IOT DEVICE TO DETECT ANEMIA

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1. Declaration

I declare that this is my own work and this dissertation1 does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Signature of the supervisor:` Date:

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2. Abstract

Global communication has become an important trend the current society and usage of internet has grown exponentially in the modern society. At the same time, diseases are increases in our society. Our project mainly detects whether they are diagnosed with anemia or not. The patient is diagnosed with anemia may symptoms can be seen. That anemia patents have some specific amount of iron reduces of the oxygen in the blood cells. That blood looks pale than normal red. This devise to use for the capture a picture of the anemia patient fingertip. Capture the picture by sending light under the finger. Then getting the picture and stored in SD card of the System Memory. That picture would be subjected to the image processing where the image would be compared with a effected patient's image sample. Then after would be decided whether this person infect anemia or not. After that all the results are sent to the server for the app connectivity.

Keywords - anemia, image-processing, Kara's, machine learning, IOT

3. Acknowledgement

Final year project is the last open door for CSNE students to confront the corporate industry in the field of Computer Systems and Network Engineering. This is absolutely a challenging circumstance for us; hence we required proper directions and assistance from our lecturers. We appreciatively acknowledge all the individuals who added their value and making our project a successful one. Most importantly we would like to thank Sri Lanka Institute of Information Technology for giving us an excellent platform for this project.

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7. List of abbreviation

Acronym Definition	Acronym Definition
ID	Identifier
DB	Database
OS	Operating System
IOT	Internet Of Things

Table 1List of abbreviation

1. INTRODUCTION

1.1. Background

This document contains high-level detailed description of the requirements gathered for implementing IOT Device to Detect Anemia, which will enable detection of Anemia. Anemia is the name applied to many different conditions that are all characterized by an abnormally low number of healthy red blood cells. There are many different causes and types of anemia. Iron-deficiency anemia, the most common type, is usually treated with dietary changes and iron supplement pills. Other types of anemia, such as those associated with chronic diseases or cancer may need more aggressive treatment. If someone is carrying this disease, then the production of red blood cells in the body is low, which causes the protein known as hemoglobin to reduce. Due to the increment in different types of diseases we need better technologies for the identification of these diseases which the patient is diagnosed from. There was a research conducted by Jamie Punter and five other members. In this research they obtain 50µL whole blood sample to test for anemia. The main aim of the project is to get a portable device so that it can be used for instantaneous detection of anemia. The developed device contains electronic instrument post processing software and plug and play disposable sensor. The disposable sensor is based on a three-gold electrode commercial sensor which is of low cost and 50µL of blood is required for the device to use in this test. In order to achieve a success with this device they had used 48 blood samples for testing of this device. These samples were collected from different clinics and hospitals for the task. Blood samples were distributed in two main groups as one for system calibration and the other 38 samples for system validation. The calibration of the device was done using a complete EIS experiment in this project to get accuracy in the detection of anemia, defining the working range of hematocrit detection. So, in this project the specialty they had used an instant impedance detection in order to make sure they achieve accuracy, sensitivity and co-efficient of variation in this project. After the proper testing has been carried out only 2% accuracy error had been seen. Therefore, this is a more successful device that is portable.

But the main difference between the project that we are developing, and this project is that we will be also developing a portable device, but our project is non-invasive where we will not be getting any blood samples to carry on any tests but rather make sure that the required in put is taken from the symptoms. For this we shall be building a device with the necessary features with image processing integrated into it. The next most important difference between the device that we are to develop, is that the device would be containing to server which in our case in the AWS (Amazon Web Services) which is cloud which we shall be connecting to send the relevant data and those would be connected to the mobile device of the patient. The patient should also answer a questionnaire that is designed in the app and the accuracy in ours would also increase because we shall be accessing many symptoms and mainly using the device we shall be taking a main input which to determine whether the patient is diagnosed with this disease or not. We are going to detect the whether the blood flow in the patient is low by using image processing and relevant technologies.

The document is bounded only to describe the functionalities embedded under detection procedure, tools and techniques to be used and relevant technologies referred for the implementation of the system. The overall system is developed that has a widespread of audience such as Medical analysts, Bio medical engineers and etc. The system is developed as a solution for find the Anemia that are existing in current Medical world. The main functionalities of the proposed system would contain are detecting Anemia, the system should be capture the picture of the color changing as red.

