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Review of Point of Care Device for Anemia Detection

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ABSTRACT

Our project is meant to support medical research within the detection of anemia through a point of care device. A disorder in which there aren't enough healthy red blood cells in the blood. The absence of red cells or the presence of dysfunctional red blood corpuscle in the body causes it. As a result, oxygen supply to the body's organs is decreased. It's a condition characterized by light oxygen delivery to cells and tissues among the body and it affects roughly quite ten million cases p.a. in India. Causes of anemia are attributed to malnutrition, low glycoprotein production, nephrosis, and sorts of cancer. Current tests for anemia involve invasive blood sampling and expensive diagnostic procedures to provide results. The invention of a non-invasive portable hematocrit sensing element to help in anaemia diagnosis at the point of care has advanced anaemia identification and treatment. Using the variance of absorption of IR and red light of oxygenated Hb (HbO2) and deoxygenated hemoglobin (Hb) a portable sensing element was designed and created to see oxygen saturation – the foremost reliable technique of anemia detection.

1. Introduction

Anemia is caused due to depleted delivery of chemical elements to cells and tissues within the body. Anemia is caused because of inadequate red blood cells [RBC]. The most frequent cause of anaemia is iron deficiency. The body needs iron to produce haemoglobin Hb is an iron-based macromolecule that gives blood its red color. Blood loss, a lack of red blood cell formation, and a high incidence of red blood cell breakdown are the three primary causes of anaemia. Heavy cycles, pregnancy, ulcers, colon polyps or carcinoma, heritable disorders, and other conditions can cause anaemia. Blood disorders such as RBC anaemia, Mediterranean anaemia, or cancer may all be caused by a diet lacking in iron vitamin Bc B-complex vitamin. Anemia will cause you to feel tired, cold, dizzy and irritable, in need of breath, or have headaches, multiplied risk of morbidity, weakness, fatigue, and giddiness. Because of the lack of access to medical and diagnostic facilities in many developed countries with high rates of deficiency disease, the use of treatment instruments for detecting anaemia will help to speed up diagnosis. The World Health Organization defines anaemia as a condition in which red blood cells or their oxygen-carrying capabilities are inadequate to satisfy psychological requirements.4.62 billion people, or 24.8 percent of the population. Preschool-aged children have the highest prevalence, while men have the lowest prevalence 32.9 percent of the population suffering from anaemia. Children under the age of five, especially infants and children under the age of two, are the most susceptible to anaemia. Pregnant mothers and the WRA Females have a higher incidence of anaemia than males in nearly all regional areas and in almost all age ranges. The elderly are among those at risk, as the prevalence of anaemia in people over 50 years of age grows with age. According to recent estimates According to the Medical

Community, the worldwide prevalence of anaemia is estimated to be 24.8 percent, affecting 1.6 to 1.6 billion people. Out of a total of 293 million preschoolers, anaemia is estimated to affect 47.4% of preschool-aged children, 41.8 percent of pregnant mothers, and 30.2 percent of non-pregnant women. The teenager's 56 million pregnant women and 468 million non-pregnant women are affected W. H. Organization., 1-6 2011. The World Health Organization predicted that about 30% of the world's population was animate in 1992; in 2008, the WHO reported that 24.8 percent of the world's population was animate, including 42 percent of pregnant women, 30 percent of non-pregnant adults, and 47 percent of preschool children.

