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Sustainable Tourism Using Security Cameras with Privacy Protecting Ability

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Abstract

For sustainable tourism, a novel method of security camera operation is proposed. In the method, security cameras, which encrypt the taken images and store them into the memory card inside, are used. Only when crimes occur, the memory cards are taken out from the cameras and the images are decrypted with the key and viewed by the city government and/or the police. When no crimes occur, images are overwritten by the new ones after a week automatically without being viewed by anyone. By using the stand-alone cameras without wiring to the control center, the installation cost and the operation cost are much lower than CCTV cameras. By using image encryption, the privacy of the tourists is protected. Using this system, high density installation of the security cameras with very low cost can be realized in encryption with image encryption privacy protection function.

Keywords: Innovative Communication, Security Camera, Privacy, Safety, Sustainable Tourism, Crime Prevention
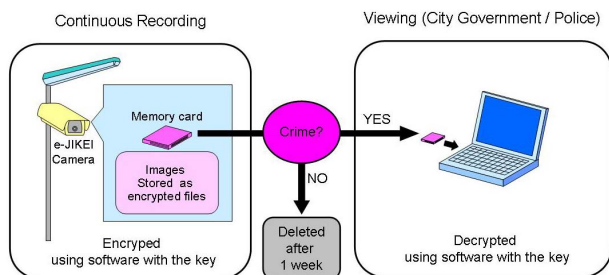
1. Introduction

In the sightseeing places, security camera systems, such as Closed-circuit Television (CCTV) system, are now widely used and can be found in ordinary shops and citizens' houses. These systems sometimes play an important role in reducing crime and identifying suspects. However, many problems seem to arise with regard to such security camera systems because of the fact that they are introduced only for the benefit of the owners. One problem is that an expensive high-end security camera system is required for maintaining complete surveillance of an owner's property. The second problem is that a typical system usually keeps watch only inside the owner's property; therefore, it cannot be used for the overall safety of the community. The third problem is that if the system keeps a watch outside the owner's property, it could amount to invasion of the privacy of neighbour. We argue that these problems can be solved if the camera systems are introduced within an altruistic, community-minded framework.

Recently, many security camera systems have been in-

stalled in some countries such as the United Kingdom and the United States of America, by the national and the local governments. Although, it is difficult to evaluate the effectiveness of the security camera system in preenting crime [1,2], which are obvious that they can capture images of any person or car passing within their range. If a considerable number of security cameras are installed without any dead angles on every road, then every criminal who uses the roads can be captured and traced.

However, a center-controlled real-time monitoring system such as the typical systems costs a considerable amount of money and cannot be introduced everywhere without any dead angles. Therefore, we propose a new concept according to which a community can effectively prevent crime if some residents keep watch on what happens around their houses with the aid of their own home computers, cheap commercially available cameras, and free software. **Figure 1** shows the concept of the e-JIKEI Network.

Many types of software applications for capturing video images are available; however, we could not find a

Figure 1. Concept of "e-JIKEI with privacy protection".

(a) e-JIKEI Camera (b) e-JIKEI Light

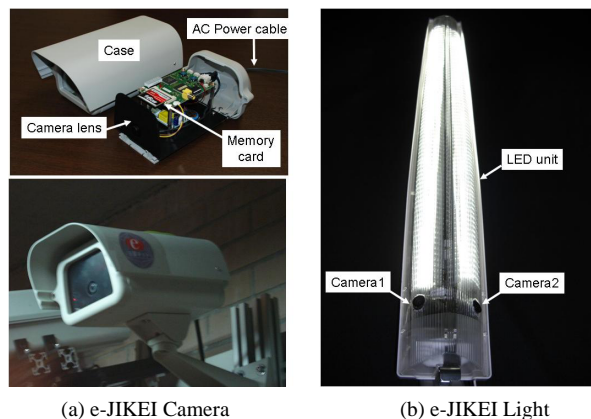**Figure 2. Prototype of the e-JIKEI camera and e-JIKEI Light.**

free one that could be used to implement our concept. Therefore, we have developed asoftware with the minimum necessary functions and distributed it free of charge through our website [3]. The software supports both English and Japanese languages. The software simply selects relevant pictures and saves them to the hard disk [4]. This concept has been discussed from the viewpoints of social science [5], homeland security [6] and e-Government [7].

2. Personal Computer (PC)-Based System Using Free Software

We have provided the first version of the free software "Dairy EYE standard." Its functions are very limited but essential. The major features of the software are as follows:

• High stability: It can be run continuously for more than 300 days.

• High operation of file storage: The file name and its path express time and location information.

• Minimum necessary storage: Simple picture selection software has been adapted. The software saves a picture only when the difference between two consecutive pictures exceeds the threshold.

• Automatic delete: Folders that are older than the save period set by the owner are automatically deleted.

• Compatibility with many types of cameras: The software can operate in the VFW mode (PC cameras and USB video adapters) and the FTP mode (network cameras).

• Simultaneous operation: The software can operate several cameras connected to a PC.

