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A Study on the Necessity of Driving Sound and Driving Sound for Electric Power Simple Transportation System

[1]Ik-Soo Ahn, [1]Myung-Jin Bae and [2]Seong-Geon Bae
[1]Department of Information and Telecommunication, Soongsil University,
Sangdo-ro, Dongjak-gu, 369 Seoul, Korea,
[2]School of Software Application, Kangnam University, Gyunggi-do, Korea

Abstract: In recent years, traffic accidents of electric power simple transportation equipment which is a simple means of moving as an alternative to environmental problems and energy problems are emerging as social problems. The social problems of the electric power simple transportation system are various such as the driving qualification requirement, the driving road requirement and the compensation requirement in case of an accident. Among them, the cause of direct accidents that cause traffic accidents while driving is the most urgent problem to solve. Above all, there is a special problem that the electric power simple transportation device causes a traffic accident when driving. That is because it is powered by electricity and does not produce sound. The lack of sound has the advantage of reducing the noise of the city center but there is a disadvantage that it does not occur when the electric power transportation system approaches or goes over and it leads to accidents. In this study, we analyze in depth the reasons why driving sound is necessary for electric power transportation system and investigate which sound will be the best driving sound.

Key words: Environmental problems, energy problems, electric power transportation equipment, traffic accidents, optimal traveling sound, requirement

INTRODUCTION

In recent years, electric power simple transportation devices developed and developed in response to environmental issues and energy issues have become popular. In the early days, electric power was installed in a bicycle or a motorcycle and a personal transport device called an electric wheel was often noticed at any time. At first, I enjoyed renting the electric wheel like a rides in a sightseeing or a nearby park but nowadays there are a lot of people who buy and buy for leisure. Since then, the variety of electric wheels with wheels has become more diverse and technology has gradually developed, making it easier to see people traveling on and off the road with electric wheels. Electricity-powered simple transportation devices include electric bicycles, electric scooters, electric quick-boards and electric wheel types such as two-wheel segway and hovercards and smart segway with one-wheel. Various types of transportation means that combine high-performance electric power charging technology are called smart mobility or personal mobility and are collectively referred to as electric power transportation means. Recently, the electric power simple transportation system has been attracting attention as a short distance transportation means because of the development of the popular type and the lowering of the price range. These electric power simple transportation devices are advantageous in that they use environmentally friendly and highly efficient energy and have no loud noises generated from gasoline or diesel power engines. However, there is a problem that the advantage of this noise is a disadvantage on the other hand. Because there is no noise, it does not cause any inconvenience when the electric power transporter is operated. That is, it cannot be detected by the pedestrians or other transportation equipment drivers when the electric power simple transportation device comes or goes. The fact that it cannot detect the electric power simple transportation device is a big disadvantage that the possibility of an accident becomes big. If a pedestrian walks and suddenly turns his head toward the electric power steering unit that is approaching or passing by without sound, a serious accident may occur (Bae *et al*., 2013; Bae and Kim, 2013; Bae and Bae, 2017; Hyung-Jin *et al*., 2007; Sung-Soo *et al*., 2010; Young-Ki and Seok-Won, 2010; Jae-Chu *et al*., 2007; Han-Woo and Yeon-Ho, 1997).

In general, unlike automobiles or motorcycles, electric-powered powertrains are generally used for leisure activities, so, there is no license plate, they are

Corresponding Author: Myung-Jin Bae, Department of Information and Telecommunication, Soongsil University, Sangdo-ro, Dongjak-gu, 369 Seoul, Korea,

