

Haemoglobin Measurement Using Non-Invasive Technique: State of the art

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Abstract:

Haemoglobin is key essential constitute of human body which represent the oxygen consumption state of body. It carries oxygen to blood cells from lungs. In many medical practices' doctors need to check the level of haemoglobin to suspect the problem. Right now, doctors offer to test haemoglobin of person to laboratories, where they test the blood sample physically. This technique is avoidable as it takes time and also have chances of spreading viruses. Now in corona pandemic, social and physical distancing is an inevitable. Also, medical staff now a days preferring not to check all patients physically. Various technologies are immersing now in this aspect to combat such situations. Doctors are using oximeter to check oxygen level of patient with just fingertip. Now a day's heart rates can be measured by a smart fit band in our hands. So, in this environment it is necessity to develop such a non-invasive device of human friendly material which can check haemoglobin level of patient without using any needle. This is good for both patients and doctors. It can

save lab practices, reduce time to proceeding next operations and saves money as well. In this paper various non-invasive techniques are discussed.

Keywords: Haemoglobin , Non-invasive, Design , Material , Develop , Method , RBC's , WBC's.

1. Introduction:

Our blood cells are comprising of Red blood cells and White blood cells. The function of red blood cells is our main focus. They conduct oxygen from lungs to cell tissue [16]. They also carry carbon dioxide between lungs and body [1]. Haemoglobin is present in these RBC's , inside the cells to be more precise. So basically, we are able to consume oxygen is because of Haemoglobin only [17]. Haemoglobin also carry carbon dioxide from cells, which is what we exhale [25]. RBC's are red in color because of haemoglobin only [2].

So, in normal human body to function properly good amount of haemoglobin is necessary. That's why before any medical treatment doctor asks to check the haemoglobin level of body [12].

Blood concentration hemoglobin (ctHb g/L)	
Adult Male	13.5 - 17.5
Adult Female	11.5 - 15.5
Child (1 year to puberty)	11.0 - 13.5
Baby (3 month)	9.5 - 12.5
Newborn	15.0 - 21.0

Fig1: haemoglobin range [13].

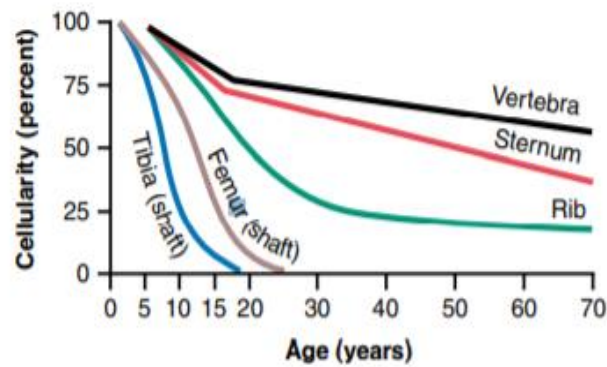


Fig 2: Age wise RBC's production in body [14] , [19].

2. Literature review:

In medical field every test is carried out by specific instruments. Each test might be non-invasive to avoid any kind of infections [15]. This will be hassle free process which required less time and money. Patients will not be required to undergo rigorous methods and practices. For oxygen checking and pulse checking such equipment are already in used. So, the motivation is clear here to introduce non-invasive haemoglobin testing machine [3].

2.1 Different methods used for Haemoglobin testing :

2.1 A) Method 1: Pulse oximetry

This is non-invasive method used to test oxygen level of blood which will be base of our research. This method is quick, hassle free and gives no pain to patient. This device consists of a LED sensor, photo detector, amplifier[4]. We have to put our fingertip below the LED light source. The light rays will pass through the fingertip. Our blood streams are nothing but the carriers of oxygen [22]. The movement of blood cells result into fluctuation of light rays. This fluctuation is cached by diode placed behind the fingertip. It forwards the data towards the amplifier. Who amplify the results and send data to display. Although it consists more parts like coding of signals.[20]

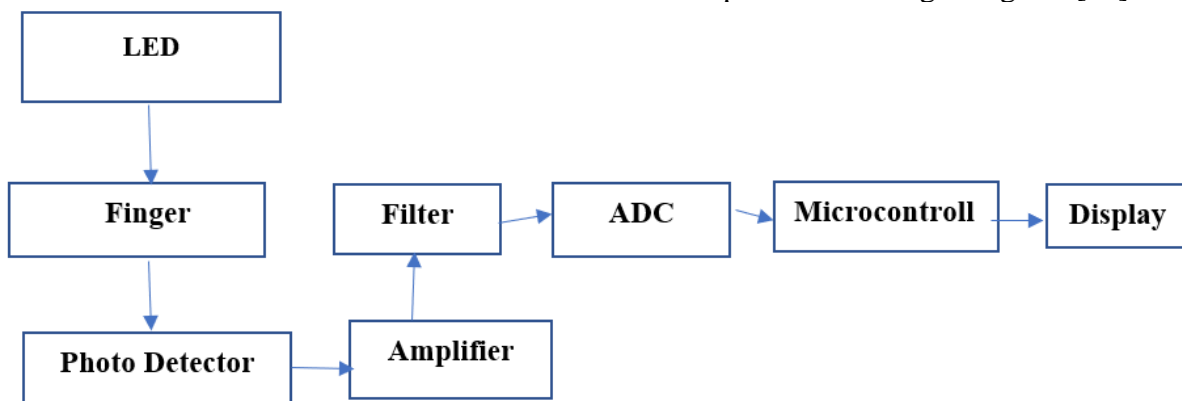


Fig 3: Pulse Oximeter [6].

