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Jaundice Colour Separation Using Machine Learning Technique with PHP Programming Language Tools.

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Abstract:- Jaundice is a disease that is occurs as a result of excess bilirubin substance found in the blood stream and it can affects at any life stage of human being. This is caused mainly by the breakdown of Red blood cells (RBC) in the blood. But for the purpose of this research, we will be considering neonatal jaundice that is jaundice that is associated with newly born children. Bilirubin is a necessity in the body but excess production of it at the early stage of a child can be toxic because the liver is not strong enough to excrete the excess of it produced. This increase in the bilirubin content in the body is directly proportional the colour of the skin as the skin gradually becomes yellowish starting from the face and upper body then gradually spreads to the rest parts of the body. Over 150 samples of Images of new born diagnosed to have jaundice of different levels were acquired from hospitals across the world, a colour clustering/separation model was developed with PHP programming language tool, then the images collected was used to train the clustering/separation model. After the training, fourteen colour codes were discovered to be common in all the images. This brought us to a conclusion after a thorough discussion with some expertise in the medical field that when an image is tested for the presence of jaundice, the number of the colour codes found in the image can depict the level of jaundice present in a baby.

***Keywords**:- Jaundice; Image; Bilirubin and Colour Seperation.*

I. INTRODUCTION

Neonatal jaundice commonly associated with new born is characterized by the yellow skin discoloration caused by bilirubin, a waste product formed during the breakdown of heme (i.e., the oxygen-carrying components in blood). Neonatal jaundice is the most common problem associated with newborns Yu-Hsun, et al, 2006. It is highly commonly among Asian neonates than in Caucasian neonates. The condition is developed by 60 - 80% of newly born children usually within their first days of existence. In some cases, jaundice does not require treatment, newborns just excrete bilirubin off themselves normally after one or two weeks. However, in a case of severe condition, and is not properly curtained, permanent damage can be inflicted on the child's brain, and the result is brain dysfunction or eventually, death of the affected child. To prevent this; systematic monitoring of all newborns is employed during birth hospitalization in most industrialized countries.

The yellow skin discoloration associated with jaundice can be an attributed of the presence of excess bilirubin. Visual examinations have been used to screen patients and are still important in clinical situations. Visual features are however, subjective to the observer, and objectively quantifiable methods to support optical diagnosis are frequently used in the medical community. A blood sample can be analyzed to precisely determine the exact bilirubin concentration of a patient, total serum bilirubin (TSB) for short, but requires equipment and is expensive. Bilirubin has a yellow colour due to its absorption of green and blue light. These absorption properties are, today, used to estimate bilirubin concentration via skin reflectance measurements. The measurements, called transcutaneous bilirubin (TcB), are performed by bilirubinometers, apparatus that emit light waves onto skin and, with sensors, record the amount of reflected light. Studies show that TcB correlates linearly with TSB and is therefore often used as a screening process, reducing the invasive evaluation method of drawing blood. But Bilirubinometers are unfortunately very expensive and it cost effectiveness has limited its widespread use in outpatient settings in low- and middle-income countries. Numbers of medical devices are becoming increasingly common for fitness, heart rate check and various other devices. As the technology increasing day by day, people move towards the efficient and low cost technology. People want the technology that save time, money and provide good results.

In this research, the colour change in the skin is carefully observed in about 150 neonates during the period of this research and a colour clustering/separation model was developed to separate the colours in an image of a baby to detect if the baby has jaundice or not.

II. RELATED WORKS

Jaundice is a common abnormality seen in newly born babies within few days after their birth Brits, et al., 2018. Over 70 percent of new born children are clinical jaundice infected, almost all new born children are jaundice infected during their first few days after birth. The word Jaundice is gotten from the word ‘Jaune’, a word in French language meaning ‘Yellow’. It is said that a baby is sick of jaundice, if such a baby’s skin colour appears to be yellowish. Doctors and midwifes most times examines the newborn by blanching of the skin so that the underlining yellowness of subcutaneous tissues and blood vessels can be visualized because it is masked by physiological plethora of the body at its earliest stage, Meharban, 2015.

Chiaro, et al. (2016) reviled that jaundice should and can be diagnosed and treated early enough to avoid brain damage. Reliable methods for TSB are not always readily available, particularly in low- and middle-income countries, making the true incidence of severe neonatal jaundice difficult to estimate.

McEwen, et al., 2006 developed a non-invasive method of detection of bilirubin using a pulsatile absorption technique. This study uses the light absorbance method. A nominal pulsatile distance, which is the change in the light path length through a blood segment between the systole and diastole, was calculated using the photo detector output and the graphical absorption coefficients. Their study used the Light Emitting Diode (LED) as the light source with five different types of light absorbance calculated using Beer-Lambert Law. The study deduced that Bilirubin has a higher absorbance at around 480 nm, while pulse oximetry is at 660 nm.

