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A Study for Drowsy Detection & Prevention System

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Abstract: ***Recently, the casualties of automobile traffic accidents are rapidly increasing, and serious accidents involving serious injury and death are increasing more than those of ordinary people. More than 70% of major accidents occur in drowsy driving. Therefore, in this paper, we studied the drowsiness prevention system to prevent large - scale disasters of traffic accidents. In this paper, we propose a real - time flicker recognition method for drowsy driving detection system and drowsy recognition according to the increase of carbon dioxide. The efficiency of the drowsiness prevention system using these two techniques is improved.***

Keywords: ***Drowsy, Driving, Prevention, Detection, Iot***

I. 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].

In this study, we were aware of the fact that the drowsy state of drivers could be detected by checking the amount of carbon dioxide in the car and using the flickering speed of their eyelids to detect and prevent the driving while drowsy. Therefore, this study tried to examine current drowsiness prevention technology through domestic and overseas cases in Chapter 2, and it proposed a design to prevent driving while drowsy by checking the amount of carbon dioxide and the flickering speed of the eyelids in Chapter 3. Finally, it suggests its conclusion and future work in Chapter 4.

II. CASES

2.1 Domestic 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].

Fig. 1. Mobis of Hyundai

Fig. 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].

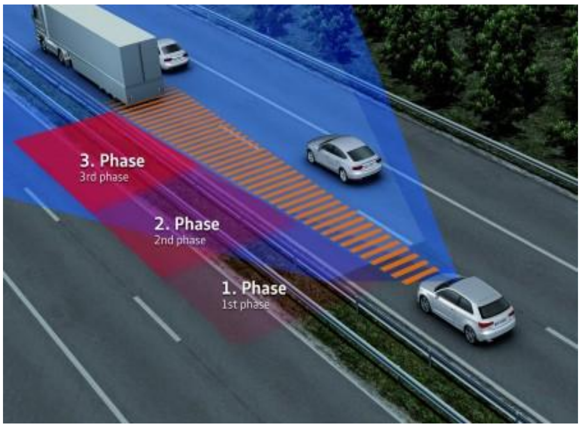

Fig. 2. Gap of Cars

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

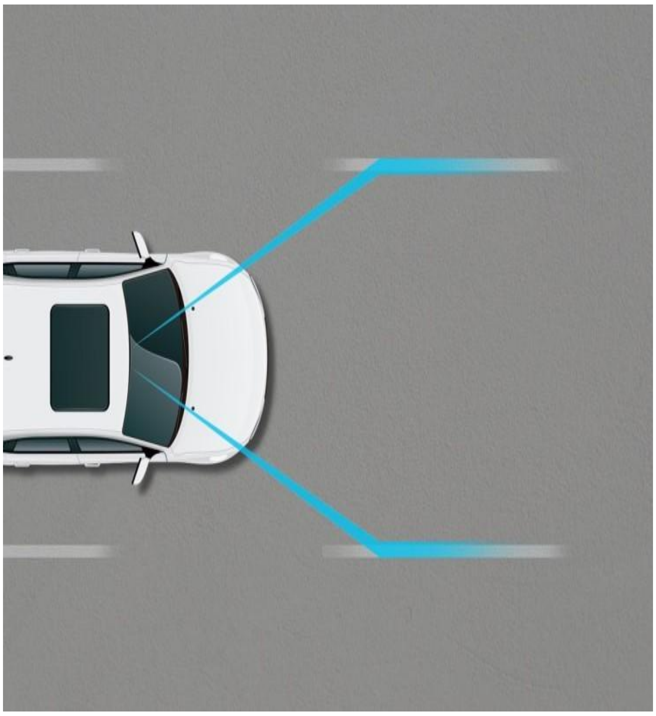

Fig. 3. Camera Sensor of Car

Fig. 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].

Fig. 4. Inclination Detection Vibration Sensor

Fig. 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].

2.2 Overseas Cases

The vehicles, Lexus, developed by Toyota have applied various ways and technology to prevent drowsy while driving.

Fig. 5. Drowsy Driving Prevention of Lexus

Fig. 5 shows screen of drowsy driving prevention of Lexus. The vehicles, Lexus, developed by Toyota have applied various ways and technology to prevent drowsy while driving.

- The image processing technology, recognizes drivers with a camera, is used. This models them in 3D with 238 points and 913 meshes.
- 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.
- 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 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 increases accuracy by using hundreds of factors to solve a variety of analytic perceptions such as age, gender and race.
- It uses a total of four alarm systems to identify the risk of accidents and to respond different situations according to each alarm level.

