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Integrated Portable Vein Measurement Device

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Abstract : The main goal of this project is to develop a low cost, non-invasive and portable vein measurement device. The parameter indicated in this project is the size of the vein. Vein mapping is performed first with near infrared (NIR) to visualize the vein under human arm. A Raspberry Pi No infrared (NoIR) camera is used to capture the image of the vein. A graphical user interface (GUI) is created for vein image processing and vein size measurement. Internet of things (IoT) is applied to store the edited image and patient data in the cloud. Mobile application is created for medical personnel and doctors as consultant and monitoring purpose. This system increases the accuracy of vein size measurement and evaluation, thus minimize the human error made by the medical personnel.

Keywords: Vein Measurement, Non-Invasive, Vein Mapping, Vein Size, Hemodialysis

1. Introduction

A hemodialysis access or vascular access is a hemodialysis patient's lifeline. Hemodialysis access or known as vascular access is a way to allow the blood to flow through. There are three types of hemodialysis access include arteriovenous fistula (AVF), an arteriovenous graft (AVG), and central venous catheter (CVC) [1]. A well-functioning vascular access is a key element in an active hemodialysis treatment [2]. Thus, pre-dialysis access is an important process in order to make sure there is a well-functioning vascular access. The pre-dialysis access i.e., vein evaluation is done in order to assist the medical personnel to provide a more straightforward approach to decide the access site. Vein

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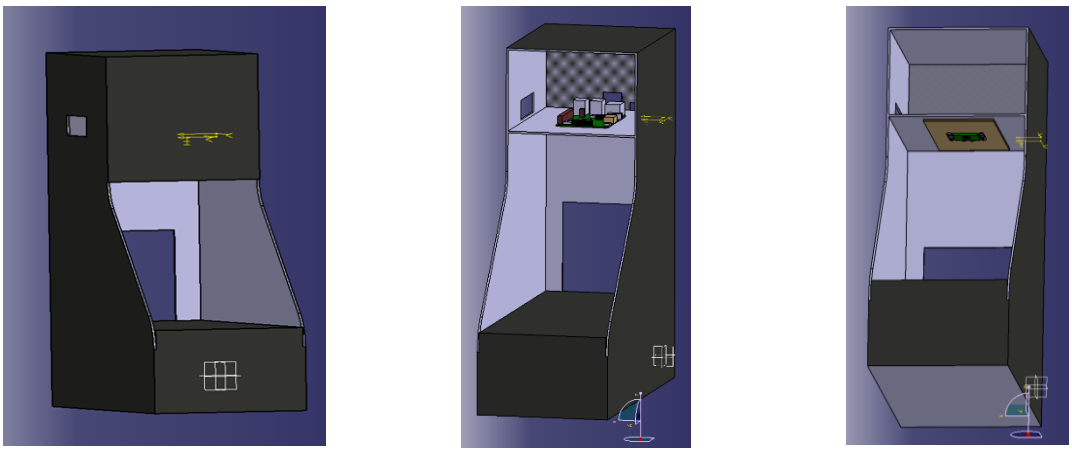
analyzation is a vital process to assist the medical personnel to get the information on the depth and size of the vein before hemodialysis access surgery. The recent method for the vein analyzation includes Doppler ultrasound vein mapping and venography test.

Previous research had shown that preoperative vein mapping helps to determine the size and direction of the larger saphenous vein [3]. There are few devices and methods that can be used to identify the veins using MRI, X-ray or ultrasound. However, these approaches are expensive, bulky, radioactive and some are only appropriate for deep veins [4]. At the same time, the value of vein size can be only predicted by using recent methods. Therefore, a more comprehensive vein size measurement system is needed so that the vein size can be measured accurately for hemodialysis access purpose.