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In 1992, the Health Organization estimated that about 30% of the world's population was animate; in 2008, the World Health Organization estimated that 24.8 percent of the world's population was animate, with 42 percent of pregnant women, 30 percent of non-pregnant women, and 47 percent of preschool children; and most recently, anaemia afflicted 24.8 percent of the world's population. Pregnant women had a prevalence of 29%, non-pregnant women had a prevalence of 38%, and children had a prevalence of 43%, with declines in each group after 1995, L. Gotloib., vol. 19, no. 2, pp. 161-167, 2006.. In Africa, there are a number of cases where anaemia is prevalent. Asia, America, and Europe, Western Pacific, the Eastern Mediterranean, and the WHO areas are all part of the Western Pacific. Anemia-prone areas in Africa, Southeast Asia, America, and Europe Pregnancy conditions are the most serious effects in the Western Pacific, Eastern Mediterranean, and WHO countries. Extreme malnutrition and diseases such as nutrition quality and gastrointestinal disorders, as well as certain diseases like colon cancers and other anemia-related conditions, lead to severe malnutrition and diseases such as nutrition quality and gastrointestinal disorders, especially in developing countries. Cancer and sickle cell anaemia treatments For detection of anemia includes the collection of blood samples and subsequent lab-based testing of hemoglobin concentration hematocrit volume and complete blood count this procedure requires the diagnostic to enhance the practicality of the point-of-care device in developing countries, there exists a desire for enhancements within the sensor's style. These procedures need access to diagnostic facilities and might be heavily pricey to try to deal with these areas of technical enhancements, an Associate in nursing optical attenuation-based hematocrit sensing element was designed and preliminary testing was performed. Light-emitting diode and IR light sources and detectors were enforced into the planning to facilitate a non-invasive mensuration modality through interactions between oxygenated and deoxygenated Hb and therefore the specific wavelengths of light. The sensing element was embedded among a custom finger mount connected to a microcontroller. . Bluetooth was used in the design to enable data to be sent wirelessly to accommodate for clinical use in circumstances where there is limited access to electronics and technology. A display screen is currently being developed for the device. This paper will present the sensing methodology utilized in the design of the point of care hematocrit sensing element, the sensing element style, preliminary testing results, and known areas of improvement.

In Paper an Instantaneous low cost point of care anemia detection device, according to the author Tiny, lightweight, and portable unit for rapid early diagnosis of anaemia at the point of treatment. The method relies on calculating hematocrit directly from blood samples. The machine is made up of custom electronic instrumentation and a plug-and-play disposable detector. Anemia is a disease in which the body's supply of red blood cells (RBCs) is inadequate to carry adequate oxygen. Anemia affects about 2 billion individuals, or 30% of the world's population. In most countries around the world, a high hematocrit level is a requirement for potential blood donors. Access to such devices is very difficult in developed countries due to a variety of reasons. In most countries, single blood donors are a unit that requires a complete blood count before being considered for a donation. Pradhan *et al.,* used blood vessel tubing and a system within the right atrium to provide constant in-vivo hematocrit tracking. Pradhan *et al.,* on the other hand, used organic synthesis, electric resistance, and chemical processing to study the properties of blood and its elements (EIS). This thesis represents a step forward in the preceding work. It's a lightweight, low-cost, and compact point-of-care device for rapidly determining hematocrit in blood samples. The machine comprises of a plug-and-play disposable industrial detector and an associated economical and reusable inexpensive unit. It employs a Frequency Response Analyzer (FRA) assisted by Digital Lock-In electronic equipment (DLIA).

A basic cellular electrical model for dilute cell suspensions is often defined using a network of passive electrical components. In response to the electrical stimulus, the current flow through which we tend to perform (ICELL) will flow through the corresponding external cellular path (RE) or across the cell wall (RM).The intracellular medium (RI) would be passed along this flow path on its way to the cell's internal membrane This is the sum of consistency in a whole blood drop that can be easily monitored by clinical laboratory technicians using normal clinical laboratory equipment. The detector electrodes may be made of gold, a well-known biocompatible mineral. The AC1 detector from BVT Technologies (Brno, Czech Republic) and the Bio-Logic SAS G-AUG detector series are among the industrial sensors that have been tested. In 4-mL tubes containing ethylene diamine tetra acetic acid (EDTA 7.2 mg from baccalaureate Vacutainer, four blood samples were drawn from four randomly hospitalized patients in the Hospital Clinic (Franklin Lakes, NJ, USA). A whole blood count (CBC) of the twain is performed using an ABX Micros sixty medication analyzer. Hematocrit is calculated using the Hb, erythrocyte range, and erythrocyte volume measurements. A full custom electronic circuit was designed to carry out measurements using a disposable three-electrode C223AT detector. An associate generator, detector driving instrumentation, and an rms-to-dc converter are the three parts of the device.