1.2 Research Gap

Past research exists in classifying and clustering anemia behavior utilizing different Machine and different hardware are in a blend with various features. We shall be using the finger as the source and will be implementing machine learning algorithm to using for the image classification. Most of the devices and methods are using find the anemia from eye or finger tips or ear tips which are main indicate that person is suffering from Anemia. But in the device functioned not only one is taken, the many input are taken and classification with the mobile app. The earlier projects are not using the deep learning to find the anemia and they do not use any specific device to get an image from the person. Which means that earlier accuracy levels are lower than usual rate. Therefore, the device is increased an accuracy rate than usual rate.

Features \ Products	Anemia detection Device by Jaime Punter(2015)	Anemia detection device by De Benoist B(2013)	Research product
Portability	✓	✓	✓
Non Invasive method	×	✓	✓
Number of symptoms accessed	Blood Test	Hb measurement	Based on 5 - 10 symptoms and image of fingertip
Mobile Application	×	×	✓
IoT implementation	×	×	✓

Table 2Research Gap

1.3 Research Problem

All the diseases are we can find blood test whether using an inject. But in this case, an anemia patent cannot inject. Anemia is a disease that is extremely dangerous because the iron is reduction in the body.so we need to develop a proper mechanism to identify the difference between the anemia diagnosed patient and the normal healthy person.

As we using the images related to the anemia patient's images are compare with the normal healthy person images.

According to statistics of the UN statement of the Anemia

Population group	Prevalence of anaemia		Population affected	
	Percent	95% CI	Number (millions)	95% CI
Preschool-age children	47.4	45.7-49.1	293	283-303
School-age children	25.4	19.9-30.9	305	238-371
Pregnant women	41.8	39.9-43.8	56	54-59
Non-pregnant women	30.2	28.7-31.6	468	446-491
Men	12.7	8.6-16.9	260	175-345
Elderly	23.9	18.3-29.4	164	126-202
Total population	**24.8**	**22.9-26.7**	**1620**	**1500-1740**

Table 3UN statement of the Anemia

Based on the table there most of the women's are suffer from this disease than men. Because most of the women's during the menstrual period they loss larger amount of blood. And they had a more blood loss due to the pregnant time. Therefore, the women's are mostly effected in this disease.so the device is most suitable for the women's.

1.4 Research Objectives

The device is to be used for detecting anemia; the patent should check the anemia to using this device easily than other way to check. That means the patent can check the anemia without needle. The device is capture the image from the fingertip under the white led light. This picture will be automatically taken by camera module. After that; image will be stored in order to the Raspberry Pi Memory Card. After that; picture ready to image processing by using specific algorithm. After that result will be sent to the cloud server via Wi-Fi connection without any wires.

The part of this research is the implementation but before the implementation of this project the team needs to collect necessary data to implement this device. From the above-mentioned symptoms

- General Fatigue
- Dizziness
- Pale Skin
- Difficulty in concentration
- Leg cramps
- Insomnia
- Shortness in breathing and headache, when exercising
- Unusually rapid heartbeat
- Cold feet and hands
- Tongue swelling or soreness
- Feeling faintish and blackout

One of the key symptoms is skin going pale. So, the researchers shall be developing a device to detect if the skin is pale and oxygenated blood flow is less so that, the skin is pale would indicate a major factor that anemia and depending on the input from the questionnaire on the app we can detect whether the patient is suffering from anemia or not. The questions in the questionnaire would mostly be related to the symptoms of anemia which a major factor in the detection anemia is. So, in order to implement the hardware device, we need the image of the finger tip of the patient when it is squeezed as well as released. The time gap between the releases after the squeezing should also be calculated.