The use of this device has been extensively increased in corona pandemic.

2.1 B) Method 2: Optical sensor

Doshi etc all [11] have proposed an optical sensor system for haemoglobin measurement. This is based on pulse photometric measurement method. It is very similar principle as oximeter has. The sensor is placed above fingertip and

infrared signals are allow to flow through the blood [8]. The blood cells have rbc's and wbc's. the haemoglobin which carrying oxygen and which is non carrying are both catches the different wavelength of the infrared light. This light is then evaluated separately to check the haemoglobin level of patient. This is continuous process which allows the

infrared rays to travel slowly to arteries deeply. Which then sensed by diode below the finger. This study can be fluctuated by

heart beats or blood circulation patterns [5].

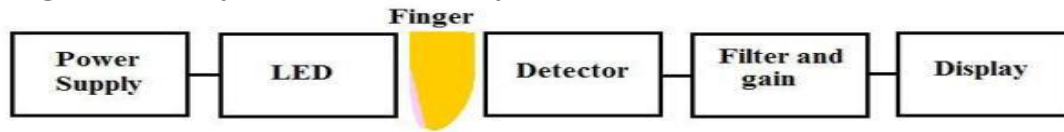


Fig 4: optical sensor.

2.1 C) Method 3: Opto acoustic method

H.-P.F. Brecht etc all [9] have worked on optoacoustic technique. As stated above, the haemoglobin molecules have two types one which carries oxygen called as oxyhaemoglobin and one which has oxygen deficiency called as deoxyhaemoglobin molecule. In this method the difference occurred in

absorption of these molecules is checked and then evaluated efficiently. This is also non invasion technique and very similar to above processes. This technique uses ultrasonic waves. A transducer is used to detect these waves. The depth of waves gives out the resultant signal [7].



Fig 5: Opto acoustic model

2.1 D) Method 4: Diffuse reflectance spectroscopy

Saigo etc all [26] have worked on this method. When a light is passed through blood cells a reflective spectrum is released. Based on that characteristics of spectrum a measurement is taken. Absorption and scattering are the

principles of this technique. The wavelength of this reflective spectrum is recorded, decoded to the language that human can interpret [18].

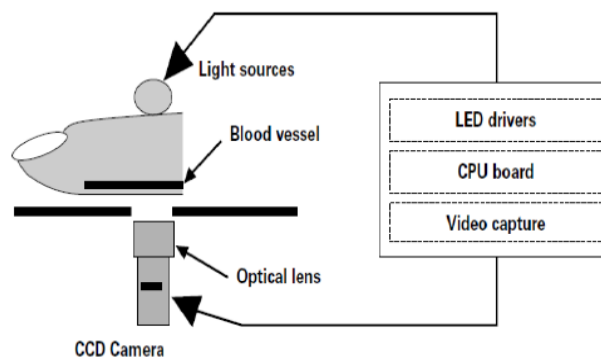


Fig 6: Image capture using principle near infrared radiation [10].

2.1 E) Method 5: Imaging based technique.

A study is carried out to check whether a digital photography is used to check

haemoglobin molecules in eyes. Our eyes comprise of blood cells and blood veins. These blood veins are in appropriate colors. We can determine the values of haemoglobin in our body, by just checking the color. When a photograph is taken using digital camera, our eyelid reflects the

light. As per the color of the image we can tell how haemoglobin deficiency is presents. Well, this study is suitable where devices and facilities are not fully developed. As the results are never going to be accurate, this study is suitable for primarily examination.[13]

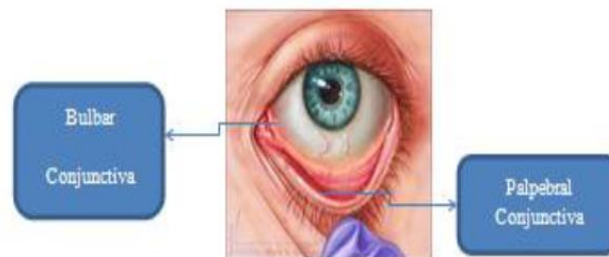


Fig: Conjunctiva

3. Research gaps:

There is no completed device who can measure haemoglobine without invasive method. Most of methods comprises of electronic circuits, resulting in delicate structure.

Many methods are not offering accurate results [24]. Cost of device is still an issue. Batteries and electricity are required in some cases. In such cases the mobility of device is hampering. Processing time for coding might be high in some methods which is absolutely not desired. Some devices are large in size. Sometimes devices are difficult to handle. Skilled labor is required. Coding, computation, manipulation of data is still high. Which eventually makes device complicated.

