

Development of Image Projection and Voice Guidance System applying the Concept of CPTED (Crime Prevention through Environment Design)

Young Sil Lee, Mikyeong Moon

Abstract: The objective of this paper is to solve the “simplicity” problem that can be reduced to the existing CPTED effect by developing (and improving) a CPTED equipment and maximize the effect. We have developed image project and voice guidance system for crime prevention based on CPTED strategy, it uses a sensor (P-IR or Microwave) to detect the human movement and projects the image on the ground and simultaneously playback the voice. It also used high brightness 20W LED and was developed to be able to attach it to facilities such as CCTV pole, street lamp by developing separate bracket. The developed equipment is a combination of an image projection device and a voice guidance system, and when the motion sensor is detected movement, an image of a separately produced image glass is projected on the ground and CPTED alters is broadcasted. Since the device usually installs at a wide variety of location, we divided into the short-distance projection and the long-distance projection, and the voice guidance system is basically powered and playback by the response of the sensor, but it is also can operate on a separately developed scheduling basis to improve the independence of the apparatus. This is because the power can be supplied from a separate port provided in the CPTED alters voice guidance system for crime prevention. Therefore, it has versatility to use both the functions of the scheduling base and the functions of the sensor base, so it is excellent in utilization according to the situation, and the image glass of the image projection device can be changed. In addition, it can be used for various purposes by replacing the sensor, it is possible to construct a line-up (e.g., smoking detection) with various products, which can actively respond to various demands of the market.

Index Terms: CPTED, Crime Prevention, Image Projection, Voice Guidance, Motion Detector.

I. INTRODUCTION

Recently, the crime rate of anti-social crimes against vulnerable social group such as deteriorating living environment, kidnapers, children and elderly people has been rapidly increasing due to the diversification of living environment. Especially, in case of South Korea (urbanization 91%), citizens’ standard of punishment is getting higher, but misdemeanors such as cigarette butts,

garbage crouching, street urination, and drinking disturbances are still being carried out easily in everyday life even if they are only looking around for a while. The graph in Fig 1. below shows the number of minor cases is still high, indicating the status of punishment by simple procedure due to minor violating among minor, special law, and physical offenses [1]. Such misdemeanors are not easy to punish even if they are caught, but they can only be resolved if there are aware of the misdemeanor itself. However, there is no method other than the method of reliance on posters, banners, flyers, etc. These are outdated method and one-off, so its effect against input cost is minimal. Particularly, the sustainability is remarkably low due to the damage, and management is required steadily, the related social costs such as personnel, time, etc. are greatly required. Furthermore, the many warning signs that harms the surrounding landscape, and night visibility is not ensured so information transmission is often difficult.

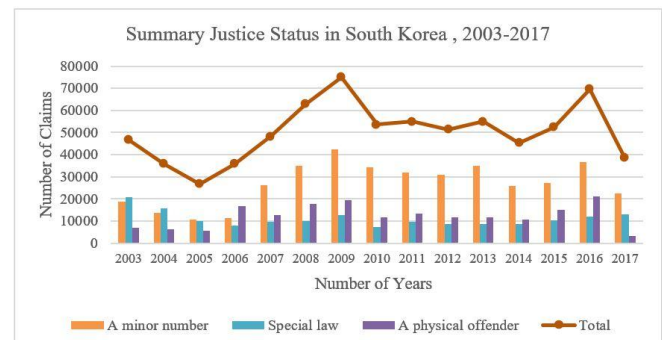


Figure 1. The Scale of Summary Justice in South Korea, 2003-2017.

In addition, as the city becomes complicated due to economic development, it is pointed out that the construction of safety services for citizens is relatively poor. Therefore, it is urgent to have three dimensional and holistic crime prevention measures to solve this problem. For this, recently attempts to prevent crime by using CPTED technique have been continuously increasing. Crime Prevention Through Environmental Design (CPTED) was introduced in the United States (the US) and the United Kingdom (the UK) in the 1980s to reduce opportunistic crimes such as



Development of Image Projection and Voice Guidance System applying the Concept of CPTED (Crime Prevention through Environment Design)

robbery and burglary by improving the residential environment such as the building structure and road shape [2].