The main reason to do this is when squeezing the finger tip of a person the fingertip turns yellow in color, so we need a camera module configured in the respective module used which is raspberry pi where the camera module will be configured. Then the image during the squeezing of the fingertip will be taken as the first shot, then the image would be taken after the squeeze is released. Then using image processing we shall be checking the time taken and the comparison. Then we would need to gather data from an anemia diagnosed patient in order to get the data when the finger is squeezed and released the time taken. So, comparatively we will be running an algorithm of an infected patient and a normal person's data to check if the patient using the device has anemia or not then the information is sent to the server. The server would detect the input and we would request the patient to use the app to register before doing the above functions in the app so that the relevant information is taken, and an account is created in the app. Then the app would contain a questionnaire where the questions related to the disease is needed to be answered by the patient in order to get a proper accurate result, so based on that we can get the input into the server from the questionnaire as well as the device.

After getting the input from both, the device and the questionnaire we shall be running a machine learning algorithm in order to detect whether the patient has been diagnosed with anemia or not. After the algorithm is run the results will be pushed to the app where the final user would be able to see if he/she is diagnosed with anemia or not. The main objective of this research is to make sure the patients would be able detect anemia at an early stage and take necessary treatments so that they can be cured at an early stage.

2. Methodology

2.1 Methodology

Main function of the device is take fingertip image under the light and store the image to the system memory to the specific folder, and connect the system via using Wi-Fi connection. This system was aligning to take a specific color change of the fingertip as red. After that picture will be aniline with an anemia patent sample under using image processing method. When the person will be scanning they are finger under the LED light. All the images are will be take system itself.

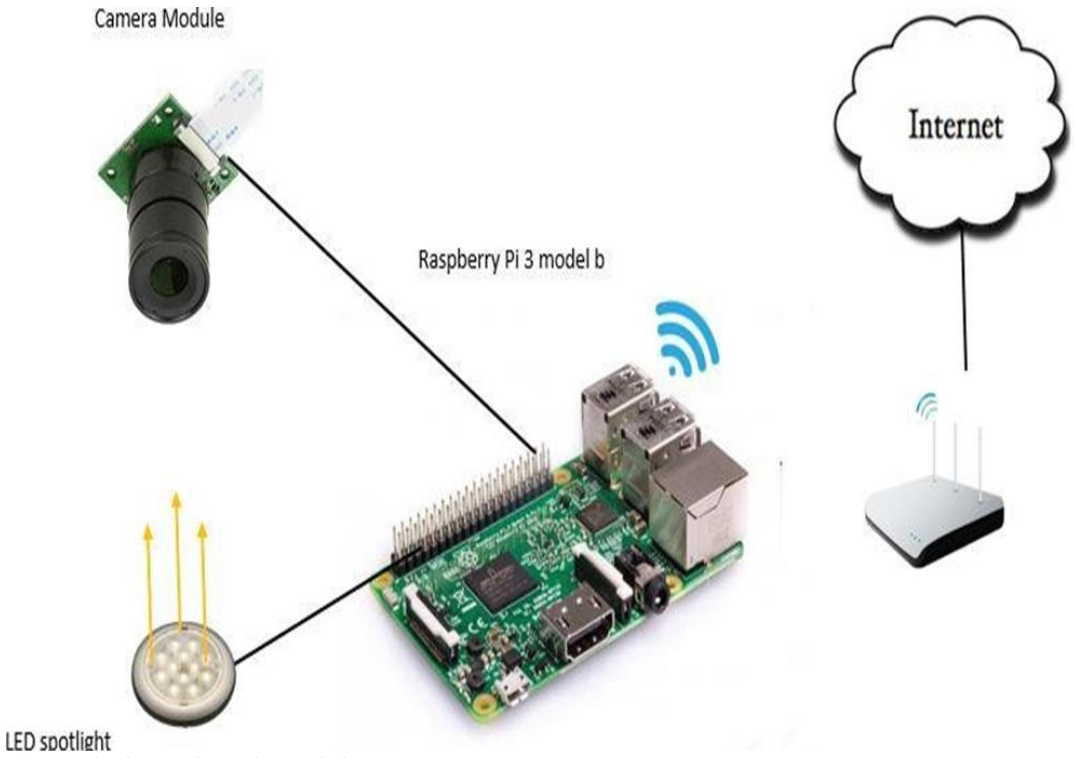

Figure 1ARCHITECTURAL DESIGN

2.1.1 System start up configuration

Here I took a photo through the camera with LED white light. Then the device automatically connected to the internet. Here can we use Wi-Fi or hotspot; image was store the real time database

