Advanced Science and Technology Letters
Vol.98 (CES-CUBE 2015), pp.161-165
http://dx.doi.org/10.14257/astl.205.98.41

Development of an Ignition Interlock Device to Prevent Illegal Driving of a Drunk Driver

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Abstract. In this paper, we introduce that embedded system can be prevent illegal using of a alcohol measuring device. Also, To prevent the driver operates the vehicle after drinking alcohol. A step-by-step operator(user) identification method of the our system is using a fingerprint and face recognition based on digital image processing. To consider the time and accuracy for fingerprint recognition, which was implemented in ASIC rather than software systems. And, to increase accuracy of the face detection algorithm by using Adaboost, PCA, LDA. Through this system, the driver is expected to be reduced drunk driving related accidents and damage that is preventing the illegal drunken driving and using start-up lock system.

Keywords: Drunk-driving, Ignition Interlock, Alcohol measurement, Fingerprint sensor, Image processing.

1 Introduction

In the past 5 years, the ratio of traffic accidents caused by drunk driving in Korea was 13%, and 15% of accident mortalities died from drunk driving.

Relevant laws and punishments are getting reinforced to reduce accidents and damages from drunk driving, but there is a lack of shift in awareness about danger of drunk driving and limit to voluntary efforts of drivers. Accordingly, the Korean government has raised the necessity for distribution of an ignition interlock device that can prevent accidents of drunk drivers. It is necessary to place research efforts into application of devices which prevent drunk driving such as drunk driving alert device and ignition interlock device based on analysis of foreign examples. Among such devices, countries like the United States, Canada and Japan are developing, obliging and distributing ignition interlock devices to prevent drunk driving accidents. However, it only involves legal restrictions upon exposure of illegal use of alcohol measuring instrument and does not include a function to prevent drunk driving in advance [1][2].

The system proposed in this paper has the same function of controlling ignition depending on drinking status, but it was also designed and implemented to prevent driving of vehicles by drunk drivers and illegal use of alcohol measuring instruments using fingerprint recognition sensor and image processing. Fingerprint recognition

ISSN: 2287-1233 ASTL

sensor used to prevent illegal use of alcohol measuring instruments has security issues such as manufacture of fake fingerprint using chemicals and silicon. This sensor can easily identify the same driver, but it is vulnerable to fake fingerprints. Face recognition and discrimination functions were added and used with fingerprint recognition sensor to increase accuracy and reliability by supplementing such disadvantage.

This paper has the following composition. Chapter 2 explains the system to prevent illegal use by drivers. Chapter 3 describes the proposed system, and Chapter 4 draws conclusions.

2 Design of Ignition Interlock Device to Prevent Illegal Use of Drunk Driver

The system proposed in this paper consists of driver information (fingerprint, alcohol, image processing), vehicle information (ignition key, vehicle velocity, brake), integrated ECU (GPS, wireless communication, ECU), and server. For driver information, blood alcohol concentration, fingerprint, and facial characteristics of driver are collected. Integrated ECU controls ignition device based on vehicle information, alcohol concentration, fingerprint recognition, and image information, uses vehicle information to determine driving status as to prevent intentional avoidance of drinking check, and transfers data to the server for real-time tracking. When a driver illegally drives a vehicle after drinking, the vehicle can be tracked from the operation center by checking GPS position information installed on the vehicle. <Figure 1> is a schematic diagram of the ignition interlock system.

Fig. 1. Schematic diagram of drunk driving ignition interlock system

2.1 Fingerprint Recognition Sensor Module

Fingerprint recognition sensor module is used for the purpose of checking whether fingerprint of the driver measuring blood alcohol concentration is identical. Capacitive sensor was used, and low temperature compensation circuit was

additionally designed for operation at low temperature. <Figure 2> shows an alcohol measuring instrument integrated with the fingerprint recognition sensor module.

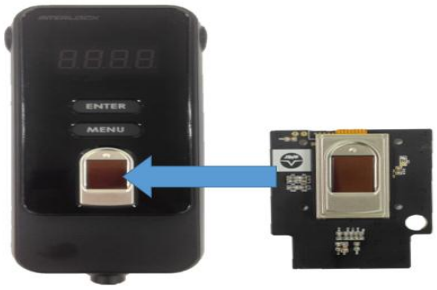

Fig. 2. Alcohol measuring instrument integrated with fingerprint recognition sensor

Integrated alcohol measuring instrument can prevent illegal use of driver by identifying fingerprint with alcohol measurement. It has an advantage of sending alcohol concentration and fingerprint data at the same time.