The unit was tested with fifty blood samples to see how it could provide accurate, solid results using disposable industrial sensors. The characteristics are beneficial to anemia-risk patients, including pregnant women, newborns, medical specialty patients, and the elderly. Low manufacturing costs and readily available value are essential benefits, especially in impoverished areas where the health realm is undervalued. In terms of application skillfulness, the device is inept as opposed to other apps. Commercial instruments, such as a hematocrit scanner at the point of treatment, a telemedicine monitor, or a controller for various clinical actuators. The method was tested by comparing it to a full blood count (CBC). The detector unit has a 0.96 Pearson's correlation and a hematocrit constant of 92.72 percent. With a worst-case precision of 2.83 percent, the coefficient of heterogeneity is less than 5%.

In Paper [2] Diagnostic of point of care devices for detection of anemia in community settings in India, The aim of the research, according to the author, In community settings, the diagnostic precision of point-of-care instruments for anaemia diagnosis. HemoCue, True Hb, Massimo's device, and spectroscopic device were the index samples. The measurement of haemoglobin (Hb) is the foundation for diagnosing anaemia. In resource-poor environments, a tool for use in communities or primary care facilities should be inexpensive, fast, and simple to use with reasonable precision. Identification of anaemia remains the mainstay for additional management in the national Anemia Mukt India (Anemia Free India) scheme. The aim is to assess the diagnostic accuracy of the instruments for haemoglobin activity and to choose the most appropriate device for use in the software. The secondary goals were to determine the degree of consensus in the classification of anaemic patients mistreating the devices that were shown to be more effective, as well as to evaluate the effectiveness of the devices in a variety of climates.

In two stages, the research was tedious. The first was a cross-sectional analysis of diagnosis precision performed in field observation areas of tertiary care hospitals in India. The accuracy of devices was tested in a variety of climates in the second segment. The data for the analysis was collected between August 2018 and March 2019. Both adult patients who visited the patient clinics of urban or rural health centers were included in the research. Pregnant women, infants, chronically ill patients, and those with a demonstrated proclivity for harm were all omitted for moral reasons. But for the comparison measure, two index exams were performed on each patient (one invasive and the other non-invasive). Blood samples for the index and comparative measurements were taken in the same session. Frontline workers documented their information on paper forms, which were then submitted to inspectors on a weekly basis. Each source's information was balanced, backed up by the unique number assigned to each research participant, and united with the most knowledge. For study, the data was exported to STATA SE eleven and SPSS version nineteen.0. The Gold standard was used to compare all of the index tests.

The research participants were divided into four categories: no anaemia (Hb 11.0 g/dl), mild anaemic, moderate anaemia, and extreme anaemia. The aim of this classification was to identify patients who would benefit from therapy. The degree of agreement between the technicians (venous) and ANMs (capillary) was determined for the instruments that were found to be right. In a very similar classroom, all members of the research team were educated in the information collection process and computer function. The findings of the index examination have little bearing on the care of patients, and were backed up by the results of the comparison examination. Any qualifying patient gave their written consent. Apart from the research team, no one else had access to the data gathered. TrueHb and HemoCue did better in the field than Masimo's system and AJO chemical analysis instruments. HemoHb was preferred for anaemia diagnosis over TrueHb, but TrueHB outperformed all other instruments, including HemoCue, for serious anaemia. In harsh weather conditions, both TrueH b and HemiCue overestimated haemoglobin.

In Paper Point-of-Care Testing for Anaemia in Children Using Portable Haematocrit Meter: A Pilot Study from Southwest Nigeria and Implications for Developing Countries, the author says, Anaemia could be a widespread public ill health that's extremely current among youngsters and pregnant ladies. It's calculable that regarding three hundred million youngsters have anaemia worldwide and most of them are in developing countries. Chronic anaemia negatively impacts a child's psychological features, growth and development, faculty performance, ability to fight infection and skill to measure a productive adult life. The presence of anaemia in youngsters could result in outright mortality if severe and not promptly detected or treated. it's been attributed to the high prevalence of protozoal infection, dietary inadequacies, infestation, microorganism infections, erythrocyte diseases, Human immunological disorder viral infection. These devices are moveable, simple to use, need nominal laboratory procedures and provides immediate results. The Mindray BC-3600 automotive vehicle medicine instrument was used because of the gold normal during this study. The findings of the study might facilitate raising awareness regarding whether or not such devices offer correct leads to the medical specialty population. Hematology analyzers are the gold standard for accurately calculating hemoprotein or haematocrit in order to diagnose anaemia. Many health services in resource-constrained areas are unable to provide them. This study looked at the agreement between a point-of-care unit and a surgical specialist instrument. The Altman method is used to assess the agreement between the two sets of measurements after mistreatment of the tasteless. It may be used as a level of care device for assessing haemAtocrit in resource-poor settings where analyzers are scarce, according to the authors. Anaemia may be a common public health problem linked to a bad prognosis. Anemia affects about 300 million children worldwide. The most of them are in developed nations.