2. Materials and Methods

The vein size measuring system consist of a camera system and an array of near infrared radiation (NIR) LED light as shown in **Figure 1**. Generally, the camera will capture the illumination conditions of the arm. The raw image later will be process by the digital image processing unit (**Figure 2**). Additionally, the python language and OpenCV is use in the image processing algorithm. Near infrared radiation (NIR) LED is used to visualize the vein at the arm site. The intensity and number of the NIR LED to light up is control by Raspberry Pi 3 Model B+ (**Figure 3**). When the near infrared radiation is transmitter to the human arm surface, the blood in the vein will undergoes absorption and scattering which will result in the energy loss at the vein site. Thus, the intensity of the vein site will look darker. The camera is used to capture this difference. The camera used is Raspberry Pi No infrared (NoIR) camera board. Furthermore, the image data is processed by the image processing unit. In this alternative design, a Raspberry Pi 3 Model B+ is used due to its fast-operating speed, which up to 1.4GHz. Lastly, Raspberry Pi 3 Model B+ is acted as a Wi-Fi bridge to connect and communicate with the Firebase cloud server.



(a) Final prototype design of device.

(b) Internal view of device (shows the raspberry pi).

(c) Internal view of device (shows the NIR led and NoIR camera).

Figure 1: 3D Model of Integrated Portable Vein Measurement Device

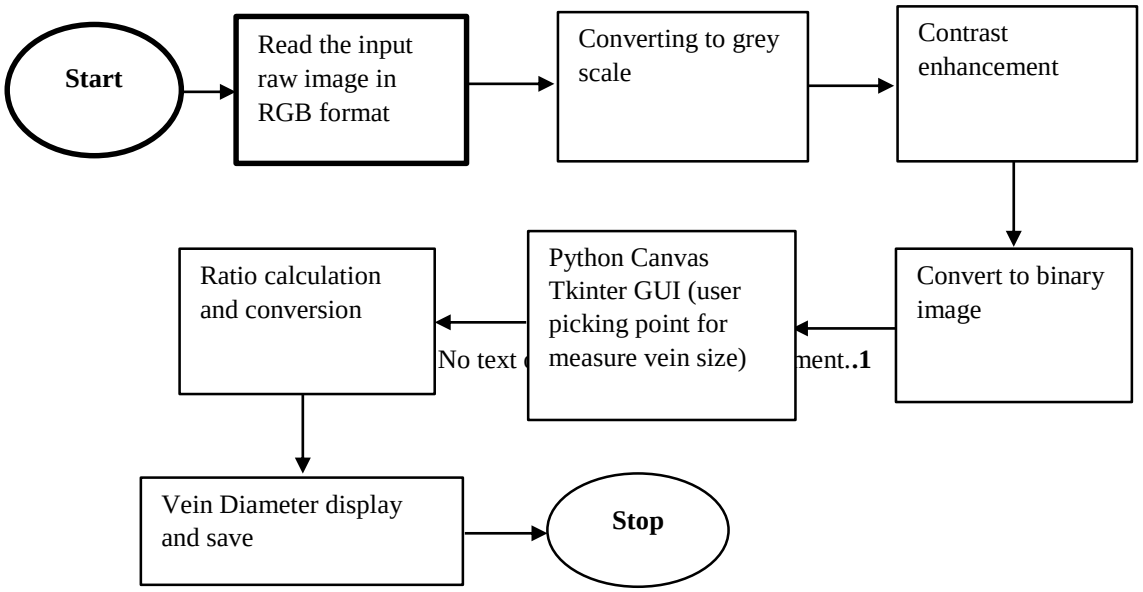


Figure 2: Flow chart of the image processing

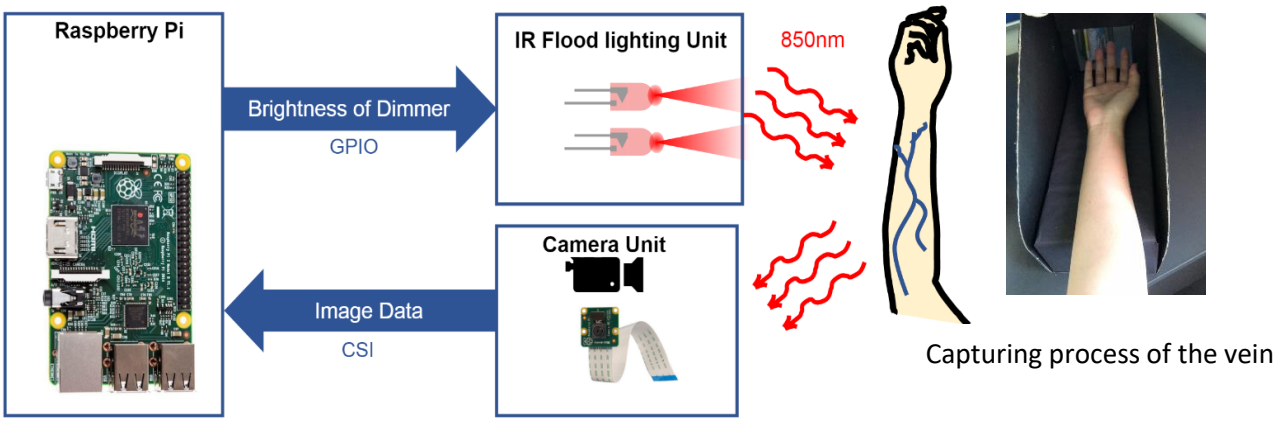


Figure 3: Screening system layout

3. Results and Discussion

