Development of bilirubin jaundice (*BiliDice*) device for neonates

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Keywords: Neonatal jaundice; bilirubin; color sensor; Arduino uno; phototherapy

ABSTRACT – In Malaysia, generally the blood samples are taken and various laboratory experiments are performed to determine the exact jaundice level for newborn. As the process is repetitive, it causes trauma to infants and also requires experts to perform the test. In this paper, the bilirubin jaundice so-called *BiliDice* device is proposed. The device consists of three main components: RGB colour sensor, microcontroller, and LCD display. The advantage of this prototype is affordable and portable. This device is simple, easy to handle, fast and accurate readings for the bilirubin level of the newborn.

1. INTRODUCTION

Jaundice in neonates is mutual. When the red blood cells are wrecked down, a constituent called bilirubin is made. Primarily new baby liver is undeveloped and hence it cannot do the task efficiently [1]. Thus bilirubin level increasing which is the cause of jaundice. Bilirubin level will increase gradually if the severity is not detected within a proper time interval and if jaundice is left untreated. Once it exceeds a certain level there is the possibility of deafness or certain forms of brain damage may occur. Therefore, blood samples are taken, and various laboratory experiments are performed to access the exact bilirubin level [2].

In this paper, a portable hardware device which can detect the bilirubin level and jaundice state by non-invasive technique has been proposed. The successful bilirubin jaundice called *BiliDice* device using RGB color sensor is well developed. Using colour sensor (TCS230), an Arduino-Uno board based on microcontroller and an OLED display 0.96-inch unit have been used in manufacture this device. TCS230 is a colour sensor which programmable light to a frequency converter. There are sixteen photodiodes each for Blue, Green and Red filters. In [3], image analysis of stool colour is compared to colour grading by a colour card, and the stool bilirubin level test is done to detect cholesteric jaundice in infants. In [4], digital images are acquired in colour, in palm, soles, and forehead. RGB attributes are analyzed with diffuse reflectance spectra as the parameter to characterize patients with either jaundice or not, and those parameters are correlated with the level of bilirubin.

2. METHODOLOGY

2.1 Device Setup

At the beginning of the device setup, the TCS230 colour sensor has been organized to obtain suitable RGB values. Regarding this purpose, the three main colour of Red, Blue, and Green level printed on paper has been used. For the calibration of Red component, the value of Red set with “255“ and the value of Black set with “0“ have been plotted. The similar technique is followed for the calibration of the Green and Blue component. After that, the percentage of blue colour is assigned as the bilirubin level. Figure 1 shows the block diagram of the operation in *BiliDice* device.

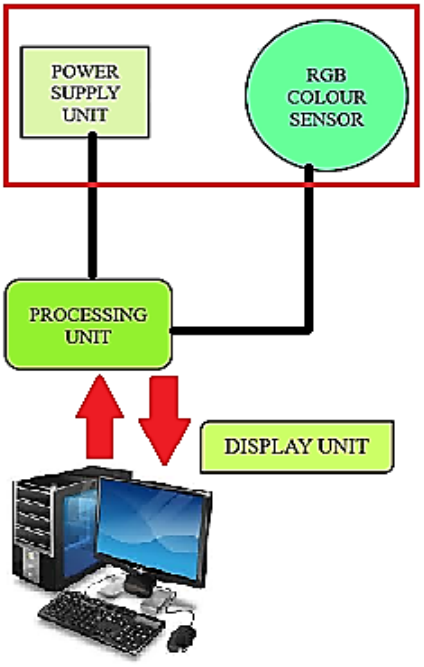

Figure 1 Block diagram of the operation in *BiliDice* device.

The power supply unit provides 9V DC supply to the processing unit. RGB colour sensor (TCS230) senses the RGB component of skin level processing based on Arduino Uno. The processing unit plots RGB value to precise values in order to arrange the colour sensor tracked by the percentage of blue taken from the colour sensor. Therefore the state of jaundice is determined and the result is transferred to the LCD display.

Figure 2 Final product of *BiliDice* device.

Table 1 Material specification.

Material	SUNLU PLA
Print Temperature	190-220^{0}C
Length	330mm

3. RESULTS AND DISCUSSION

In this study, the *BiliDice* device is successfully developed by using the non-invasive method as shown in Figure 2. The infected area is irradiated with light of specific wavelength and change in properties of light after reflection from the skin is noted. In order to detect neonatal jaundice, Light Emitting Diodes (LED) of a specific wavelength is employed as a source of light, which is an occurrence on baby skin. The light is reflected back and absorbed by photo-detector. In Table 1 show details the material specification of the *BiliDice* device.

Table 2 Implementation of colour level and bilirubin level [5].

Colour series (CS)	Label of colour	Bilirubin level (mg/dl)
CS-1		8
CS-2		11
CS-3		18
CS-4		22

The preliminary study on jaundice and non-jaundice was observed base on correlating the label of skin colour as shown in Table 2 and the decision making on jaundice and non-jaundice as shown in Table 3. The bilirubin level is intended conforming to a specific level. The physical process flow of an implementation of the *BiliDice* device as shown in Figure 3.

4. SUMMARY

As a summary, the proposed *BiliDice* device would use technique detection of jaundice by using a non-invasive method which can regularly monitor the bilirubin levels. The use of color sensor is a good alternative in detection of jaundice. However, this *BiliDice* device is still in the early development with positive progress. The device is also simple, and easy to use.

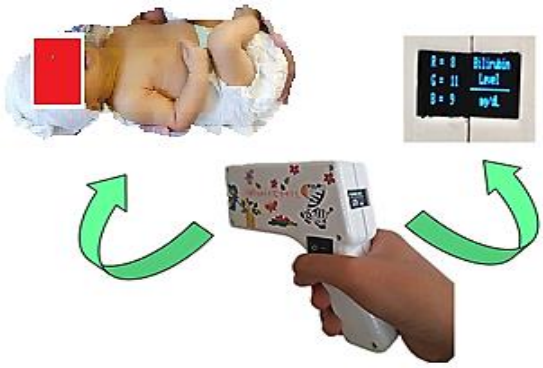

Figure 3 Process flow of an implementation of the *BiliDice* device.

Table 3 Reference for decision making on jaundice and non-jaundice.

Bilirubin level (mg/dl)	Jaundice level
BL < 5	Normal
5 < BL <11	Mild
11 < BL < 19	Severe
19 < BL	Critical

ACKNOWLEDGEMENT

A big thank you dedicated to University Malaysia Pahang (UMP) for providing us with a good environment and facilities in order to complete these research activities. By this opportunity, we would like to thank Mr. Idris Mat Sahat from Human Engineering Group, Universiti Malaysia Pahang for sharing valuable information in accordance with our research interest. We would face many difficulties without his assistance.

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