Kudavelly, et al., 2011 had designed a method that used two specific wavelengths at 455 nm and 575 nm in absorption spectrophotometry. The application of spectrophotometer is to evaluate the absorbance peaks of the prepared solutions. National Instruments (NI) Data Acquisition (DAQ) Card has the purpose of capturing the photo detector output. A miniature tungsten lamp or a white LED light is used as the light source. The lens in the system collimate the light rays. Cuvette with the volume of 5 microliter (μL) and an optical path of 1cm is used as the sample station to place the sample. Narrow band interference filter of desired wavelength was applied to isolate a narrow band of frequencies from a wider bandwidth signal. The photo detector with a high sensitivity is intended to detect the desired spectrum. This prototype showed an outstanding result as a potential portable bilirubinometer.

Ali, et al., 2015 later revealed a technique that uses optical technology in other to diagnose jaundice in infants. The philosophy he disclosed as light absorption of oxy hemoglobin at various wavelengths was applied by implementing two colours of LED lights, blue and green. A blue LED light is placed above the infant in other to serve as a source of light that will determine the level of concentration of bilirubin and a green LED light which will indicate the reference point to discriminate the difference of bilirubin and hemoglobin. The light will be reflected on the infant’s skin and their rays will interact with different molecular tissues, then a photodiode will absorb the reflected light to be further investigated. A photodiode is used to measure the light reflection and the outcome will go to an Arduino Uno to be further processed and it will give the level of concentration of the bilirubin.

BiliCam technology introduced by De Greef, et al., 2014 for detection of jaundice in newborn using a smartphone camera (iPhone 4S) attached to an 8-megapixels camera. The method operates using a calibration card at as big as the size of a business card placed on the infant’s abdomen; sternum and forehead before a set of images are captured.

Leung, et al., 2015 had introduced another technique in diagnosing for neonatal jaundice with his bases on scleral images from a photography snapped with digital camera. Nikon D3200 camera with the specifications of 24.6 megapixel Complementary Metal Oxide Semiconductor (CMOS) sensor is used with a prime macro lens of 60 mm focal length. The study uses the scleral hue to estimate the serum bilirubin level. The captured images were analyzed using MATLAB and a customized colour chart was used as a reference.

III. DESIGN METHODOLOGY

For this study, water fall design methodology was adopted to develop the colour clustering/ separation model. Because of the high sensitivity required by this model, it is expedient that a step by step process is followed so as to easily pinpoint and work on the faulty phase when it is time for maintenance of the system.

IV. DESIGN

The images of over 150 cases of children diagnosed to have jaundice was collected with camera with high image quality resolution in the presence of white light to avoid reflection on the colour of the image from hospitals in Indian, United Kingdom and Nigeria. After which lots of interactions were done with pediatricians at all levels to identify questions to be asked in other to collect Meta data information of babies that may have jaundice issue and also to know other possible factors that may cause jaundice.

The next phase is the development various building blocks like colour clustering class, colour separation class, colour filtration class and code generation class. This was developed with PHP programing language to filter, cluster and separate every colour in the image and then generate all colour code(s) in the image. After the designing of all these classes, the resultant module was applied the images collected during the first stage and it was observed that 14 colour codes (colour codes; d8c0, c0901, c0902, c0903, c0904, coa8, a8903, a8904, a8a8, 9078, a8783, a8784, c0c0 and cod8) were common and the higher the no of jaundice colour code in the image supplied, the higher the jaundice level of the child. These colour codes were then used as the bases for the conclusion. The software was then developed to do its jaundice colour separation on any image using this premix.

❖ *ALGORITHM OF THE JAUNDICE COLOUR SEPARATION MODULE*

Step 1: Returns the colours of the image in an array
Step 2: Ordered in descending order
Step 3: Assign keys as the colours, and
Step 4: Assign values as the count of the colours.
Step 5: Resize the image
Step 6: Get the most significant colours.
Step 7: Get the nearest neighbour resizing
Step 8: Ensure the colours are not altered
Step 9: Round up the colours,
Step 10: Reduce the number of duplicate colours
Step 11: Reduce gradient colours
Step 12: Reduce brightness variations
Step 13: Convert counts to percentages
Step 14: Return array_slice

❖ *EXPERIMENTAL METHOD TO GENERATE JAUNDICE CODE*

The jaundice code can be generated from any image supplied by the steps in Figure 3.1.Tthe architecture for code generation is given in Figure 1.

