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Realization of the Image System for Prevention of Traffic Accidents Inside Tunnel

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Abstract

The tunnel construction is inevitable due to geographical features but the preparing for safe driving is relatively lack in consideration of increasing the number of tunnels. There are various risks involved in the tunnel due to its unique structure and accidents are often accompanied by a lot of personnel and materiel loss in case of traffic accident such as a multiple collision and fire accident. It must be needed to make improvements of inside tunnel environment to solve problems in main reason such as drivers for speeding, sleepiness, and lack of concentrating.

Most accidents in tunnel occur as a result of the careless of the driver and it cause a successive fire accident or a chain-reaction collision by a forward collision. Accident prevention is possible if the prevention of drivers' carelessness such as speeding, sleepiness and too much manipulation of handle is committed in advance. It is necessary for an implementation of video contents in the tunnel wall to prevent the lack of driver's concentrating and sleepiness as a means of improving inside tunnel environment.

Development of projector capable of being interlocked with a video in an external environment through a speed sensor and tunnel external sensor to implement video system for preventing traffic accident in tunnel is essential and projector case study is also important to be able to protect outside dust.

Video system for protecting traffic accident in tunnel is implemented to show the size variable video according to the speed detection of cars in case of high and low speed driving respectively. The outside only projector is not only to prevent traffic accident in tunnel but also to display video for a large information system in the airport or an external walls of building.

Keywords: Tunnel, traffic accident, prevention system, peltier, projectoer Case.

1. Introduction

As a seventy percent of Korean territory is covered with mountains, it is an inevitable fact of constructing tunnels. The preparation for safety driving is relatively insufficient in comparison of an increasing a number of tunnels.[1]

According to data analysis of traffic accidents inside tunnels in 2014, the rate of traffic accidents inside tunnels indicates that this starts ramping up very rapidly to over 170 percent increase from the latter of 2000s. The fact that there has been a 120 percent increase in its traffic accidents all over the country during five years means to increase rapidly a critical or emergency situation which can be occurred in a narrow and dark tunnels.[2] The characteristic of tunnel structure includes risks of various accidents. Serious damage and casualties is often accompanied by big accidents like a multiple pile-up and fire accident. In order to provide visual effects a projector is essentially needed to indicate image inside tunnel. General projector which is vulnerable to dust is usually used indoor. The new projector case which can prevent heat and dust is developed to solve the problem and the projector to increase the width of image is developed to be applied in this study. [3, 4]

2. Related Works

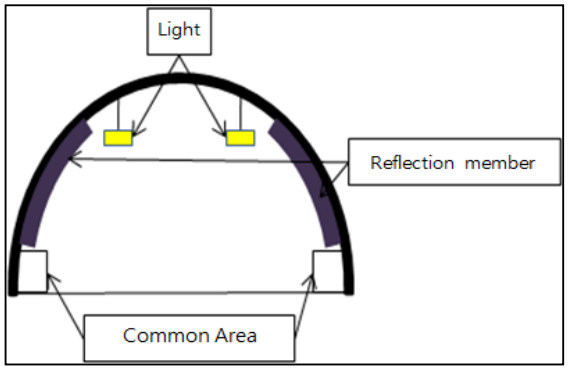

Figure 1: Tunnel Structure for Preventing Accident

The Korea Expressway Corporation has put a multilateral effort into calling the attention of the drivers for using tunnel. Visual guidance facilities that can offer drivers road alignment as well as structural changes in road for safe driving play an important role in tunnel section that is especially important for secure driving ability. [5]

The basic exterior structure of tunnel is used the installation of lighting, reflected tiles on wall, reflected paint, and reflector for the purpose of improving a visibility. Using the rainbow light or the sound of a siren by adding them here can also call a driver's attention. The tunnel structure for accident prevention is shown in Fig. 1.

Peltier Element

Peltier element has a thin-plate-type that is composed of absorbing heat plate and radiating heat plate. An absorbing heat plate is supposed to drop below room temperature(normally below zero temperature) after absorbing an environmental heat when applied voltage while a temperature of heat plate is becoming to increase over 100°C due to radiating the heat in absorbing heat plate and the loss of its electrical energy.[6]

