International Conference on Latest Advancements & Future Trends In Engineering, Science & Management
Sambhram Institute of Technology, Bangalore (India)
03rd - 04th May 2019 www.conferenceworld.in
SAMBHRAM INSTITUTE OF TECHNOLOGY
ISBN : 978-93-87793-86-6

DETERMINATION OF BLOOD TYPE AND HAEMOGLOBIN CONTENT USING SENSORS

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ABSTARCT

Analysis of suitable blood type within a short period of time is important in blood transplantation and transfusion. The conventional method involves drawing of blood samples from patient andaddition of chemical. Ourproposed idea is a non-invasive method for identifying the blood group, haemoglobin level and blood sugar level. Light acts as a source for optical signals which is passed through the fingerand detector detects the varying voltage. Depending upon this, blood groups, haemoglobin content and blood sugar level are determined. The process is uncomplicated, convenient andeconomicalduring hospitality, emergencies, war fields and infants without human error.

Keywords-Non-invasive, Blood type, Haemoglobin, Blood sugar, optical signal

I. INTRODUCTION

Blood type identification is one of the key stages to safeguard blood transfusion. Blood type and level detection is most important and avital activity.

Haemoglobin level is an essential clinical factor for evaluating anaemia in both chronic and acute conditions, and is among the most commonly performed blood tests. If Hb concentration drops below normal, this is called anaemia. Anaemia is a disorder in which the Hb concentration in the blood drops below a defined level, resulting in an abridged oxygen-carrying capacity of red blood cells.

Diabetes is a common chronic disease in mostly all countries worldwide.Perceiving of blood sugar level is important to avoid complications of diabetic and damage to organs. The most commonly used method to measure blood sugar level in blood is an invasive method which is painful, expensive and danger in spreading infectious diseases.

Apart from the uneasiness of ejecting blood samples, the drawbacks aredelay between the blood collection and its analysis and non- standardized accuracy since it depends on the operator's capabilities and tiredness. Hence,

it is necessary to develop an automated system for blood group identification, haemoglobin content detection and blood sugar level detection.

A non-invasive method allows pain free constant on-line patient monitoring with minimum risk of infection and assists real time data monitoring allowing immediate clinical response to the calibrated data.

This non-invasive multi-spectral measurement method is based on radiation of near monochromatic light, emitted by light emitting diodes (LED) in the range of 940*nm*, through a region of skin on the finger. The point of this framework is to give the result inside the briefest conceivable time without the human mistakes using Near Infrared Sensors. The sensor embedded in this analysis is fully assimilated into a wearable finger clip and allows full wireless operation through on board miniature wireless enabled microcontroller. The detected blood group and the measured haemoglobin level, blood sugar level is displayed in LCD display and also transmitted to the android application which is created in the mobile phone to display and store data.

Individual Blood Groups are identified based on the Antigens are present on the surface of RBC. There are many categories of blood group. But, the main two types of blood groups are- ABO blood system and Rhesus blood system. Blood Groups are inherited and composed of RBC, WBC, Platelets, and Plasma. The determination of ABO Blood is dependent upon the inherited properties of RBC by the presence or absence of Antigen A and Antigen B which are expressed on the surface of Red Blood Cells.

The ABO blood system is the most important blood group system in human blood transfusion.Classification of blood group by the presence or absence of two antigens A and B on the surface of red blood cells:

- Group A which has only the A antigen on RBCs, the serum has anti-B lectin.
- Group B which has only the B antigen on RBCs, the serum has anti - A lectin.
- Group AB which has both A and B antigens on RBCs, have no anti-A and anti-B lectin hormone in serum.
- Group O whichhas neither Antigen A nor Antigen B in their RBCs, the serum has anti- A and anti B lectin.

Antigens are usually proteins and polysaccharides located on external surface of red blood cells having many epitopes of different specificities as shown in Figure 1.