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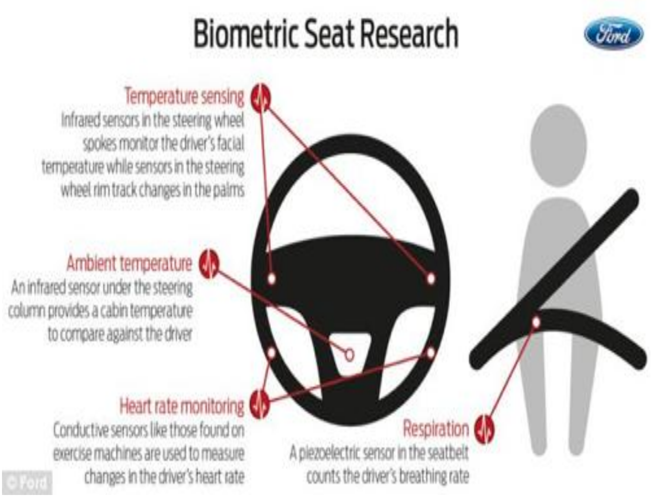

Fig. 6. Drowsy Driving Prevention of Ford

Fig. 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].

- 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 dressed.

III. DESIGN

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.

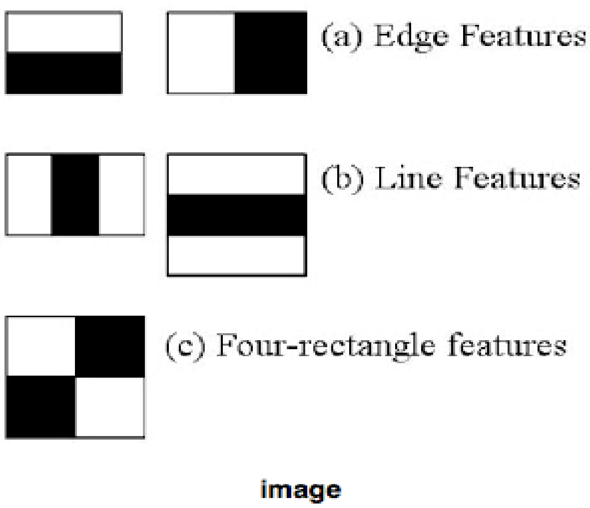

Fig. 7. Haar Cascade Method

In Fig. 7, the Haar Cascade technique, which uses the patterns of light and shade in OpenCY, 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.

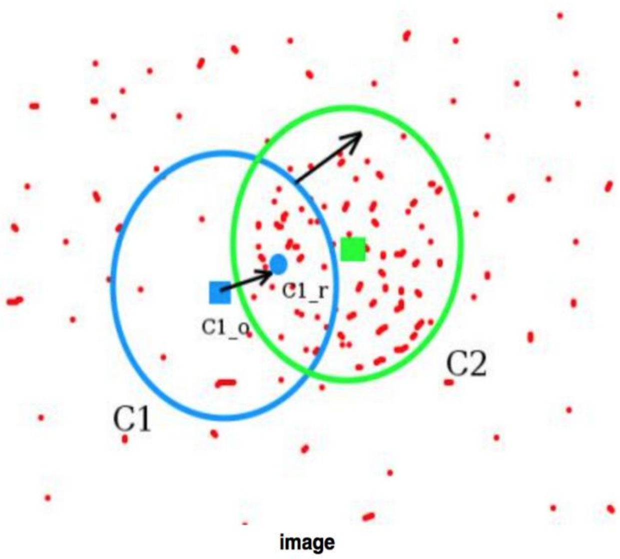

Fig. 8. Mean-Shift Method

Fig. 8 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.

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.

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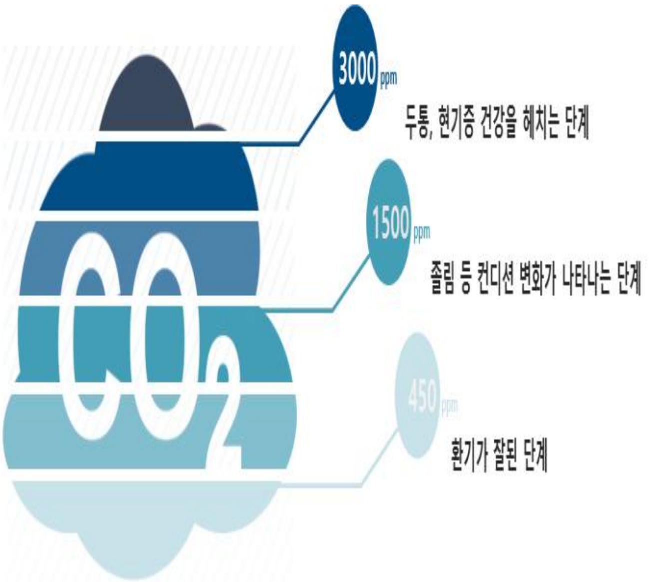

Fig. 9. Result of Carbon dioxide concentration

Fig. 9 indicates the result of body reaction according to the concentration of carbon dioxide. 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.

