A Novel Non Invasive Approach for Jaundice Detection and Photo Therapy System

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ABSTRACT

Jaundice is a significant condition in new born that leads to yellowing of the skin and eyes due to elevated bilirubin levels. While various underlying conditions can contribute to this issue, it typically arises from the underdeveloped liver function of infants. In the past five years, 60% of new born experienced jaundice, resulting in a yellow tint to their skin and eyes. Thanks to improved screening and management practices, the proportion of affected infants with severe jaundice requiring treatment has dropped by approximately 20% over the last five years. This condition generally occurs as the infant's liver matures and starts processing bilirubin more efficiently. This study introduces and validates a non-invasive device known as the "Golden Hue Detector" for the identification of neonatal jaundice. Infants often experience jaundice, a condition that requires prompt and precise diagnosis to prevent complications such as kernicterus. Conventional methods of detecting jaundice rely on blood tests, which can be stressful for babies and demanding on healthcare resources. These conventional approaches often necessitate multiple blood samples, raising the risk of infection and causing significant distress to the infants.

Keywords—TCS3200 Sensor, Node MCU, RGB value.

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1. Introduction

Approximately 60% of full-term and 80% of premature infants globally experience neonatal jaundice, a frequent condition characterized by a yellowing of the skin and eyes due to elevated bilirubin levels. While severe jaundice is often benign, it can lead to significant complications such as kernicterus and acute bilirubin encephalopathy, which may result in irreversible brain damage. Therefore, early and accurate detection of jaundice is crucial to ensure timely treatment and prevent adverse outcomes. Traditional methods of diagnosing jaundice typically involve blood tests to measure serum bilirubin levels. Although these methods are reliable, the need for repeated blood samples poses risks of infection and discomfort, which can be distressing for newborns. Additionally, routine blood testing can be demanding in terms of resources, leading to challenges in healthcare environments, regardless of their resource availability.

Recent advancements in medical technology have enabled non-invasive techniques for detecting jaundice. Non-invasive techniques offer notable advantages, including lower infection risk, decreased discomfort, and the opportunity for fast, cost-effective, and extensive screening. Among these inventive solutions, the development of portable electronic devices and optical sensors has shown promise in accurately assessing bilirubin levels by analyzing skin discoloration. This study introduces the "Golden Hue Detector," an innovative non-invasive device designed to detect jaundice in infants. The device measures bilirubin levels by analyzing the wavelength and intensity of light that reflects off the skin with Node MCU-based optical sensors. The aim of merging advanced optical technology with a user-friendly interface is to provide healthcare providers with a reliable, efficient, and readily available instrument.

The Golden Hue Detector was subjected to thorough testing to evaluate its accuracy and reliability when compared to standard serum bilirubin measurements. The device's capability as a viable alternative to laboratory-based testing for jaundice screening is emphasized through initial findings that indicate a robust correlation between the device's metrics and those assessments. The Golden Hue Detector is a diagnostic instrument designed to enhance the early detection and treatment of neonatal jaundice by addressing the limitations of current methods. This introduction addresses the necessity for non-invasive jaundice detection, the technology behind the Golden Hue Detector, and the implications of its application in clinical environments. The subsequent sections of this paper will elaborate on the design of the device, the testing methods employed, the results obtained, and the potential impacts on neonatal care.

Also encouraging for improving neonatal care in low-resource settings with the Golden Hue Detector. Due to its affordability and accessibility, even resource-limited healthcare facilities can utilize it, potentially reducing the occurrence of severe jaundice and associated issues. The device can enhance newborn health results by facilitating the early identification and treatment of jaundice, particularly in regions with elevated newborn morbidity and mortality rates.**Literature Survey**

Md. Messal Monem Miah et al. introduces a non-invasive imaging technique for quantifying bilirubin levels in human blood. The technique assesses the sclera's yellowness to determine the bilirubin concentration. In contrast to the conventional method, the non-invasive technique can swiftly and precisely detect a jaundice issue while minimizing discomfort. The method outlined in this document, however, is mainly suited for adults.