Among the various methods that utilize the CPTED technique, in particular, the application of the floor image projection equipment, which can show a great effect at a low cost, is being applied to police stations / government offices all over country. However, the quality of most of these image projection equipment is still low and the brightness is low that the CPTED effect also very insufficient. In addition, simply projecting image continuously can be problematic because of the emergence of similar solutions and the simplicity of relying solely on visual information delivery.

In this paper, in order to solve the problem of “simplicity” which can be reduced to the existing CPTED effect, we developed CPTED equipment that is possible to maximize the CPTED effect by projecting the image on the ground and simultaneously playing back the voice when the movement is detected, thereby enabling simultaneous audio-visual information transmission.

II. RELATED WORKS

A. CPTED strategy

In the early 1960s, Jane Jacob explored the interactions of residents with the physical environment through “the Death and Life of Great American Cities” based on their residence in New York, the concept of CPTED was introduced for the first time, explaining the impact of road activation on life, and the various connections between residential environments and crime. And Elizabeth Wood developed guidelines by addressing security issues in her “Social aspects of Housing in Urban Development” book in 1967. And later, Ray Jeffery, who first introduced the term CPTED, theorized on the relationship between urban design and crime in 1971, “Crime Prevention Through Environmental Design”. Specifically, the defensive design of crime in the urban environment such as appropriate architectural design and urban planning, reduces opportunities for crime, reduces the fear of crime and maintains the sense of safety, and ultimately the quality of life of the total crime prevention strategy [3-5].

In CPTED, the environment is a concept that includes the physical and social environment in which people and people live, and environmental design means a technique to prevent specific crimes or fears by changing variables closely related to the environment itself. It is based on four basic principles: natural surveillance, natural access control, territoriality, and maintenance.

1) Natural surveillance is the placement of buildings and facilities to maximize visibility. It can create an easily observable state when an intruder occurs, allowing residents to easily distinguish between activities of neighbors and strangers, and it is possible to reduce the possibility of criminal activity by take appropriate measures such as reporting to the police if there is a point of crime. Particularly, in order to maximize

visibility at night, proper lighting should be installed in parking areas, entrance and exit of buildings such as doors and windows, walkways, roads, and garden benches.

- 2) Natural access control induces people to a specific space through roads, pedestrian paths, landscaping, doors, as well as blocking unauthorized access and making access to crime targets difficult and increasing the risk of exposure to criminal behavior. Also, in the case of apartments or apartment complexes, it means minimize the number of entrances in the complex considering the convenience of the residents and at the same time to set up access control devices to block unauthorized access. The principle allows criminals to relinquish access to other people’s residential areas, and to allow the locals to clearly recognize the public passageway (local) and private area.
- 3) Territoriality is virtual realm in which local residents can claim their rights by freely using or occupying an area. It can create real or virtual boundaries to distinguish legitimate users from those who do not, and create community by creating a consensus among local residents. It has the function of distinguishing public and private area and showing the boundaries of this site. For this purpose, physical characteristics such as fence, sign, landscape, lighting, road pavement design, etc. are used to express ownership. While those who are active in the area or who use the area are more likely to be in control of the area, potential criminals are less likely to commit crime by recognizing these controls.
- 4) Maintenance refers to the management of any facility or public place so that it can be used continuously as it was originally designed, and it has the effect of preventing crime by restraining the deviant behavior of the people. Public places that appear to be devastated or abandoned can be turned into places where there is a high probability of disorder and crime, by indicating control or lack of interest by the people. In order to prevent, proper maintenance is necessary such as clearing things that tempt criminals, cleansing the gardens, refusing garbage, and repairing houses and warehouses.

