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Research Article

Design of Video Detection for Drowsy Prevention Based on Car Driving

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Abstract In this paper, a drowsiness prevention system was developed to prevent large-scale disasters in traffic accidents. And drowsiness was predicted using face recognition face recognition technique and eye blink recognition technique, and prediction was improved by applying machine learning to improve drowsiness prediction. Additionally, the CO2 sensor chip was used to detect additional drowsiness prevention. In addition, STT (Speach To Text) was applied using voice recognition technology so that the driver can apply for a desired music or broadcast or make a phone call in order to break drowsiness while driving.

Key Words : Drowsy, driving, prevention, detection, real - time flicker recognition method

1. INTRODUCTION

According to statistics of KoROAD on traffic accidents in the recent 5 years, driving while drowsy has been one of the most important factors of traffic accident, and its mortality rate is more than 2 times higher than other traffic accidents [1]. As a solution to resolve these problems, it is possible to reduce the mortality rate of such traffic accidents by detecting and preventing the driving while drowsy. Therefore, studies for detecting and preventing the driving have been actively researched in academic fields [2] [3]. Therefore, in this study, a device for preventing drowsy driving was selected as an idea, and interviews and surveys were conducted with operators who do a lot of driving. The survey consists of a total of 61 questions related to car driving and life, driving life related to drowsy driving, use of peripheral devices, vehicle environment, accidents, and drowsy driving in order to gain insights to refine ideas. The survey was conducted for about 200 people. Online survey was conducted.

2. CASES

Hyundai Mobis is most actively studied as a system to detect and prevent driving while drowsy for domestic automobiles. The company developed a new technology with a camera recognizing driver's face and detecting driver's sweat or breathing conditions to prevent those drivers from driving their car when they fell asleep [4]. And its alarm sounds when their eyes are not watching the front. In addition, it is designed to prevent the driving while drowsy with the alarming by checking the flickering times and speed (cycle) of their eyelids, which recognizes differences in the times and speed and heart rate more than 10% from standards [5][6]. However, it is still in the design phase and has not yet been developed.

Fig.1.Mobis of Hyundai

Figure 1 presents that the drowsiness prevention system developed and used by Hyundai Mobis. A surveillance camera in front of drivers detect the movements of their eyes, nose and mouth, continuously providing statistical data [7].

In addition, another domestic car-maker developed the technology with an interval distance sensor among cars. This is designed to provide drivers with alarming and to activate forced brake through various steps when the distance between the sensor and front vehicles gets narrowed [8]. However, there are no drowsiness detection and prevention systems in Korea that support all of these.

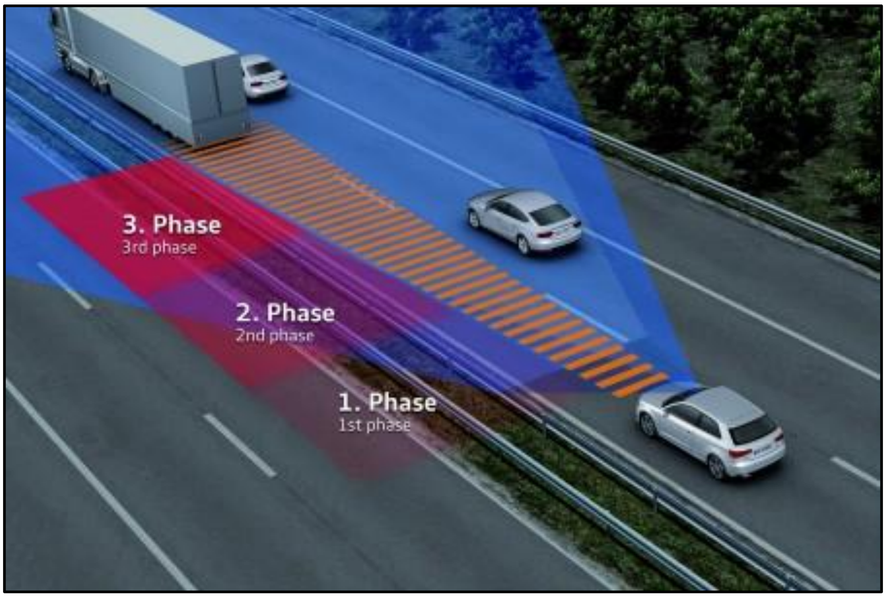

Fig.2.Gap of Cars

Figure 2 shows the system keeping the distance among cars to prevent traffic accidents by driving while drowsy [9].