1. Raspberry Pi 3 Model B – Raspberry with Linux environment will be the main hardware Interface. Ubuntu is used as the operating System
2. Camera Module - Sony Exmore IMX219 sensor Capable of 4k30, 1080P60,720P1080 and 8MP Camera module will be the main hardware for capture the image.
3. LED white light – LED light will be used for capture the red color density of the fingertip.
4. 220^0 wide angle fisheye lens- Aperture f2.1, field of view (220^0), 6 element lens (2 glasses and 4 plastic), image circle(2.80mm), Focal length (0.79mm), Mount type(M12), Lens diameter 16mm, IR Filter (RP-L220).
5. Wi-Fi Router – Wi-Fi router to provide an internet facility to the system.

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Figure 3final out look of the devices

Figure 2inside of the devices

2.1.2 Insert finger for scanning process

When the device was turn on, the device is ready to capture the image of the fingertip. Whether their fingers possession less than 16mm the picture well be automatically capture the image and store the image as a specific allocated folder.

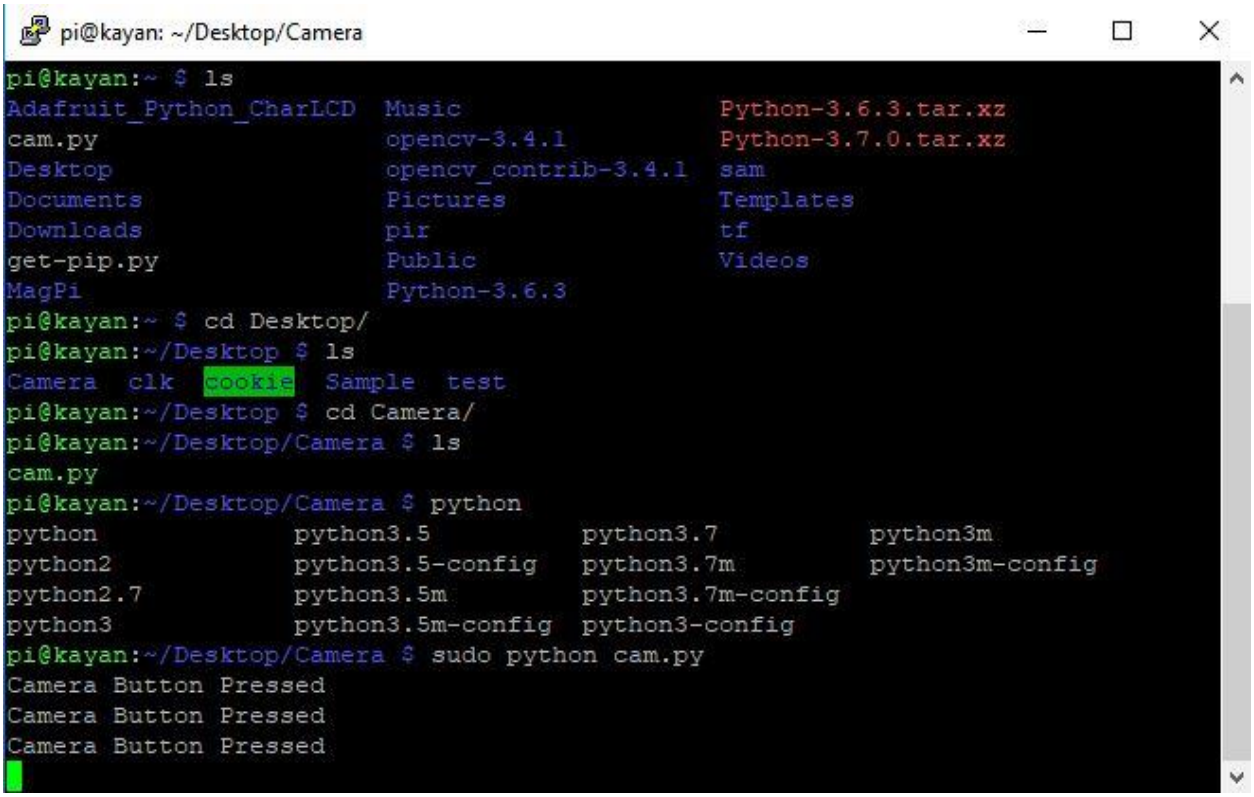

Figure 4remotely access the system via using putty

This code was express the GPIO pin 18 push button attached. When you push the button it will capture the image with in 2 sec time delay. At the time the LED light would bling or Flash and the image were captured. Then the captured image was store in the real time database as sample.jpg. Then the Image go through the image processing the algorithms the image was verified and the result would send to the android app.

