Development of Brady-Tachy Heart Automotive (B-T Heartomotive) Device for Monitoring Heart Rate during Driving

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ABSTRACT – The rate of car accidents is worrying nowadays. Other than problems in driving attitudes and skills, road accidents are also caused by uncontrollable factors such as medical conditions and drowsiness. These factors can be avoided by having early detection. B-T Heartomotive device is a device that can detect early signs of drowsiness and health problems by measuring the heart rate of the drivers. Heart rate measurement can reveal a lot about the physical conditions of an individual. B-T Heartomotive device consists of three main components: the sensor, microcontroller and heart rate monitor.

1. INTRODUCTION

The causes of road accidents vary between two groups of drivers: young and old drivers. Young drivers tend to be involved in road accidents due to the lack of experiences, risk-taking behaviors, over-speeding as well as alcohol and drug influences. Most of the accidents among older drivers are due to the medical problems such as stroke, heart disease and psychoactive medications [6]. Another main factor contributing to road accidents is drowsiness. 21% of fatal road accidents was due to drowsiness according to AAA Foundation for Traffic Safety between the year 2009 to 2013 [1] and 54% of adult driver's drive despite in the state of drowsiness [10].

The development of B-T Heartomotive device is to address road safety issue among old drivers, people with medical problems and drowsiness. The mechanism of action of B-T Heartomotive is based on the measurement of the heart rate by a sensor. Many information can be extracted from the heart rate data. The most important data is the state of drowsiness. Bergasa et. al. [8] stated that, heart rate is one of the factors that detects drowsiness with high precision other than brain waves, respiration and skin conductance [5] due to the decline and variability in the heart rate measures during drowsy state [2,12]. Heart rate variability (HRV) is connected to autonomic nervous system, allowing it to measure drowsiness state [11]. The accuracy rate of drowsiness detection based on HRV could reach as high as 90% via neural network [9]. According to a study done by Abdul Rahim et al. [4] there is a big difference in the heart beat between normal and drowsy conditions. In a normal, relaxed state, the heart beats in the range of 70 to 100 BPM but, only in the range of 45 to 65 BPM in an early drowsiness state. Other than drowsiness, the measurement of heart rate can reveal information about the health state of an individual such as the risk of having cardiovascular disease [13], undetected heart attack, blood pressure condition as well as the level of blood electrolyte [3]. B-T Heartomotive can also monitor blood pressure and blood oxygen saturation level (SpO_2). The degree of hemoglobin binding to oxygen (lung factor), hemoglobin concentration (anemic factor) and cardiac output (cardiac factor) are the three factors that can affect the quantity of oxygen transported throughout the body. Oxygen saturation is the ratio of the amount of oxygenated hemoglobin compared to the amount of hemoglobin in the blood to indicate the sufficiency or insufficiency of oxygen in our body. The level of healthy SpO_2 ranges from 96% to 99%. The level decreases significantly for patients with pulmonary or cardiovascular chronic diseases [7].

In this study, we are working on the functional prototype to improve the consistency and reliability of data so that it can be used for the intended purpose. Essentially, the data is to be stored and to always be reliable and usable. The proposed device uses the data to send an alert to the driver and passengers as a precaution. They should pull over and take action as early as possible to prevent motor-vehicle accidents. The device is also simple, easy to use, and automated.

2. MECHANISM

2.1 Wristband

Consists of MAX30100, an integrated pulse oximetry and solution of heart-rate monitor sensor that combines one photodetector, optimized optics, low-noise signal processing and two LED to detect heart-rate signal and pulse oximetry from which the heart rate, blood pressure and SpO_2 level can be obtained.

2.2 Microcontroller (Arduino Uno)

Arduino Uno is an open-source electronics platform based on easy-to-use hardware and software. Arduino intended for making interactive surface. The function is to obtains the value of heart rate in beats per minute (BPM) based on the photoplethysmograph (PPG) data from MAX30100.

2.3 Monitor

Displays the heart rate, blood pressure and SpO_2 level of the driver after receiving the value of heart rate in BPM from the microcontroller via a Bluetooth system.

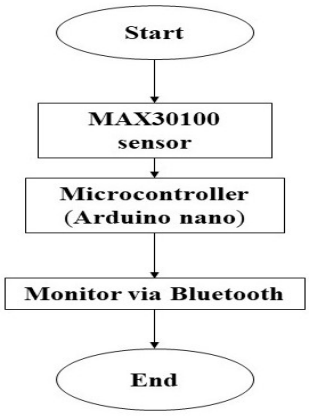

Figure 1 Flowchart of the function of B-T Heartomotive device

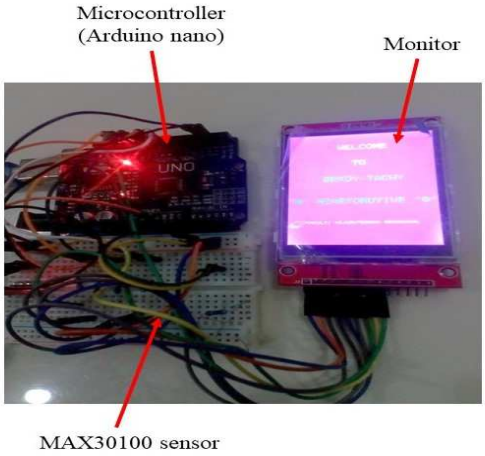

Figure 2 Assembly of B-T Heartomotive device

In this study, the driver's heart rate monitoring problem was considered to decide the heart rate level for safety driving. To detect the heart rate of the driver, we adopt sensory system. This system consists of three parts: sensing, analysis and feedback. The sensing part measures the driver's physiological data and environment. The analysis part extracts the heart rate of the driver and determines whether the driver is in the early stage of brady-tachy or not. As the driver is in or close to brady-tachy state, the feedback part is activated to awaken or alert the driver. Direct information of the heart rate (heart beat) can also be obtained by using electrocardiographic (ECG) sensor attached to the driver's body. The drawback of the ECG based system is to mount pieces of sensor to the driver's body. The system seems to be attractive due to its contact-free property but the effect of active sensing to driver's health is not clear.

Figure 3 Parameter display on LCD screen

3. CONCLUSIONS

As a conclusion, the proposed B-T heartomotive device uses the data to send an alert to the driver and passengers so that they are in precaution. They should pull over and take action as early as possible to prevent motor-vehicle accident. B-T Heartomotive device is still in the early development with positive progress. The device is also simple, easy to use, and automated.

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