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Development of a Sleep-driving Accident Prevention System based on pulse[*1]

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Abstract

The purpose of this study is to develop a pulsatile drowsiness detection system that can compensate the limitations of existing camera - based or breathing pressure sensor based Drowsiness driving prevention systems. A heart rate sensor mounted on the driver's finger and an alarm system that sounds when drowsiness is detected. The heart rate sensor was used to measure pulse changes in the wrist, and an alarm system based on the Arduino, which works in conjunction with the laptop, generates an audible alarm in the event of drowsiness. In this paper, we assume that the pulse rate of the drowsy state is 60 ~ 65 times / minute, which is the middle between the awake state and the sleep state. As a result of the experiment, the alarm sounded when the driver's pulse rate was in the drowsy pulse rate range. Based on these experiments, the drowsiness detection system was able to detect the drowsiness of the driver successfully in real time. A more effective drowsiness prevention system can be developed in the future by incorporating the results of the present study on a pulse-based drowsiness prevention system in an existing drowsiness prevention system.

Keywords: Drowsiness, Driving, Pulse Number, Prevention Systems, Sensor.

1. Introduction

According to the National Police Agency, the number of drowsy driving accidents in 2016 was 2433 and the number of deaths was 98. The mortality rate is 4%, which is twice as high as the mortality rate of 1.9% in the same period. It was nearly twice as high as the death rate (2.4%) of drunk driving accidents. The number of traffic accidents has increased due to the increase in the number of vehicles driving on the roads, and traffic accidents caused by driver sleepiness have been a significant part of the traffic accidents (The Statistics on the National Police Agency, 2018).

Many intelligent systems have been developed to prevent traffic accidents. The drowsiness prevention system, which is being developed and studied domestically so far, is a system that predicts drowsiness by monitoring facial feature points through a camera (Ji, Zhu, & Lan, 2004), a system for recognizing the distance between the lane of the forecast and the vehicle ahead(Jeong & Jeong, 2013), a system that predicts drowsiness by breathing measurement by attaching a pressure sensor to the seat belt(Kim, Park, & Lee, 2013), a system for measuring drowsiness by measuring driver's gripping force(Park, 2011), a system for predicting driver's sleepiness with ECG sensor and PPG sensor attached to the driver's handle(Shin, Jung, Kim, & Chung, 2010), and a system for observing driver's sleepiness by attaching a pressure sensor and a temperature sensor to the handle are being developed and studied(Lee, Park, & Bae, 2005).

These systems are expensive, and camera-based systems can interfere with predicting drowsiness due to system deactivation when sunlight shines on the driver's face and a large amount of light is reflected off the camera or the driver turns his or her head. In the case of a seat belt pressure sensor that measures breathing, it

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can affect respiration according to attire. The driver's motion and the prediction by the driver's hand position on the handle have many disadvantages. This will be an obstacle to predicting sleepy driving.

Therefore, the purpose of this study was to develop a system to prevent drowsiness in the human body using pulses in order to predict the drowsiness operation with higher accuracy.

2. related research

2.1. drowsiness (Somnolence, sleepiness)

Somnolence, sleepiness, or drowsiness refers to the state of being close to sleep, the intense wind that wants to sleep, and the condition of long periods of unlike usual (Wikipedia, 2018).

Drowsiness can be dangerous when performing tasks requiring constant concentration, such as driving a car. When a person is very tired, the person can blink and lose concentration. When the drowsiness is pouring, our body becomes active in parasympathetic nerves, and the heart rate is lowered and the tension is relaxed. According to a paper published by the Korean Institute of Safety in 2015, subjective drowsiness can only be felt after a physiologically sleepy state. It means that the physiological drowsiness of the body appears before the drowsiness is actually perceived.

The activation of parasympathetic nerves by physiological drowsiness means that the body has been converted into a state of storing energy. The pupil contracts, the pulse slows, and the blood pressure falls. In addition, the heart rate is reduced and the tension is relaxed. This leads to a reduction in body reaction time, memory, information processing, and speed of selection and decision processes. This is why drowsiness leads to accidents by reducing attention to roads and traffic (Lee, 2018). The pulse rate of normal state is 60 to 80 times per minute and the pulse rate is reduced to less than 55 times in the sleep state by about 20 percent in the sleep state (Jang, Jang, Han, Han, & Ahn, 2006), It is assumed that the sleeping state in which the pulse rate of drowsy falls to about 20% of the normal state.

2.2. Arduino

It is an open source computing platform and software development environment based on a simple microcontroller board as a tool for creating interactive objects and digital devices that can detect and control the physical world.

Arduino can accept inputs from various switches and sensors and control the output to electronic devices such as LEDs and motors, thereby creating an environmentally interactive object. For example, a variety of products such as simple robots, hygrometers, motion detectors, music and sound devices, smart home implementations, infant toys and robot education programs can be developed based on Arduino. In addition, Arduino is open source, so anyone can create and modify boards directly.

A microcontroller is a small computer that performs a specific function by making a microprocessor and an input / output module into a single chip. Arduino includes all the development tools and environments associated with these microcontroller boards. Arduino was originally based on Atmel AVRAVR's microcontroller, but it has a variety of boards depending on the application, and libraries of development tools and functions are available.