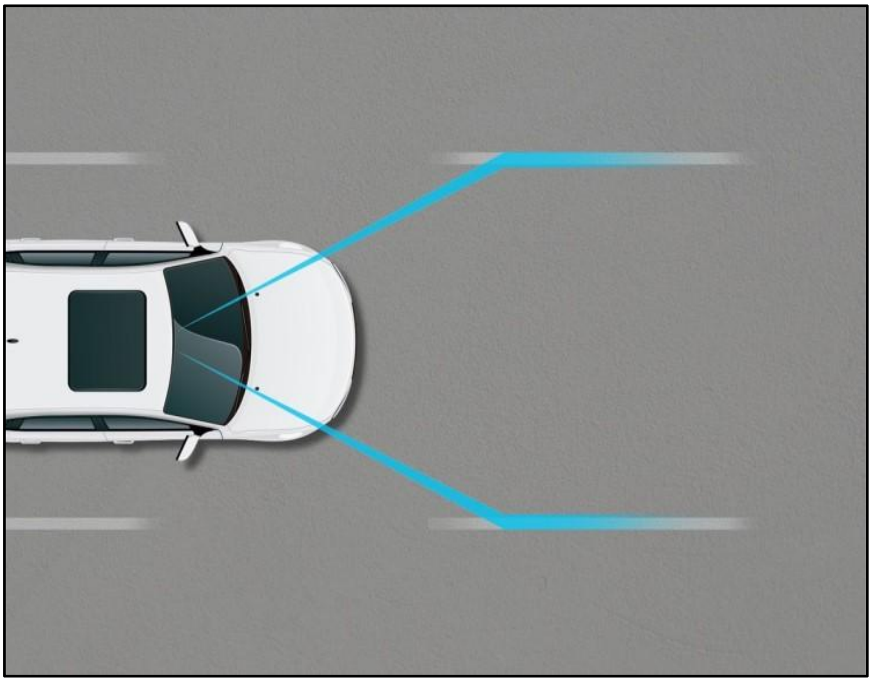

Fig.3.Camera Sensor of Car

Figure 3 shows that the front sensor detects the lane of automobiles and sounds an alarm to warn drivers if the vehicles leave the lane [10]. It has not been applied to the system yet, but in future development, it will also add these features to improve drowsiness detection.

Fig.4.Inclination Detection Vibration Sensor

Figure 4 indicates that the tilt and vibration sensor on ear-flaps measures the tilt of a driver face and generates the vibration of a certain tilt value is detected [11].

The vehicles, Lexus, developed by Toyota have applied various ways and technology to prevent drowsy while driving. For Toyota, the Lexus model, introduced in 2008, has been equipped with anti-drowsiness features. Figure 5 shows an infrared camera mounted behind the steering wheel to recognize and operate the driver.

Fig.5.Drowsy Driving Prevention of Lexus

The vehicles, Lexus, developed by Toyota have applied various ways and technology to prevent drowsy while driving. Currently, only commercially available functions are available for camera recognition.

• The image processing technology, recognizes drivers with a camera, is used. This models them in 3D with 238 points and 913 meshes.

• The information on driver's feelings (angry, sadness and happiness) is extracted by using mesh points.

• An analysis system recognizes the behaviors of drivers such as staring at another person or looking at a smart phone.

• It increases accuracy by using hundreds of factors to solve a variety of analytic perceptions such as age, gender and race.

• It analysis the distance between the upper eyelid and the bottom eyelid to calculate how long drivers open their eyes.

• It uses a total of four alarm systems to identify the risk of accidents and to respond different situations according to each alarm level.

