

A Study on Warning Sound for Drowsiness Driving Prevention System

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Abstract

The Korea Expressway Corporation has studied various preventive measures to prevent drowsiness driving accidents, such as providing various drowsiness driven prevention measures, establishing drowsiness rest areas, and operating alarms on drowsiness driving in highway tunnel have been implemented. Recently, the Korea Transportation Safety has also used the monitoring of the driven state (DSM - Driven State Monitoring) and the driving information of the vehicle (VDI - Vehicle Driving Information) to confirm the state of the driver in the running car and perform a drowsiness driving and We are showing good reaction by introducing a drowsiness driven prevention system which sounds vibration and warning sound. As described above, when a driver wakes up during a drowsiness operation, a warning sound plays an important role by installing it in a tunnel or in a car. In this paper, we further developed the warning sound for battle against drowsiness used in the tunnel of the existing highway and studied focusing on using inside the vehicle. This research aims to verify and further improve the warning sound part of the in-vehicle drowsiness driven prevention system which is just introduced and enforced, effectively and contribute effectively to prevent drowsiness driven accidents.

Keywords: Acceleration accident prevention, warning sound, driven state monitoring, vehicle driving information

INTRODUCTION

In case of the car turns into a weapon on the road, it is a case of drunk driving, violent driving, and drowsiness driving. Among them, repeated drowsiness accidents that do not diminish year after year are called as a hidden killer on the road, causing a terrible traffic accident. Among them, drunk driving and violent driving are subjected to severe punishment because the driver's willfulness is fully suspected. However, from the viewpoint that drowsiness driving can become a

criminal without knowing himself, everyone must be careful not to become a perpetrator by thorough self-management. According to a survey conducted by Korea Highway Corporation in 2016, 74.3% of highway users answered that they had experience driving drowsy driving. Recently, the risk of drowsiness driving has been increasing more and more as the damage of the person has continued due to the drowsiness driving accident of the bus. In order to prevent such drowsiness accidents, The Korea Highway Corporation and Korea Transportation Safety Corporation are making efforts. Korea Highway Corporation has established a drowsiness shelter based on drowsiness driving prevention education and has operated a drowsiness driving warning sound in a tunnel. The traffic safety corporation is showing a drowsiness driving prevention system for a bus driver and is in the process of commercialization. Warning sound system for the drowsiness driving in the tunnel of Korea Highway Corporation and warning sound to awaken drowsiness are used in the drowsiness prevention system disclosed by the traffic safety corporation. In this paper, we propose a new sound system to verify the warning sound for the drowsiness warning system and the drowsiness prevention system for the tunnel. This study is a process to increase the efficiency of the drowsiness prevention system to prevent drowsiness driving.^{[1][5][6][7][8]}

CAUSES AND DANGERS OF DROWSINESS DRIVING

The cause of drowsiness driving is the driver's excessive schedule and bad sleeping habit. In addition, there are many people who are drowsiness congenitally and have frequent daytime sleepiness, and there are times when sleep is frequent due to irregular lifestyle. More serious cases are morbid, but even if it is normal, it suddenly falls off and there is a disease that can fall drowsiness enough to not control itself. These people must be treated and treated by a doctor, and driving should be controlled as much as possible according to the symptoms.



Figure 1: Comparison of causes of accidents on the highway

The traffic safety corporation stressed that the risk of road traffic accidents leading to road traffic accidents was the highest in drowsiness driving accidents (22.5%). According to a survey conducted by the Korea Transportation Safety Authority on sleep drivers conducted by 400 drivers, 4 out of 10 people experienced drowsiness driving, and 19% of them had an accident. The main cause of driving drowsiness on the expressway was the accumulation of fatigue (51.5%) and feel drowsy after eating (27.0%), and the drowsiest driving time was from noon to 3 pm (47.5%). Especially, in the case of bus driving, many passengers are aboard, so sleep driving of a bus

driver causes a large disaster. The sleeping attack coming to driving is also scary, also called Hidden Killer which is unknown

It is no exaggeration to say that once a driver falls into a drowsy driving, He does not show an avoidance reaction and therefore he is killer driving. Evasion reactions and drivers will detect accidents, step on the brakes or take actions compared to before the crash, but drowsiness driving cannot do that.