excluded from the use notification under the Automobile Management Act and it is difficult to comply with the compulsory insurance under the Automobile Compensation Guarantee Act. It can cause a great loss. This study presents the necessity of driving sound of electric power simple transportation system to prevent accidents of electric power simple transportation equipment which is likely to cause an accident because there is no traveling sound and is a research paper for designing suitable traveling sound. First, the outline of the electric power simple transportation device is explained in order to understand the electric power simple transportation device. Secondly, in order to suggest the necessity of driving sound of electric power simple transportation system, the present state of supply and the occurrence of accidents were investigated. Finally, the optimum traveling sound of the electric power simple transportation system was studied in order to design optimized traveling sound of the electric power simple transportation system. It is important to study the driving sound to prevent accidents during the operation of the electric power simple transportation system. However, those who use the electric power simple transportation equipment are well equipped with the safety equipment, it is most necessary to have a sense of knowing that you need to be safe such as knowing well (Se-Bin, 2014; Bum *et al*., 2012; Lee *et al*., 2008; Moon and Dae, 2015; Kyoung and Jin, 2015; Sang-Hwi *et al*., 2017; Han-Woo and Yeon-Ho, 1997; Pyung-Nam, 2007; Ahn *et al*., 2016).

OUTLINE OF ELECTRIC POWER SIMPLE TRANSPORTATION DEVICE

The electric power simple transportation device refers to a simple ride that uses electric power as an electric power source except electric vehicles. There are electric bikes with electric power devices connected to bicycles, electric motorcycles with electric power devices connected to motorcycles and electric quick discs with electric power devices connected to the quick board. In addition, various kinds of electric power simple transportation devices developed from the development stage to electric power have appeared. Segway is a ride that puts a footboard on two relatively large wheels, a pole in the center, a turn to the knee or a handle to change direction. The electric wheel is a device that puts a footboard on two small wheels and changes the direction of the center by the force applied to the foot. In addition, a variety of electric power transportation devices have been introduced and used such as a wing wheel which is a one-wheeled wheel equipped with a function to move the center of the wheel itself and to change the direction after making a foot on both wheels.

Electric vehicles such as electric bicycles, electric motorcycles and electric wheels are classified as motorized bicycles (similar to motorcycles under 125 CC) in accordance with Article 43 of the Road Traffic Act in Korea, so that, they cannot ride without license. Naturally, if an accident occurs, it is considered to be a car accident. According to Article 13 of the Road Traffic Act, it is stipulated that motorcycle bikes cannot be removed from bicycle roads, cannot be walked on foot and must be driven by roads. For those aged 16 and over, motorcycle licenses must be obtained. For those aged 18 and over, motorcycle licenses or two or more small motor vehicle licenses must be obtained. Recently, the national assembly has proposed a revision bill for the Revitalization of Bicycle Utilization Act to the supervisory board. However, there is a good news that the bike-related legislation that recognizes electric bicycles as a bicycle from March this year will pass the national assembly plenary session and will not be required to carry a license for the electric bicycle and will be able to drive bicycle roads. In addition to electric bicycles, the electric power simple transportation system is also very likely to be able to use bicycle roads if the safety equipment is well equipped and safe (Lee *et al*., 2008).

A STUDY ON THE NECESSITY OF DRIVING SOUND OF ELECTRIC POWER SIMPLE TRANSPORTATION DEVICE

The electric power simple transportation system is environment friendly noise free transportation system because there is no exhaust gas and no noise but it is difficult to comply with the laws that guarantee safety, so, it is necessary to understand the related laws and regulations, so that, it can be operated safely to prevent accidents and take appropriate measures in case of accidents. Especially, the electric power simple transportation device drives the wheels by using the high performance motor, so, unlike the power device using the oil energy, there is no operation sound. The absence of operating noise has the advantage of helping to suppress noise in the city center by not making noise on the road but it often happens that the accident does not occur to pedestrians or other means of transportation. At night, there is a front headlight and a taillight to give some warning but in the daytime you have to be in sight but you have to be able to recognize the Clackson and beep.

According to recent trends, the distribution of the most popular items of electric wheel, one-wheel and two-wheel, shows that the number of supply of wheel wheels has increased at the beginning and that of two-wheel has increased sharply, since, 2016. In addition as the number of supply units increased, the number of

accidents caused by electric wheels rapidly increased. The cause of the accident was various but there were many accidents because the electric wheel did not have a driving sound and it did not act as a warning sound. Hybrid cars that use electricity as a power source do not generate sound which causes accidents, so, they are used to create virtual engine sounds and running sounds. Still, cars have private roads, so, the number of accidents has decreased considerably after adopting the virtual sound addition method. However, since, the electric power simple transportation system has no dedicated road and the body is small, its presence is insufficient and a driving sound is urgently needed because it uses a lot of pedestrians.

