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Neocherish - An Intelligent Care Unit For Neonatal Icterus

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ABSTRACT - NeoCherish - Noninvasive monitoring and treatment for neonatal icterus. Neonatal icterus, a problem in 60% of full term babies and 85% of pre-term babies. NeoCherish provides an effective solution for neonatal icterus. It is an intelligent system which is fully automatic noninvasive measurement of bilirubin in blood serum and treats with the higher wavelength LED (Light Emitting Diode) for cure. In existing method after arising the symptoms in the neonatal due to the cause of hyperbilirubinemia, blood sample is taken for testing bilirubin value in blood serum. For treatment, phototherapy method is handled. In proposed system, newborns are placed in NeoCherish intelligent care system, it checks for the bilirubin value in blood serum noninvasively using LED wavelength about 400nm. If the obtained value exceeds the predefined value, results in three different states as normal, mild and critical jaundice. Based on this states treatment process will be turned at slightly higher wavelength of LED ranges from 410nm to 490nm, which posses the photo transformation process to reduce the level of bilirubin in blood serum. Monitoring system keeps on monitors and displays the bilirubin value. Data are transmitted for doctors monitor using zigbee module. Configure the device could be done by the doctor from the remote location. Database is also maintained for future analysis.

KEYWORDS - Bilirubin, Hyperbilirubinemia, Phototherapy, LED.

I. INTRODUCTION

Newborn babies are not healthy due to some abnormal conditions occur sometime. These could be detected by using Newborn Screening (NBS) test [1], which is a process of screening genetic, metabolic, and hematologic and blood diseases. About 30 rare disorders could be detected for these tests which include jaundice. Jaundice is also known as hyperbilirubinemia or icterus. Nowadays 60 to 80 percent of newborns are suffering from this disorder. Due to the increase of bilirubin level in the blood serum hyperbilirubinemia occur. Bilirubin is a yellowish pigment which is deposited under the skin. Due to this, skin and eyes will become yellowish. When the baby was in mother's womb, placenta will separate the bilirubin. After the baby born, baby's liver starts to do this function. The bilirubin which are water soluble is known as conjugated bilirubin, whereas water insoluble are known as unconjugated bilirubin which leads to hyperbilirubinemia. Excess of bilirubin in blood will cause kernicterus [2], a brain damage. Before that treatment should be provided and the level of bilirubin in blood should be reduced. In this paper section II is about the bilirubin metabolism and treatment for icterus in newborn is explained in section III. The NeoCherish project development is explained in section IV. Simulation results are discussed in section V and about the conclusion in section VI.

II. BILIRUBIN METABOLISM

Senescent red cells are a major source of hemeproteins. Breakdown of heme to bilirubin occurs in macrophages of

reticulo endothelial system which are tissue macrophages, spleen and liver [3]. Unconjugated bilirubin is transported through the blood to liver with the help of albumin. Then the bilirubin is diffused by the liver and conjugated with glucuronic acid. Conjugated bilirubin is actively secreted into bile from liver and then to intestine. The glucuronic acid will be removed by bacteria in intestine and resulting bilirubin is converted to urobilinogen. Few of urobilinogen are reabsorbed by gut and enter portal blood, a part in enterohepatic urobilinogen cycle. Remaining will be transported by blood to kidney where it is converts to yellow urobilin and excreted, giving urine yellow color. Urobilinogen is oxidized by intestinal bacteria to the brown stercobilin and excreted via feces.

III. PHOTOTHERAPY

Phototherapy method is handled to cure unconjugated hyperbilirubinemia. It is the emission of light rays in newborns to make them cure from icterus [4]. In older day's fluorescent or halogen lamps are used for phototherapy treatment. Nowadays Ga/Sapphire LED are used. These are operated at the wavelength of 410nm to 490 nm. Also using of LED than the fluorescent and halogen will increase in decrease of bilirubin concentration when done in hours. The photo transformation using LED is good considered with other methods include fibre optic phototherapy too. During phototherapy, photo-oxidation process is taken place which reduces the bilirubin level.

