expected to perform own routine before departure check/pre-flight inspection. Intel and Airbus have started cooperation to improve this process with a usage of robotic solutions. Intel delivers UAV equipped with video recording devices that enable recording images or data which can later be used to generate whole three-dimensional models of Airbus aircraft. Airbus Aerial a subsidiary established by Airbus S.A.S provides equipment inspection services in different aviation industry sectors [1]. Development of such procedures provides a wide range of solutions for the mentioned inspections [2].

Conclusions

To gain the officially recognized maintenance program terminologies, processes and common practices, the sustaining organization must implement a properly adjusted a MSG-3-based maintenance program [3], [4]. This approach combined with usage of different robotic solutions to improve and speed up the MRO of aircraft allows separating safety-related items from economic and defining adequate treatment of hidden functional failures and excessive maintenance.

References

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