A STUDY ON OPTIMAL DRIVING SOUND OF ELECTRIC POWER SIMPLE TRANSPORTATION SYSTEM

In urban areas, the sound required to operate the electric power transportation system should be developed as a warning sound that can sound like a pedestrian or other means of transport, not an audible harmful noise but a natural sound to other sounds. It can be seen that the existing gasoline luxury passenger car sounds soft enough to give attention to the pedestrian even though the noise is not large. We focused on the driving sound of such a luxury passenger car and the sound for the traveling sound design of the electric power simple transportation device was firstly selected as the lion roar sound and the tiger roar sound which are the sounds of the similar frequency band. In the future, it is necessary to develop various sounds but in this study, first of all, we analyze the acoustic sound of the running sound of a luxury gasoline passenger car and the roar of a lion and a tiger. Time domain, spectrogram and spectral analysis were performed for the acoustic analysis. The time domain graph is a graph that can analyze the frequency composition and persistence of sound. To design the electric power transporter, we analyzed the roaring sounds of the luxury passenger car and carefully selected lions and tigers using time domain graphs (Fig. 1).

Looking at the time domain graph above, it can be seen that all three sounds continue to remain calibrated in a continuous, moderate dB range. The roar of the lion and the tiger was analyzed as a driving sound of the electric power transportation system and it was analyzed that it would be able to provide a warning function without any bouncing more than the sound of the surrounding

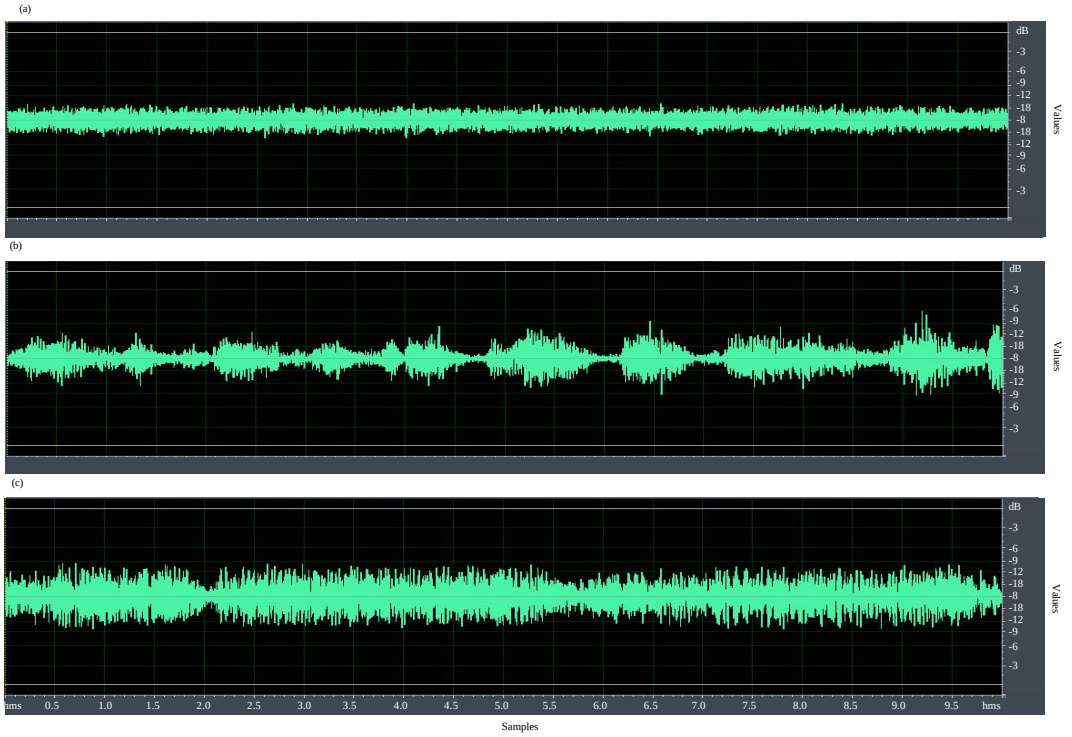

Fig. 1: Sample sound time-domain graph for electric power simple transport device travel sound design: a) Waveform of luxury car sound; b) Waveform of lion roaring sound and c) Waveform of tiger roar sound

