Sustainable non-intrusive inspection through remanufacturing based innovation: A feasibility study

EagleiSystems Ltd and University of Strathclyde

A Scottish Institute for Remanufacture Case Study

Project background

As an emerging field, unmanned aerial vehicles (UAV) based smart sensing is increasingly popular for condition monitoring, asset management, abnormality detection, decision support and process automation. Compared to traditional techniques utilising manned aircraft or rope work, UAV platforms can benefit from cost reductions, enhanced data quality, faster turnaround and reduced risk. Relevant applications can be found in a number of UK-focused themes, such as energy, future cities, health and manufacturing. As a result, the range and amount of relevant products is booming in recent years, which has caused a fundamental problem for the remanufacturing of the associated products and increasing the lifecycles of these products.

UAV for inspection

The remanufacturing of UAV-based non-destructive inspection platform (NDIP) involves several key aspects, which include i) the model and how it works, ii) component inspection, iii) design and reuse process, and iv) validation and performance assessment of the remanufactured products.

This project brought together experts from the University of Strathclyde's Centre for Signal and Image Processing and EagleiSystems Ltd, an aerial survey company and manufacturer of high performance UAV systems, to conduct a feasibility study looking at a number of these aspects:

- the level of performance a multi-spectral system can achieve when comparing to a much costlier hyperspectral imaging system;
- how to optimise such a system for non-intrusive inspection tasks such as power distribution networks.

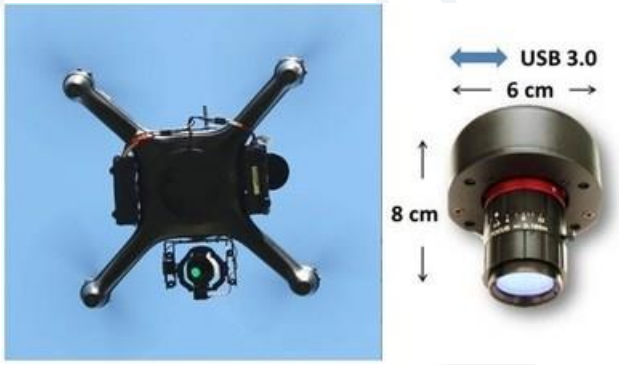
The findings from this would provide a solid base for sustainable business modelling of a UAV based inspection platform where the key components of the sensors can be remanufactured to fit the purpose of industrial needs.

Approach

The project team conducted extensive research in optimising the sensor usage for nonintrusive inspection, in particular a cost-effective multi-spectral one to replace the hyperspectral imager. This can not only significantly reduce the cost but also enhance the response time and cut emissions due to less loading and longer inspection time per run. Other parts including framework and structure were also adjusted for optimization accordingly.

To ensure the overall system was optimised, the team worked on four aspects;

1. the structure/framework, i.e. mechanical part,
2. the battery focused electrical part,
3. the sensor part, and
4. the control and software part.



Sensor design and optimisation

Findings

The project demonstrated that remanufacturing of UAVs can be achieved in several aspects;

- The sensor part is the key to cut the cost of the overall system by reducing the expenses for spectral imaging and also reduced payload – which can in turn save the power consumption and the requirement of the mechanical part. We have developed algorithms for band selection to enable customised design of multispectral systems for specific applications.

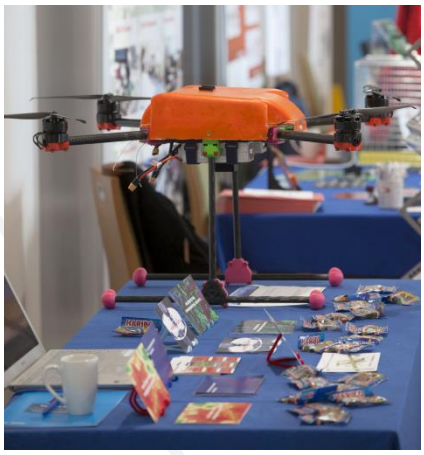
- Battery is another key factor which may affect the performance, and there are different ways for its remanufacturing.

- The software and control part can be module based implemented so that they can be easily upgraded accordingly;

- The structure and framework can also be partially remanufactured, subject to quality control, and the material can be inspected and reused.

Benefits of the project

With the developed models and solutions, economic savings (~40% overall) are apparent to cut the cost for sensors, battery and raw material. In addition, with the reused components for remanufacturing, 30% of less waste is generated to landfill.



With a multispectral system used rather than the hyperspectral sensors, the payload has be cut to less than 1/4, hence the power consumption is reduced to less than 60%. This has also the significantly improved the efficiency of the UAV based inspection system, which has a faster respond speed, longer inspection period and less data acquisition/storage/processing time.

Accessing matched funding from the Scottish Institute for Remanufacture enabled the research team to demonstrate the feasibility of remanufacturing various components of UAVs, whilst optimising performance.