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Institute for Entrepreneurship 企業發展院
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Technology Frontier
News Bite on PolyU's Innovation

Automated System for Surface Pitting Analysis on Airplane Jet Engine

Improving inspection accuracy and flight safety

Air travel has become more and more popular, and aviation safety is more important than ever. While many procedures of aircraft servicing have been automated, the surface defect known as pitting is still identified by technicians with naked eyes. To enhance inspection efficiency, accuracy and safety, researchers from the Aviation Services Research Centre (ASRC) developed an automated system that identifies and measures surface pitting on jet engine blades. The system can also be adapted to scan the aircraft fuselage and wings for lightning strike damage. Coupling with the automated surface defect removal system, it repairs the defects on an artisan level, saving much time in aircraft maintenance.

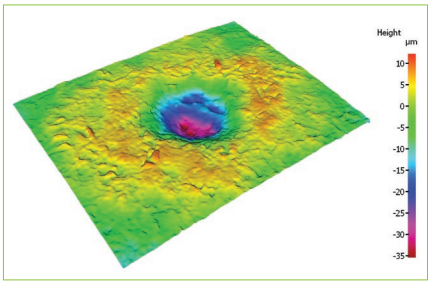
Dr Stephen O'Brien (left) and Dr Hon-ping Tang

Alicona sensor captures the 3D model of pitting

Some say air travel is now a way of life. As air travel becomes more affordable than ever, more and more of us fly regularly, for business and leisure. Needless to say, aviation safety is of paramount importance. Unlike a broken-down car or ship, air passengers cannot wait by the roadside or float on the sea if anything goes wrong. Even a tiny cavity on metal surface as small as 1/100th of 1 mm can imply potential threat. Such surface defects are known as pitting and are considered dangerous because they are difficult to detect, predict and design against. So far, to detect pitting, experienced workers have to examine the surface with naked eyes, costing many man-hours and the result is prone to human errors. In light of this, Dr Stephen O'Brien, Director of Operations, Aviation Services Research Centre[1] (ASRC) led a research team to develop an automated system for surface pitting inspection of jet engine blades. We were honoured to have talked to a team member, Dr Hon-ping Tang, senior engineer and project lead, ASRC, who explained the technologies behind.

Microscopic vision and AI recognition

Pitting is a surface defect in complex shapes and various sizes. It is caused physically by airborne



3D model of pitting (enlarged)


DIPLÔME
Inventions Geneva
SALON INTERNATIONAL DES INVENTIONS
GENÈVE
Après examen, le Jury International a décidé
de remettre à: Dr Stephen O'BRIEN, Dr Hon Ping TANG, Mr Pengfei FU, Mr Wai Woon NG, Mr Suen Shing LAM, Mr Ngai Kit KAM
pour l'invention: Système automatisé d'analyse de piqûre corrosive de surface de moteur d'avion
MÉDAILLE D'OR GOLD MEDAL GOLDMEDAILLE
Genève, le 13 avril 2018
The Automated System for Surface Pitting Analysis on Airplane Jet Engine won a gold medal in the 46th International Exhibition of Inventions of Geneva.

particles that hit the metal surface, or chemically due to the sulphur content in jet fuel. "Airplane jet engines operate under high temperature and high pressure. Corrosion and damage tend to intensify," said Dr Tang.

Their system that automates surface pitting inspection employs a number of state-of-the-art technologies, namely robotics, image processing, deep learning, 3D sensor and non-destructive testing. A camera or 3D scanner can be attached to a robotic arm and it takes pictures of the metal surface. A computer would then learn to identify and locate pitting with the artificial intelligence (AI) algorithm known as deep learning. Not only are the shape and size of each cavity captured, but also the depth. "In the past, even the most experienced workers cannot easily identify and measure pitting in the order of a micrometre with naked eyes. Only when portable microscopes became available in the past few years, the measurement of microscopic pitting was made possible. The system significantly cuts down on labour cost and time required for such inspection, while minimizing human errors, enhancing accuracy and aviation safety," explained Dr Tang.

Automated surface repair

The system can also be seamlessly linked with an automated surface defect removal system. "Surface defects on jet engine blades are usually not repaired. The automated inspection system just finds out whether a blade needs to be replaced. Yet, when surface defect is found on other critical parts of the jet engine, a repair system can automatically repair the defect on an artisan level. This may save much time by shortening the repair process from 4 hours to 1.5 hours."

ASRC is investigating the possibility of applying the automated surface pitting analysis system on a larger scale to identify lightning strike damage on the aircraft fuselage and wings. It is also working on further automating aircraft maintenance inspection with deep learning algorithms, Big Data analytics and Industry 4.0. Dr Tang said, "With naked-eye inspection, it's not possible to keep a detailed record of the positions, sizes and shapes of pitting. Now that a vast number of surface defect images can be stored and bulk analysed with AI, we can study the defect patterns. That would help design better jet engines in future."

In April 2018, the Automated System for Surface Pitting Analysis on Airplane Jet Engine won a gold medal in the 46th International Exhibition of Inventions of Geneva, Switzerland.

[1] The Aviation Services Research Centre is an applied research centre established by The Hong Kong Polytechnic University in conjunction with Boeing in a bid to develop new or improved aviation service technologies applicable to MRO industry. Visit www.asrc.hk for more information.