Development of smart infant-wrap (*InfaWrap*) device for neonates

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ABSTRACT – Nowadays, with advanced technology, most of the parents choose to monitor their baby's health using a pulse oximeter device. However, the existing pulse oximetry device was a hassle for infant and this makes the monitoring process difficult. In this study, we focus on the development of smart infant wrap or so-called *InfaWrap* device for neonates in order to accommodate clinician and parents in monitoring the heart rate and oxygen level of the baby with advanced wireless network sensor. This device easier to use, fast and accurate readings of the baby's oxygen and heart rate.

1. INTRODUCTION

A study was conducted [1] where they found that 90% infant with congenital cyanotic heart disease were detected with the use of pulse oximeter for screening within several hours of birth. This data show there is a very serious issue related to cyanotic heart disease. Pulse oximetry was considered abnormal if oxygen saturation at room air or on oxygen therapy measured <90% [2]. This is due to issue with the heart valves, which are the flaps in the heart that make sure the blood flows through in the right direction, an interruption in the aorta, and abnormalities in the large blood vessels can occur congenital cyanotic heart disease

The Sudden Infant Death Syndrome ("SIDS") also can be related to congenital cyanotic heart disease. The main causes of SIDS may be difficult to determine [3], many parents do an extraordinary effort and are worried about checking their baby's health. For this reason, a simple but efficient system is required to monitor the conditions of the patient continuously. To help parents in this effort, nowadays various products to monitor the health of infants, especially when the baby is sleeping.

Currently in monitoring system hospitals used cable connections and the size and power consumption are often too large and not easy to carry [4]. The system becomes unsuitable in the development of today's technology. By applying the wireless health care technology there are many advantages one of them, people who carry the sensing devices can move around freely without the obstacle from complex connecting cables; and finally, doctors in the remote server center can watch the patient's health condition closely and hence provide real-time advice for the patients' recovery and long-term care [4,5].

In this paper, the smart infant wrap (*InfaWrap*) device is developed. One of the features of this device implements healthcare monitoring using wireless network sensor. This device need is equipped with several sensors such as oximeter MAX30100 and LM35 which can measure several parameters. Bluetooth HC05 is used to display the parameter result at smartphone. In addition, the buzzer and display are applying in this system to ensure physician and parent more alert if the parameter value at the system indicates a negative value.

2. METHODOLOGY

The *InfaWrap* device consists of three main components; ankle wrap, monitoring system, and mobile application as shown in Figure 1.

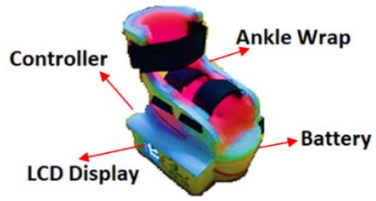

Figure 1 The smart infant wrap (*InfaWrap*) device.

For the *InfaWrap* device circuit of the project to connect all the component as shown in Figure 2. The details of each component are described in this subsection.

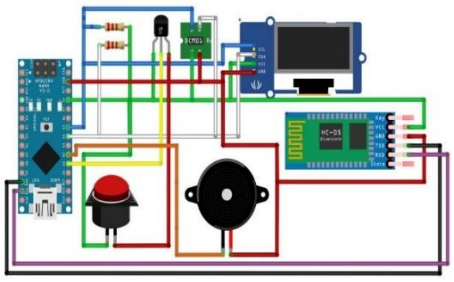

Figure 2 The *InfaWrap* device circuit.

2.1 Ankle Wrap

Consists of MAX30100 and LM35 sensor. MAX30100 is the combination of two LEDs, a photodetector, optimized optics, and low noise analog signal processing to detect the parameter of heart rate and SpO_2 level. LM35 is used to monitoring the body temperature of the infant. This sensor is safe for an infant because it does not emit any harmful electromagnetic wave to the infant. The main body of the device was developed using Flexible TPU filament and the inside of the ankle has been insulated using a sponge to protect the

skin of the infant.