Fig. 10. Carbon dioxide concentration Sensor

Fig. 10 represents a sensor for measuring the concentration of carbon dioxide of the NDIR system. 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.

3.3 System Configuration Diagram

The configuration diagram of the drowsy driving detection and prevention system in this study mainly consists of three stages. The first step is an input part and it consists of sensors, microphones and cameras. The second step is a internal module part and it consists of STT, drowsiness prevention, internal environments and entertainment.

The final step is the part of this project, and its system configuration diagram represents the whole configuration diagram of this project.

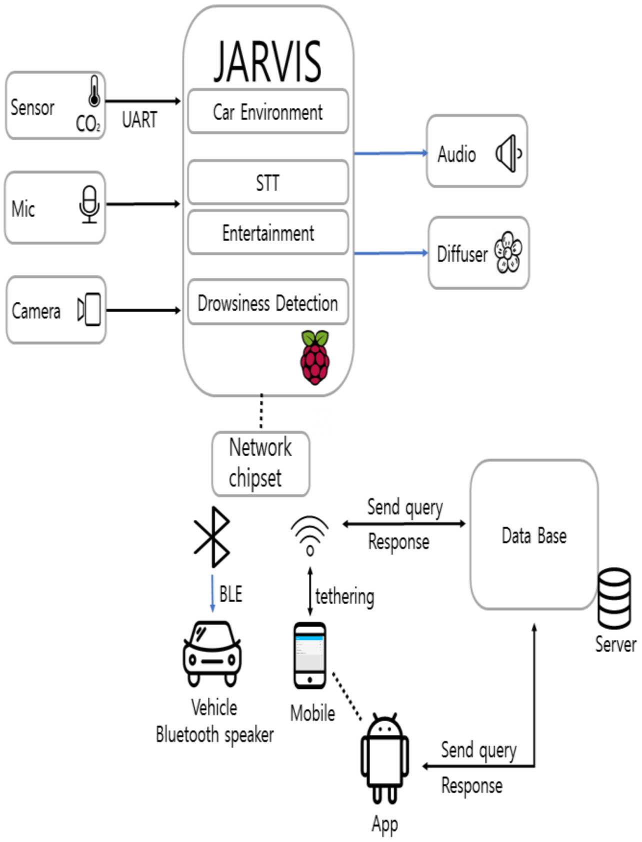

Fig. 11. Structure of System

Fig. 11 represents the system configuration diagram. The following items summarizes the system configuration diagram.

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- Input
  - Sensor: CO2 temperature sensor, which can measure the concentration of carbon dioxide by up to 3,000 ppm
  - Microphone: Microphone that receives user voice commands
  - Camera: Infrared camera that can operate in the night
- Iternal Module
  - STT : Infrared camera that can operate in the night
  - Drowsiness Detection: Drowsiness detection module
  - Iternal Environment: Temperature & carbon dioxide sensor, module and weather & environment module
  - Entertainment: Broadcasting, music and news module
- Output
  - BLE : Output by a car built-in speaker with the connection of bluetooth
  - Audio: Motion output of automobile secretary (audio guidance, conversation, broadcasting and music)
  - Air Freshener: Operation for indoor ventilation and drowsiness prevention

```
left_eye = right_eye = None

if len(eyes) > 0:
    for i, v in enumerate(eyes):
        ex = v[0]
        ey = v[1]
        ew = v[2]
        eh = v[3]
        if ex + (ew/2) <= w / 2:
            left_eye = eyes[i]
        elif ex + (ew/2) > w / 2:
            right_eye = eyes[i]

    if left_eye is not None:
        cv2.rectangle(img, (x + left_eye[0], y + left_eye[1]),
                      (x + left_eye[0] + left_eye[2], y + left_eye[1] + left_eye[3]), (0, 255, 0), 2)

    if right_eye is not None:
        cv2.rectangle(img, (x + right_eye[0], y + right_eye[1]),
                      (x + right_eye[0] + right_eye[2], y + right_eye[1] + right_eye[3]), (255, 255, 0), 2)
```

Fig. 12. Example of Source

Fig. 12 indicates some of the actual developed sources. There were many cases of wrong detection such as eyebrows, hair, etc. Therefore, this study implemented this source of reducing the wrong detection by exactly recognizing left eye and right eye when both eyes are located in each face position according to the center of the face.

IV. CONCLUSION

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. 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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