3.1 Problem definition:

To create such a device who can test the blood without cutting or penetrating the skin. Non- invasive technique must be carried out with patients to conduct any tests, as possible in many cases. This reduced chanced of infections to various extend. Also, the result may have to come fast in an urgent case.

4. Scope to research study:

This proposed model is for the situation where the tests are need to be quicker. Many times, we see patients need rapid tests. In such cases we can observe a single minute can be very fatal. Also, in this corona pandemic we have seen importance of physical distancing. This proposed device is such that fulfilling above criteria without disturbing the accuracy of device. Many cases we observe in medical fields where sugar patients suffer from low sugars. They need rapid saline to consume. At this time, they have to undergo haemoglobin test. This test takes longer time and also patient remains on wait. This also consumes extra charges for patients. Our proposed devices can help in such cases and will improve the speed of process. This device can be used in many labs as well.

4.1 Feasibility of proposed model:

Now a days, with advancement in medical field, every process is supposed to be quick and accurate. The regular process of carrying tests of blood sample and examine in laboratory for no of hours, is hectic and time consuming, Here comes the idea of non-invasive haemoglobine testing which carrying test without pain to patients. It reduces direct contact of blood

to other staff. Reducing any chances of infection. Hence such noninvasive technique is highly recommended in medical fields.

4.2 Appropriate approach for proposed model :

To get the best possible solution from above problems, need to create very feasible and less complicated, portable device. For this consider some electronics part. The use Arduino device will make things easier in order to manipulate the data [21]. Infrared rays are also necessary

to make measurements. From above suggested devices, the best promising option is optical sensor [23].

Its advantages:

No direct contact. Compact device. Portable. Quick readings.

This block diagrams shows the basics of our proposed device. The effort we must to take is making device compact and very easy to use. We can try many other methods for manipulation of data. As now we are supposed to use Arduino.

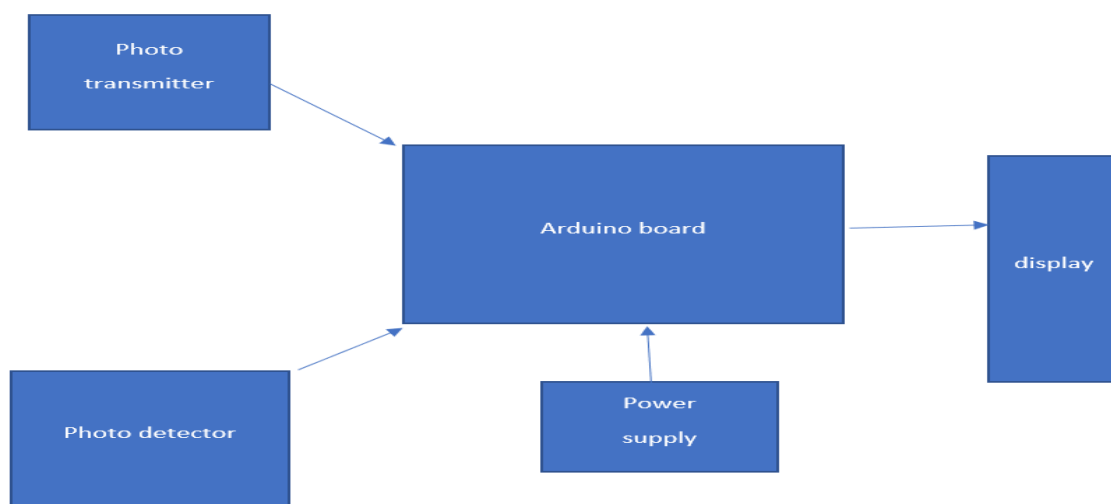


Fig: block diagram of device

4.3 Expected improvement in solution:

One can measure the haemoglobin from the device instantly. The results and data must readable easily and directly. The device could read the heart rate and haemoglobin at the same time, then it will be an asset. If the device is capable of reading all the data like bpm, pulse rate, oxygen level, haemoglobin at the same time, then this device can be very useful. It may not be complex in structure. The device must be usable for all the semi-skilled persons. The manipulation may not take a lot of time.

5. Conclusion from paper:

First, the basics of haemoglobin and its importance in human body is studied. The necessity of rapid testing as well. Then studied various methods used by various

researchers and their principles. The optical sensor method is most feasible and effective method among all.

This is based on pulse photometric measurement method. It is very similar principle as oximeter has. The sensor is placed above fingertip and infrared signals are allow to flow through the blood. The blood cells have rbc's and wbc's. the haemoglobin which carrying oxygen and which is non carrying are both catches the different wavelength of the infrared light. This light is then evaluated separately to check the haemoglobin level of patient. This is continuous process which allows the infrared rays to travel slowly to arteries deeply. Which then sensed by diode below the finger. This study can be fluctuated by heart beats or blood circulation patterns.

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