B. Current status of application of CPTED strategy based crime prevention techniques in South Korea

In South Korea, it is the first time to pilot CPTED in the city of Bucheon, and has been conducted in a way similar to the UK, by screening at the Korea CPTED Association and certifying the CPTED to the building. In 2012 Seoul launched a program titled as Crime Prevention Design Project to prevent crime through environmental design and the city of Seoul chose Yeomri-dong as a first CPTED pilot project area and is being implemented through residents’ participation (as shown in Fig. 2 below). Yeomri-dong, called “Daldongnae (same meaning as inner city)” is a place where narrow and dark alleys lie like spider webs. In addition, among 161



protected area in Seoul, it is one of the urgent need for measures. The goal of this project to change the spaces into a space of favorite sports and community by making the narrow alleyway which was scary 1.7km “Sogum-gil (a.k.a. Salt way)”, based on the CPTED theory, they have installed a prominent yellow gate, emergency bell, IP camera and image projection solution. As a result, there is a report that the fear of crime among of residents of Yeomri-dong decreased 9.1% for individuals, 13.6% for families, and the neighborhood attachment has increased by 13.8% [6-7].



(a) A view of Maruboshi's house in Yeomri-dong



(b) Yeomri-dong alley

(c) Gilmok Market

Figure 2. After applying the environmental design and image projection solution based on the CPTED theory in Yeomri-dong, Seoul.

In 2017, Ganeung-dong safety village environmental design project is the first Uijeongbu-si to introduce universal design and CPTED techniques to install security management centers for safety at night, security lighting, gobo lighting, roadside safety trails, and utilized the neglected space to create a community space for residents (as shown in Fig. 3 below). In addition, through the murals, the old and shabby alleys are made into safe streets, improving the harsh residential environment and brightening the image of the village so that all residents can live safely and conveniently. As the result of comparing crime occurrence trends of this area, the crime reduced rapidly after proceeding the project [8].



(a) Crime prevention and management center



(b) Non-smoking signs



(c) Image projection on the floor

Figure 3. Safety village applying the concept of CPTED in Gaeneung-dong, Uijeongbu-si, South Korea

III. METHOD

Among the various solution applied in above projects, the image projection product based on the CPTED theory is known to have excellent night vision visibility and to prevent the nighttime crime directly or indirectly, and is being used in many places such as the local government. In fact, lighting is a basic item in terms of strengthening the surveillance function, which is one of the basic principles of the CPTED, especially strengthening the monitoring function at night. Therefore, we developed an image projection and voice guidance system to maximize the CPTED effect which is projecting the image on the ground when the sensor detect the movement, and playing back the voice (or audio) at the same time.

A. Image Projection Equipment



Development of Image Projection and Voice Guidance System applying the Concept of CPTED (Crime Prevention through Environment Design)

To implement an image projection equipment, first we used 20W LED COB (chip-on-board) which has a brightness from 1700 to 1800 LM, and it can emit bright light sufficiently such as security light, dark night alley. However, it requires a heat sink that can dissipate heat when the power is applied because the device itself generates a high temperature of 80 degrees or more. Therefore, we effectively removed heat by using a heat sink made of aluminum or copper, which has a good thermal conductivity, rather than common steel material.

In addition, LED requires DC (direct current) power, so SMPS (switched-mode power supply) is required to convert AC (alternating current) to DC, but, since the existing SMPS is installed in the image projection equipment separately rather than as an integral type, there is a problem that the installation itself becomes complicated due to the need to prepare a separate high box for storing the SMPS when the installation is performed in the actual site. In order to solve this problem, we developed a SMPS housing that can operate immediately when only AC power is connected by combining SMPS in image projection equipment to ensure efficiency of design, installation and management (as shown in Fig. 4 and Fig. 5 below).