The patient vein (**Figure 4**) had been captured through Raspberry Pi Camera and NIR sensor for vein detection, the image will go to the image processing. The patient's data and vein size measurement that obtained will be uploaded to a Firebase cloud. **Figure 5** shows the vein image store into the Firebase database by using the Raspberry Pi 3 B+.Raspberry Pi fetch a data NIR sensor and process it and give it to a Wi-Fi module. Wi-Fi module, it is one of the leading platforms for Internet of Things and it can transfer a data to IoT cloud.

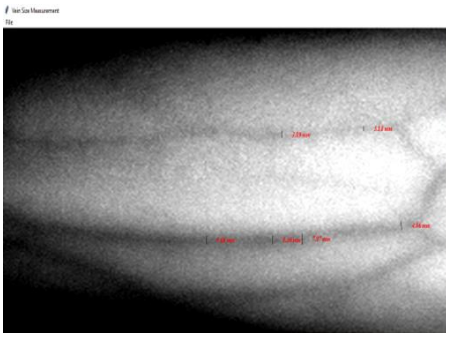


Figure 4: Image of the patient veins captured through Raspberry Pi Camera and NIR sensor for vein detection

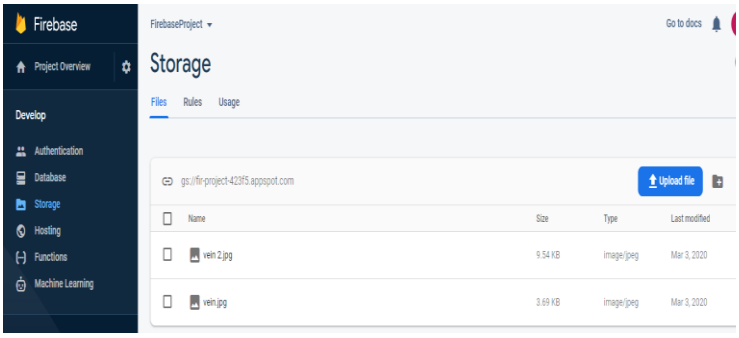


Figure 5. Vein image store in the Firebase cloud database.

4. Conclusion

The IPVMD 1.0 system was developed to overcome the issue related with the vein measurement whether it size is suitable for dialysis access. It is conceptually aimed to reduce the human error made by medical personnel which providing more straightforward approach to determine the access site. By accepting the fact that the prevention is than cure, thus the efficient and relevant way we can do is to avoid the dialysis access site dysfunction since it can cause harm to the patient. An innovation of the system that have a complete system contain several processes which are vein image capturing system, vein image processing, vein size measurement and cloud for data and information storage. Thus, by designing this system, it enables to increase the accuracy of vein size measurement and evaluation, thus minimize the human error made by medical personnel.

Acknowledgement

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