Microcontroller-Based Embedded System for Drowsiness Detection and Vibration Alertness

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ABSTRACT

Microcontroller – Based Embedded System for Drowsiness Detection and Vibration Alertness is a prototype that helps in indicating an individual who has the signs of drowsiness. The purpose of this study is to design and develop a microcontroller-based embedded system that can detect drowsiness and that can alert the nurses through vibration alertness. Shift workers like nurses often have the tendency to fall asleep thus also showing a lack of energy and a sense of fatigue due to drowsiness during working hours particularly at night or graveyard schedules. According to the proponents’ survey that was conducted for the nurses from Callejo Medical Clinic, 14 out of 15 nurses (93.33%) said that drowsiness affects their duties. This paper aims to develop a proposed study to produce a hardware that consists of a (1) Si1143 Proximity Sensor that would detect the pulse rate of a nurse and an embedded (2) PIC16F689 Microcontroller in which it would process the vibration when the pulse rate drops below its normal condition (i.e. 59 BPM and below). MPLAB X IDE v.3.10 was used as the software for programming, the microcontroller.

KEYWORDS

Drowsiness, Microcontroller, Ambient Light Measurement, Pulse Oximeter, Toplexil

1 INTRODUCTION

The development of microcontroller-based embedded systems is also the development of technologies for detecting or preventing conditions like drowsiness. Drowsiness is a medical condition and sleep disorder wherein an affected individual begins to feel tired or sleepy in an unsuitable time and place on an unusual way (e.g. having drowsiness while at work, having drowsiness while driving on the road). Compared to normal shift workers, night shift workers such as nurses are commonly affected by drowsiness, making them prone to accidents and mistakes. A microcontroller-based embedded system can be a countermeasure that has the function to prevent such events that are occurring on a real time environment. Microcontroller-based embedded system can monitor various parameters (e.g. pulse rate on the wrist) that are necessary in order to detect drowsiness. In case when the drowsiness is detected according to the measurement, sensible signals and movements (e.g. vibrations) are issued to alert the user.

For the time being, microcontroller-based embedded system for drowsiness detection is used commonly for drivers. The capability of implementing microcontroller-based embedded system to other industries such as hospitals and nurses is of greater degree for the prevention of conditions like drowsiness. The aim of the study will be positioned on the design and development of the prototype that uses a microcontroller-based embedded system for nurses to improve their efficiency during work, and to lessen the human errors when considering drowsiness.
2. Microcontroller-Based Embedded System for Drowsiness Detection and Vibration Alertness

The study is primarily focused and used only for nurses from medical institutions. It emphasizes on drowsiness detection that can sense the pulse rate of the nurse using a Si1143 Proximity Sensor and on vibration alertness that can produce vibration through the use of a PIC16F689 microcontroller-based embedded system that is programmed in MPLAB X IDE v3.10 software. The vibration of the prototype will trigger only if the nurse manifests drowsiness or the pulse rate of the nurse reaches below sixty beats per minute (60 BPM). The Beats-Per-Minute (BPM) rate of the prototype has a normal condition of sixty (60 BPM) – eighty five (85 BPM) and has a drowsiness condition of fifty (50 BPM) – fifty nine (59 BPM). The pulse rate that will display in the prototype is only from fifty (50) BPM up to eighty five (85) BPM.

3 HARDWARE DESIGN

The fabrication of the prototype’s hardware is to first consider the components which are the key to operate the functions of the prototype and then to create its design. The diagram below illustrates the required components and its process to complete the prototype.

Inter-Integrated Circuit is a bus register that is used for transferring data that was initiated by a master device that controls the SCL (Clock line). Slaves device can only send data if it responded to the master (i.e. it cannot start a transfer of data over the I2C bus without the master). I2C commonly has two (2) wires, SCL (Clock) is used to initiate all the transfer of data over the I2C bus, and SDA (Data) is the line of data. The function of this component is to be the host interface of the Si1143 proximity sensor together with another line which is the INT (Interrupt) to interrupt the host processor, and its purpose is for the Si1443 to transfer and receive data that would control the operational state of the device.

Figure 2. Inter-Integrated Circuit

Si1143 Proximity Sensor is a 3.3 voltage chip power that features proximity measurements. The function of the Si1143 proximity sensor is to detect the pulse rate coming from the device through the use of light measurements and it is also provided with a wearable ground strap.
PIC16F689 microcontroller is an integrated circuit that contains programmable features such as input and output peripherals. The function of the PIC16F689 microcontroller is that when the pulse rate reaches below sixty (60) BPM coming from the device, it would then be processed in its program that will activate the vibration alarm.

4 Software Design

After initializing the input of the components, if it’s true, the Si1143 Proximity Sensor will calculate the pulse rate and will update the display. If it’s false, the process will stop. Figure 38 illustrates on how to calculate the pulse rate. The baseline is at eighty five (85) BPM. The program will detect the pulse rate, if it’s true, the BPM will be calculated, if the BPM is below the lower threshold or the minimum value of the normal condition, the Vibrator Motor will be activated for vibration. If it’s false, the program will keep on reading the values coming from the sensor.
### 4.1 GENERAL PROCEDURAL STEPS

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<th>Objectives</th>
<th>Procedures</th>
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<tr>
<td>1. To design and develop a microcontroller-based embedded system concept that can detect drowsiness and that can alert the nurses through vibration.</td>
<td>A. Brainstorming of proponents to form concepts and to recognize potential problems that the study may have to encounter.</td>
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<td>2. To gather information of nurses who work and are located in a medical clinic, a hospital, and a children's hospital in Las Vegas.</td>
<td>B. Data gathering was practiced such as searching on the internet for references and conducting surveys and interviews at medical institutions that is specified in Data gathering.</td>
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<td>3. To design a microcontroller-based embedded system by using a microcontroller as its main components.</td>
<td>C. Data analysis was exercised that expanded the proponents' knowledge of the study.</td>
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<td>4. To develop a program on MPLAB XIDE v1.10 software that will create the vibration which will alert the nurses when their pulse rate is below sixty beats per minute (60 BPM).</td>
<td>D. Design of the prototype was carried out and its hardware potential and its battery will be tested for nurses when using it by establishing a suitable design.</td>
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<td>5.</td>
<td>E. Programming and Testing of Code was performed to build a program for the purpose to use the functions of the prototype.</td>
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<td>6.</td>
<td>F. Testing of the prototype was executed by the proponents to be familiar with its operation.</td>
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<td>7.</td>
<td>G. Finalizing the prototype by conducting final tests to nurses.</td>
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**Table 1. General Procedures**

### 6 CONCLUSION

The proponents concluded that the proposed study, entitled “Microcontroller-based Embedded System for Drowsiness Detection and Vibration Alertness” is capable of detecting pulse rates from nurses who are experiencing drowsiness which would alert them through vibration. The information gathered that was based on the surveys and interviews gave the proponents the necessary data for determining that a problem such as drowsiness occurs in the field of nursing. The information gathered was also helpful for the device to be accurate in measuring drowsiness. The proponents have concluded that the design was complied well in fitting all the components on a device that is suited on a wrist. The developed program was complied as the device will vibrate when the pulse of the nurse is below sixty beats per minute (60 BPM).

### REFERENCES

1. “Microcontroller-Based Heart Rate Measurement from Fingertip” http://embedded-lab.com/blog/?p=1671