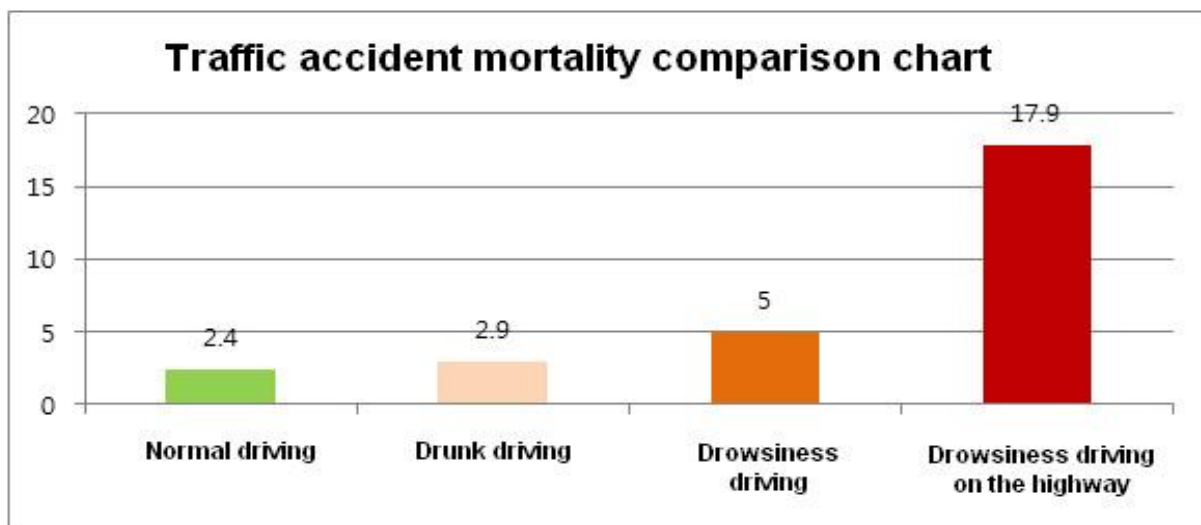


Figure 2: Traffic accident mortality comparison chart

Last year, 215,354 traffic accidents occurred in Korea. The death toll is 5,092, which means 2.4 people per 100 traffic accidents on average. According to the Road Traffic Authority, the mortality rate for drowsiness driving accidents was 5.0 per 100 cases, which was more than twice the overall mortality rate (2.4 per 100 cases). Especially, in case of sleepy driving accident on the highway, 17.9 persons per 100 cases. This were 7.5 times higher than the total traffic accident rate. Drunk driving is looking at the front and the spirit is very powerful while the doze driving is in an unconscious state for a while, so a solution is urgent in that a further fatal accident occurs. [2][3][6][7][8]

DROWSINESS DRIVING PREVENTION SYSTEM

Drowsiness driving prevention system is a way to catch the driver's drowsiness inside the vehicle and sounds and vibrations for fight against drowsiness sound like an alarm and wake up the driver's drowsiness. In the past, warning sound for drowsiness driving was used only for highway tunnels. It is now possible to install a warning sound for drowsiness driving in a vehicle without using it only in a highway tunnel, so that when a drowsiness behavior of a driver is perceived, it automatically sounds like a warning sound so that drowsiness can be eliminated. Various methods are currently under study to detect driver's drowsiness. Install a camera at the top of the driver's seat to detect when the behavior is disturbed and shows drowsy behavior, or a camera

that detects the driver's eye and detects when the eyelids are wrapped for a long time or bowed. It is important that the driver's drowsiness detection system can detect the drowsiness operation of the driver by installing the sensor by various means such as installing the sensor or installing the sensor on the accelerator.