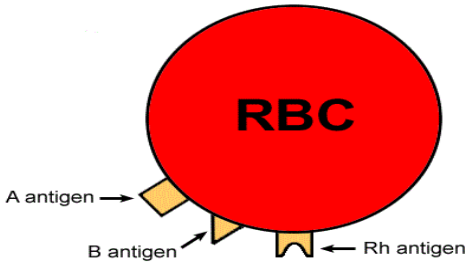

Figure 1. A red blood cell (RBC) with different antigens on the surface of its membrane.

The RBCswhich has antigen A can agglutinates with anti A lectin; anti B lectin can agglutinate with B antigen of red blood cells, based on this principle, ABO blood group identification can use red cell agglutination test, and then through the technique of system vision to govern blood type by whether the results obtained agglutination. Refer Fig 1 .The Rh framework (Rh meaning Rhesus) is the second most serious blood-assemble framework in human-blood transfusion.

Globins are a portion of the haeme-containing globular superfamily of proteins that are liable for binding and/or carrying O2 . Four types of globins have been discovered in humans, and they are myoglobin (Mb), neuroglobin (Ngb), cytoglobin (Cygb), and haemoglobin (Hb). Haemoglobin (Hb) , as shown in Fig.2 is a tetrameric haemoprotein that is positioned in red blood cells (RBCs) and is responsible for O2 transport in the circulatory system. It is a foremostelement in red blood cells (RBCs) with a molecular weight of 64.5 kDa. The chemical structure of Hb consists of two parts, an organic component and prosthetic groups. The organic components are termed globin or (protoporphyrin) which are made up of four pyrrole rings linked by methane bridges to form a tetrapyrrole ring and four methyl, two vinyl groups and two propionate side chains are attached to the ring. The bound prosthetic groups which are also called the (haeme or iron groups) are crucial for fast binding of O2 in the lungs and transport it to the tissues in alterable manner. The Chemical structure of haeme complex in Hb is given in Figure 1.2. Moreover, the haeme group gives the characteristic colour to muscle and blood.

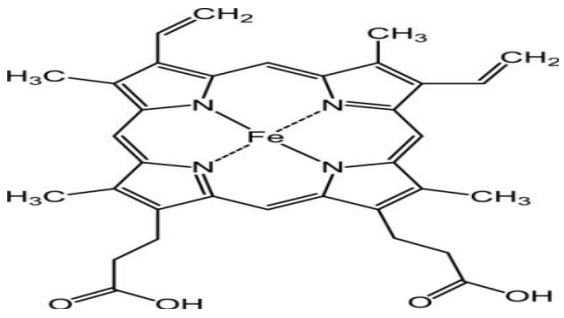

Figure 2 Chemical structure of haeme complex in Hb

Diabetes is a type of metabolic ailment in which the blood sugar level in human body rises drastically from its normal level. The rise in sugar level is due to scarce production of insulin in blood cells or can be because of inappropriatereaction of body cells to the insulin or can be because of both the reasons quantity of insulin adequately required to maintain normal level of blood sugar. When a light ray passes through biological tissues, it is both absorbed and disseminated by the tissues. Light scattering occurs in biological tissues due to the mismatch between the refraction index of extracellular fluid and the membranes of the cells.

Dissimilarity in blood sugar level in blood affects the intensity of light disseminated as shown in Figure 3 from the tissue and this method is used in the judgement of the blood sugar level using Near Infrared Sensor.

ISBN : 978-93-87793-86-6

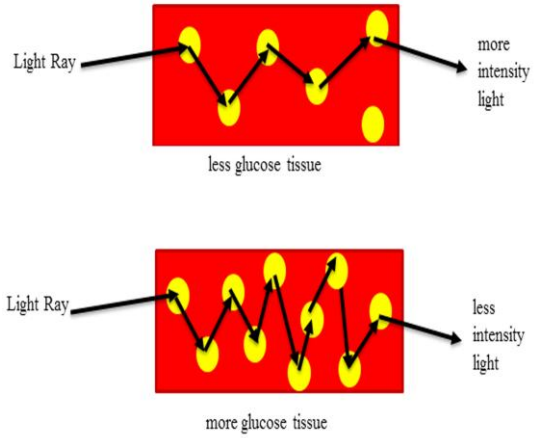

Figure 3 Effect of Glucose On light Path

The objective of the work is to decide the blood group of a person swiftly using the kit which should be handy, relatively low-priced, environmentally gentle and long-lasting in addition to the attributes of safety, eco-friendly, quick result, flexibility, economy, in-vitro.

