Summary
A robotic optical-biopsy scanning framework termed EndoDrone is proposed to improve the sensitivity of gastrointestinal (GI) endoscopy by automated scanning and real-time classification of wide tissue areas based on optical data. A “hot-spot” map is generated to highlight dysplastic or cancerous lesions for further scrutiny or concurrent resection. The device works as an add-on accessory to any conventional endoscope and to our knowledge is the first of its kind. The current functional prototype, which uses hyperspectral (HS) optical biopsy, is compatible with the anatomical dimensions of the colon, is envisaged to allow the identification of flat and small precancerous lesions that are currently missed.

Features & benefits
- The device has been validated in vitro and is currently being validated on GI tissue.
- The device acquires spatially-registered HS data and reconstruct it as 2D and 3D images with sub-mm resolution.
- Single-point HS sensors obtain 0.6 mm-deep rich diagnostic optical biopsy data. With the device, full images can be generated by accurate actuation of a radial array of multiple single probes.
- Real-time automated image segmentation is achieved via machine learning classification of acquired HS data, allowing the generation of a “hot-spot” map.
- Current size is compatible with the anatomical dimensions of the colon and oesophagus, but further miniaturisation is possible.
- The mechatronic framework could be used with other optical and non-optical single-point probe modalities (Fluorescence, FLIM, Polarised, Confocal, Raman, OCT, US).

Applications
- Aims to improve the adenoma detection rate of endoscopy operators independently of their skills.
- Special focus on the automated detection of small flat dysplastic lesions (<5mm) which are often missed by conventional methods.
- The device works as an add-on overtube accessory to any conventional endoscope. Could be included as a fixed-feature in future endoscope designs.
- In principle, other non-GI hollow organs (upper airway, bronchi, bladder) could be scanned with miniaturised versions.

Endoscopic scanning probe device for rapid screening of hollow organs dysplasia
Background
GI endoscopy is the gold-standard procedure for detection and treatment of dysplastic lesions and early stage cancers. Despite its proven effectiveness, its sensitivity remains suboptimal due to the subjective nature of the examination, which is substantially reliant on human-operator skills. For bowel cancer, colonoscopy can miss up to 22% of dysplastic lesions, with even higher miss rates for small (<5 mm diameter) and flat lesions.

Technology
A team at Imperial College London led by Dr George Mylonas and Prof Daniel Elson developed the EndoDrone. The proposed system seeks to improve the sensitivity of GI endoscopy by automated scanning and real-time classification of wide tissue areas based on their hyperspectral optical biopsy features. A “hot-spot” map is generated to highlight dysplastic or cancerous lesions for further scrutiny or concurrent resection. The device comprises a radial array of eight optical sensors that can be partially rotated and translated along the GI tract by using a conventional endoscope as a guide-rail, while acquiring optical data (see Figure 1, above).

The key features of this technology are:

- Different optical and non-optical biopsy modalities can be easily integrated within the framework, including fluorescence spectroscopy, fluorescence lifetime spectroscopy, confocal, etc.

Market
The global endoscopy market is expected to expand at a compound annual growth rate (CAGR) of 6.9% and reach USD $9.7 billion by 2021. Colonoscopy is among the most promising areas of growth, where there has been significant focus on pipeline development due to increasing patient population and awareness.

Team
- Dr George Mylonas: George was the Deputy Director of the Hamlyn Centre for Robotic Surgery at Imperial College. More recently, he joined the Department of Surgery & Cancer at Imperial College London to concentrate on developing surgical technologies suitable for clinical translation. He is also a Senior Engineering Fellow with the HELIX Centre.
- Prof Daniel Elson: Daniel is a Professor of Surgical Imaging and Biophotonics in the Hamlyn Centre for Robotic Surgery, Institute of Global Health Innovation and Department of Surgery & Cancer at Imperial College London.
- Mr. Fernando B. Avila-Rencoret: Fernando is a PhD candidate at the Hamlyn Centre for Robotic Surgery and the Department of Surgery & Cancer at Imperial College London. Fernando is a medical doctor and holds an M.Res. in Medical Robotics. He was selected as an MIT Technology Review ‘Innovator under 35’, and a ‘<Google X> Pioneer’ at “We solve for X”.

Intellectual Property
Relevant publications