The drowsiness warning device is equipped with a face recognition engine (FSE-Face Sensing Engine) to check the state of the eyes and facial expressions while constantly detecting the face, and a DSM(Driven State Monitoring) To monitor drowsiness driving. As shown in Figure 3, the FSE senses that the eyes are slowly winding downing like E1, E2, and E3, and the DSM checks the change of body condition like B1, B2, B3. The sensing devices operated by the Drowsiness driving prevention system are combined with the digital driving record device, the driver state recognition module, the forward driving image recognition module, and the driver biometric module to manage the driving pattern, the driving record and the driver's state. In this way, when it is detected that the managed detection device is not in a normal state, immediately gives a sound and gives a strong vibration to the seat, thereby announcing a danger warning of the accident to a driver who performs a Drowsiness driving. Especially in the case of a bus, by integrally managing operation information and programs, introducing a wearing band for driving, and managing the body such as blood pressure, pulse, heart rate, etc., an integrated control device for preventing Drowsiness driving. [4][7][8][9][10][11][12][13]

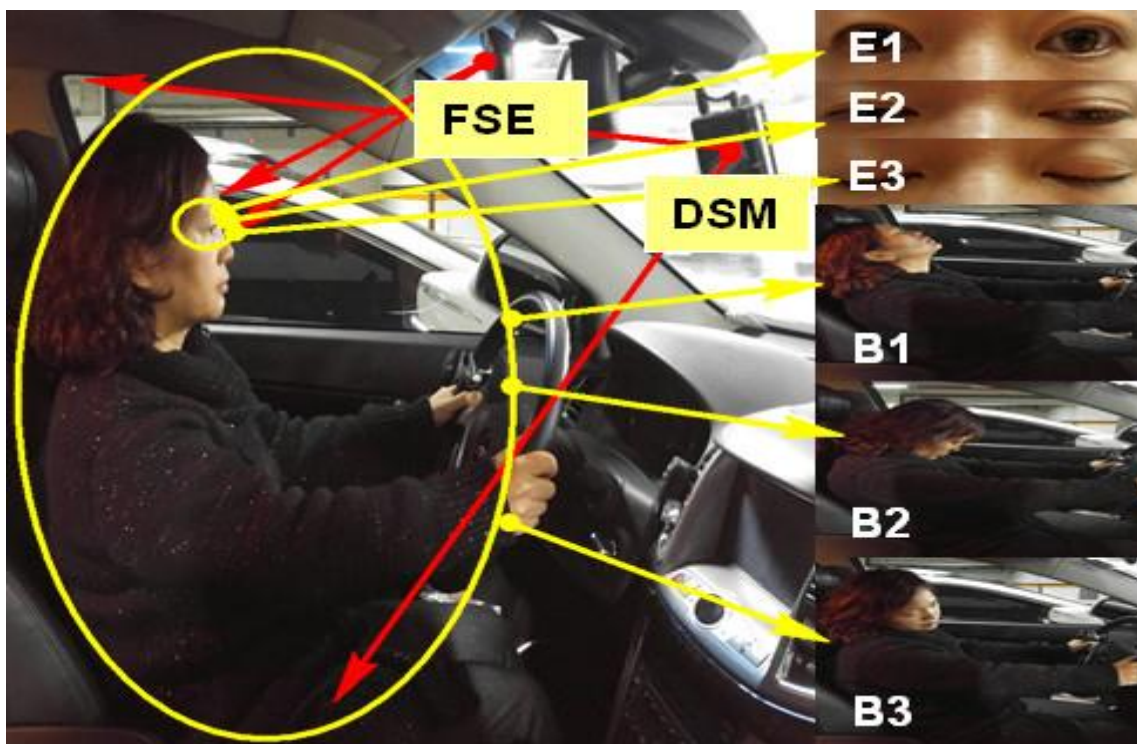


Figure 3: Drowsiness driving warning device Vehicle application example



July 9, 2017 at 2:42 pm near the kyongbu Expressway in Wonji-dong, Seoul

Figure 4: Drowsiness driving accident situation

CONCLUSION PREVENTION OF DROWSINESS DRIVING

The best way to prevent drowsiness driving is to take a good night's sleep. Sleep is also said to be debtors. To maintain the normal rhythm of the human body, sleep is required because it requires adequate sleep. Prevention of drowsiness driving is especially important for drivers. Taking quality sleep through proper driving schedule and regular lifestyle is a prerequisite for prevention. Drunk driving and speeding can be controlled, but drowsiness driving is difficult to control in advance, so check your body condition yourself and get in the car. However, you are driving on the highway and then get drowsiness, it will be a way to prevent accidents by taking enough rest and using the drowsiness shelter made on the element. However, the use of drowsiness shelter is only an improvisational prescription, and regular prevention is necessary.^{[1][5][6][7][8][11][13]}