Many scholars in the past have presented different methods for measurement of Hb concentration non-invasively. Most of these methods determine the Hb content using calibration which involves invasive blood testing via chemical methods and the non-invasive sensor designed measures the absorbance levels at the same instance. Defective calibration can lead to inaccurateoutcomes.

Many scholars have introduced different methods for measurement of blood sugar level non-invasively, like spectroscopy, Fluorescence based method, Reverse iontophoresis etc,. Nevertheless, experiments have only been performed in vitro and not on human subjects.

Blood group detection using fibre optics proposed by T.M. Selvakumari. In this method, the transmitter is used to generate pulses of frequency 10KHZ.Then these pulses are fed to the Light Emitting Diode [LED], which converts electrical variations into optical variations. Due to the optical variations of diverse blood group, there will be corresponding voltage variation in the output of the photo detector. Thereby the blood groups (ABO) can be determined without using the antigen.

A Novel Approach in Identification of Blood Group Using Laser Technology by Priyadharshini. R. This is centred on the principle, that the LASER intensity changes due to the happening of clumping in the blood sample which in turn changes the concentration of the blood sample. This variation is detected by the level of the energization of the photocell. The output from the detector is in the form of voltage which is fed to the comparator which chooses the blood group using embedded controller.

Haemoglobin level measurement using Photoplethysmography Technique. This method uses Kalman filter to remove the artifacts or any sort of distortion or effect of noise. The Kalman filter uses State Space Representation for estimating the signals filled with noise. The filter designing in this method is complex.

Spectroscopic techniques have been used for non-invasive methods of blood glucose measurement, including near-infrared spectroscopy (NIR), Raman spectroscopy, bio-impedance spectroscopy (BIA), and thermal emission spectroscopy. NIR uses infrared to capture reflected light from body tissue, suggesting a level of blood glucose. Fluorescence-based methods for the determination of blood glucose levels are used to assess a diversity of chemicals extracted from the human body all through the measurement and taxonomy process.

II. SYSTEM DESIGN

2.1METHODOLOGY

Progress of a non-invasive calibrationmethods would be a godsend for the people. The major benefit of non-invasive calibration methods is the relief from pain and ease due to no finger piercing and also reduces the cost of healthcare. Itpermits pain free continuous on-line patient monitoring with least risk of contamination and enables real time data monitoring allowing immediate clinical reaction to the calibrated data. Ever since the near infrared light was found to penetrate to anexcessive depth into biological tissues, near-infrared spectroscopy has been developed into a non-invasive method for biomedical sensing and clinical diagnosis. The absorption of whole blood in the visible and near infrared range is dominated by the different haemoglobin derivatives and the blood plasma that comprises mainly of water. It is acknowledged that pulsatile changes of blood volume in tissue can be observed by calibrating the transmission or reflection of light via the blood sample.

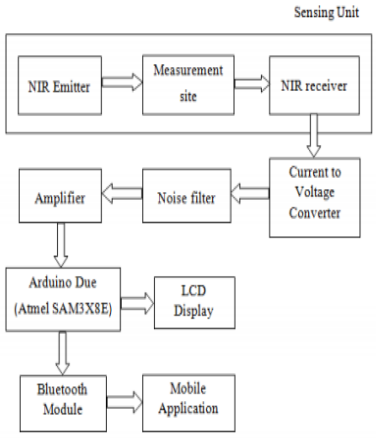

Fig 4 Block Diagram of the Proposed model

\The proposed work as shown in Fig 4 is based on NIR optical technique. NIR light source of 940 nm wavelength is chosen because it is suitable for measuring blood type. The sensing unit consists of NIR emitter and NIR receiver (photodetector) positioned on either side of the measurement site (fingertip).

When the NIR light is propagated through the fingertip in which it interacts with the blood, a part of NIR light gets absorbed by the blood and remaining part is passed through the finger-tip. Refer Fig 5. The transmitted signal is detected by the photodetector.

