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Vein Detection: A System-on-Chip Approach

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The Infra-Red (IR) imaging techniques are proving to be a great boon to the field of medicine and diagnostics, as they promise to deliver high-end results at low development costs. We propose two prototypes, which uses infrared technique to capture vein images of limb-under-test, process these images and display them on screen. One prototype displays image, whereas the other displys a stream of images (video). The image capture needs proper illumination with IR source (850 nm), hence different illumination methods are implemented and compared. The prototype is portable, easy to use and safe is proposed in this paper. The captured image from a customized IR camera needs image processing because the image lacks contrast. For contrast enhancement Histogram Equalization (HE), Adaptive Histogram Equalization (AHE) and Contrast Limited Adaptive Histogram Equalization algorithms (CLAHE) are implemented and compared using ARM Cortex A8 and Open Source tools. Rigorous experiments have been performed on many subjects. The experimental results prove the feasibility of proposed design. The proposed device is non-invasive and helps the physicians to avoid unnecessary puncturing of limbs while injecting a medicine. The use of open source tools and software make the system low cost.

Keywords : CLAHE, Infra-Red, Non-Invasive, Prototypes.

1. INTRODUCTION

The first and perhaps the most important phase of a surgical procedure is the insertion of an Intra-Venous (IV) catheter. But a major clinical problem faced by the physicians is difficulty in accessing veins for IV drug delivery or drawing blood samples for tests. It has been observed that, in case of obese people, critical care patients, the elderly, children and neonates and drug addicts, locating veins becomes a very difficult task. Unnecessary puncturing of veins occurs due to poor visibility. These practices may compromise drawing the sample and thus affect the test results. Also, wrong puncturing may lead to infections, bruises or permanently damage the vein. Survey of such medical devices reveals that there are devices like Accuvein® which are available for vein detection; however, these devices are very expensive. Therefore, there is a need of a low-cost device which would assist the physician in detection of veins thus reducing the errors caused in injecting the drug.

A lot of work in this field is being carried out. Authors in paper [1] discuss a vein pattern extraction algorithm for biometric identification using low quality sensors and study the image acquisition and pattern detection techniques for veins. The work in [2] discusses a technique to look past the subcutaneous fat to detect tissue patterns using thermal (IR) imaging. A non-invasive vein detection device is discussed in [3]. However, it is much more complicated than the device discussed here and requires costly equipment including bulky illumination setups and multiple sensors.

The paper discusses a prototype which involves three major parts *viz*., image acquisition, image processing and image display. The limb-under-test is illuminated with an IR source and captured using customized IR camera. The image is sent to the BeagleBoard for processing which enhances contrast of the vein images. The processed image is then displayed

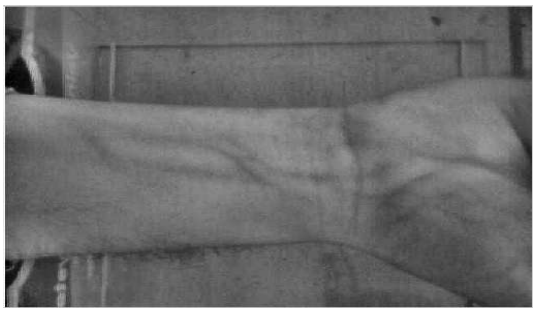

Figure 18. Image Processed with AHE

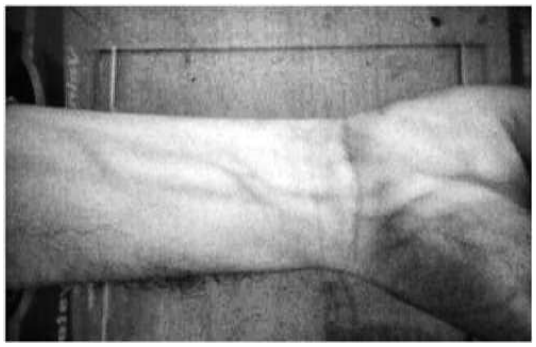

Figure 19. Image Processed with CLAHE

AHE algorithm. Figure 25 shows the image processed using CLAHE algorithm.

6. CONCLUSIONS

The concept has been successfully implemented on ARM Cortex A8 and presented in this paper. Since, open source tools are used in the prototype, it is low cost. The two prototypes discussed aim towards safety. The second prototype also has a feature of flexibilty incorporated. The IR technology makes the prototype non-invasive and thus preferable by physicians. Further, three specific algorithms for contrast enhancements were tested on the hardware and the results were compared. It can be concluded from the efforts that CLAHE is the more suitable method out of the three compared as it enhances the contrast of images to a better degree making them distinctly visible to the naked eye.

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