IV. NEOCHERISH - PROJECT DEVELOPMENT

NeoCherish - An intelligent care unit for neonatal infants which automatically monitors and treats icterus. For monitoring in proposed system, a non-invasive method [5] using LED with certain wavelength ranges from 380nm to 500nm is used [6]. By using this light the bilirubin value is measured without any heel and displayed immediately in display [7]. According to the measured value the system automatically turns to treatment mode. In treatment mode the LED wavelength is increased and phototherapy treatment is done. System keep on monitor the bilirubin value, when it becomes normal, system will turn to normal mode. Treatment done is based on normal, mild and critical value of the bilirubin. Monitoring of temperature in NeoCherish system is also done. The data are transmitted for doctor monitoring using zigbee wireless communication. Data are received and viewed in local PC for analysis. Monitoring and treatment details are stored in database for future analysis. Manual configuration could be done.

A. Transmitter Module

Neonatal infants whom to be tested are placed in NeoCherish intelligent unit. The transmitter module is shown in Fig. 1. The LED light rays of wavelength 380nm to 500nm are emitted and they are injected to the neonates. The reflected rays are absorbed by the photodiode placed in NeoCherish system. The output of the photodiode is based on the bilirubin concentration in blood.

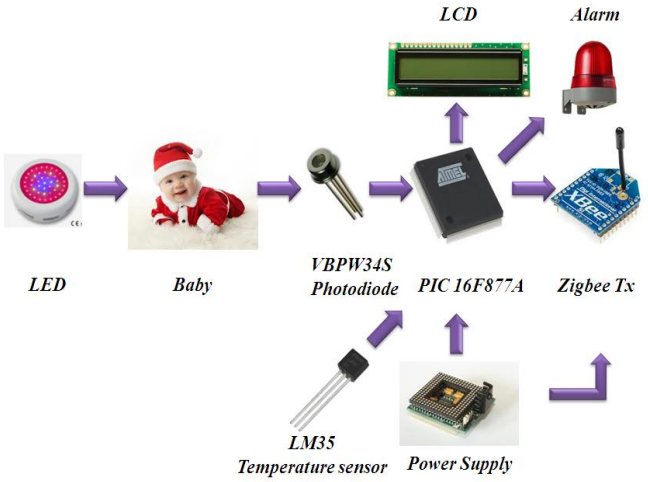

Fig. 1. Transmitter Block Diagram

If the bilirubin value is less than 5mg denotes normal and the output of photodiode is about 4v to 6v. If the bilirubin value ranges from 5mg to 12 mg is denoted as mild jaundice and the photodiode output will be ranges from 2v to 4v. If the bilirubin value is greater than 12mg it is denoted as critical level and the photodiode output will be ranges from 0v to 2v. Based on this voltage the microcontroller in the intelligent system will display the bilirubin value and the state as normal, mild or critical. Temperature in the system is measured using LM35 and displayed for local monitoring. All these data are transmitted to remote place for doctors monitoring using zigbee wireless module [9]. The buzzer is to give alarm in critical stage and in the change of state during monitor to treatment mode and from treatment to monitor mode.

B. Receiver Module

The data which are transmitted from the NeoCherish system is received by zigbee wireless module. Then by using max232 the data are displayed in personal computer. Doctors available in remote location could monitor the NeoCherish system. It also includes a functionality that configure the device from the remote location by the doctors could also be done. It is shown in Fig. 2. A separate database is maintained to store the values and functions of

NeoCherish system alone with the time to maintain the patient history for future analysis.

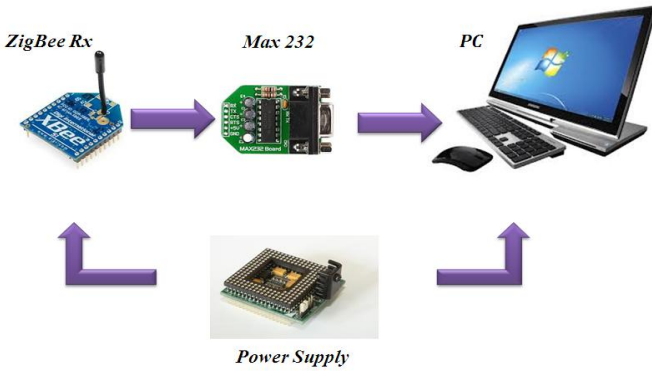

Fig. 2. Receiver Block Diagram

C. Treatment

As soon as the bilirubin value in the blood serum is detected. The wavelength of LED array in increased based on the state ranges from 410 nm to 490nm since it only has the peak absorption coefficient [8] and treatment is done.