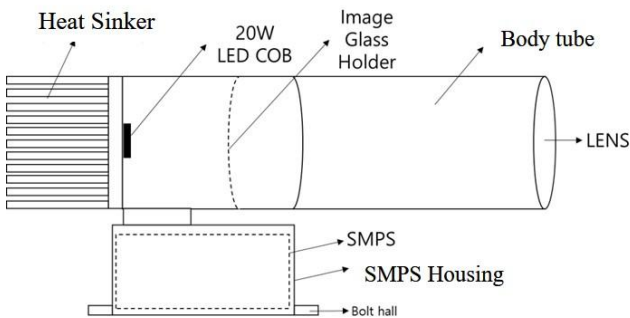


Figure 4. Structures of short-range (projection distance within 4m) projection model

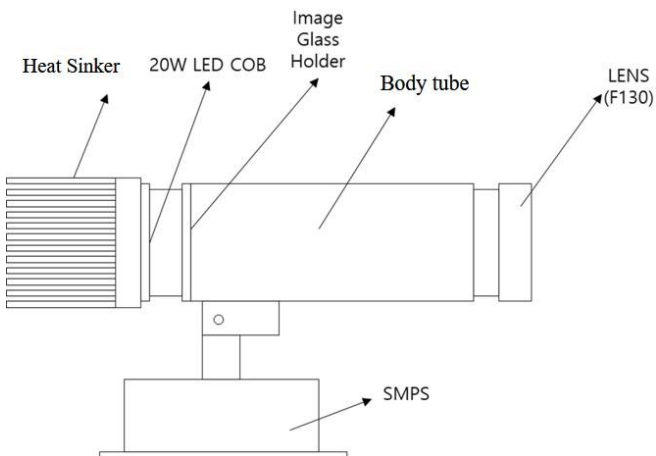


Figure 5. Structures of long-range (projection distance more than 4m) projection model

A design of a flat barrel type in which the straightness of the LED light source can be taken advantage of, and a holder capable of inserting an image glass by turning the barrel is processed in the barrel. And the lens has a separate lens hole

for replacement. Also, created image glasses for the experiments as shown in Fig. 6 below.

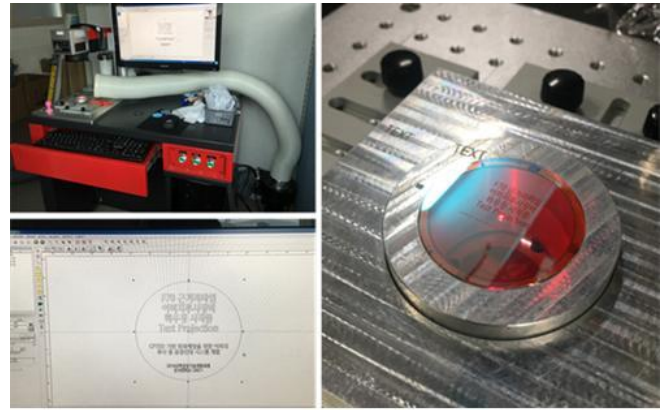


Figure 6. Image glass making process

B. Voice Guidance System

The CPTED alerts voice-guidance system has reduced system construction costs by using the Raspberry PI hardware development board. In order to convenience and simplify system operation, we have developed a system that controls the operation of the equipment using a digital electric timer and determines whether power is applied to the image projection equipment and the voice guidance system through the motion sensor. In addition, since most of the products are installed outdoors, speaker units exposed to the outside of the parts need waterproofing. Therefore, the speaker grill and the speaker unit are improved in the integrity and stability of the system by using a module obtained waterproof and dustproof grade (as shown in Fig. 7 and Fig. 8 below).