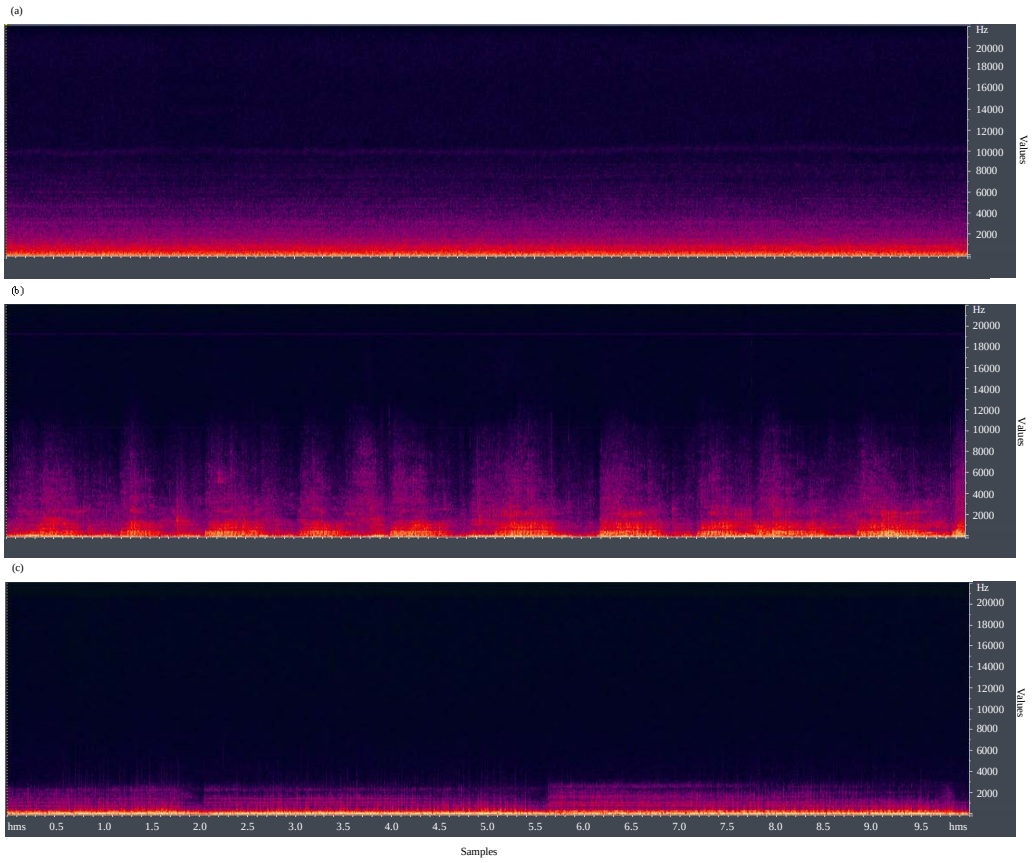

Fig. 2: Sample sound spectrogram graph for electric power simple transport device operation sound design: a) Spectrogram graph of luxury car sound; b) Spectrogram graph of lion roaring sound and c) Spectrogram graph of tiger roar sound

environment. The spectrogram graph is a graph that can analyze the energy of sound by frequency. To design the electric power simple transportation system driving sound, we analyzed the roaring sound of a luxury passenger car and carefully selected lion and tiger by a spectrogram graph (Fig. 2).