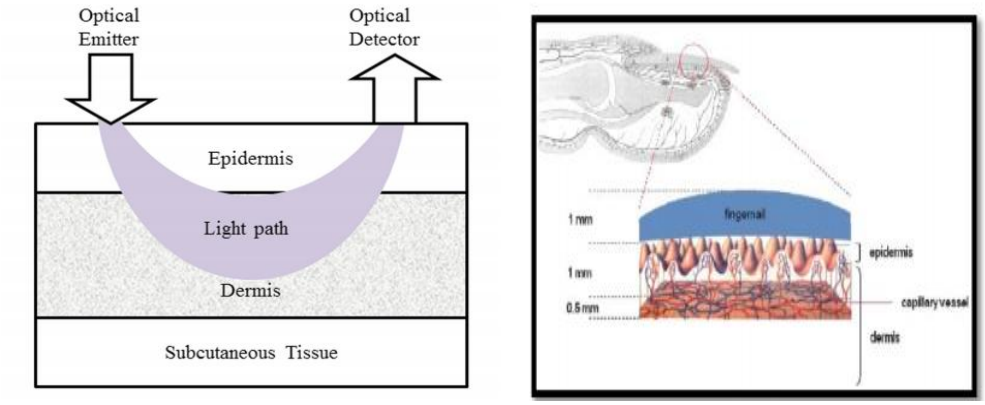

Fig 5Cross section of skin and light path

The output current of the photo detector is converted into voltage signal and then it is filtered and amplified. This amplified signal is fed into Atmel SAM3X8E microcontroller. The inbuilt ADC block is used for converting the received analog signal to digital form. This digital signal is processed by using second order regression analysis to predict the blood type and the hemoglobin level and the same is displayed on the LCD display.

Fig. 6 shows the flow diagram of the working module.

The Table 1 gives the blood groups and its corresponding voltage values.

Table 1: Blood groups voltage levels

Blood Groups	Voltage Levels
A	0.56-0.58
B	0.59-0.60
O	0.53-0.55
AB	0.61-0.62

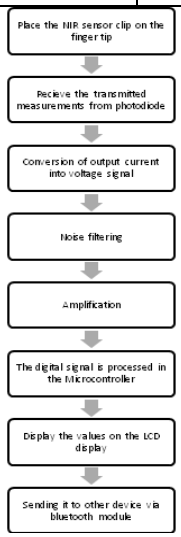

Fig 6: Flow Diagram showing the Working of the Module

2.2 WORKING

1. Once the sensor is kept on the finger, the flow is detected and it triggers the IR source that is Near Infrared.
2. IR source generates some kind of algorithm approximations depending on the voltage and current levels in the body.
3. When we pass it from our nail and test then it measures the photodiode strength and it receives the transmitted light from the measurement side.
4. We are placing transmitter above our nail and receiver on the other side, it produces voltage and current values.
5. As this is a disadvantage we add noise filter which amplifies the output.
6. Then the converted output current is amplified, the output current then determines the haemoglobin level the blood type and the Sugar level.
7. The values are displayed on the LCD display.

2.3 COMPONENTS

2.3.1 LED

A light-emitting diode is a two- lead semiconductor light source which has a p–n junction diode that emits light when energised. When a current is applied to the leads, electrons recombine with electron holes, which release in the form of photons. This effect is called electroluminescence; the energy band gap of the semiconductor decides the colour of the light. LEDs are less than 1 mm in size and integrated optical mechanisms may be used to shape the radiation.

2.3.2 NODE MCU

NodeMCU is an open source development board based on ESP8266 Wi-Fi module. The board unites General Purpose Input Output (GPIO), Inter Integrated Circuit (IIC), ADC (Analog to Digital Converter). Its firmware runs on ESP8266 Wi-Fi Soc from Espressif Systems. The NodeMCU has 128 kB of memory. The scripting language is easy and a solid developer community exists. The board uses a micro USB port for power and communication with PC making it very stress-free to use. It can be easily power-driven by a power bank using a USB to micro USB port. NodeMCU has been chosen over the other microcontrollers due to its ease of use and due to existence of an in-built Wi-Fi module.