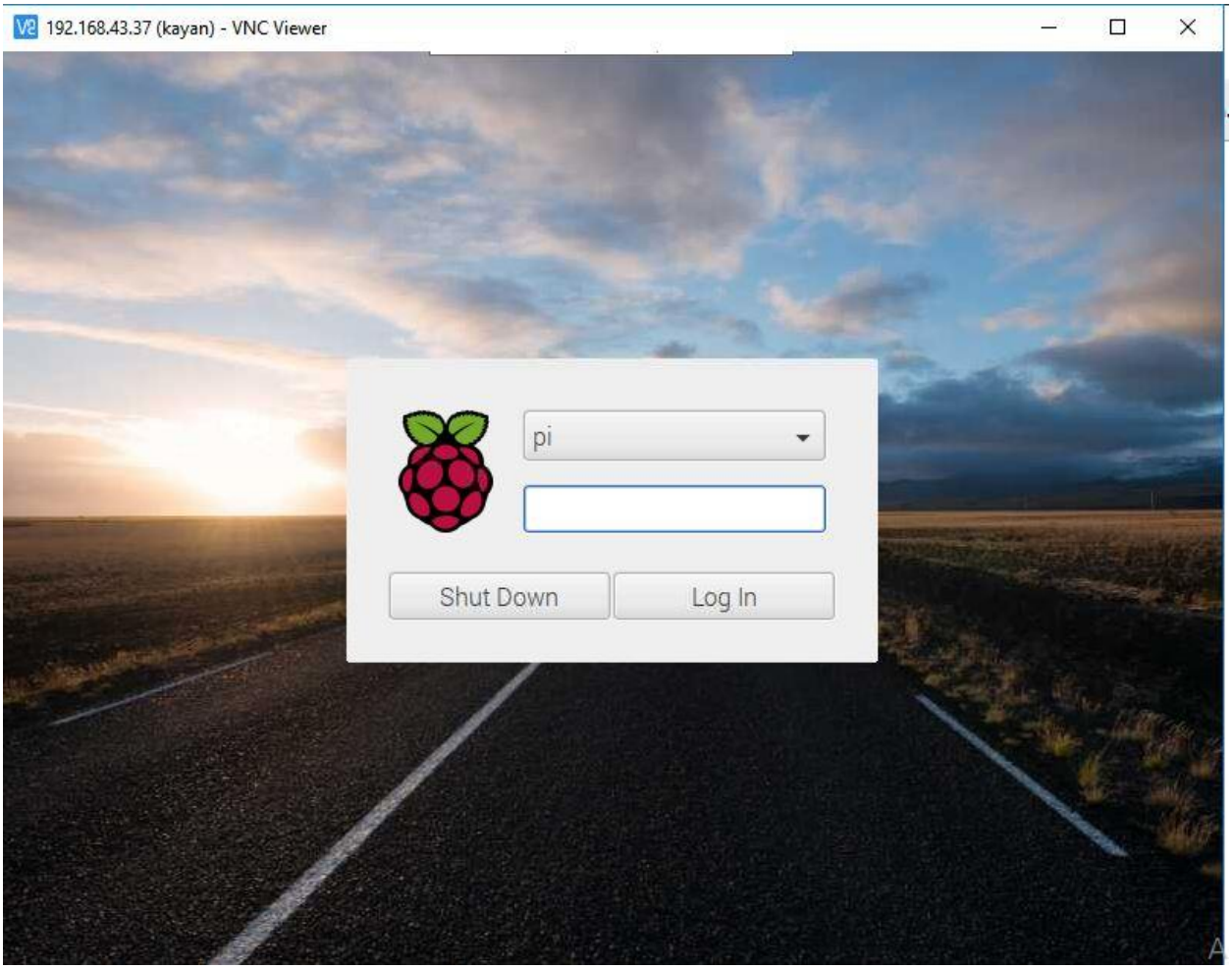

Figure 5Raspberry pi login interface

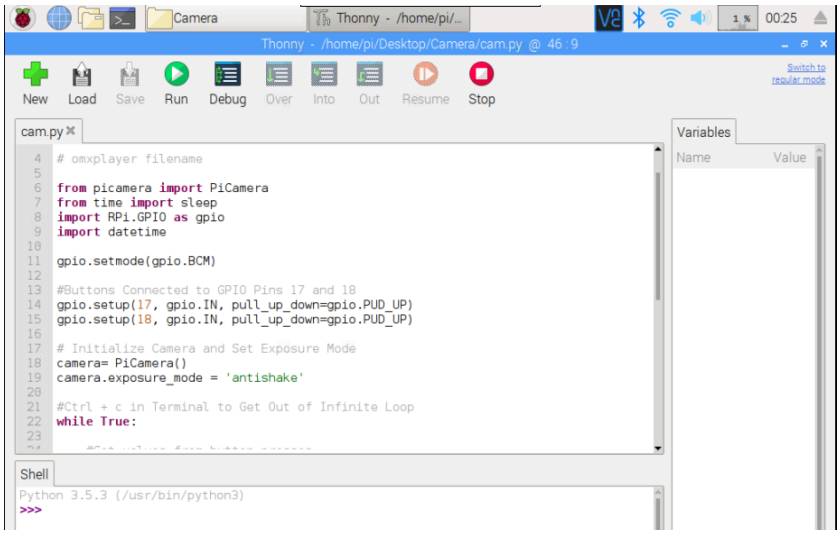

Figure 6inside python code

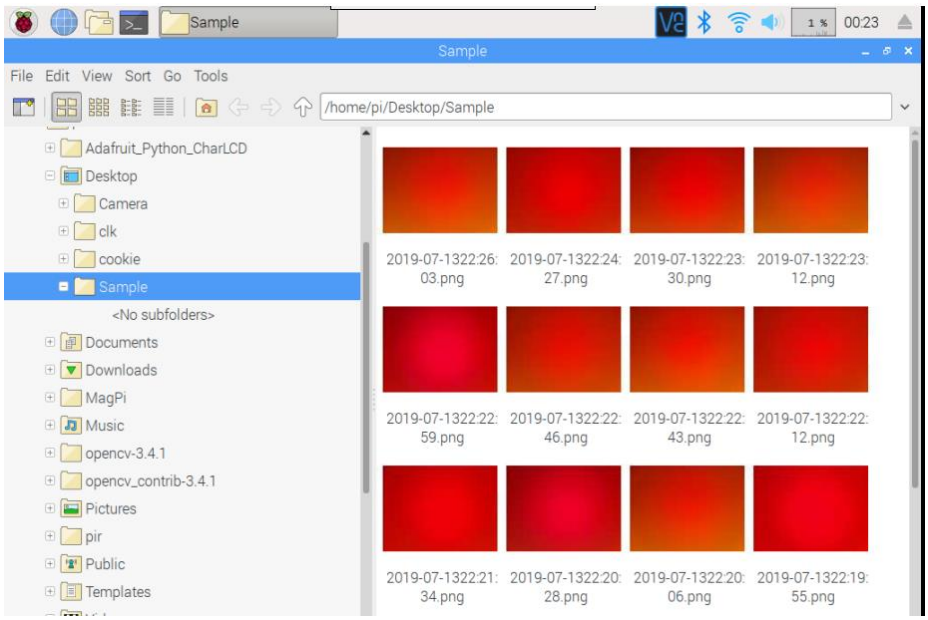

Figure 7Sample images

The image of a healthy patient

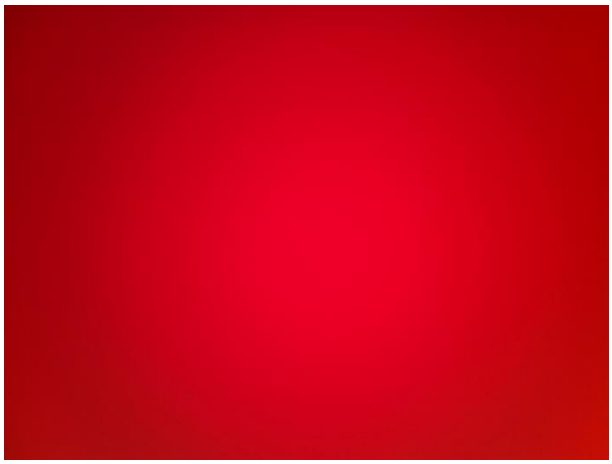

Figure 8The image of a healthy patient

The image of anemia difected patient

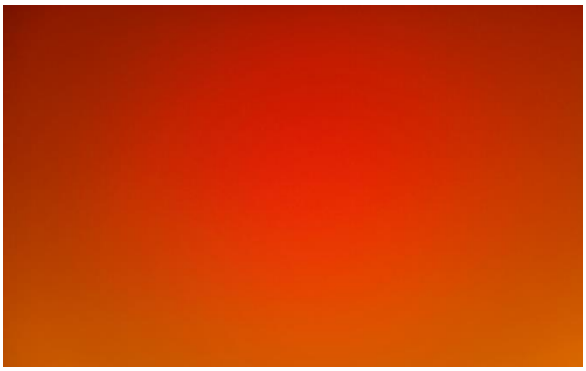

Figure 9The image of anemia defected patient

2.1.3 Server connection

Whether the images it will stored to the specific folder after that, that the specific folder will be shared to the AWS cloud server to process an image processing.