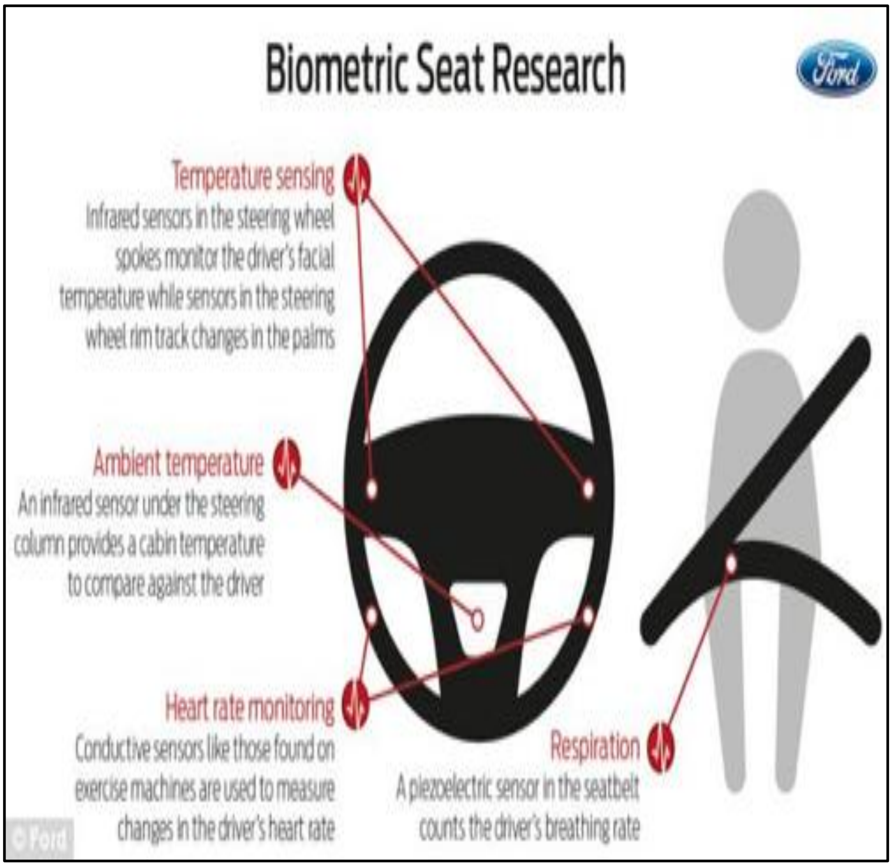

Fig.6.Drowsy Driving Prevention of Ford

Figure 6 represents the technology to detect and prevent drowsy driving in the automobiles developed by Ford. The company applied the prevention technology of the drowsy driving as follows [13]. Ford's driver condition management system uses the ir sensor on the handlebar, the heart rate sensor, and the breathing sensor on the seat belt to collect biometric information, analyze steering wheels and pedals, and calculate driver fatigue so that you can concentrate on driving. It is a guide system. Ford comes with a temperature sensor and heart rate detection. However, the accuracy of drowsy driving detection is not high with these functions alone.

- It performs collective analysis using automobile information (speed, length, acceleration, tilt, etc.).
- The driving activities of drivers (accelerator pedal and brake pedal tilt), surrounding environments (road surface and traffic situation) and biometric information on drivers (ambient temperature, body temperature, respiration rate and heart rate) in order to check the states of drivers.
- It uses six electronic sensors on the driver's seat to examine the heart rate even though drivers are

Fig. 7. Driving State Monitoring System in DENSO

Figure 7 shows DENSO's operating condition monitoring system. Denso's technology maps faces to 68 feature points and reads the user's facial expressions, using 1 to 6 scales to detect drowsiness and alert.

3. Design of Drowsy Detection

3.1 Eye Blink Detection

Face recognition should be first performed in order to detect eye blinking. Therefore, a system recognizes pupils of driver's eyes after recognizing the face and examines the blink speed of eyelids to detect drowsiness.