To prevent drowsiness, the traffic safety corporation should make frequent ventilation in the car and take a rest in a resting place or drowsy shelter after 1 to 2 hours driving. Driver have to have enough rest time the day before long-distance driving and to sleep for 15-30 minutes when I was too tired. Especially on the day before long-distance driving is planned, you should avoid drinking and take a good night's sleep. Do not drive in a hurry, Rest 20 minute after 2 hours driving, drink moderately caffeinated beverages or stretch frequently.

It is good for passengers to talk to the driver instead of sleeping. One way is to open the window to ventilate or use gum or spray to chase sleepiness. Normal people also need to improve their sleep quality through regular lifestyle habits.
^{[6][11][12][13]}

STUDY ON WARNING SOUND FOR DROWSINESS DRIVING

The drowsiness driving prevention system also uses a powerful vibration system, but the warning sound is very important. Because it has to play an effective role in awakening the driver. Currently, highway tunnels use various warning sounds. However, the sound outside the vehicle generates a Doppler effect, the sound cannot be heard intensively due to the perspective, and the sound is distorted due to the space inside the tunnel, so that the effect may be ineffective. However, if you install a warning sound inside the car, you will be able to get the maximum effect by directly stimulating the driver. In this paper, we propose the use of a new warning sound for the drowsiness prevention system, such as Gong sound, kkwaenggwari (small gong) sound, cymbals sound, tofu bell sound, and shaman bell sound. In order to verify the proposed warning sound, we check the frequencies of each sound, compare and analyze each other, and EEG analysis and MOS test.



Figure 5: Warning sound tools for drowsiness driving

Frequency comparison analysis of warning sound for drowsiness

A warning sound for the drowsiness driving prevention system was proposed as the sound of the Gong sound, kkwaenggwari (small gong) sound, cymbals sound, tofu bell sound, and shaman bell sound. The frequencies of the five preliminary warning sounds were compared and analyzed.

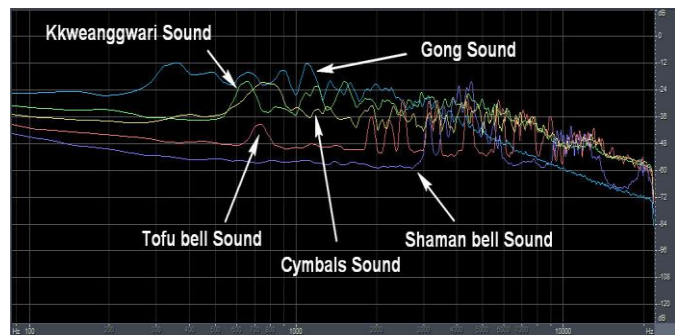


Figure 6: Frequency comparative analysis of the newly proposed warning sounds

The gong sound was analyzed as a sound giving a strong energy from the low frequency band of 300Hz to the band of 3,000Hz and giving the awakening effect. The energy of the kkwaenggwari (small gong) sound was lower than that of the gongs, but the energy was increased from 500Hz to 5,000Hz. The cymbals sounds show high energy at 600Hz to 900Hz and the third highest energy after 8000Hz band. Tofu bell exhibit high peaks at 700 Hz to 800 Hz and exhibit peak peaks at

