Near infrared illumination optimization for vein detection hardware and software approaches

ABSTRACT

Venepuncture is one of the most crucial processes in many medical procedures. However, finding a real-time and vibrant visualization of the vein structures faces many difficulties. Several devices were introduced to solve this problem, yet, these devices shared common drawbacks, primarily when visualizing deep veins or veins in a thicker tissue of the human body. This study proposes a novel method for visualizing vein structures using a near-infrared (NIR) imaging technique enhanced with Hessian ridge detection. Several factors, including the wavelength of NIR light, square LED and ring LED arrangement and the effect of the diffuser and number of LEDs, were evaluated in the study. This study improves the overall quality of the acquired vein images and highlights the vein-morphological structure through image processing techniques. The study's main aim is to achieve the highest number of visible veins. Based on the optical window, the maximum absorption range in the NIR spectrum was found from 700 to 950 nm. The NIR light absorption of human deoxygenated blood in the vein was highest at 850 nm peak of wavelength. The image processing further enhances the vein image by highlighting the extracted vein. The study also suggests that the square LED arrangements of NIR illumination are much more robust than the ring LED arrangement in ensuring excellent light penetration. The light diffuser further adds promising effects to the NIR illumination process. In terms of the square LED arrangement, increasing the square LED for enlarging the illumination area did not show any degradation effects in the visualization process. Overall, this paper presents an integrated hardware and software solution for the NIR image acquisition of a vein visualization system to cope with the image visualization of the vein for a thicker part of the human tissue, particularly on the arm and palm area.