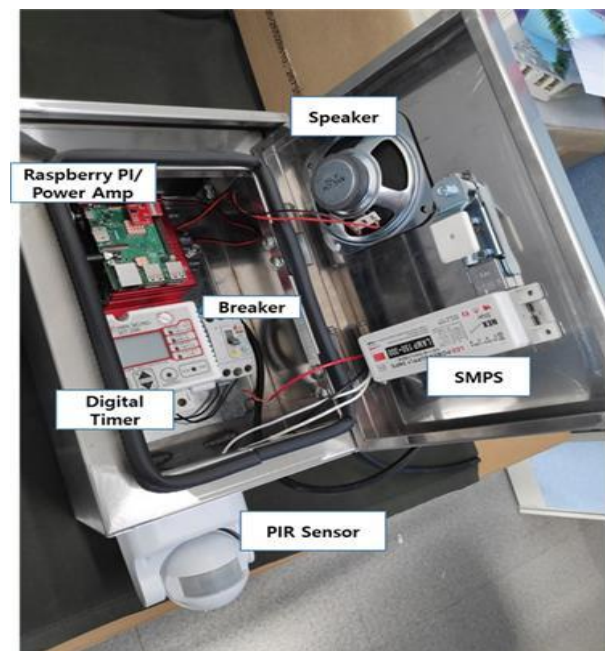


Figure 7. Configuration of play-back device for CPTED alerts voice guidance



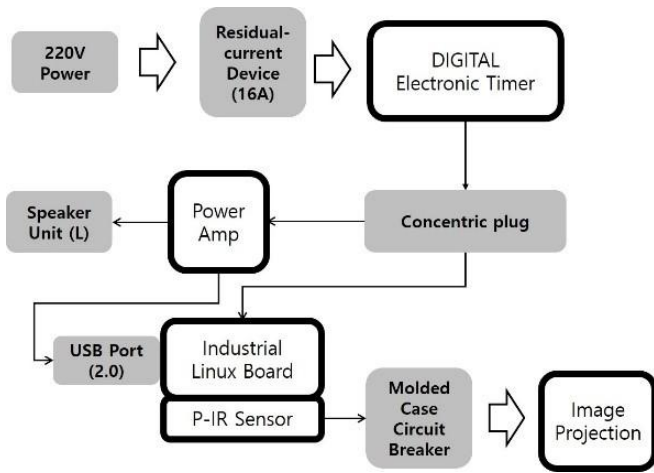


Figure 8. Voice guidance System Diagram

We have developed a program for setting up a guide (or alter) voice playback scheduling on the administrator's PC, when a USB mini USB cable is connected to the industrial mini PC, the voice file and the scheduling file are automatically copied and set. After that, when the sensor and the scheduler operate, the updated voice file is reproduced. The function of the playback device for CPTED alerts voice guidance is composed of three functions. First, an administrator schedule creation program - Windows TOOL that creates media file information including schedule set by the user and makes USB that can be updated to the player; Second, a scheduled media file (created by the administrator's schedule creation program) - A USB memory stick containing the schedule-containing media file information copied from the schedule creation TOOL; Third, a warning voice player - a device (Raspberry Pie) that automatically recognizes media file information including schedules, copies information on USB, and plays media files according to a set schedule, and plays media files according to the registered schedule.

IV. RESULTS

The developed image projection device has two types of projection distance of less than 4m and a projection distance of 4m to 10m, and table 1 below show the characteristics of them.

Table 1. Feature Comparison of developed image projection device

Image projection device for short distance	Image projection device for long distance
<ul style="list-style-type: none"> ♦ Projection distance: within 4m maximum ♦ SMPS integrated design ♦ Rugged aluminum housing with large heat sink for heat generation and outdoor installation ♦ With panning neck that can adjust the projection angle and position after mounting 	<ul style="list-style-type: none"> ♦ Projection distance: 4m ~ 10m ♦ Efficient design that can integrate / disassemble the box housing the SMPS according to the installation situation ♦ Rugged aluminum housing with large heat sink for heat generation and outdoor installation

♦ Angle adjustment part with adjustable projection angle and position

Although the currently developed product is at the prototype stage, since the safety of the field installation is required, EMI (electromagnetic interference) Receiver and V-network were used to radiated and conducted emission testing (a.k.a. EMC test) on the input power. The operation of the prototype AC power supply is 220V through the constant voltage supply (DC 43.5V / 0.5A for DC) and the following results were obtained (as shown in Fig. 9 on the top right).

In addition, in the case of the voice guidance system for the CPTED-based crime prevention developed, most of the cases are installed outdoors, so that the housing and the speaker unit exposed to the outside of the parts are adopted as the waterproof type. Also, it reproduces image projections and announcements when the sensor responds, and plays the alerts voice based on the scheduling regardless of the sensor response.