various frequencies from 1,800 Hz to 9,000 Hz, indicating the fourth most distinct energy. Shaman bell sounds show low energy at 3,000Hz or less, and high energy peak from 3,000Hz to 6,000Hz. In the case where five warning sounds are displayed in the order of energy by frequency band distribution overall, it was the Gong sound, kkwaenggwari (small gong) sound, cymbals sound, tofu bell sound, and shaman bell sound.^{[7][11][12][13]}

Study on EEG response of warning sound for drowsiness

The reason we are awake is because the hypocretin, a neurotransmitter made in the hypothalamus of the brain, is normally maintained. Moreover, our brain suppresses the hypocretin secretion which is an awakening substance when it is necessary to induce usual sleep, feeling tired at night or in the night. However, when excessive work and irregular lifestyle are not taken properly at night, the secretion of hypocretin is suppressed during driving during the day, causing drowsiness. The alpha wave is an EEG (Electroencephalogram) that is activated when awake, blindfolded, or resting reliably. Beta waves are concentrated or active when low beta waves are present, and high beta waves are activated when they are nervous or excited. In other words, alpha and beta waves are active when they are awake. On the other hand, Theta and Delta waves are activated when they sleep. Among them, Delta waves are activated when they fall into deep sleep. Based on these EEG phenomena, each proposed warning sound was heard and then EEG was performed. We investigated the effect of a certain warning sound on the arousal effect.