2.2 Monitor System

In this monitoring system, the device displays the heart rate, SpO_2 and temperature level of the infant after receiving output feedback from the microcontroller. The buzzer was used to alert the clinician or parent if the parameter showing unhealthy reading. In order to develop this device. the microcontroller Arduino pro mini is used. This Arduino is chosen because of the size is easy to attach with the device.

2.3 Mobile Application

The mobile apps. is developed to record and display the heart rate, blood pressure and temperature data trend of the infant as shown in Figure 3. The data keep in the storage system as a black box function. These data will use as the emergency tread record or research activity.

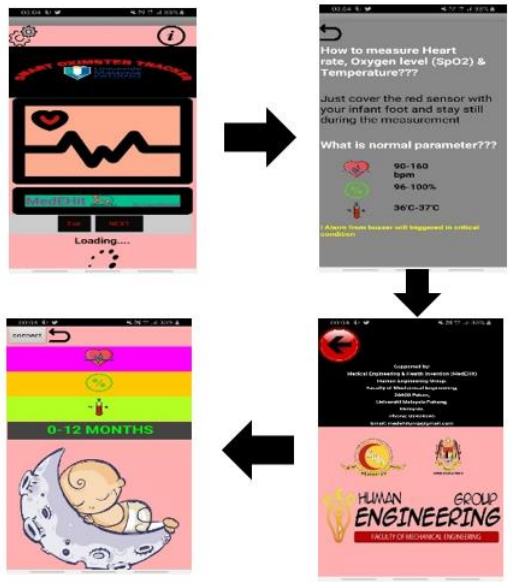

Figure 3 Illustrated the design of *InfaWrap* device mobile application.

3. RESULTS AND DISCUSSION

In this study, the *InfaWrap* device is well developed. Figure 4 clearly shows the stress analysis of the *InfaWrap* device developed using two differences material, between PLA and TPU. This analysis has been done to ensure the safety of the infant. According to the result for PLA material, the parts will not crack or bend when it is pressed. This is because the maximum stress for PLA material is only 1.084e+006 *N*/*mm*2. For TPU material shows a similar result with the PLA material but the mechanical properties for TPU is different which is the natural characteristic for this material is soft. To ensure the accuracy of this device, one ability test has been done for two hours without non-stop. Data from parameter device is taken for every 10 minutes. This test is very important to make sure after the occurrence of voltage drop, the battery output still remain the same and exactly as in starting reading. In Figure 5 clearly shows the accepted output parameters. The output value start changes in 100 minutes but the value still under the maximum limit.

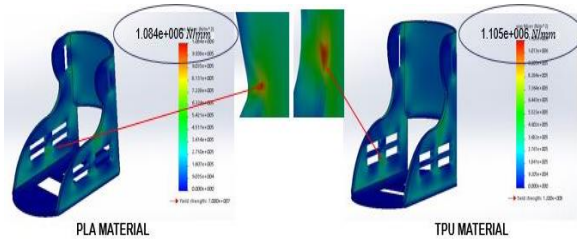

Figure 4 Stress analysis: the comparison between PLA and TPU materials.

Time taken (Minutes)	Parameter output		
	Heart Rate (Bpm)	SpO_2 (%)	Temperature (C°)
10	66.28	99	35
20	68.92	99	35
30	70.23	98	36
40	64.56	98	37
50	72.66	97	36
60	71.68	98	34
70	74.23	98	36
80	79.64	98	35
90	78.66	96	36
100	80.22	96	37
110	76.23	96	35
120	81.03	96	35

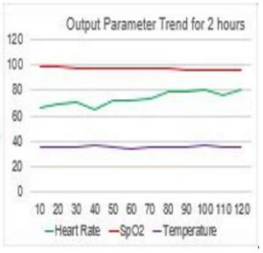

Figure 4 Demonstrated the output parameter value within two hours' test.

4. SUMMARY

As a summary, the proposed smart infant wrap (*InfaWrap*) device is well developed and really integrated with a mobile application. We forecast that the *InfaWrap* device has the potential to be used widely in Malaysia with affordable price.

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