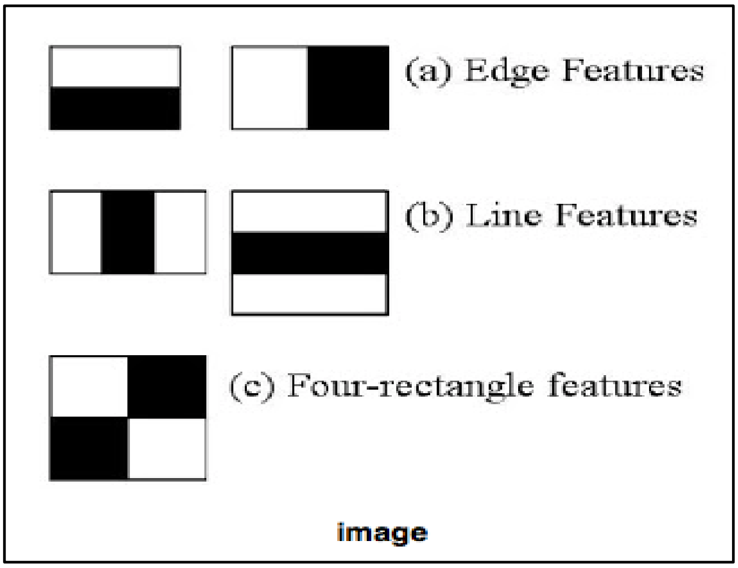

Fig.8.Haar Cascade Method

In Figure 8, the Haar Cascade technique, which uses the patterns of light and shade in OpenCV, is applied to recognize the face of human beings. In the face of drivers, the eyes are dark and the nose is bright. Therefore, the technique extract face information by analyzing the pattern in the black and white image. Further, extracted face information is recognized by using the Haar Cascade in the OpenCV [14]. The study actually applied this technique to recognize the eyes of a human face. However, the Raspberry Pi environment used in this study was poor in its performance. So the study referred to Korean standard face data to determine the eye position of drivers.

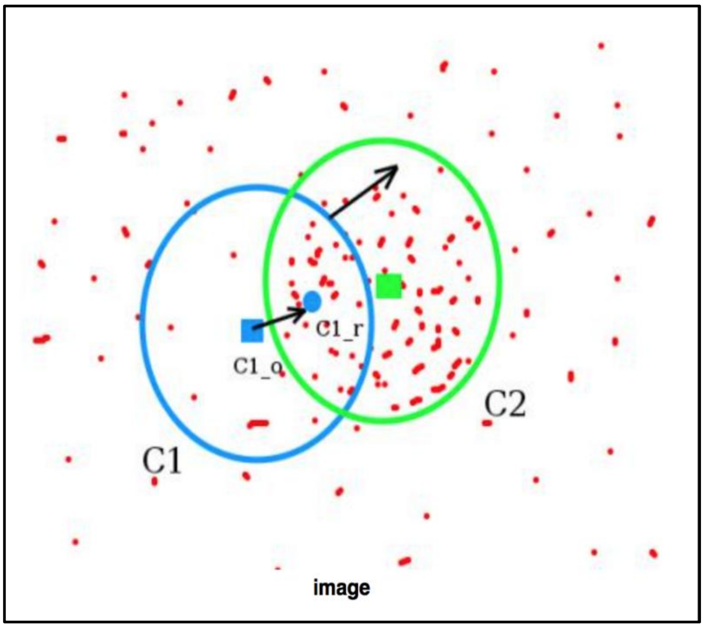

Fig. 9.Mean-Shift Method

Figure 9 shows that eyes of drivers can be continuously tracked by applying the Mean-Shift to continue to track them even though they move. The Mean-Shift is a method to find the peak or center of gravity of data distribution, which indicates the algorithm moving to data dense area and the center of the distribution. When data is distributed on a 2D plane, the process of finding the most dense peak point of data is constructed by the following methods [15].