Ahmad Yaseen Abdulrazzak.et.al indicates that an algorithm-based computer vision system is utilized to identify jaundice or hyperbilirubinemia. The setup features an Arduino Uno serving as the microcontroller to operate an LED UV light, a digital HD camera, and a computer equipped with a MATLAB application for analyzing and detecting variations in the infant's skin color. For training the algorithm, a collection of neonate images was compiled, including 374 pictures of healthy neonates and 137 photos of infants suffering from jaundice. An accuracy of 98.4375% was achieved in the experimental results when this algorithm was applied for classification. The positive results of the study open the door for new monitoring technologies that could effectively identify various medical conditions.

Nainika Saini et al. seeks to identify severe jaundice promptly to prevent fatality or permanent brain injury. Techniques: Current detection methods include invasive bilirubin measurement or clinical testing that utilizes blood samples. Relying on yellow skin discoloration, this non-invasive technique for identifying jaundice can assess bilirubin levels using a dedicated smartphone app created for measuring jaundice levels. Muhammad Naufal Mansor et al propose a new method for monitoring first aid in cases of infant jaundice

Mitra Mohammed. Addi et al. employs a phototherapy method. Phototherapy is a skin disease treatment technique that utilizes light sources. Common light sources utilized in phototherapy systems include light emitting diodes (LEDs), fiber optics, halogen lamps, and fluorescent lamps. Blue LEDs are now employed in phototherapy systems because of their unique

characteristics, including high sensitivity to bilirubin reduction, energy efficiency, lightweight design, low heat generation, cost-effectiveness, and long lifespan. The efficacy of blue LEDs in reducing bilirubin levels in bilirubin solutions was compared to fluorescent light, commonly used in medical facilities. A bilirubin level detector was developed using LabView to measure the concentration of bilirubin. The findings indicated that blue LEDs outperformed fluorescent lights in lowering bilirubin levels during a 30- to 3-hour exposure duration (10%–20% bilirubin reduction). This study suggests developing an automated phototherapy suit for addressing jaundice in infants by employing an Arduino microcontroller and blue LED lights.

N. Ali et al. identify jaundice issues with greater simplicity, likely causing less discomfort than the earlier technique. A photodiode will sense the light reflected from bilirubin, and bilirubin will absorb light intensity at a specific electromagnetic spectrum wavelength. The voltage generated from this reflection will be analyzed by the Arduino Uno. After processing, Dreamweaver will be utilized to transform the system into an online platform. The doctor can always monitor the state of the newborns

L. C. Ku presents a Non-Invasive Bilirubin Device utilizing Direct Photometry to address the issues. The basis of direct photometric measurements is the direct assessment of properly prepared serum at bilirubin's peak absorption wavelength of 455 nm. Direct photometry can be used only for newborns.The application is based on the comprehension of light absorption and transmission within a specific tissue compartment. The pertinent skin photo diagnostics assess blue monochromatic light at 450 nm and green at 575 nm

Ashish Chakraborty et al. discuss our proposed non-invasive neonatal jaundice detection system that employs a CNN algorithm. The various detection systems presented in this paper illustrate the method's accuracy and practicality for application. The techniques and detection strategies discussed here are all beneficial in facilitating the early identification of neonatal jaundice. However, real-time monitoring remains unfeasible due to the time-intensive nature of the limitations associated with current invasive methods. Patients may endure trauma from existing invasive procedures, while non-invasive technologies can cost thousands of dollars. We propose a non-invasive approach for jaundice detection in newborns, utilizing a CNN algorithm and image processing techniques to reduce the trauma associated with traditional methods.

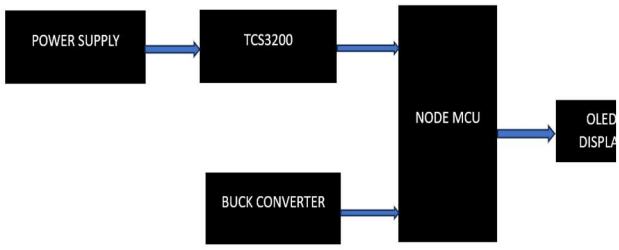
Karthika A. et al. identifies and detects neonates in need of phototherapy. The current equipment for continuous bilirubin measurement is neither more accurate nor more expensive. In this study, we develop an affordable device capable of continuously monitoring bilirubin levels during phototherapy. Collectively, these measures ensure that infants do not receive inadequate phototherapy. Additionally, we incorporated heart rate monitoring and oxygen saturation monitoring for comprehensive multi-vital sensing.