Analogous to Arduino, microcontrollers and platforms that enable physical computing are diverse, but Arduino simplifies operations based on microcontrollers and has the following strengths

3. System configuration

To measure heart rate, the simplest circuits and measuring electrodes were studied. We measured the pulse rate with the ring type pulse sensor of Laxa Corporation and connected the piezo sensor so as to generate an alarm sound when measuring the pulse rate under certain conditions. The data processing is transmitted to the PC by using the Arduino serial communication. Connect the red, gold, green, and green wires of the sensor as follows, and distribute the voltage using a 10K ohm resistor to reduce the drive voltage by half (1.5V). Complete the hardware setup for the measurement in the same way as above.

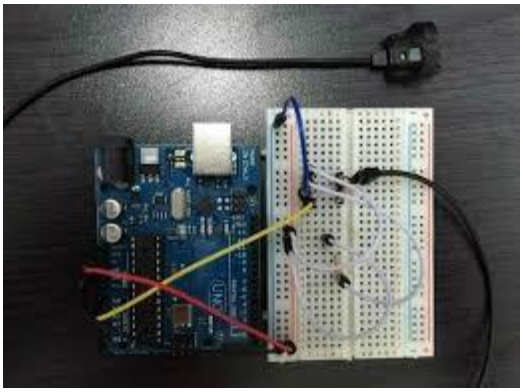

Figure 1. Arduino configuration

If the pulse rate is a steady state value as in the following algorithm, a notification indicating normal operation is activated. If it is close to the hypothermic heart rate assumed in this paper, a warning light will be activated and the driver will be alerted.

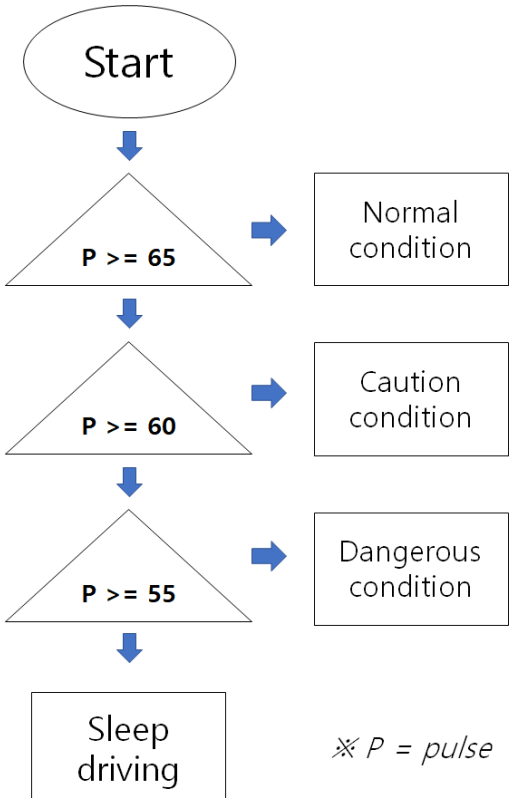

Figure 2. Pulse-based drowsiness prevention system algorithm

When it is determined that it is completely drowsy, the system is implemented so that an alarm is emitted with a warning light using an arduino piezo buzzer.
The research subjects were four college students, and conducted an experimental survey for one day on June 5.

4. Result

The pulse - based drowsiness prevention system developed in this study showed that the subject ‘A’ had a pulse rate of 78 before drowsiness, but the pulse rate decreased to 51 after drowsiness and the alarm sounded.

Subject ‘B’ had a pulse rate of 69 before drowsiness, but the pulse rate changed to 52 after drowsiness, and a warning sound also worked. The subject ‘C’ had a pulse rate of 73 before the drowsy state, and the pulse rate was 60 after the drowsy state, and the alarm remained in the state without warning. Subjects ‘D’ had a pulse rate of 67 before drowsiness and a pulse rate of 53 after drowsiness.

The results of the experiment are shown in <Table 1>.

Table 1. Results of beeping according to pulse rate

Subject	Steady state pulse rate	Drowsy pulse rate	Beep behavior
A	78	51	O
B	69	52	O
C	73	60	X
D	67	53	O

There was no reaction in the system because the pulse rate was measured to be more than 65 times, which is normal. If the reading falls below 65, the driver will be alerted to the drowsy driving condition by a warning of drowsiness when the reading falls below 55 and the reading falls below 55.

5. Conclusion and Suggestions

In this study, we have developed an Arduino - based system that can detect drowsiness through driver 's pulse. In order to develop a system to detect driver's drowsiness, we conducted a literature survey on domestic and foreign studies and conducted a survey on the drowsiness prevention system that is currently being applied to a finished car.

Since this system does not attach large or heavy sensors to the body, there will be no inconvenience to the driver when driving, and there will be no hassle to mount multiple devices in the body similar to camera based systems. If the system is used in conjunction with several drowsiness prevention systems, it may be possible to compensate for the malfunctions or shortcomings of existing systems. A higher probability will prevent drowsiness driving. And in order for this system to perform better, you need to develop a more efficient driver sleepiness algorithm.

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