In Paper Point-of-care estimation of haemoglobin concentration in neonates and infants, According to the author, point-of-care testing (POCT) or near-patient testing is the fastest growing laboratory method in the developing world. Laboratories have become more interested in promoting research outside of traditional laboratory environments in order to increase the quality and efficacy of medical care, It has been used in a variety of settings, including clinics, first assistance stations, newborn units, and urinary organ chemical research centers, as well as patient departments. The most basic and important screening check is done in hospitals and it is the most widespread and plays a crucial role in POCT. HemoCue may be a point-of-care hemoprotein concentration (Hb) measurement device. We always contrast the HemoCue's analytical efficiency with that of the Advia a hundred and twenty machine-driven medicine analyzer. Of instrument analysed samples from forty-four patients and the findings

were compared to mistreatment differentiation plots. The hemoglobinometer's diagnostic performance in neonates and babies was comparable to that of the Adva120. The inaccuracy was within fair limits, and the disparity in prejudice between the two methods was minor. The levels of haemoglob in ranged from four.8 to twenty g/dl. The HemoCue is a portable haemoglobinometer that was first used in clinical settings almost two decades ago. It enables Hb determination in a short amount of time with a limited sample number. A short sample is the most common error made when calculating Hb, since most analyzers need a minimum sample volume of 500 l. The HemoCue was correct over a wide Hb spectrum, accurately reflecting the big Hb zero in the first six months of life. It's a battery-operated gadget, perhaps reversible battery-operated, that can be extremely useful.

Methods and Methodology:

1) **Proposed Algorithm**

These are some of the algorithms proposed for the detection of anemia. We have classified into 2 main streams. One using Machine learning and the other using Deep learning technique. Under machine learning there are many proposed algorithms such as random forest algorithm, decision tree algorithm, naive-bayes algorithm, vote algorithm, Knn algorithm, mlp etc. (fig 1). We have considered a few of them for our comparison studies. Deep learning image segmentation algorithm is considered as the best and it does involve much steps.

