

Analytical Review on the Technologies Designed for the Better Detection and Treatment of Neonatal Jaundice

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Abstract - - Neonatal jaundice is a common occurrence observed globally. Due to lack of proper phototherapy treatment, many infants meet the fate of death. Making sure that appropriate phototherapy treatment is given to the needy is an important factor under consideration. Most widely accepted treatment is phototherapy. And to make it easier, a lot of innovations have been happening in terms of detection of neonatal jaundice and its treatment. Designing the software and algorithms for better treatment techniques is the trend observed in this field. This paper aims to analyze the developments in this field and come up with a review about their efficiency.

Key Words: Neonatal Jaundice, Skin colouration, Bilirubin, Data Collection, Monitoring, T-Bil

1. INTRODUCTION

Jaundice is a disease where there is yellow coloration of skin and eyes due to build-up of bilirubin levels in the blood. Neonatal jaundice is the type of jaundice observed in new-borns. Either in case of mature or premature new-borns, neonatal jaundice is a very commonly observed situation that over 80% of the new-borns go through. According to observations it occurs in babies born before 38 weeks of gestation, and few breast-fed babies. In case of new-borns, since the liver might be premature or underdeveloped, neonatal jaundice is expected. It is not obvious that every new-born will need to have infant jaundice but the chances of expecting it are over 85% in almost every case.

So, the most important aspect of dealing with infant jaundice is its treatment. The most trusted a treatment technique is phototherapy. Being a very efficient solution, phototherapy is unfortunately not available to everyone who is in need. There are many reasons for this. But the point is, many of the babies suffering from infant jaundice die due to lack of phototherapy treatment. The numbers might change eventually since people are more aware about it. But the challenge is to make sure that the phototherapy treatment is

given in its most efficient way and is reachable to people even in the remote areas of the country.

In the developing world like today, it is important to adapt to new technologies to give out most efficient services and make the process of treatment much easier.

2. TECHNOLOGIES IN THE CONTEXT

- **Image Processing:** Detection and inference of the condition, by the images captured by the camera depending on the designed algorithm.
- **WSN (Wireless Sensing Network):** A Network of sensors and connections, which collect data and store it in a central storage location.
- **Electronic Health Record:** It is the patient's medical record, maintained electronically and stored accurately for treatment references. This can be linked with various algorithms, to extract data and perform analysis.
- **Fly Eye Lens:** 2D pair of lens lets, which transform the light. The key point to note is the transformation from a non-uniform source of light to spreading it in a uniform fashion.
- **Linear Regression:** A supervised machine learning algorithm which performs regression on the set of points and detects the independent value hence helping in searching a pattern.
- **SVM Regression:** Support vector machine, is also a supervised technique of analyzing the regression and helping in data management.
- **KNN Regression:** K Nearest Neighbour is a non-parametric method of regression, where the anomaly is compared with the continuous nearest values of the point of consideration. This helps in detection of a point in a considered proximity.
- **Random Forest Regression:** A Random Forest technique works by constructing many decision trees while training time and the output being the mean of the classes under consideration as the prediction of all the decision trees.

- **RGB LED Source:** Red Green Blue Light Emitting Diode light source. Using this the light therapy can be in different intensities depending on the type of colour of the light.
- **LPLS:** Low-cost Phototherapy Light System; A system setup for an efficient light therapy while expanding its connectivity with different tools.
- **ANN:** Artificial neural networks, mimicking the neural design of a human brain. construction of a network working in a similar pattern as of the brain to establish a collaborative system which intakes the signals and gives out the results in expected formats.
- **ABSS and SMD:** Artificial bilirubin standard solution and Surface Mounted Devices. Using the mimicking technique where the action of real bilirubin content is studied and implemented in the design to set the standard for reading. To track the deviations, SMDs are used.

3. SURVEY ON ADVANCEMENTS

Most of the times, it is the manual investigation by the doctor, which proves to be 100% efficient in detection of Infant Jaundice. But technological advancements help the doctors get the results in a quicker manner. With respect to treatment, these advancements are proving to be helpful in the medical field, to track down the treatment and maintain the records of the patients in an efficient way.

[1] This paper proposes a non-contact and non-invasive detection method for neonatal jaundice using image processing and computer vision technology. the method for automatic detection of neonatal jaundice by monitoring the changes in babies' skin colour from the video data was proposed. Here, the skin colour feature extraction was taken into consideration. From the image of the whole face, only required skin area was extracted excluding mouth and hair. When compared with the final T-Bil value, in the experimental, the skin colour detection worked effectively. But it was not effective in case of premature infants because, image scanning and T-Bil values did not match.

[2] This paper deals with real-time patient health (jaundice) monitoring using wireless sensor network. An optoelectronic sensor is designed with consists of components like analogue circuits for signal conditioning, Xbee transceiver, as well as ADC converter. This device is connected to software for visualization. Bases of the standard chart of yellow discolouration according to severity of jaundice, the frequency obtained by the sensor is matched. This data is available to doctors and nurses in real time via the software. In real time implementation, this project seems very convenient to be helpful for easy treatment of infant jaundice.

In the paper [3] a systematically structured health infrastructure that is cloud-based is modelled which provides permission for the self-acting process of data

collection, its processing and transmission, storage, and NICU personnel availability. The Electronic health record is transmitted to the cloud for people to access it through a distributed DBaaS network. The device like bilirubinometer is connected to this network so that the recordings can be monitored by person far away from the location for accurate for treatment. The flexibility of any device being able to be monitored and recorded is the most important part of this system. Such Designs will help in building most efficient clinical decision support systems.