Weirui Tan, Liyuan Zhang, et al. have developed a cost-effective, battery-free analytical tool based on paper, designed for the rapid, point-of-care quantitative evaluation of blood bilirubin levels in adults suffering from hepatopathy and in jaundiced infants.Utilizing a specially designed smartphone application, this tool effectively separates plasma from whole blood and enables visual quantification of chromogenic data. The application not only measures bilirubin levels, particularly in jaundiced neonates, but also provides recommendations for necessary treatment if the infant's age is at risk based on the detected bilirubin level.This affordable design is believed to offer a practical solution that allows patients and parents to monitor their own health and that of their newborns at home.

2. Methodology

A Node MCU microcontroller, TCS3200 color sensor, OLED display, SMPS power supply, and buck converter are utilized in the jaundice detection and rehabilitation system. The TCS3200 sensor captures the skin's RGB readings, which are then processed by the Node MCU to determine the bilirubin concentration, an indicator of jaundice. The buck converter steps down the voltage to suitable levels for the Node MCU and sensor, while the SMPS provides a stable power supply. Once all components of the system are initialized, the TCS3200 sensor continuously collects skin color data. After processing this information, the Node MCU calculates the bilirubin level using a predefined algorithm that correlates RGB values with bilirubin concentrations. The OLED display then presents the calculated jaundice level, facilitating real-time monitoring. Additionally, the device offers rehabilitation advice, such as hydration recommendations or suggestions to consult a physician, based on the identified level. This approach harnesses the accuracy of the TCS3200 sensor along with the compactness and adaptability of the Node MCU to provide a compact, efficient, and user-friendly system for the early detection and management of jaundice.

3.1 Block Diagram



3.2 Block Diagram Explanation

The incoming direct current (DC) is adjusted to 5 volts through the use of a Buck Converter. Each component operates at a voltage of five volts. The microcontroller responsible for regulating the input and displaying the output is known as Node MCU. The output is presented on an OLED display.

Hardware Description

4.1 TCS3200 Sensor

The TCS3200 can detect and measure the color of an object or surface. It utilizes a set of photodiodes that are covered with red, green, and blue filters to record color data. The device measures the intensity of three colors—red, green, and blue—and produces digital values that represent the color components of the detected object. This functionality allows it to identify or differentiate between colors based on these measurements. The output frequency generated by the TCS3200 is directly proportional to the intensity of the detected color. A microcontroller or another processing unit is capable of reading this output to ascertain the color information.

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4.2 Buck Converter

The primary function of a buck converter is to transform a higher DC voltage into a lower DC voltage. For example, it can change 12V DC to 5V DC. Buck converters are well-known for their high efficiency. Due to their ability to store and transfer energy through inductors and capacitors rather than dissipating it as heat, as is the case with linear regulators, they frequently achieve efficiency levels ranging from 80% to 95%. Buck converters regulate the output voltage via feedback mechanisms. In order to ensure a consistent output voltage, a feedback loop assesses the output voltage against a reference value and adjusts the duty cycle of the switch as needed.

FIG 4.2 BUCK CONVERTER

4.3 NODE MCU

Due to the inclusion of an integrated ESP8266 Wi-Fi module, the Node MCU is capable of connecting to Wi-Fi networks, making it suitable for Internet of Things applications. For sensors that generate analog voltages, the Node MCU is equipped with a single ADC pin that facilitates the reading of analog signals. Through a web interface, users are able to access and manage the device via a small web server that it can host.

The Node MCU is well-suited for battery-operated applications as it can operate on various power sources and includes features to manage power consumption.