2.3.3ARDUINO

The Arduino Integrated Development Environment is the tool that is used to write and upload code to unlike Arduino boards. The Arduino IDE contains many built-in libraries that contain essential functions that make programming at ease. Arduino also has a great community environment which makes it expedient to fix errors and overcome problems. The NodeMCU can also be programmed using Arduino IDE by setting up the libraries required and choosing ESP8266 NodeMCU in the Board Manager Option. Arduino board designs use a range of microprocessors andcontrollers. The boards are armed with sets of digital and analog input/output (I/O) pins that may be interfaced to various extension boards or Breadboards (shields) and other circuits. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. Our

suggested idea is to determine the blood group non invasively using LED. The Arduino we are using for our project is ATMEGA3289 and ESP8266, NodeMCU pinout v3.0.

2.3.4NIR SENSOR

NIR light source of 940 nm wavelength is chosen because it is suitable. The sensing unit consists of NIR emitter and NIR receiver (photodetector) positioned on either side of the measurement site (fingertip). When the NIR light is propagated through the fingertip in which it interacts with the blood, a part of NIR light gets absorbed and the remaining part is passed through the fingertip.

2.3.5VOLTAGE TO CURRENT CONVERTER

The transmitted signal is detected by the photodetector. The output current of the photo detector is converted into voltage signal.

III IMPLEMENTATION AND RESULTS

The modules for detecting the blood type, haemoglobin content and glucose level are made and the results are verified with the actual blood type and the values. The obtained output values are displayed on the LCD display.

The Table 2 shows the accuracy and discrepancy obtained while detecting the blood group.

The Table 3 shows the variation of haemoglobin content with respect to gender, age and also the difference in values obtained in invasive and non-invasive method.

The Table 4 shows the tabulated values of blood sugar levels obtained from different people using non- invasive method.

Table 2 Blood Type Detection

Blood group	Sample numbers	Accuratenes	Divergence	Rate of Success(%)
A	15	13	4	86
B	13	9	5	69
O	12	11	1	91
AB	9	5	4	55

Table 3Haemoglobin level detection

Serial No.	Gender	Age	Invasive Hb (g/dl)	Non-Invasive Hb (g/dl)	Differ by
1	Female	50	14.1	12.91	1.19
2	Female	22	11.1	12.5	1.1
3	Male	22	13.9	13.61	0.3
4	Male	21	14.3	13.96	0.34
5	Female	45	11.5	11.27	0.23
6	Male	55	15.5	14.67	0.8

ISBN : 978-93-87793-86-6

Table 4 Blood Sugar Level Detection

SERIAL NO.	GLUCOSE VALUE DETECTED (mg/dl)	SERIAL NO.	GLUCOSE VALUE DETECTED (mg/dl)
1.	85	6.	215
2.	90	7.	113
3.	115	8.	105
4.	110	9.	98
5.	120	10.	65

IV. CONCLUSION AND FUTURE SCOPE

Currently, skilledspecialists do calibration of blood type, haemoglobin content and blood sugar level via chemical approaches in clinical test centres, which involves pricking one's finger to acquire a sample of blood. This can be circumvented using the blood type detection using Near Infrared Sensors as specified in this paper.

In this paper, a portable device by means of a novel non-invasive method of determining blood type, calibrating haemoglobin concentration and blood sugar level is anticipated. Existing non-invasive models encompasses calibration of the system, which may lead to meticulousness errors each time the system is calibrated.

The approach presented in this work, based on Near Infrared Sensors, consents determining safely, the blood type, haemoglobin and blood sugar level of a patient within a short time devoid of the compulsion of taking blood samples, in this mannereradicating the pain of being wedged with a needle. The procedure is advantageous in emergency situations, blood transfusions, etc. as it prominentlycondenses the time and difficulty of manually.

The error in blood typing is due to the integumentary issues such as thickness of the epidermal layer. The error can also be due to perspiration by the sebaceous glands. Thus, in future, a device or sensor could be designed to consider and overcome the above mentioned factors.

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