1. Obtain data coming in the radius r from the current position.

2. Move the current position to the coordinates of the center of gravity.

3. Repeat step 1 and 2 until the position converges.

For pupil detection, OpenCV's Hough Circul Transform was applied. This method detects pupils in the eye region. The detected pupils are binarized and filtered, and all pixels brighter than the threshold are designated as white, and the other areas are designated as black. The following formula was applied to obtain a binary image.

$$\mathrm{T(x,y)} = \frac{1}{n^2}\sum_{x_i}\sum_{y_i} I\left(x + x_i, y + y_j\right) - C$$

Then, using the Canny Edge Detection algorithm, an object boundary was found in the image. This method is efficient for contour extraction and can remove all contours related to the gray matter in the original image. This technology is improved over the existing face recognition and blink detection technology, and machine learning is also applied to improve detection performance. The existing pure image processing could not achieve the desired performance within a short period of time. Therefore, the user's senses decided to create a program to learn what the state of the new frame would be after learning the eyes and the open eyes. By creating a module that stores the image of the user's eye area in the category.number.jpg format, a vector with 1024 features is created. This value was determined through a hyperparameter tuning experiment. Softmax was used as the activation function. Stockastic Gradient Descent was used as the learning model.

3.2 Carbon Dioxide Detection

As a result of a questionnaire survey, it was found that many drowsy driving operations would occur depending on the air quality in vehicles. Therefore, this study tried to prevent the drowsy driving by detecting the concentration of carbon dioxide in the vehicles.

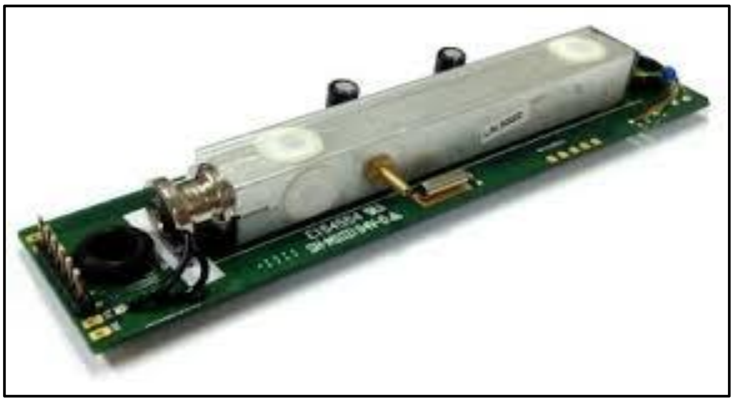

Fig.8.Carbon dioxide concentration Sensor

Figure 10 represents a sensor for measuring the concentration of carbon dioxide of the NDIR system. In case of the concentration of carbon dioxide is over 1,500 ppm, it was expected that drowsiness would appear. Further, in case of concentration of carbon dioxide was high, it not only caused drowsiness and stiffness but also caused dizziness and headache and health problems. This sensor measures the concentration of carbon dioxide to the extent that refraction is caused by gas concentration using a non-distributed infrared emitting unit. The sensor has high durability and high accuracy, thereby detecting drowsy driving quickly. Among the sensors of semiconductor resistance, electrochemical and the NDIR, this study used the NDIR method to measure driving conditions, with the consideration of cost-effectiveness and efficiency.

4. Conclusion and Future Work

This study designed a system to detect and prevent drowsy while driving. In addition, it developed and tested actual cases based on the design. It used Python and C language for its developmental environment, and it used Raspberry Py 3, infrared camera, speaker, microphone, carbon dioxide sensor, Galaxy S4, and the automobile model, Sonata. In the future, it plans to build a system that is linked with the application on the smart phone and check the real-time reaction rate through actual testing.

Table 1. compares and analyzes the functions of this system with domestic and foreign products that are currently commercialized.

Table 1. Compare Analysis of Product

	Hyundai	Toyota	Ford	Our System
Face Detection	O	O	O	O
Eye Blink Detection	X	O	O	O
IoT Sensor Chip(Co2)	X	X	O	O
Auto(TV,Radio) Play	X	X	X	O
Rest area Map Position Information	X	X	X	O
Auto Air Fresh	X	X	X	O
Heart rate Check	X	X	O	X

Finally, it will develop the application not only on Android but also on iOS environment for further development and inter-working.

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