FIG 4.1 TCS3200 SENSO

FIG 4.3 NODE MCU

4.4 OLED DISPLAY

OLED screens are utilized to display text and various visual information. They can be found in numerous portable electronic devices, such as smartwatches and smartphones. The visual quality of images and videos can be enhanced by OLED displays, as they are capable of producing a wide range of colors with remarkable accuracy and brightness.OLED displays are ideal for battery-powered devices due to their lower power consumption compared to other types of displays in compact devices like smartwatches or microcontroller projects.

FIG 4.4 OLED DISPLAY

5. Software Description

5.1 Embedded C Language

Embedded C is a specialized extension of the C programming language designed specifically for developing code for embedded systems. These systems require highly efficient and reliable programming due to their limited hardware configurations and resource constraints. Embedded C allows for direct manipulation of hardware components, such as registers and memory, providing users with precise control over system operations. Since its syntax and semantics closely resemble those of standard C, experienced C programmers can easily adapt to it. Key features include the use of specific data types, the capability to write low-level code, and support for interrupt management. Embedded C is commonly used to develop firmware for microcontrollers and various embedded devices, which are integral to a wide array of applications ranging from consumer electronics to industrial automation. Its control, efficiency, and portability make it a preferred choice.

5.2 Thinks peak

An Internet of Things (IoT) platform known as Things peak enables users to collect, store, process, analyze, visualize, and act upon data sourced from sensors or devices. Due to its powerful data analytics capabilities, user-friendly interface, and integration options, it is commonly employed across various IoT applications. Users can utilize the integrated charts and graphs to create both historical and real-time visual representations of their data. This supports the monitoring and long-term evaluation of trends.Users can generate dashboards that can be either publicly shared or kept private, simplifying the process of communicating data to stakeholders.When certain conditions are met (for instance, when sensor readings exceed a specified threshold), users have the ability to set up triggers that send notifications through email, SMS, or other communication channels.

6. Results and Discussion

The TCS3200 color sensor is utilized by the non-invasive neonatal jaundice detector to assess skin color and effectively measure RGB levels. It compares the RGB value with the bilirubin value. The Node MCU processes this data, evaluates the severity of jaundice, and presents the findings on an OLED panel. This device offers a quick, simple, and reliable method for monitoring jaundice in newborns. Its portable design and easily interpretable display make it suitable for use in both home and clinical environments.

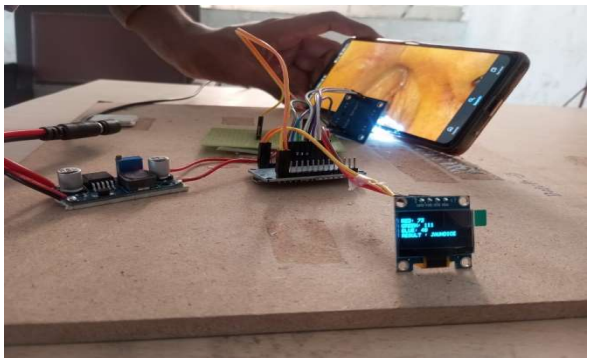

FIG.6.1 JAUNDICE DETECTOR

7. Conclusion

In conclusion, the Golden Hue Detector represents a significant advancement in the detection of jaundice in newborns. Its non-invasive, precise, and economical

method overcomes the shortcomings of earlier techniques, offering a viable option for both caregivers and healthcare providers. It is recommended that further research and development be conducted to enhance the technology and explore its integration into routine neonatal care. This could lead to improved early detection and treatment of neonatal jaundice on a global scale.

8. Future Scope

The creation of compact, portable devices that facilitate immediate diagnosis and treatment in both urban and rural settings represents a possible application for a neonatal jaundice detector equipped with integrated UV light therapy. This integration could lead to a reduction in the severity of jaundice and avert potential complications, thereby enabling faster intervention. Furthermore, advancements in the technology are necessary to guarantee sufficient UV exposure while enhancing safety and accuracy. It may also become more affordable, thereby increasing accessibility in resource-limited areas and improving neonatal health outcomes worldwide.

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