The operating principle is the opposite of a differential thermal generation. Differential thermal makes production of electricity -> Applied electricity makes the formation of differential thermal. Applying theory that free electron is moving toward a positive hole when an electricity is applied in jointed N type/P type semiconductor is used. P type semiconductor is lost lots of heat energy when a free electron of P type semiconductor is moving toward a positive hole even though it has a tiny heat. On the contrary, N type semiconductor will be received a lot of heat. Both side of plates will be heated regardless of absorbing and radiating heat if Peltier element does not solve the self-heating problem. So it is important for the element to reduce heat in the part of heating source in order to show its cooling performance. Peltier element plays an important role to control temperature for an electronic products.[6]

Seebeck effect was discovered by Thomas Johann Seebeck in 1822. He had studied medicine in the Berlin University and shifted to physics. He was a member of Berlin Academy and he discovered that he named Seebeck effect which is the conversion of temperature difference directly into electricity and this contact potential will occur between any two solids. This is the exact opposite concept of Peltier mentioned above. High temperature thermometer is commonly used on measuring high temperature for quantitative measurement thanks to Seebeck effect. Peltier effect was discovered by Jean Charles Athanase Peltier in 1834. The production of heat at one junction and the absorption of heat at the other junction of a thermocouple when a current is passed around the thermocouple circuit. The heat produced is additional to the heat arising from the resistance of the wires. Thermoelectric cooling uses the Peltier effect to create a heat flux between the junction of two different types of materials. Local cooler applied Peltier effect is widely used due to simple structure, eco friendliness, and high reliability. A cool water purifier adopted semiconductor is also used by the effect.[7]

Thomson Effect-Thomson effect was discovered by William Thomson in 1854. He found out a connection between Peltier effect and Seebeck effect and established the relationship of them. Also he created a concept to predict that the heat sink or emissions will be occurred at the ends of conductor when applied a potential difference in the each ends of single-conductor. This prediction was really existed and verified and it was named after Thomson. [8.] The principle of peltier effect is shown in Fig. 2.

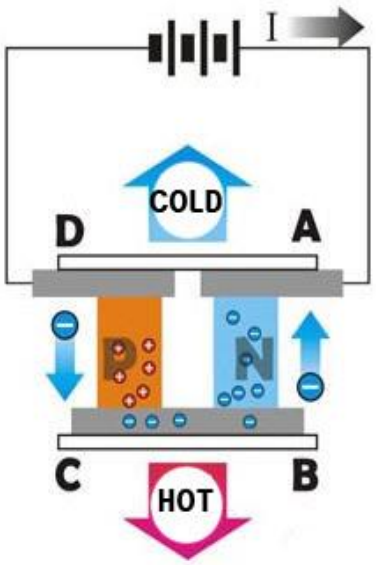

Figure 2: Principle of Peltier Effect

Principle of Projector and Its Type

Its principle is like a cine projector as simple as projecting recorded films to a screen at a distance using a penetration of strong light. A cine projector magnifies the picture of film dozens of times on the big screen even though the size of film is very small like 35mm or 70mm. The application of using its simple principle that makes small picture into big one through an illumination device is a projector. A projector is received an electrical image signal such as video, LD, DVD, TV broadcasting, Cable broadcasting, and others instead of film and its electrical signal is magnified many times on the big screen. Therefore it is possible to make the desired size of image on the screen whereas TV has a fixed size of picture. There are three types of projector such as CRT, LCD, and DLP.

The principle of CRT projector is shown in Fig. 3.

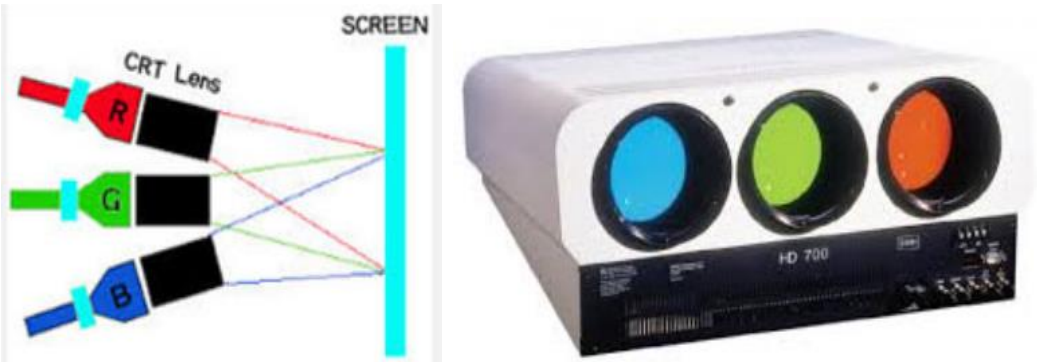

Figure 3: Principle of CRT Projector

CRT Mode-This mode is one of the oldest projection method which is projecting the object through lens after making small and bright picture in cathode ray tube. There are two types of projector according to the number of CRT. Video images were projected onto a same position of screen by the projector with three tubes which are in charge of each color respectively such as red, green, and red. There is an inconvenience of refocusing due to an optical axis not lie on the same line. Another drawback is large volume due to its three CRT built in main body.