• No Internet connection: Because of concerns related to privacy, the function of connection to the Internet was disabled in the distributed version of the software. Even in this case, the e-JIKEI Network can be formed, where the word "Network" refers not to the Internet but to the personal network of the residents.

We think that the e-JIKEI Network system should be easily installed in a D.I.Y. (Do It Yourself) manner at a low cost. **Figure 2** shows the examples of camera set-

tings. In one case, an inexpensive network camera is installed outside a house. In the other case, an inexpensive USB PC camera is installed inside a house by using adhesive tape.

3. E-JIKEI with Privacy Protection

We propose a new concept regarding the management of security cameras, e-JIKEI with Privacy Protection, in which those who own and manage images (owners) and those who have the right to view these images (viewers) are separated by means of the encryption of the images [8]. On the basis of this concept, encrypted images are transferred from an owner to a viewer only when both the owner and the viewer consider it necessary, such as in the case of crimes; then, the encrypted images are restored for viewing by the viewer. By this method, the images can be viewed only when absolutely necessary. This concept has been proposed to prevent the risk of privacy violation, as well as to reduce the unnecessary psychological burden that third parties may be subjected to, with the aim of promoting the placement of security cameras throughout local communities.

By managing the security camera system using our concept, it is possible to markedly reduce the negative effects associated with the introduction of security cameras, such as concerns over the violation of privacy, without reducing the positive effects, such as crime prevention at places other than those requiring high-level security and constantly manned surveillance, i.e., most communities, while providing recorded images to investigating authorities in the case of crime.

In a practical example carried out in Kiryu City, Gunma Prefecture, a PC-based security camera system is owned and managed by the owners of retail stores affiliated with the merchant association "Suehirocho Shotengai Shinkokyokai," and images are encrypted and stored

in the system. To view the stored images, special software installed in the PCs at the Police Department of Kiryu City must be used. Only when the owners of the retail stores and the police determine that it is necessary to view these images, are the stored images transferred from the owners of the retail stores to the police. Then, the stored images are viewed by the police and used as information for investigations. The encrypted images that are stored at retail stores are automatically deleted after 30 days if no incidents or accidents have occurred.

To prove that the software installed in the PC definitely encrypts the images with the cipher-key owned by only the police, a paper on which the owner states the purpose of the camera system and allows the investigations by the merchant association at any time is posted near the cameras. Because the owners of retail stores purely wish to safeguard their shopping street and the customers, and do not intend to violate the privacy of their customers, the installed system is ideal for them.

4. All-in-One System "E-JIKEI Camera"

In the experiments of the PC-based system, we have realized that the PC-based system is not very user-friendly since it is difficult for ordinary residents to maintain and operate PCs. In the near future, when home automation is widespread, this problem of PC operation will be solved. However, at this time, it is a serious obstacle for the widespread nationwide use of the e-JIKEI Network. Therefore, we decided to develop an all-in-one system without the use of a PC.

We have developed a prototype of security camera systems "e-JIKEI Camera," which can realize the concept of "e-JIKEI with Privacy Protection." **Figure 3** shows the prototype of the e-JIKEI Camera. It only requires an AC power supply and can be attached outdoors just like a streetlamp. If it is mass produced, the cost per camera will be less than 200 USD. The features of the developed camera are as follows:

1) It can realize the concept of "e-JIKEI with Privacy Protection."

2) All images are encrypted and stored in the memory.

3) To decrypt and view the image, both the special software and the secret key are required.

4) It has a card-type memory of 16 GB, in which the images for the last 1 week are recorded.

5) It can be placed outside.

6) It requires an AC power supply of only 100-240 ACV.

7) The price of the prototype, the first 1000 pieces, is 500 USD/piece.

There are many types of security camera systems

available; however, a system with the above features does not exist, except for the newly developed e-JIKEI Camera.

The e-JIKEI Camera is used for realizing our concept of a security camera system in which those who own images (owners) and those who have the right to view the images (viewers) are separated by means of image encryption. This concept was suggested with the aim of preventing the risk of privacy violation, reducing the unnecessary psychological burden that third parties may experience, and promoting the placement of security cameras in local communities.

In Kiryu city, Japan, a social experiment has been conducted since 30 May 2009, in which eleven cameras are installed on the poles of the street lamps in a residential area, as illustrated in **Figure 3(b)**. **Figure 4** shows the location of the 11 e-JIKEI Cameras and the 411 street lamps in the area, where 2218 homes are located. In the experiment, the owner of the images is the PTA (Parent-Teacher Association) of the Higashi Elementary School, and the viewer is the Kiryu Police Station.