If you look at the spectrogram graph, you can see that all three sounds continue to remain calm and sound with the proper dB range. The roar of the lion and the tiger was analyzed as a driving sound of the electric power transporter. The spectrum graph is a graph that can compare and analyze the average distribution of dBs per frequency of sound (Fig. 3). To design the electric sound power transporter traveling sound, we compared and analyzed the spectral graph of the roaring sound of the lion and the tiger carefully selected from the passenger car driving sound.

The luxury gasoline passenger car had a sound characteristic that gradually became stronger in the low frequency band and a high frequency sound characteristic that gradually decreased in the 1,000 Hz standard. Experience has shown that people are accepting car sounds of these characteristics rather pleasantly without feeling discomfort. As a result of tracking the sound with the acoustic characteristic that the low frequency band is gradually increased and the high frequency band is gradually lowered based on 1,000 Hz, it is found that the roar of the lion and the tiger have sound characteristics almost similar to the running sound of the high-could. Even if you do not have a roaring sound of a lion or a tiger, you can design a distinctive electric power transport sound system by designing an acoustic instrument such as an electric musical instrument, a sampler or a synthesizer. Of course, it should be noted that it should be used with surrounding sounds, so that, it does not infringe on the surrounding sound of the city, it should be used as a warning sign and there should be no objection to pedestrians.

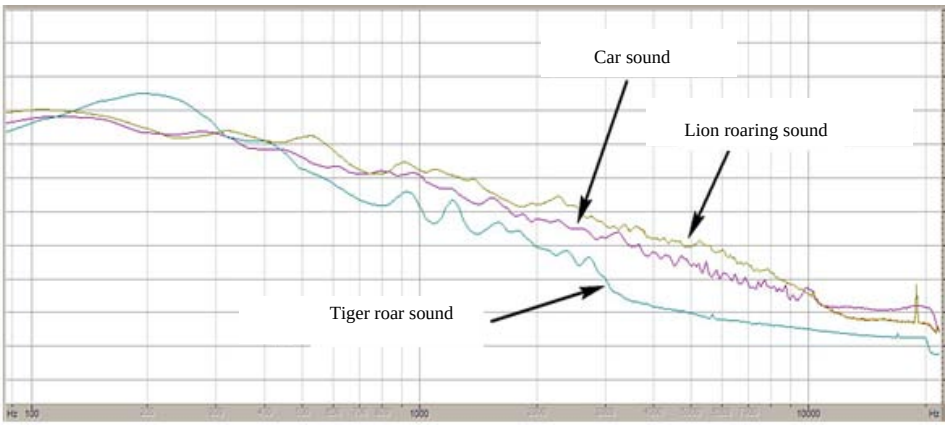

Fig. 3: Sample sound frequency comparison for design of electric power simple transport device operation sound

CONCLUSION

In order to solve the absence of traveling sound which is one of the causes of accident of electric power simple transportation device, we have carried out a study to add a new traveling sound. First of all, we should study harmony with surrounding environment sound in the city center and do not have a sense of discomfort to pedestrians, surrounding drivers or residents. In order to extract a sound model that meets these reference points, we modeled the driving sound of a conventional high-end passenger car. It is to analyze the acoustic sound of a luxury passenger car that produces a smooth and luxurious traveling sound and to model a characteristic of the acoustic sound to design a new traveling sound of the electric power simple transportation device. Acoustic analysis of the traveling sound of a luxury passenger car revealed that the energy gradually increased toward the low frequency side and the energy gradually weakened toward the high frequency side at the reference point of 1,000 Hz. The spectrum frequency graph shows a graph in which the left side of the low frequency side is high and the lower side of the high frequency side is a diagonal line with a low diagonal line. These sound characteristics are heavy but soft sound. When I looked for this sound, the roaring sound of the lion and the roaring sound of the tiger showed similar acoustic characteristics. The roar of lions and tigers is a sound similar to that of a soft luxury car sound but based on these acoustic characteristics, you can customize the sound you want.

RECOMMENDATIONS

In the future, we will continue to research the direction of the electric power simple transportation device in harmony with the environmental sound around the city to make people feel the line without any sense of resistance and to act as a warning sound to prevent accidents, it should be possible to contribute to the further reduction of the incident.

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