LCD (Liquide Crystal Display)

LCD Mode-The performance of LCD panel which is projecting onto a screen through lens that the light from the lamp is passing through LCD panel is to decide a resolution. There are two types such as one chip color sensor and three chip color sensor according to the type of panel. Mixed image through lens is projected onto a screen by the light from the lamp through a dichronic mirror that is separated R, G, B for the input to LCD panel. [9]

The principle of LCD projector is shown in Fig. 4.

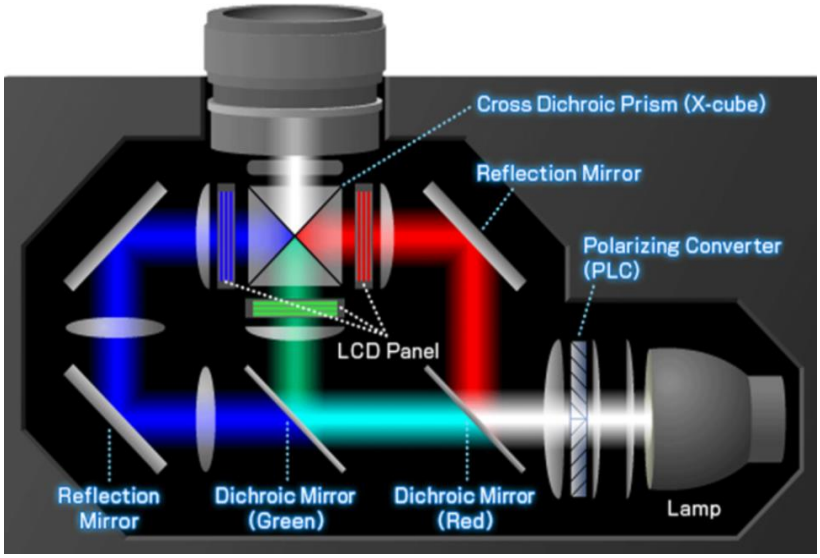

Figure 4: Principle of LCD Projector

DLP (Digital Light Processing)

DLP Mode-Image is to be implemented by the process of reflecting light and that of not reflecting it as DMD (Digital Micromirror Device)is built-in the projector. It is possible to switch on or off condition with very high speed according to video signal due to hundreds of thousands of mirror elements in DMD chip. Also it is suitable for watching movies with high resolution because of a high contrast ratio and an expressive power. But its price is relatively higher than LCD projector and it makes lesser competencies of price.[10]

The principle of DLP projector is shown in Fig. 5.

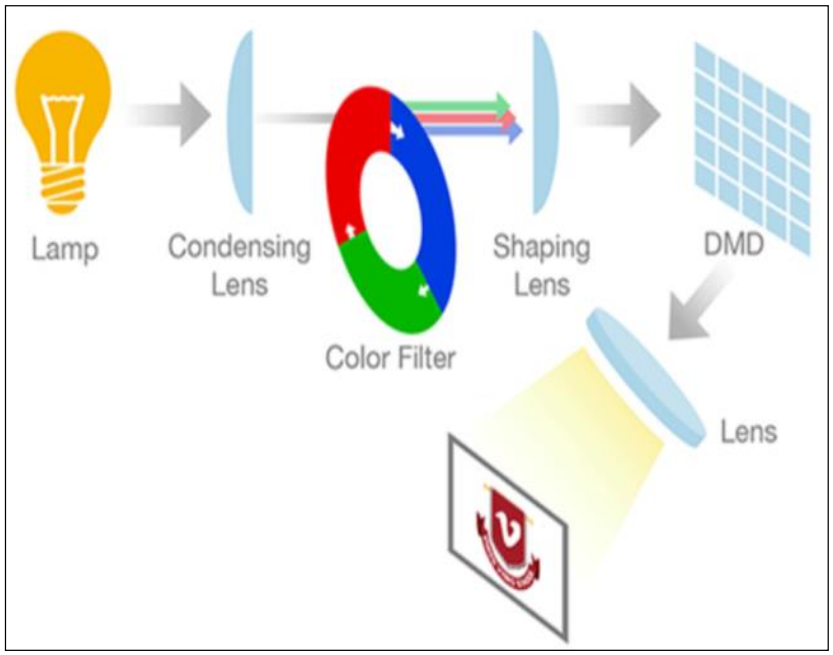

Figure 5: Principle of DLP projector

3. Proposed Method

Driving inside tunnel would make drivers less attentive, and more prone to become severe sleepiness due to an inside tunnel environment shown in Table 1. The measure to improve its environment that causes traffic accidents is surely necessary.