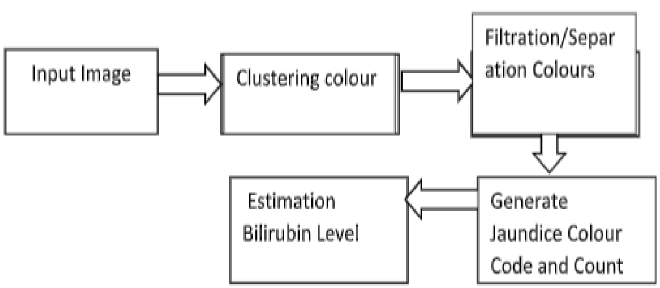


Fig 1:- Architecture for Jaundice Colour Separation

V. DISCUSSION OF RESULT

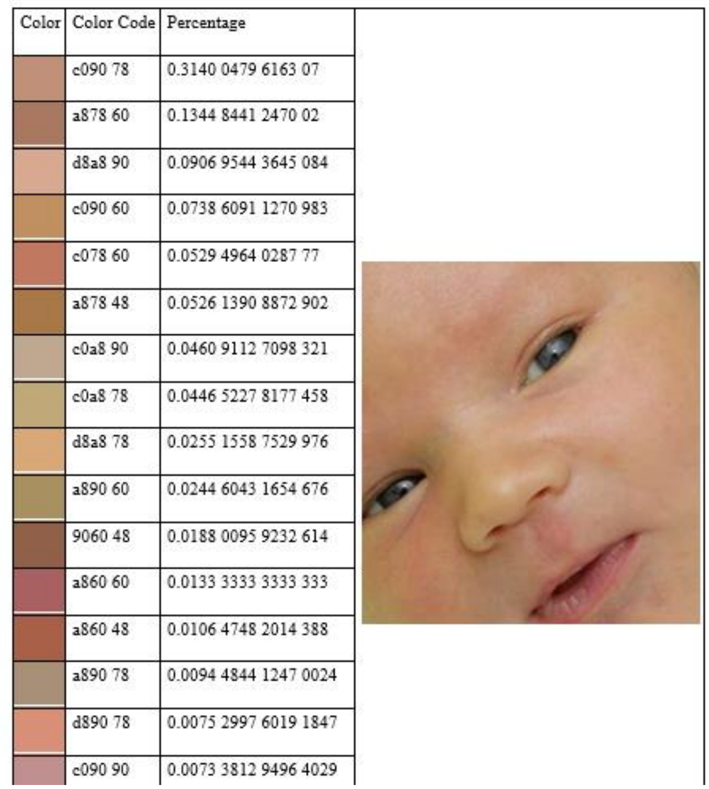
From our findings as shown in table 1, if the jaundice colour code present in the image is one, then the bilirubin level is said to be very low. If it is two to six colour code present, the bilirubin level is said to be low. When it is six to eight, the bilirubin level is said to be high and when it is above eight, the bilirubin level is said to be very high.

Colour Codes Present in the Image	Bilirubin Level	Remark
1	< 2 mg / dl	Very low bilirubin level
2 to 3	< 10 mg / dl	Low bilirubin level 1
4 to 5	10 to 14 mg / dl	Low bilirubin level 2
6 to 7	15 to 16 mg / dl	High bilirubin level 1
8	17 to 19 mg / dl	High bilirubin level 2

Table 1:- Bilirubin Level According to the Jaundice Colour Code(s) Present in the Image

❖ *Colour Seperation Formation Chart*

The colour chart in fig 2 is gotten from one of the samples used for testing the developed module. The different colours is shown and their colour code representation given with their respective jaundice concentration percentage.



Color	Color Code	Percentage
	c090 78	0.3140 0479 6163 07
	a878 60	0.1344 8441 2470 02
	d8a8 90	0.0906 9544 3645 084
	c090 60	0.0738 6091 1270 983
	c078 60	0.0529 4964 0287 77
	a878 48	0.0526 1390 8872 902
	c0a8 90	0.0460 9112 7098 321
	c0a8 78	0.0446 5227 8177 458
	d8a8 78	0.0255 1558 7529 976
	a890 60	0.0244 6043 1654 676
	9060 48	0.0188 0095 9232 614
	a860 60	0.0133 3333 3333 333
	a860 48	0.0106 4748 2014 388
	a890 78	0.0094 4844 1247 0024
	d890 78	0.0075 2997 6019 1847
	c090 90	0.0073 3812 9496 4029

Fig 2:- Jaundice Colour Seperation Module

From the colour separation don on the image above, it was established that the neonate contains 4 jaundice codes and this is estimated to likely be between the 4 to 5 range from table 1 which is 10mg/dl to 14 mg / dl that is a Low bilirubin level of level 2.

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VI. CONCLUSION

This colour separation module can be used as a standard in a jaundice image separation system to do the colour separation and from several test done, it is sure to give an accurate result. The different bilirubin level according to the jaundice colour code(s) present in the Image deduced were after lots of research and consultations with different Consultant, Expertise, Pediatricians and Specialists in children health care.

FUTURE WORK

This jaundice colour separation module can be combined with some other medical factors that can cause jaundice to give a standard bilirubin detection system. Our research team are presently working on the different platforms and modules to be added to this jaundice colour separation module in other to give a jaundice detector that will give accurate result closest or equal to a Blood test result and will be able to stand the test of time.

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