The device was connecting via Wi-Fi using VNC server

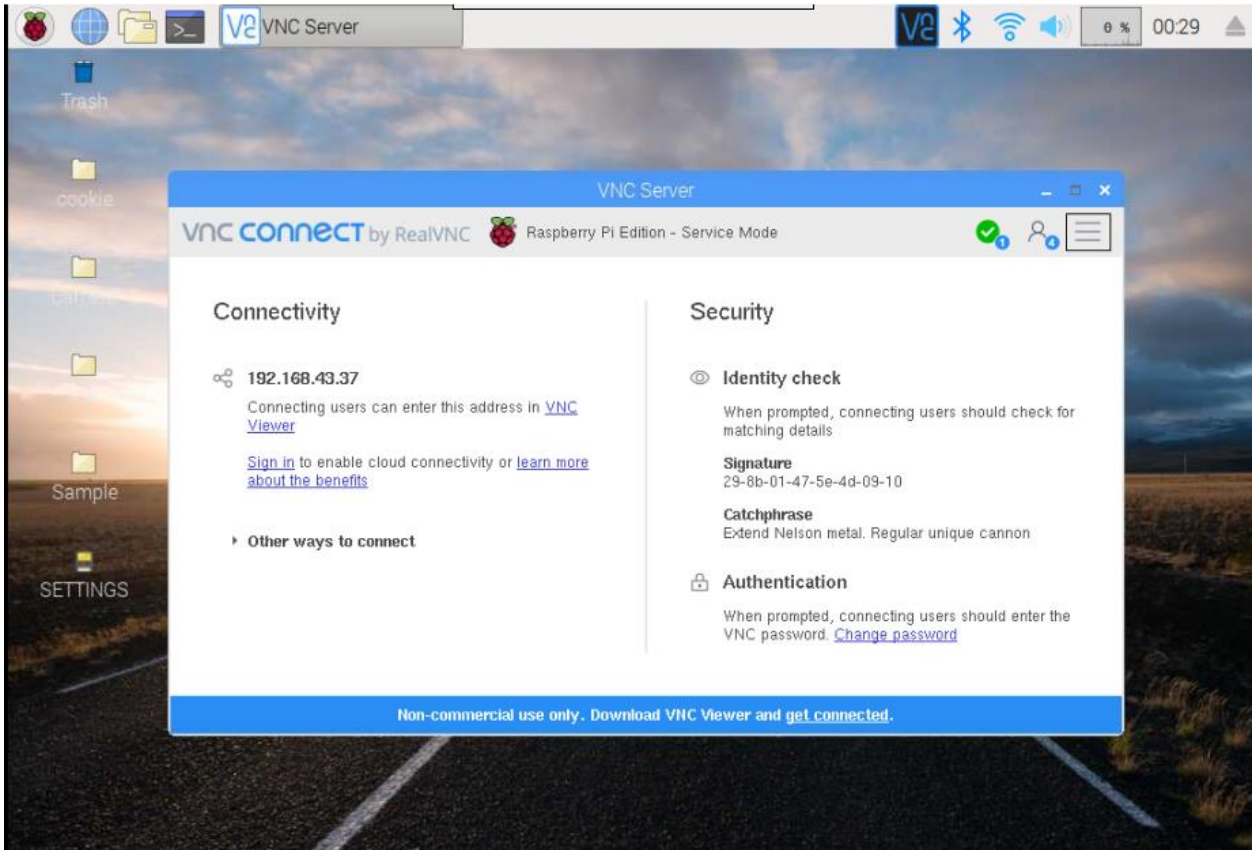

Figure 10VNC connection

2.1.4 Testing

The normally we can identify the differed between an anemia patient fingertip color to healthy person color. That data set was not much to get a better result .so we need to train more images sample to under the image process.

First I used the USB webcam. The problem was there is no GPU assistance so all work is maintain by the CPU to communicate with the device to extract frame data at the cost of higher CPU load. And USB camera doesn't have the option anti shake option. Therefore it can't be provide the quality picture. Then the major impact was here couldn't filter the infrared or couldn't use this in the dark room or the night version.

That I got some data samples collection of the anemia patients. Then i subjected the data's (anemia patients and normal people blood samples images) through the image proccing. And we found the result like which photos had impacted and which a photo doesn't impacted from the anemia. But it would take more storage. And it couldn't be store in the real time database.

Therefor I changed to camera module. And first I planned to take the data as video but here have to think about the storage and the time limitation. The time limitation was less than 10sec. couldn't take the video more than 10sec. So clear option was captures the photos and it stores it in the real-time database. And the image was override as sample.jpg. So it would help to couldn't complicate the systems storage.

In the starting I preferred the camera model v2 (5MP) but then had to consider about the photo quality therefore I changed the camera model to (8MP).

3. Results & Discussion

After the implementation of the device the research team was able to test it on a certain number of individuals who were healthy as well as who were diagnosed with anemia. The results were initially showing an accuracy rate of as shown below. But with continuous training that the device was subjected to it was able to show an accuracy rate which is more than 80%. The device has then been configured with an external