

DESIGNING OF A PORTABLE HEMOGLOBINOMETER USING RASPBERRY PI

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Abstract: Hemoglobin is an important iron carrying pigment present in the blood. The portable hemoglobinometer is aimed to count the hemoglobin count present in the blood of a person from anywhere at any time and to give the result at real time. It uses the absorbance of light theory to measure the hemoglobin present in the blood. This equipment is designed to increase the efficiency and at the same time decreases the size of the equipment. The hemoglobinometer is designed so that it will be easier to take the test anywhere and anytime, especially women. This hemoglobinometer also displays the result in an application installed in the mobile phone of the patient hence making it portable and also the patient can access the test results from anywhere in this world.

Key Words: Hemoglobinometer, hemoglobin, Portable, anemia, polycythemia, HgB count.

1. INTRODUCTION:

Hemoglobin is an important pigment present in the blood which is responsible for carrying oxygen from the lungs to various other organs, tissues, and cells through the bloodstream. It is a parameter that needs to be closely monitored especially in women during their pregnancy. The hemoglobin value should be within the normal range for men and women. If it deviates from this then it can cause problems in the human body like fatigue, etc. If the hemoglobin count is high it is called polycythemia and if it is low it is called anemia. To maintain the hemoglobin level it is important to test the blood and check it routinely. To test the hemoglobin present in the bloodstream one must go to established labs and wait for half a day or should collect it from the lab later. This is a waste of time and energy.

This project focuses on saving the time of the patient as well as making the procedure more efficient and the testing system more compact to make it easier to carry from one place to another. This procedure doesn't use the traditional cyanmethemoglobin method to measure the hemoglobin instead of an equivalent circuit is used to increase efficiency.

Table 1: The normal range for various categories of human beings

S.No.	CATEGORY	RANGE OF HB (gm/100ml)
1	Women	12 – 16
2	Men	14 – 18
3	Newborn	14 – 20

2. METHODOLOGY:

The block diagram shown below shows the simple circuit used for designing this hemoglobinometer. It is designed to increase efficiency, compactness and also the cost of the equipment so that it can be used by all.

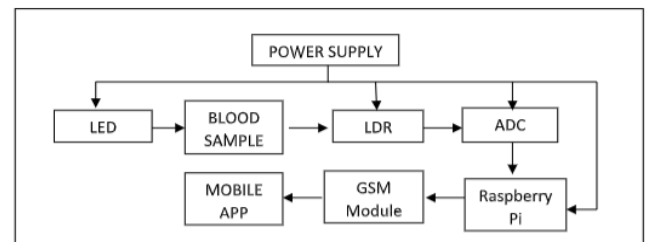


Fig 1: Block diagram of the designed circuit

The LED used in this circuit is of the range 450 to 750 nm in wavelength. This light from the LED is used to pass through the blood sample that is collected from the patient. This blood sample is collected by pricking the patient's finger and getting a few drops of blood from the patient. This is then placed on the glass slide to examine.

The hemoglobin present in the blood gives the blood a reddish hue and this pigment will also obstruct light in its path. So when the light from the LED is allowed to pass through the blood sample it will absorb some of the light which will change the wavelength of the light but not its frequency. This light coming out after passing through blood sample will have a different intensity than the light from the LED.

This light is then detected by the LDR (Light Dependant Resistor). The current value after passing through the LDR depends on the resistor value and the resistor value depends on the light falling on the resistor. In this case,

the resistor value depends on the light after passing through the blood sample, so the current from the LDR is dependent on this light.

The current from the LDR is an analog signal which is then converted to a digital signal by using an ADC. This conversion is important as the Raspberry Pi needs a digital input. This digital output from the ADC is then fed into the Raspberry Pi.

The Raspberry Pi is interfaced with a GSM module to send the output to the application in the mobile phone. The app then displays the result, that is the hemoglobin count and also if the count is within the normal range or not. The user can also book an appointment with the doctor using this app.