[4] In this paper, the fly-eye lens technology has been considered to contribute technical support for development of complex application. The analysis shows 85% uniformity in the illumination and effectiveness of simulation method with Tracepro. Two fly-eye lenses are placed parallelly to avoid wastage of illumination of phototherapy. This setup provides uniform illumination. The optimization in medical lighting system design for the phototherapy apparatus of neonatal jaundice, is requirement of the day. With high performance and low cost, the optical system dependant on fly-eye lens is supposed to be used in medical equipments widely. But in a few cases due to lack of awareness and inefficient technological knowledge leads to not implementing of such advancements and hence wastage is not professionally managed.

[5] In this paper, a method being non-invasive is structured for quantification of bilirubin level and detection of Jaundice by utilizing sclera photographs or visuals. The image is captured with the help of sensitive goggles. The sclera feature extraction to detect the extent of jaundice is done by colour thresholding, where skin is deleted from the image and only clear part of the image is into consideration. The regressor being trained computes the level of bilirubin from features that are extracted. The data collection of comparative sclera samples had been done with permissions and consents. The new sample for testing was compared with the standard sclera samples and through regression algorithms, it was confirmed about the severity of jaundice. Several algorithms were under consideration for testing like decision tree regression, linear regression, Random Forest Regression, k-NN Regression, SVM Regression. Among them, Random Forest Regression gave the best results, with an absolute mean error of 0.29. The technique of 5-fold cross validation was used to compare the performances of the algorithms. The lack of dataset for reference causes hindrance for the productivity of the system, but that can be resolved by real time on spot data collection process.

Paper [6] aimed at attempting to estimate the unconjugated bilirubin levels from skin samples based on diffuse reflectance spectroscopy measurements using a smartphone. The skin of the infant was exposed of RGB LED source due to the clear picture was obtained through the smartphone. In this case, the consolidated average value of the RGB light intensities is analysed with the image of the infant whose bilirubin level is to be tested. This picture was further processed using the ANN algorithm to detect the bilirubin

level intensities. For comparison, images of the infant after birth must be considered. The affordability of this system on a general basis is difficult, as the cost efficiency of the system is not much highlighted. But with accurate optimization and funding, this process can be helpful in detection.

[7] This paper presents the process of upgrading the LPLS (Low-cost Phototherapy Light System) to enhance facilities and improve efficiency with affordability. Solar panels were used to charge the batteries through which the LEDs were charged. The standard capacity of LEDs must 20 W. But here 7W LEDs were used and the wavelength of the light supply was increased, which proved to be an efficient way of optimization for a low-cost affordable system. There were sensors and cameras setup to record and monitor the infant's condition so that they can be reviewed by the experts through a cloud network. The concern was of the duration. Since the standard type of phototherapy units take a certain of time for effective treatment, making sure that this cost-effective unit does not affect the treatment efficiency is the concern. Point being, to reduce the cost of treatment, the life of the infant must not be compromised.

[8] The paper puts light on the developing of a bilirubin detector which is non-invasive using photodiode and light emitting diode (LED) and applying skin optic theory. The APPG (automatic and portable phototherapy garment) has integration of bilirubin detector and is suitable to measure level of bilirubin in a non-invasive manner. It finds out accurate treatment duration automatically depending on range of severity of bilirubin levels. The model displays real-time bilirubin readings that represent three jaundice conditions levels namely normal, mild, and critical. Degradation experiments with respect to bilirubin levels were conducted using ABSS (artificial bilirubin standard solution) to imitate the actual bilirubin in blood. This method reduced the repeated blood drawing from the infants for the testing. Among the others, comparatively, this system is more achievable since the accuracy rate is high. It uses blue LEDs as surface mounted device on the body of the infant for constant sample collection of decolouration. This results in continuous evaluation of the condition hence reducing risks in treatment.

Paper [9] describes a model which prevents subjection of phototherapy light therapy to eyes and the surrounding area of the infant. An array consisting of two white LEDs with ten blue LEDs are parallelly placed which ensures even light illumination to the body. The one who uses can adjust the intensity and the illumination time before light therapy. A method that is non-invasive to detect the jaundice is designed using the technique of image processing. This is done by the spectrogram analysis which compares the images of the normal skin with jaundice coloration skin. This system uses the images to form a spectrogram using Matlab programs. These spectrograms help to decide the extent of treatment required. Also, the systems ease the process of monitoring since the timer is set. Since it simplifies the process of treatment, it is feasible to be implemented.

Collaborating this system with the existing phototherapy units will create more effectiveness.

[10] This paper deals with assembly of the spectrophotometric instrument with the control and calculation software. The system intends to measure phototherapy sources used in neonatal wards in hospitals. Based on the measured wavelength and radiation intensity spectrum and other input parameters are calculated photometric spectrometric, colorimetric, and radiometric values by the program. The tests are implemented in the LabView software for all the possibilities of the wavelength ranges in the above-mentioned scales. An error of less than 5% was observed. The main advantage is of minimalization of the wavelength ranges and cost reduction estimation depending on post implementation.

4. CONCLUSIONS

This review paper game store provides an analytical overview of the technological advancements in the field of detection and treatment of neonatal jaundice. Infant jaundice being a quite common situation in the world, has provided the scope for more research and advancements to achieve more efficiency. The survey provides the details of 10 such advancements, where scientific implementation of the designs has been studied and resulted in increasing the efficiency of detection and treatment of neonatal jaundice. Technologies like image processing, wsn, artificial neural networks, regression techniques and data management have proved their efficiency once again through the survey conducted. The major concern during the analysis of these advancements was about the affordability and productivity of the newly designed systems. while some of them proved to be easily made productive, the others seem to have a bit off cost effective issue. the analysis of these advancements has proved another point of the changes and adaptability in medical technology. Medical science and technology go hand in hand when it comes to efficient treatment with more president using the machineries as well as manpower.

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