DEVELOPMENT OF MICROCONTROLLER BASED HAEMOGLOBIN METER

Physics

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ABSTRACT

Development of microcontroller based Haemoglobin meter using wide band sensor and OLED display is aimed in this work. The detection of blood Haemoglobin using this own developed Hb – meter and it's comparison with the W.H.O approved HemoCue Hb 301 meter is carried out in this work [1]. Hb is a protein in red blood cells which carries oxygen throughout our body. The low Hb count may indicate anemia which is a severe nutritional disease [2]. The device is developed using the light sensor and RED LED with a specific circuit designing. The blood sample is illuminated by RED LED using 450/00 C.I.E. standard geometry [3-4]. The light sensor (TEMT 6000) receives the reflected light at a location 0 degree from the perpendicular to the sample. Using the linear interpolation method, the Haemoglobin value is determined with continuous analog data acquisition from the sensor [11-14].

KEYWORDS

Light sensor, OLED Display, C.I.E. standard geometry

INTRODUCTION

In rural areas of Maharashtra, the accurate and quick detection of anemia- status is very challenging. So the necessary treatment according to the anemia-status cannot be readily given. According to the survey of Red Cross and W.H.O., during 2017-2019, the issue of anemia in young (under age) mothers in Palghar district was a serious issue. One of the reasons is the difficulties of people in interior areas in reaching to the P.H.C.s. A solution is dreamed through the indigenously developed, portable (handy) and cost-effective device which can be easily used by health workers like nurses or Aasha workers for the betterment of society.

The "Development of Microcontroller based Hemoglobin meter using color sensor is carried out in the research lab of N.B.Mehta Science College, Bordi, Department of Physics. This is in the absolute rural area, the village of Dahanu Taluka, District Palghar ,which is Aadiwasi -Bahul district. The poor people around are not serious about their health due to their economic, educational and overall bad conditions. Even the P.H.Cs cannot meet the required needs of these people in the expected ways due to many lacuna on both sides. The marriages at early age, lead to the young girls facing the problem of anemia. The focus of this research is mainly to identify the hemoglobin deficiency in young mothers and infants to do the needful to eliminate this deficiency through the work undertaken to find the anemia status.

Theoretical Background:

A molecule of haemoglobin consists of two pairs of polypeptide chains or globin and four prosthetic haeme groups, each containing one atom of ferrous iron [14]. A Hb molecule is able to bind 4 molecules of oxygen by means of its haeme groups. Thus more the haemoglobin molecules the red blood cells contain, more oxygen will be transported [15]. The brightness comparison method is the part of measurement; hence the red LED is used as the blood samples are red [13]. The red object reflects red light & absorbs the other. The human eye has three cones with peak color sensitivities at wavelength 580 nm-red, 540nm-green and 450nm-blue. Colorimetry is a physical science that deals with objective and quantitative ways of describing color [20]. Colorimetry tries to connect the notion of a standard color sample with the physical concept of light as a form of energy. The tristimulus theory allows to think of color as a positively weighted sum of the primary colors red, green and blue. It turns out that, large number of colors can be reproduced by mixing red, green and blue color lights with proper proportions [5-10]. It has been known since the inception of color science that ,object colors are determined not only by the spectral composition of the light reflected from them but also by the spectral composition and brightness of the light reflected from the objects [15].

The three CIE standard weights can be calculated by using following equations:

$$X = \sum_{380}^{780} R(\lambda)E(\lambda)\bar{x}d\lambda$$

$$Y = \sum_{380}^{780} R(\lambda)E(\lambda)\bar{y}d\lambda$$

$$Z = \sum_{380}^{780} R(\lambda)E(\lambda)\bar{z}d\lambda \quad .....(I)$$

Where R () is surface reflectance and E () is light source distribution. The weights X, Y and Z define a color in the CIE space $x + y + z = 1$, the result in a 2D space known as the CIE chromaticity diagram. The coordinates in this space are usually called x & y and they are derived from XYZ using following equations:

$$x = \frac{X}{X+Y+Z}$$

$$y = \frac{Y}{X+Y+Z}$$

$$z = \frac{Z}{X+Y+Z} \quad ....(II)$$

$$x + y + z = 1$$

$$i.e.z = 1 - x - y$$

Microcontroller:

The NanoEvery is Arduino's 5V compatible board in the smallest available form factor: 45x18mm.The Arduino Nano is preferred as it is a small, low price and easy to use microcontroller board.ATMEGA4809 chip with clock-20 MHz, Memory-6KB, Pinout-14 and USB, SPI, 12C, UART interfaces is used.

TEMT6000 Ambient Light Sensor:

It measures illuminance. The **Illuminance** is a measure of the total quantity of visible light emitted by a source. It is referred to as **luminous flux** and measured in **lumens (lm) per meter square**. The TEMT6000 is made up of a single **phototransistor**, which acts just like a simple **NPN transistor**. The greater is the incoming light on the Base, the more the current flowing from the Collector to the Emitter. The sensor works in the wide visible spectrum **(390–700 nm)**. It gives, near human eye response. The method of reflectance is used.

