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TITLE: Superficial vascular imaging system using near infrared radiation and tomo-synthesis algorithm, Tuned-Aperture Computed Tomography

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Abstract To develop the superficial vascular imaging system using near infrared radiation and tomo-synthesis algorithm, Tuned-Aperture Computed Tomography. Near infrared sensitive CCD camera was surrounded by approximately sixty light emitting diodes, which have alternating wavelengths of 700nm and 810nm. NIR-sensitive camera detected the reflected NIR from superficial subcutaneous tissues. By rotating the camera and LEDs, multiple near infrared projections of superficial vascular images were obtained at each wavelength, and tomo-synthesis algorithm in accordance with the optical aperture theory was applied to a group of images. The depth discrimination was obtained by the TACT program. Due to the difference and similarity in the absorption coefficients at 700nm, 810nm and 940nm wavelength, the venous oxygenation index (VOI) was estimated by signal intensities at each wavelength. The VOI was seemed to reflect the oxygen saturation level. Results: The superficial vascular imaging system using near infrared radiation and tomo-synthesis algorithm created thin tomograms of superficial vascular subcutaneous tissues. Changes in VOL after the load test were more significantly observed on tomograms than on projection images. The superficial vascular imaging system using near infrared radiation and tomo-synthesis algorithm enable to carry out the non-invasive tomograms and provide estimates of in oxygen saturation. Also we confirmed that the system is the beneficial tool for finding subcutaneous foreign bodies.
Keywords near infrared radiation imaging, tomo-synthesis, vascular imaging, vein pattern

Introduction

The near infrared (NIR) radiation is known as the water-window. To some extent the human body has the transparency to the NIR radiation. NIR spectroscopy is widely used for the clinical oxygen monitor. Tuned-Aperture Computed Tomography (TACT) is a method of tomo-synthesis. It is applied for clinical mammography and intraoral radiography in dentistry [1-3]. The purpose of the study is to develop the superficial vascular imaging system using near infrared radiation and to obtain the depth discrimination using the tomo-synthesis algorithm, TACT.

Methods

Near infrared sensitive CCD camera was surrounded by approximately sixty light emitting diodes, which have alternating wavelengths of visible light 700nm, and NIR's 810nm and 940nm (Fig. 1). NIR-sensitive camera detected the reflected NIR from superficial subcutaneous tissues. By rotating the camera and LEDs while keeping the distance and the angle (30 - 45 degree) to the perpendicular line to the skin surface constant, multiple near infrared projections of superficial vascular images were obtained at each wavelength, and tomo-synthesis algorithm, TACT, in accordance with the optical aperture theory was applied to a group of images [1-3]. The depth discrimination was obtained by the TACT program.

Due to the difference and similarity in the absorption coefficients of oxy-hemoglobin and deoxy-hemoglobin at 700nm and 810nm wavelength, the venous oxygenation index (VOI) was estimated by signal intensities at each wavelength. The VOI was seemed to reflect the oxygen saturation level.

In addition, the examination for the feature extraction of finger-vein patterns using transmitted 940nm NIR was carried out and the TACT algorithm was applied.

Results

Images by the reflected light taken at three wavelengths at insides of elbow and wrist are shown in Fig. 2. Two color images in the figure show the image capture. Images of fingers by the transmitted light taken at 940nm NIR are shown in Fig. 3. Images produced by TACT algorithm applied to these reflected images and transmitted images, are shown in the presentation. The superficial vascular imaging system using near infrared radiation and tomo-synthesis algorithm created thin tomograms of superficial vascular subcutaneous tissues. To change the vascular imaging quality the iterative restoration was carried out for these images. Changes in VOL after the load test were observed on tomograms than on projection images.

Conclusion

The superficial vascular imaging system using near infrared radiation and tomo-synthesis algorithm enable to carry out the non-invasive tomograms and provide estimates of in oxygen saturation. The interactive tomo-synthesis, TACT, is still the convenient method to obtain volumetric images using only a few projections. Also we confirmed that the system is the beneficial tool for finding subcutaneous foreign bodies.

References

1. Matsushita T, Miyati T, Hayakawa Y, Farman AG, et al.: Development of qualitative near infrared vascular imaging system with tuned aperture computed tomography. Proceeding of the SPIE International Symposium Medical Imaging, Vol.6510, pp.65103G, 2007.
2. Hayakawa Y, Yamamoto K, Kousuge Y, Kobayashi N, Wakoh M, Sekiguchi H, Yakushiji M,

Farman AG：Clinical validity of the interactive and low-dose three-dimensional dento-alveolar imaging system, Tuned- Aperture Computed Tomography. Bull Tokyo Dent Coll 44(3): 159-167, 2003.

