KEYWORDS: confocal microscopy, endoscopy, rigid endoscopes, real-time imaging, in vivo imaging

ABSTRACT
Endoscopy is a vital, yet minimally invasive, operative procedure, increasingly employed for both diagnosis and management of many medical and surgical conditions. There are broadly two classes of purely optical endoscope. The first, developed in the 1960’s, uses a long flexible fibre-optic coupling between the remote lesion site and the user. This gives adequate diagnostic information, although the image quality may be compromised by both the number of (intact) elements within the fibre bundle and the light losses, which become significant when the individual fibres of a bundle decrease below 6-8 µm diameter. An alternative class of endoscope uses a thin rigid tube enclosing a distributed lens system [1]. These instruments are optically superior to their fibre bundle counterparts, although their use is confined to regions of the body that afford reasonably straight line access to the region of interest or keyhole surgical access e.g. imaging ports in laparoscopic surgery.

The image contrast in these instruments originates from both the surface and subsurface regions of the translucent tissue under examination. In order to discriminate between these structural features in a controllable way, it is advantageous to be able to introduce confocal imaging. Fluorescent labelling may allow greater differentiation between cell layers capable of absorbing the dye solution. The use of digital signal detection methods together with the absence of image degradation due to a fibre bundle leads to higher quality image formation and manipulation.

The host confocal microscope must be able to capture images in real-time and, preferably, should not interfere with the conventional operation of the endoscope. We have elected to make all the modifications to the endoscope at the proximal end so as to obviate the need for governmental approval to use the modified instrument in patients. This talk will describe several simple modifications to a rigid endoscope so as to provide both high quality conventional endoscopic as well as confocal endoscopic images of reasonably accessible regions of the body in real time. The systems are based around either host lenslet-array tandem scanning microscope together with laser illumination [2] or a structured illumination approach together with a conventional incoherent illumination source [3]. Images taken in both brightfield and fluorescence imaging modes are presented using this combined conventional and confocal endoscope.