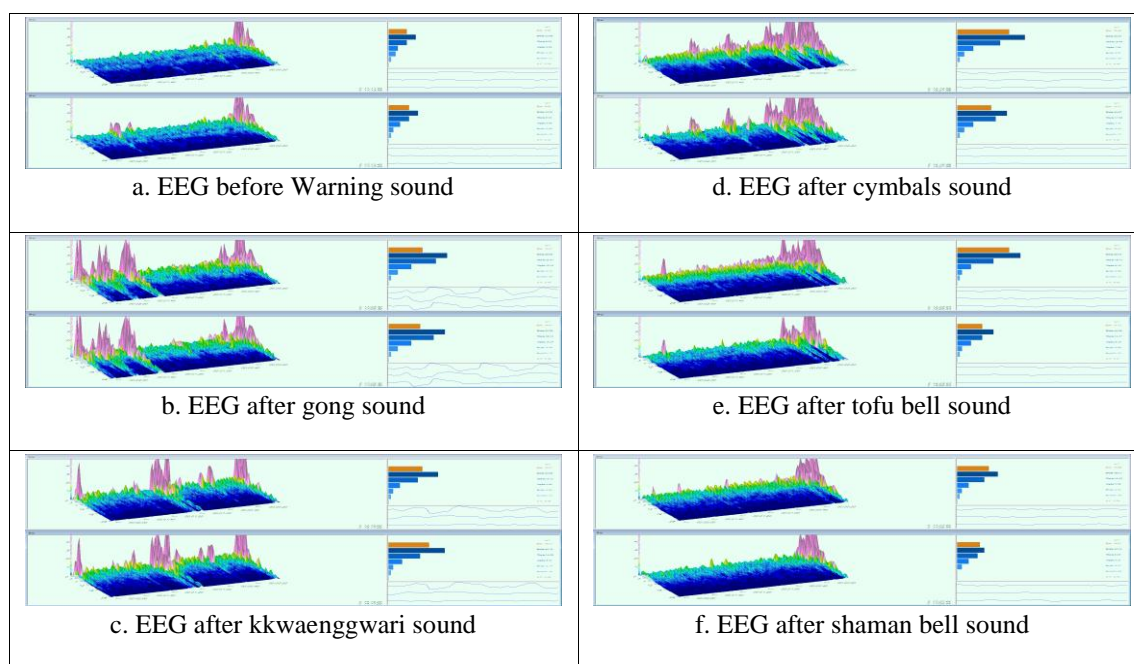


Figure 7: EEG analysis of newly proposed five warning sound

The contents of the brain wave analysis also showed that the degree of response varies according to the results similar to the content of frequency analysis, in the following order gong sound, kkwaenggari sound, cymbals sound, tofu bell sound, shaman bell sound. gong sound wake up the EEG as a whole, and the arousal effect was very active. The kkwaenggari sound also shows that EEG becomes active and awakens sleepiness. The cymbals sound stimulated strongly the brain waves. The head and bell sounds are not as strong, but they are more active than the warning echoes. [8][9][11][12]

MOS(Mean Opinion Score) test of warning sound for drowsiness

We asked five listeners to listen to the five sounds that we would like to propose to use in the drowsiness prevention system and examined their preference score. The preference score is the score according to the effect of warning sound to awaken drowsiness. The best score is 5 point and the score of five listeners for each warning sound was calculated as the average score, and the result of the MOS test was analyzed.

Table 1: Auditor response MOS test for warning sound of drowsiness

Auditor \ Sound	Gong	Kkwaenggari	Tofu bell	Cymbals	Shaman bell
A Auditor	5	4	2	3	1
B Auditor	4	5	1	3	2
C Auditor	5	4	3	2	1
D Auditor	5	4	2	3	1
E Auditor	5	3	4	2	1
Average	4.8	4	2.4	2.6	1.2

Best score: 5 point ※The higher the score, the higher the preference of sound.

Celadon response of warning sound for battle against drowsiness MOSTest result The highest evaluation score 4.8 points of going sound, 4 points of kkwaenggari sound, 2.6 point of cymbals sound, 2.4 points of tofu bell sound, 1.2 point of shaman bell sound. It appeared in the previous order. That is, if the preferences are listed in the order of high sound to low sound, they are in the following order: going sound, kkwaenggari sound, cymbals sound, tofu bell sound, shaman bell sound.

RESULT

Frequency comparison analysis, EEG analysis, and MOS test survey were conducted on five sounds to provide use for warning sound of the drowsiness driving prevention system. Frequency analysis was used to compare the energy of each frequency of the warning sound. The EEG response to the warning sound was analyzed through EEG analysis, and the MOS test was used to investigate the preference that the warning sound would be effective for drowsiness. As a result, in the frequency analysis, it was found that the energy of each of the five warning sounds is strongly distributed in the frequency band which gives a strong arousal effect to the human auditory a little bit. In the EEG analysis, the proposed warning sound prevent drowsiness driving as the proposed warning sound shows the EEG characteristics changing from delta wave or theta wave to alpha wave or beta wave. The average scores of the five auditor responders in the MOS test were in the following order: kkwaenggari sound, cymbals sound, tofu bell sound, shaman bell sound.

CONCLUSION

In Korea Highway Corporation, we are actively striving to prevent drowsiness driving on expressways, such as using sound for drowsiness prevention on highway tunnels. In recent years, the Traffic Safety Management Corporation has held a demonstration to install a drowsiness prevention system inside the bus, and various automobile related industries are studying various systems to prevent drowsiness driving. In this study, we propose to use five sounding gong sound, kkwaenggari sound, cymbals sound, tofu bell sound, shaman bell sound. in the future drowsiness driving prevention system which will be equipped in public. All five proposed sounds were proved by frequency analysis, EEG analysis and MOS test survey that awakening is sufficient. Both of the proposed five sounds were proved through frequency analysis, EEG electroencephalogram analysis, and MOS test survey that the arousal effect of sleepiness is sufficient. Among them, the gong sound and the kkwaenggari sound were proved to have a very good arousal effect. The Sori Sound Engineering Research Institute of Republic of Korea will contribute to prevention of drowsiness driving accidents by continuing various sound researches for eliminating drowsiness and using it as warning sound of drowsiness driving prevention system.

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