To decrease traffic accidents inside tunnels the implementation of video contents on the tunnel wall makes drivers maintain attention, and prevent sleepiness

Table 1: Inside Tunnel Environment

1. As drivers are entering tunnel the tension builds because the entrance of tunnel seems to look like a black hole for them
2. Decreasing drivers' visibility due to dark reaction and light reaction according to the difference of illumination intensity between before entering tunnel and after entering.
3. Closed and dark environment for driving after entering
4. Shortage of decelerating facilities sufficiently inside tunnels
5. Simple exterior construction due to cost-saving from the entrance to the end of tunnel without using to link a various design concept
6. Monotonous and dark environment of tunnel makes drivers less attentive, and prone to sleepiness

Thermal Dustproof Projector Case

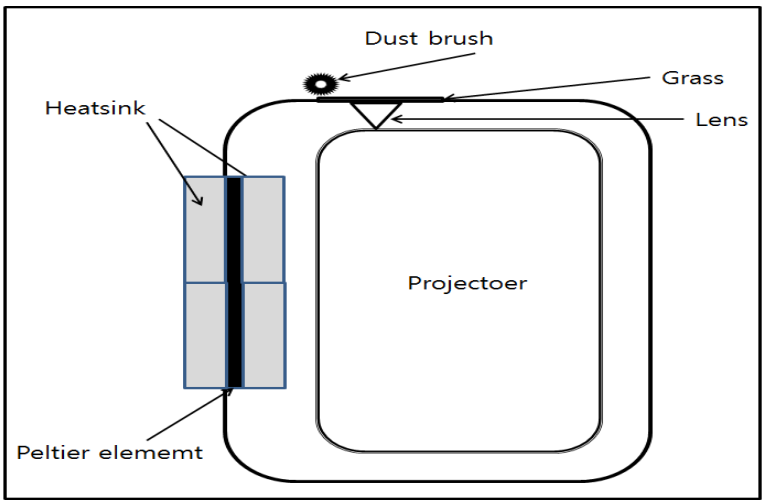

Figure 6: Structure of Projector Case

Projector that is possible to deliver information is equipment that is capable of receiving external data for projection on the screen. It can be installed not only indoor but also on the wall or on the ceiling of the building. Also it is possible to install additional attachments for fixing as well as the supported objects. So it is very vulnerable to foreign materials. Projecting pictures on a screen inaccurately by light due to lens with foreign materials is generally to produce low quality images or broken ones with a poor performance. In order to prevent the performance degradation of projector its case is necessary to protect. The structure of projector is shown in Fig. 6.

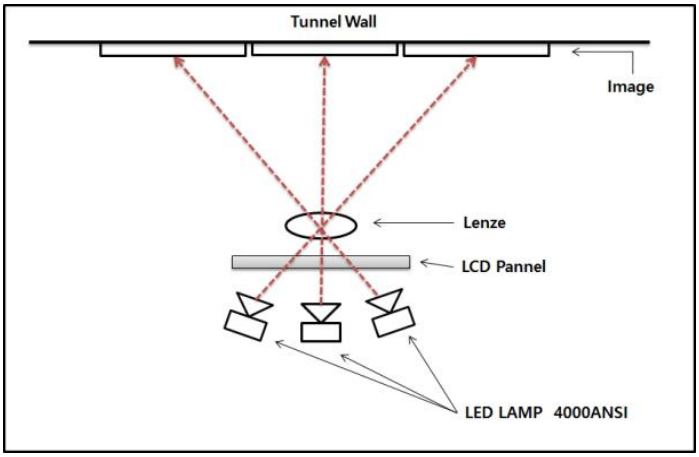

Figure 7: Inside Structure of Projector

The structure of projector case shown in Fig. 6 that is composed of an installation body, a penetration window that can transmit a light from that of projector, and a cleaning part to remove foreign material cab be installed

outdoor. A cleaning device used by a sole for removing foreign material that makes brush rotate while swaying movement from left to right is like windshield wiper in a car. The projector that makes a projected image expandable vertically is developed according to a response of vehicle speed. When LED lamp turns on in regular series shown in Fig.7, the projected image provides magnifying effect.