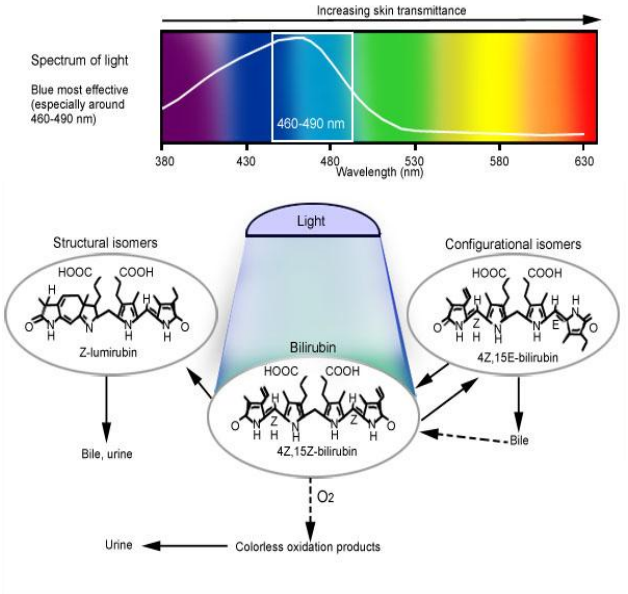

Fig. 3. LED Phototherapy

When the light rays are injected to the infants they are absorbed by the blood. Which converts the unconjugated bilirubin into conjugated one by structural isomers and configurational isomers is shown in Fig. 3. By this function the excess bilirubin will be excreted via urine and feces, which is to be done by liver is done via phototherapy treatment.

V. SIMULATION RESULTS

The complete design is made by using the proteus software. The components are selected and paste in design workspace. The connections are made according to the functionality. The hex file created upon the compilation of embedded c coding developed in MPLAB IDE is dumped on to the microcontroller. Then the design is simulated for desired output. The complete design is made and it is shown in the Fig. 4.

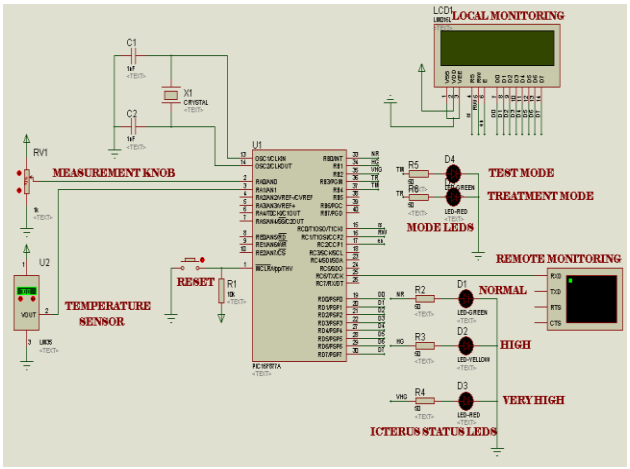

Fig. 4. Schematic before run the simulation

The schematic explains about the functionality of the bilirubin testing and treatment through indication. Green, yellow and red LEDs are used for indicating the bilirubin value normal, high and very high respectively. One more red and green LEDs are used for treatment and normal mode indication. LCD is used for local monitoring which display the bilirubin value, mode and temperature of the system.

A. Bilirubin Normal Value

When the bilirubin value is measured and if it is below the normal value, green led will be glow to indicate normal. The bilirubin value along with normal indication is displayed in the LCD. The intelligent system remains in the test mode. Wavelength also displayed along with the temperature in the NeoCherish system. It is shown in the Fig. 5. A virtual terminal display is also displayed to indicate the wireless remote display.