2.2 Face Discrimination Using Face Recognition

Face discrimination is used for the purpose of determining whether the driver is the same person as registered person on the device by registering facial image of the driver in advance and comparing face of driver to the existing image during alcohol measurement.

Integrated control unit uses an algorithm that combines Adaboost, PCA (Principal Component Analysis) and LDA (linear Discriminant Analysis) to classify and recognize face during registration and discrimination of driver's facial image [3][4]. Eigenface and Fisherface algorithms are used to extract and learn characteristics of driver from several images. <Figure 3> illustrates the driver discrimination process.

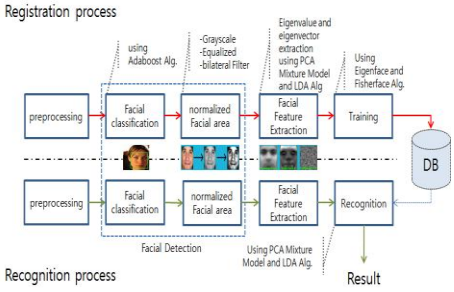

Fig. 3. Driver discrimination process

3 Development of Ignition Interlock Device to Prevent Illegal Use of Drunk Driver

This system provides guidance on fingerprint recognition and faces discrimination using display of alcohol measuring instrument and audio of the integrated control unit before the driver starts the vehicle.

When the system is started, buttons on the alcohol measuring instrument are used to register fingerprint and face of the driver if there are no fingerprint and face data on the fingerprint recognition sensor module and memory of the integrated control unit. Once registration of the driver's fingerprint and facial image is completed, driver authentication can be done to control ignition based on alcohol concentration. <Figure 4> shows the system flow chart and ignition interlock device module.

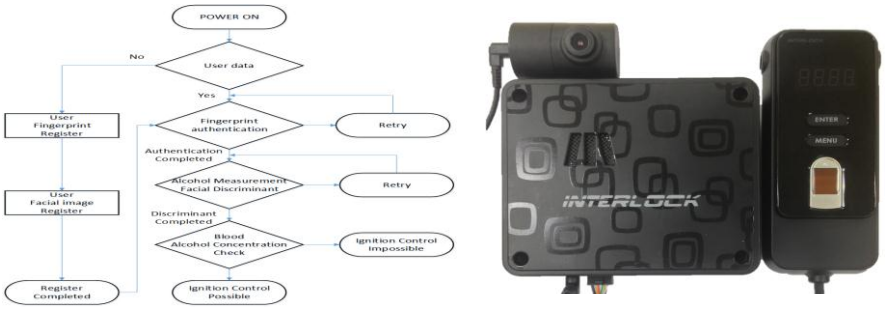

Fig. 4. Flow chart and ignition interlock device module

Face discrimination function was implemented to display ID (User1, User2, ...) granted upon registration or 'Unknown' if the driver is not registered. <Figure 5> is the result of face discrimination on a driver.

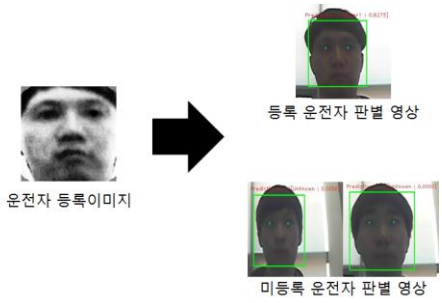

Fig. 5. Screen for driver discrimination

The results of alcohol concentration, fingerprint identification, and face discrimination can be checked through audio of the integrated control unit.

4 Conclusion

In this paper, an ignition interlock device was designed and implemented to prevent drunk driving of drivers and illegal use of alcohol measuring instruments. The proposed system was made to use fingerprint recognition sensor and image processing to determine whether the driver is the same person as registered driver and to control ignition of vehicle based on blood alcohol concentration. However, various scenarios and wrongful uses that may occur in actual vehicles remain to be improved.

Using this system, drivers can reduce accidents and damages related to drunk driving by preventing drunk driving and illegal use of ignition interlock devices.

Acknowledgments. This research was financially supported by the Korea Evaluation Institute of Industrial Technology (KEIT) through the Infrastructure Project for Intelligent Automotive Commercialization Research (No. 10043328)

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