中文題目:運用可攜式高光譜影像系統偵測血液透析患者之動靜脈廔管狹窄

英文題目:A Novel Portable Non-invasive Hyperspectral Image System for Detecting Stenosis of Arteriovenous Fistula in Hemodialysis Patients

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Background: According to the 2013 annual report of USRDS, Taiwan had the highest rate of prevalence of end stage renal disease (ESRD). Over 80% of ESRD patients receiving hemodialysis as renal replacement therapy, some of them will seize with arteriovenous fistula stenosis or thrombosis. The earlier to detect the stenosis, the higher opportunity to restore the function. Current applications were used for detecting arteriovenous fistula stenosis including the ultrasonography and angiography. The former was equipment and technician dependent, and the latter was invasive, radiation exposed, and experience-needed, respectively. We designed a novel portable non-invasive optical instrument for detecting stenosis of arteriovenous fistula with the target of providing early detection and real-time monitoring.

Method: Hyperspectral imaging system is a microminiaturization device, which used two wavelength lasers (636 nm, 808 nm) as light sources with sub-pixel displacement resolution enhancement to illuminate the target area on the skin surface. Since the different absorption spectra of hemoglobin and surrounding tissue, the image was captured by USB microscope, and computer digital processing for image-handling, to measure the vascular distribution and width, and then to develop a non-invasive hemodialysis fistula stenosis monitoring aid kit (Figure 1). We apply the hyperspectral optical imaging system in human skin and superficial vasculature. The prototype device was applied on suspected arteriovenous fistula stenosis without randomization.

Result: Data acquisition involves two wave length of laser sources (wavelength: 636nm and 808nm) onto the skin surface obliquely (Figure 2), and capture the diffusely reflected light by a set of UPG650 USB microscope. The USB microscope obtains optic signals pixel-by-pixel through 2D detector array, which can then be combined to produce an image (Figure 3), changing to the extractable amount of information. Furthermore, sub-pixel displacement resolution enhancement was applied to describe the image acquisition and processing techniques. The texture features of human skin and vessels were then screened by spatial filtering. The image could be digitized with Matlab software for image transformation and Labview software for image handling (Figure 4).

Conclusion: The goal of this research is to develop and apply a non-invasive, non-expensive, and easy-used optical instrument for detecting or monitoring stenosis of arteriovenous fistula. In this study, we proposed this developing hyperspectral optical imaging system to detect the vascular distribution and width. Early detection and real-time monitoring of arteriovenous fistula stenosis could be achieved, and was followed by improving quality of clinical care. Further device revision and data accumulation are needed in the future.

Key words: Hyperspectral image , Arteriovenous fistula stenosis, Hemodialysis,

高光譜影像系統，動靜脈廔管狹窄，血液透析