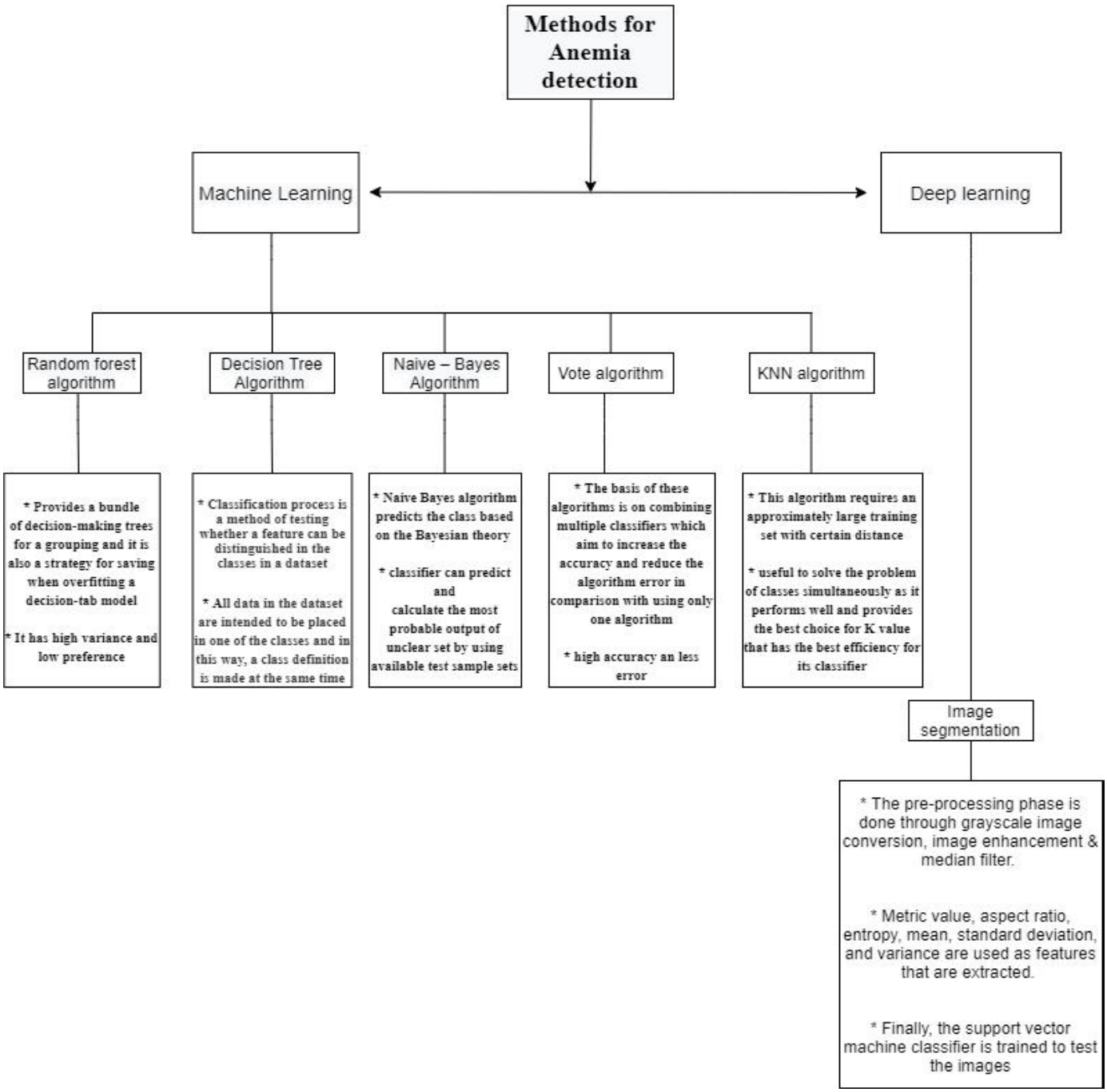

Fig1: Different algorithm used for anemia detection

According to all offered information, the accuracy may be thought to be the premise to check the algorithms and to the diagnose IDA, β-thalassemia attribute and α-thalassemia attribute (cis and trans) and select the foremost efficient model. to research all the options with planned algorithms, the vote the most effective had the simplest accuracy of 96.343 and conjointly the lowest mean absolute error rate of 0.0183. In Fig. 2 M and a pair of the comparison of the accuracy and mean absolute error of algorithms (fig 3) mistreatment all options square measure shown individually.