3. CIRCUIT:

The block diagram in the segment shown above is implemented to give real time results. This circuit which we designed is shown below:

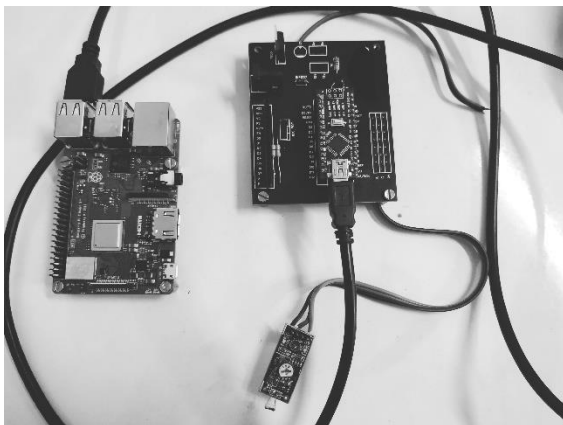


Fig 2: Circuit

The various components used, hardware and software, is explained below

3.1 HARDWARE:

3.1.1 LED

The LED is used here to produce light of the wavelength 450 - 750nm. This light is then allowed to pass through the collected sample of blood. This particular wavelength of LED is chosen because it is the most suitable and ideal wavelength required for this experiment.

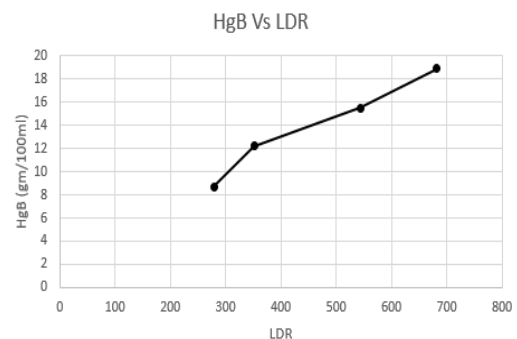
3.1.2 LDR

The light dependent resistor here is used as a receiver for the light that is gotten after passing through the blood sample. The LDR is a variable resistor and the value of the resistor varies according to the light that falls on the LDR. So the LDR is calibrated so that the

output is proportional to the hemoglobin present in the bloodstream. The current after passing through the LDR is proportional to the hemoglobin count.

Table 2: LDR Vs HgB (gm/100ml)

LDR	HgB(gm/100ml)
682	18.9
543	15.5
352	12.2
279	8.7



Graph 1: HgB Vs LDR value

3.1.3 ADC

The analog current from the LDR is not suitable to transmit or to read. So this converted to a digital signal using an analog to digital converter. The ADC gets the input from the LDR as an analog current whose value is proportional to the hemoglobin count. This is converted to a equivalent digital value with the help of an ADC.

3.1.4 RASPBERRY PI

The Raspberry Pi is a mini computer with Wi-Fi, Bluetooth, HDMI port, USB port, etc. Here it is used to interface the GSM module with the circuit. The Raspberry Pi model used is Pi 3 model B+. The Raspberry Pi gets the digital output from the ADC which it send to the GSM module to transmit.

3.1.5 GSM

The Global System for Mobile communication is a module that is used to transmit messages or calls to other mobiles using the mobile communication network and TDMA techniques. Here a GSM model SIM850Mhz is used to send the HgB count to the application in the mobile phone. It is interfaced to the circuit using the Raspberry Pi.

3.2 SOFTWARE:

3.2.1 RASPBIAN

This software is used to program the Raspberry Pi to interface the GSM module. This is a Linux based OS and the programming language used to interface the GSM module is Python. The program is dumped into the Raspberry Pi and stored in the SD card in the Raspberry Pi.

3.2.2 PHP

Personal Home Page is used to receive the data from the GSM module and stores in the local database server. This then transfers the data stored in the database to the mobile application.

3.2.3 ANDROID STUDIO

This software was used to create the application in which the HgB count and range is displayed. The programming language used was Java to develop the application. The application is free of cost and is also needs a very small memory. It can also be used to book an appointment with the doctor.

3.2.4 APPLICATION

The app is used to display the final output, the hemoglobin count and also the range i.e. if the count value is in the normal range or high (polycythemia) or low (anemia).

RESULT	
HgB Count (gm/100ml):	<input type="text"/>
Range:	<input type="text"/>

4. OBSERVATIONS AND RESULTS

The circuit is tested and the readings are noted and compared with actual reading taken at labs. These are compared to check the accuracy of this circuit.

Table 3: Actual value Vs Tested value readings

TESTED VALUE HgB(gm/100ml)	ACTUAL VALUE HgB(gm/100ml)
11.6	11.9

12.5	12.5
6.3	6.2
16.1	16.3
9.7	9.7

5. CONCLUSION

The hemoglobinometer designed now is compact in size and also gives us quick result over the application installed in your phone, which is also efficient. Thus, this hemoglobinometer can be used in remote and rural areas where the people do not have access to established labs to take tests. This will be helpful for patients all across the world.

6. ACKNOWLEDGEMENTS

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