design so that it can be marketed at a later stage. When configuring the above-mentioned models there were certain problems which would be faced when configuring the image processing as the data samples which has been collected for the implementation of the demo is not exceeding more than 150. The amount of data sets that should be collected in order to train the system is manually done as the data set is not available therefore if a large sample of dataset can be collected then it could be used to train the system more accurately that would make the system eligible to attain a greater result with a better accuracy. But currently due to the low amount of data that is available a low amount of accuracy is arrived at. The ability to make the device portable and the usage of non-invasive method is an attractive feature that leads more users to suggest the device. This reduces the blood loss in anemia patient facilitating the users the device fearlessly. The data processing algorithm to train the predictive model which produces the results was set up in Microsoft Azure Machine Learning Studio as shown in the figure below. The dataset is split into two portions in 80:20 ratio and the first portion are used to train the model while the latter portion is reserved to test the produced predictive model in order to measure its accuracy.

The result of the evaluation is shown in the figure below with the predictive model achieving an accuracy of 82.6%.

4. Conclusion

In the research project anemia can be identified in a noninvasive method so that the blood loss can be minimized for an anemia patient. The implementation of questionnaire which collects more symptoms related to anemia and not only depending on the device. But it also takes multiple inputs from the device which makes the accuracy rate higher than only getting one symptom out of the device. As an improvement for the device this can be designed to read the amount of hemoglobin level in the blood. If the amount of hemoglobin level in the blood can be detected, then some major diseases can be detected easily.

5. References

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