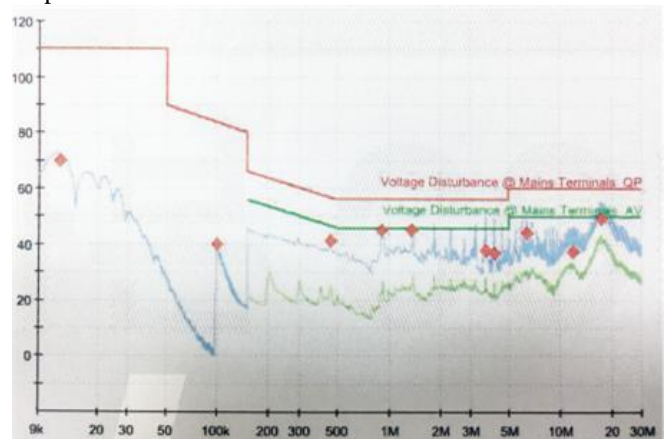


Figure 9. EMC test result (the x-axis is frequency (Hz), and the y-axis is length (m) which combined length of cable and equipment size)



Figure 10. Developed voice guidance system

Development of Image Projection and Voice Guidance System applying the Concept of CPTED (Crime Prevention through Environment Design)

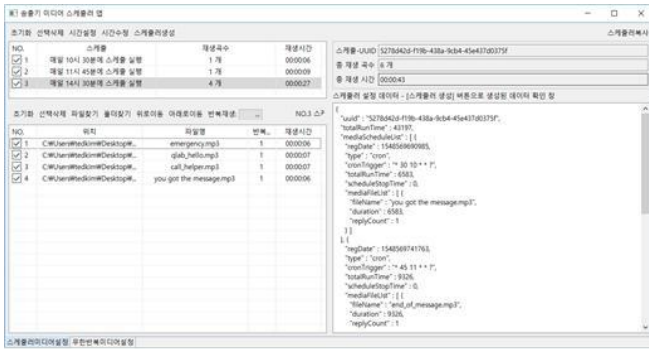


Figure 11. Media scheduler application

Finally, the developed image projection device and the voice guidance system can be used independently or in combination (as shown in Fig. 10 and Fig. 11 above). This is because the power can be supplied from a separate port provided in the voice guidance system for the prevention of crime based on CPTED. This port is configured to supply power when the motion of the human body / object is recognized by the PIR sensor. It has the versatility to use both the functions of the scheduling base and the functions of the sensor base, so it is excellent in utilization according to the situation. Also, the image glass manufactured can be changed, so it is possible to provide a customized service suitable for the application site.

V. CONCLUSION

The paper concludes, the although we did not mention all cases in domestic and oversea, there is a large and growing body of research, which supports the assertion that crime prevention through environmental design is a pragmatic and effective crime prevention tool [9-10]. CPTED does not require tremendous and brilliant ways, but it ensures safe life by minimizing the fearful and uncomfortable environment around us, and lighting is the most basic element for safety.



Figure 12. Image projection and voice guidance system and its experimental result

The objective of this paper is to maximize the CPTED effect by developing and also improving the image projection equipment which is widely used among various solution

based on the CPTED strategy. The developed equipment is a combination of an image projection device and a voice guidance system, and when the motion sensor is detects movement, an image of a separately produced image glass is projected on the ground and CPTED alters is broadcasted (as shown in Fig. 12 above). Since the device usually installed at a wide variety of location, we divided into the short-distance projection and the long-distance projection, and the voice guidance system is basically powered and playback by the response of the sensor, but it is also can operate on a separately developed scheduling basis to improve the independence of the apparatus. This is because the power can be supplied from a separate port provided in the CPTED alters voice guidance system for crime prevention. Therefore, it has versatility to use both the functions of the scheduling base and the functions of the sensor base, so it is excellent in utilization according to the situation, and the image glass of the image projection device can be changed.

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