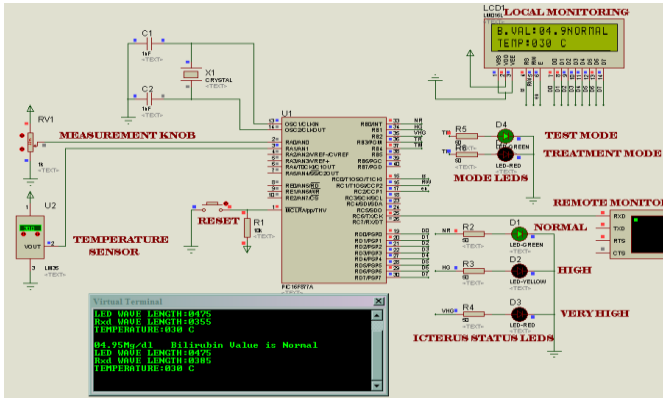

Fig. 5. Bilirubin normal indication and test mode with virtual terminal display

B. Bilirubin High Value

When the measured bilirubin value is above the normal level and below the danger level it is indicated as high and yellow LED will glow. System will change to treatment mode. The bilirubin value along with high indication was displayed in LCD. This will lead system to slightly increase the LED wavelength. Wavelength also displayed along with temperature. It is shown in Fig. 6. The virtual terminal display is to indicate the remote wireless display.

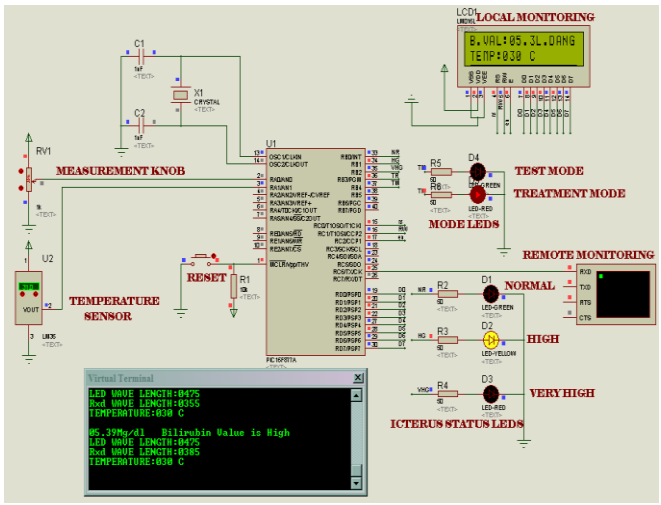

Fig. 6. Bilirubin high indication and treatment mode with virtual terminal display

C. Bilirubin Very High Value

When the measured bilirubin value is very high which results in danger. The intelligent system turns to treatment mode and it is indicated by red LED. The bilirubin value along with temperature will be displayed in LCD. It is shown in Fig. 7. The virtual terminal display indicates the remote wireless display.

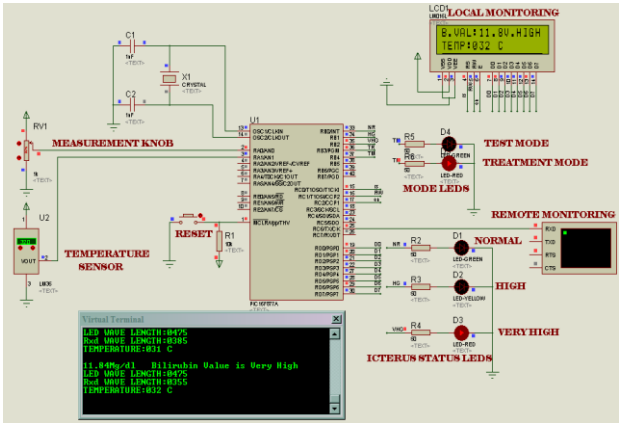

Fig.7. Bilirubin very high indication and treatment mode with virtual terminal display

The treatment is done by increasing the LED wavelength. This will effectively reduce the bilirubin in the blood. Till then the system will be in the treatment mode. Again the bilirubin value is measured and check for the normal value. The normal, high and very high indication of NeoCherish intelligent system mentioned above in the simulation results is due to the normal, mild and critical stage of jaundice in neonatal.

VI. CONCLUSION

The NeoCherish intelligent care unit will provide the efficient monitoring and treatment for neonatal icterus automatically. This system will make the work easier and provide faster treatment. The data are stored in the database to maintain patient history and also for future analysis. Manual configure by the doctors in remote location could also done in NeoCherish system. This system will provide an effective solution in measuring, monitoring and to provide treatment to icterus. In future the device will be enhanced with many measurements that are related to hyperbilirubinemia. Many features like count of haemoglobin in blood, with display of parameters that enhance the treatment will be considered.

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