3. Yamamoto K, Hayakawa Y, Kousuge Y, Wakoh M, Sekiguchi H, Yakushiji M, Farman AG: Diagnostic value of tuned-aperture computed tomography versus conventional dento-alveolar imaging in assessment of impacted teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 95: 109-118, 2003

Figures

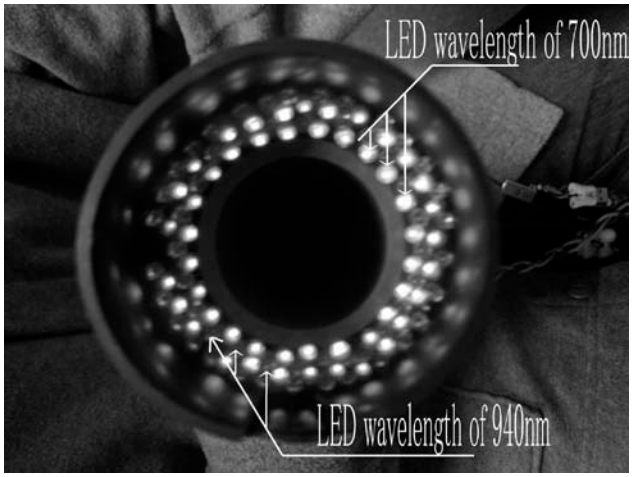

Fig 1. Arrangement NIR LEDs surrounding the NIR-sensitive camera.

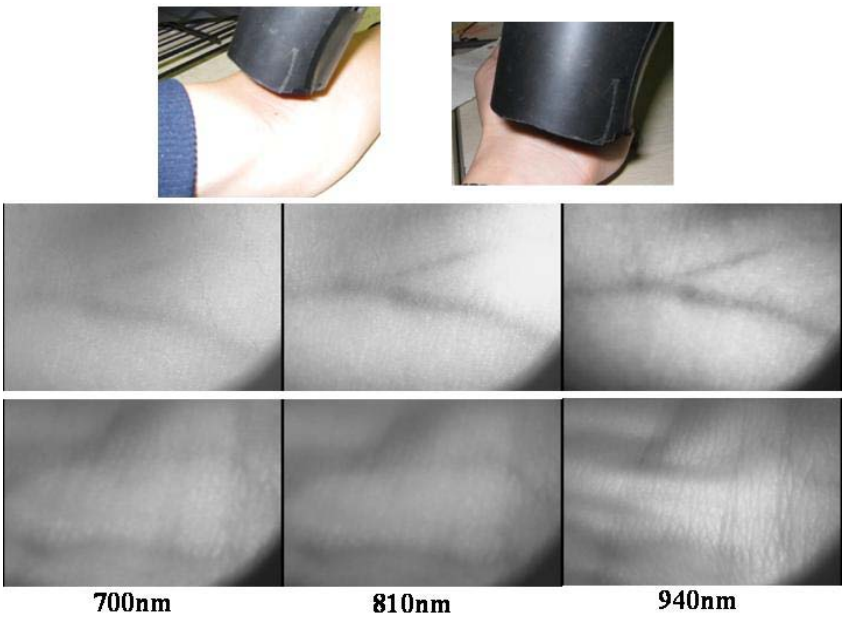

Fig 2. Images by the reflected light taken at three wavelengths at insides of elbow (upper row) and wrist (lower row). Two color images are showing the image capture.

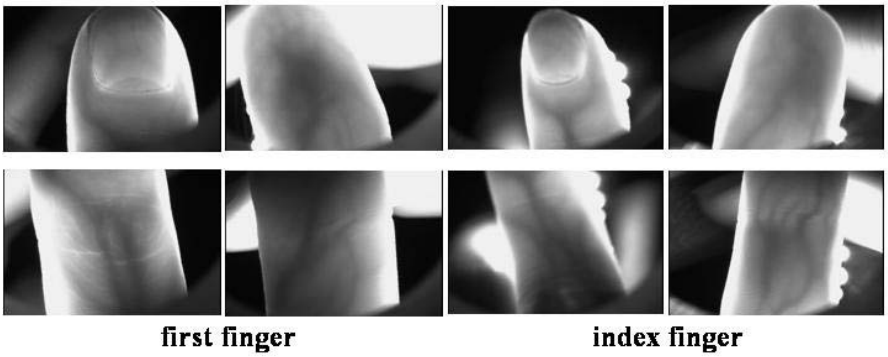

Fig 3. Images of fingers by the transmitted light taken at 940nm NIR.