The inner structure of projector is shown in Fig. 7.

4. Experimental Results

The projector for implementation of image on the tunnel wall is installed as the device that is able to guide drivers' attention such as a speed reduction inside tunnel, preventing sleepiness, and maintaining concentration. A luminous intensity for inside of a tunnel is 80Lux and it is used three LED lamp for 4000ANSI. The tunnel entrance is to be considered to avoid the contrast between light and shade taking account of rapid change between light and shade.

- Implementing sound level above 120dB in the 30m distance base point
- Implementing transmitting video signal with wireless above 1Km in the distance.

In order to implement image that is capable of responding a vehicle speed, the projector is used like Fig.7 and is detected a vehicle speed for the image implementation according to its speed. One image is supposed to implement in case of low speed, two images for middle speed, three images for high speed, respectively. The product to induce driver to focus on reducing speed inside tunnel, preventing sleepiness, and maintaining concentration is to be developed

Hardware Implementation

The projector is installed to implement video on the tunnel wall and the visual environment to maintain complete comport according to choosing proper lighting fixtures and its color provide clear view against obstacles. The tunnel entrance and exit are to be considered to avoid the contrast between light and shade taking account of rapid change between light and shade and UPS (Uninterruptable Power Supply) applied new renewable energy is also installed 30m from the starting point together with sound implementation with above 120dB.

Video Contents Implementation

Video contents based on video design direction is set up by the analysis of characteristic and landscape in the target area and the variety of video contents such as a cheerful background screen and its sound, a background screen and its sound related local public relation, and a backdrop with a depiction of warm or cool condition is also implemented.

System Management and Control

Wire and wireless communication based an existing communication system

makes it possible to control for the use of data stably thanks to loading software. Video and sound which can express a various situation such as a rainy day image in oceans and cool and warm situation according to seasons are implemented by the sensor installed outside tunnel that is linked with a weather information to provide a related image and sound automatically.

The projector implemented the protection against dust as well as heat is shown in Fig. 8. The inner structure of projector which is implemented the protection against dust as well as heat is shown in Fig. 9.

Figure 8: Projector for Protection Against Dust and Heat

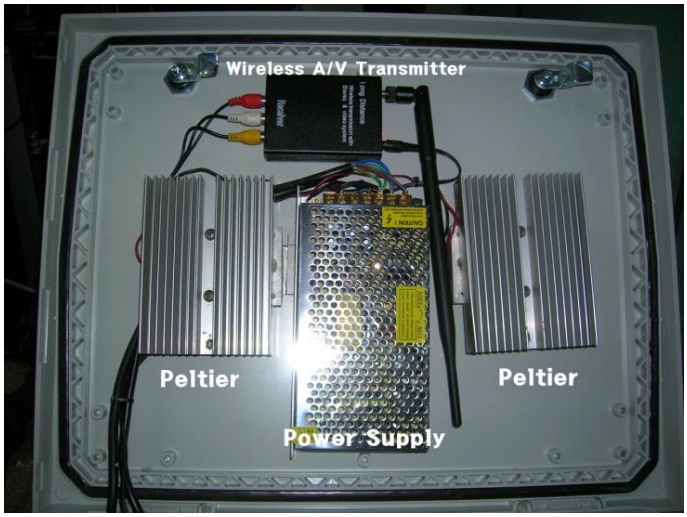

Figure 9: Inside Structure of Projector Case for Protection Against Dust and Heat

5. Conclusion

An application of projector in the tunnel that is capable of implementing multi image makes it possible to prevent traffic accidents due to drowsy driving in the tunnel. The existing video devices that provide simple image and color of light has declined in effect after a time due to the studying effect of drivers. Image contents for each seasonal characteristic and an external environment condition by change are implemented to prevent the study effect. Image expression for reaction velocity of vehicle also has a great effect. The image system for prevention of traffic accidents inside tunnel can not only prevent a sleepiness by calling driver's attention thanks to video and its sound output but also maximize the effect for prevention of driving while drowsy providing a variety of video and sound contents, not the same contents. Multiple sound output devices make it possible to solve the distortion problem of the sound due to the speed of cars between the sound device and its distance. Implementation of the system can provide all drivers with these contents at the same time and it is one of suitable method that best matches the prevention of a chain-reaction collision which can be resulted in a full-scale accident.

6. Acknowledgment

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