Experimental Work:

For the quick and accurate hemoglobin detection, as shown in the block diagram, Blood sample is taken on the strip. Red LED is used and the collimated light falls on the sample, Light gets reflected back and

sensed by the sensor (TEMT6000), which is silicon array NPN phototransistor, having peak sensitivity at 570 nm. This is wide band sensor in visible range. Output of the sensor is in the form of voltage. This output of voltage is given to the ARDUINO NANO EVERY (ATmega4809) Microchip. ATmega4809 is 8-bit microcontroller. This microcontroller is highly responsive command and control applications and expands the performance of real-time control systems. This MCU combines intelligent hardware peripherals and low power capacity of AVR core. This MCU has a high speed ADC and easy-to-Configure.

This output is divided into 1024 parts for conversion, for which, in-built ADC is used. Interpreting output voltage graphically, using linear interpolation method, the Hemoglobin values are calibrated and indicated in two decimal terms on OLED Display. The sensor is capable of taking number of readings in less time. The output is averaged over.

During the process, the $45^0/0^0$ CIE standard geometry is used through the method of reflection. The output sensed by the wideband color sensor is displayed with OLED in following Figure 1 and its Block diagram shown in Figure 2.
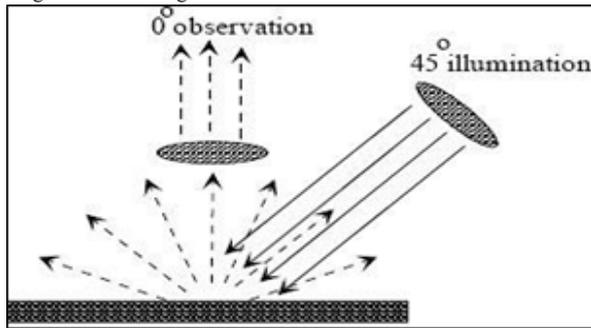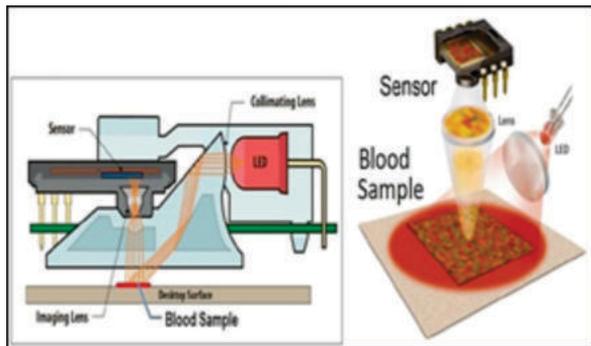

Figure 1: CIE standard Geometry of $45^0/0^0$

Figure 2: Block Diagram

The developed model of microcontroller based Haemoglobin meter is shown in Figure 3.
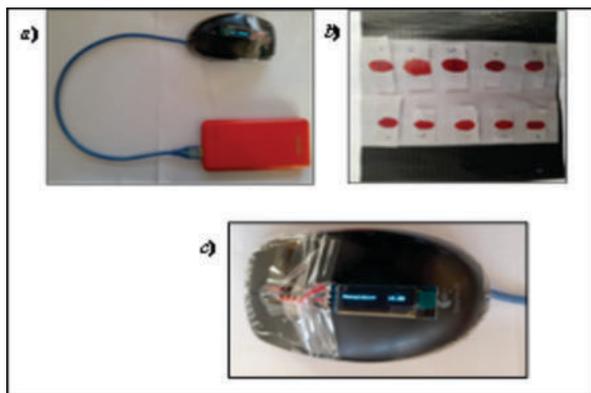

Figure 3: Developed Model Of Haemoglobin Meter Based On Microcontroller

The standard Hemoglobin measuring device HemoCue Hb 301 is used to compare the Hb reading of the blood samples is shown in Figure 4.

Figure 4: Standard Haemoglobin Measuring Device HemoCue Hb 301

The readings of Hemoglobin values of blood samples measured by our own designed device were recorded and then compared with the values obtained by HemoCue Hb 301 for the same blood samples is illustrated in following Table.

Table: Readings Of Hb Values Measured By Developed Haemoglobin Measuring Device And HemoCue Hb 301

Obs. No.	Hb Values measured using own device	Hb Values measured using HemoCue Hb301
1	9.2	9.1
2	10.6	10.0
3	13.7	13.9
4	11.5	11.4
5	10.1	10.0
6	9.4	9.2
7	6.9	6.9
8	9.3	9.2
9	11.2	11.2
10	11.9	11.8
11	5.3	5.3
12	9.80	9.7
13	11.1	11.1
14	9.6	9.5
15	10.3	10.3
16	12.6	12.0
17	10.7	10.5
18	12.0	11.8
19	11.3	11.0
20	12.5	12.3

RESULT AND DISCUSSION:
The readings of Hb are taken for the volunteers and observed to be in good agreement with the values taken by standard device.

The developed microcontroller-based haemoglobin meter is portable, cost effective and easy to use. This haemoglobin meter will help to take instant necessary Haemoglobin measures for the patient. This haemoglobin meter shows value of haemoglobin in decimal, on OLED Digital Display.

In the interior areas of Dahanu (Palghar), the lab-instruments are not accessible for the detection of anemic status and even the samples cannot be carried to the labs in the proper state. If this Handy, accurate and quick-detection Hemoglobin meter can be a part of the health kit of Aasha workers, due to this portable and handy device, sample can be diagnosed at the home of the patient and the workers can communicate with the doctors or experts and give the medicine immediately to the needy people, after communicating with the doctors. **Telemedicine** can be introduced and effectively used as the routine process, which will lead to the Healthy future.

W.H.O. approved HEMOCHECK haemoglobin color scale and HEMOCUE 301meter, are used for the result comparison.

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