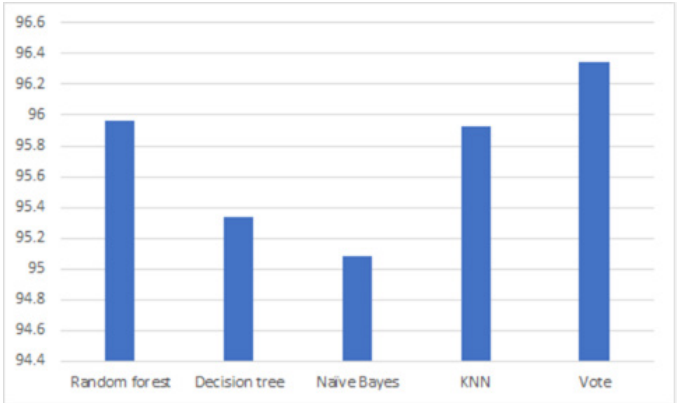

Fig2: The Comparison of the Accuracy of the Algorithms with all the Features

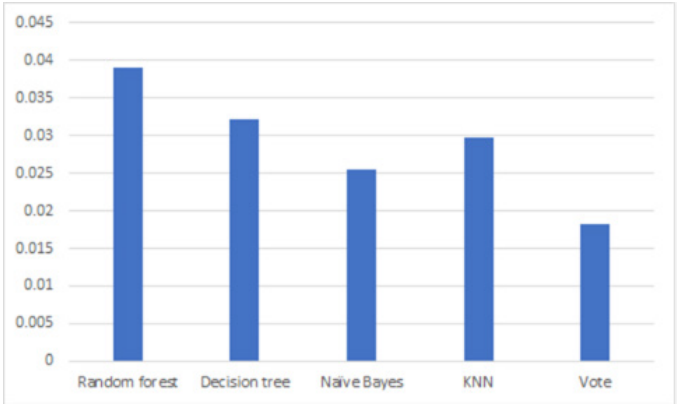

Fig3: The Comparison of the mean absolute error of the Algorithms with all the Feature

2) **Methodology**

A portable hematocrit device was developed based on activity the variance in absorbance of light-emitting diode and IR light through blood by measurement the attenuation of signals through the proper index finger. By analysis of the quantitative relation of led and IR signals, hematocrit and blood activity can be determined. To contain the light-emitting diode and IR lights and also the associated detectors (Fig 4), a finger clamp was designed and 3D printed exploitation ABS material. This finger clamp is adjustable to accommodate a range of finger sizes to boost the functionality of the device. As this device was designed as associate degree initial proof of construct, further designs can involve desegregation the electronics and microcontroller into the finger clamp to produce a complete measure system. IR and light-emitting diode light is transmitted from the supply, through the inserted finger – wherever it interacts with and is absorbed by hemoglobin and HbO_2 molecules, and also the attenuated signal is received by IR and red photodiodes. The detected signals are then transmitted to a microcontroller (Smraza UNO R3 Board ATMEGA328P) for signal processing. A custom code was developed to convert these signals into IR and red lightweight values that are displayed to the user. The values are then compared using the subsequent formulae: AR = log (I0/I) Using this formula to see the absorbance of the light, a quantitative relation between the red absorbance and IR absorbance may be measured knowing the far-famed wavelength of both sources before attenuation. This quantitative relation is then correlative to a far-famed hematocrit level and is used to see the relative quantitative relation of oxygenated and deoxygenated Hb in the blood – indicating the oxygen saturation of the blood. From the oxygen saturation, anemia could be detected in people exploiting the system in a very portable and non-invasive manner.

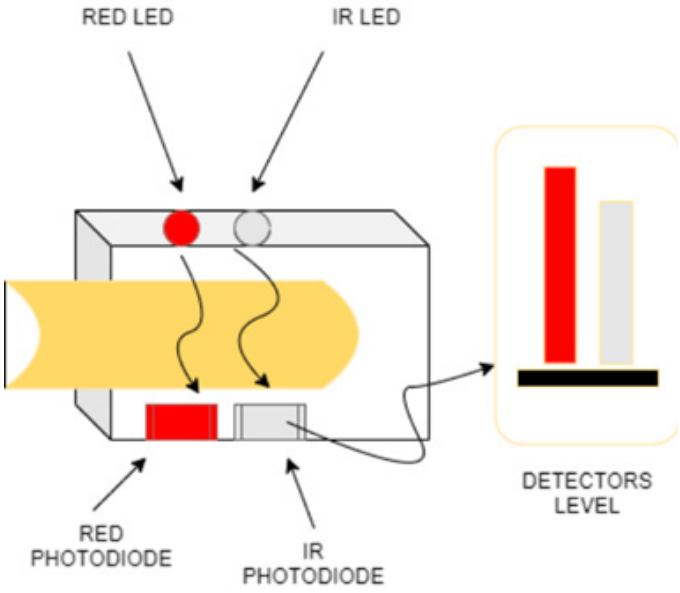

Fig 4: Operation principle using IR and Red Light

Conclusion

As lack of saturated hemoglobin, hypoxemia can be detected. Knowing a personal has hypoxemia will enable quick diagnosing for health conditions, like anemia, moving forward, a non-invasive methodology for detective work iron is explored and integrated into the present design. This can alter correct detection of anemia while not the requirement of blood sampling. Other areas of improvement embody app development, size reduction of the circuit board, and correlation of results with blood iron and protein levels. With these enhancements, the technology has the flexibility to scale back the cost, ability and time needed to discover iron deficiency anemia round the world.

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