(a) Setting of e-JIKEI Camera   (b) Setting of e-JIKEI Light
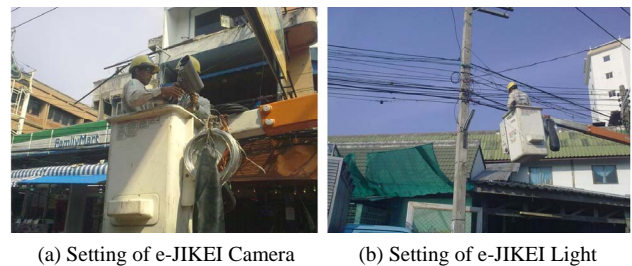
Figure 3. Examples of camera installation in walking street in Pattaya City.
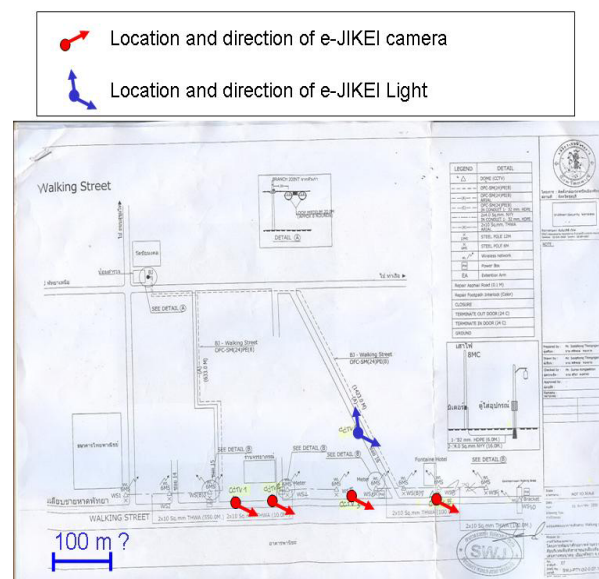
Figure 4. Locations of e-JIKEI cameras and street lamps.

Figure 5 shows the procedure for using the e-JIKEI camera in the experiment. Before the experiment, we explained the concept of e-JIKEI with Privacy Protection to the residents of all the 2218 homes by circulating a notice for the same and in an explanation meeting held at the community hall. Our proposal for this experiment was granted by the residents without any negative opinions. During the first six months of the experiment, three crimes were committed. In each case, the police asked the PTA to provide the images, and the PTA decided to grant the police request. During the experiment, many residents expressed their opinion that the e-JIKEI Cameras were very effective in improving the safety of the community but the number of cameras was still very small compared to the number of street lamps.

Recently, we held a discussion with the residents, PTA, and police. The residents and the PTA provided the following opinions about the installed system:

1) It seems very effective in improving the safety of the community.

2) Number of cameras is very small.

3) Privacy violation seems to be perfectly prevented.

4) The cost is comparable to that of the usual street lamps and therefore affordable.

(a) Picture taken by e-JIKEI Camera-1

(b) Picture taken by e-JIKEI Camera-5

Figure 5. Pictures taken by the cameras.

The police had the following opinions:

1) The reliability of the system is very high. (There has been no trouble for more than six months now.)

2) The quality of the images is acceptable but can be improved.

3) We hope this camera system spreads all over the city.

If our concept on the security camera system with privacy protection is accepted by society, then a considerable number of cameras, which is comparable to the number of streetlamps, will be introduced in communities throughout the country and the world. Then, every street will be watched by numerous cameras, and photographs of suspects can be provided to the police once a crime occurs in a community.

In the current all-in-one security camera in the e-JIKEI Network, the camera has to be opened to remove the memory card. However, this inconvenience is preferred from the viewpoint of privacy protection, especially in the initial stage of the society's gradual acceptance of our concept. However, in the near future, the cameras will be connected to the Internet after the information security system between the owners and the viewers is established. Thereafter, online operations of solving crime, such as the rescue of kidnapped child CCTV camera system [11,12] is suitable for the real time monitoring of the very important points. However, the cost of installation/maintenance/operation is high, Then the number of the cameras are strictly limited due to such costs.ren, can be implemented.

5. Discussions

Comparing to the existing the CCTV camera system in Pattaya City, the e-JIKEI Camera has the following features,

1) Low installation cost: The wiring to the control room and control room itself are not necessary. Only AC power supply is required.

2) Low maintenance/operation cost: The memory cards of the cameras are only taken, when the city government thinks that necessary.

3) Privacy Protection: Only crime occurs, only the certain officers of the city government can view the images.

In the case of the Pattaya City, we propose that the combination the existing CCTV system and the e-JIKEI Cameras. 300 pieces CCTV system watches for only the very busy points, and the huge number of the e-JIKEI Cameras watch the dead-angle of the CCTV in the busy area. In addition, if a huge number of the e-JIKEI Cameras are installed to the quiet residential area, the safety of the whole city will be increased significantly.

If the memory capacity is sufficiently large, the selection of images, in which only the images that are sufficiently different from the previous ones are saved, is not necessary. If the memory capacity is small and memory needs to be conserved, then the selection of images is useful. However, in general, there is no selection algorithm that has a zero failure rate with respect to the selection of necessary images. If all the images are saved without image selection, then the failure of saving a necessary image is prevented. In addition, without this selection, the CPU power can be saved.

At this moment, only the software and programmable stand-alone camera devices, which do not connect to the Internet, have been developed. If the system of security cameras connected to computers and to the Internet spreads nationwide, a very powerful and flexible social structure can be formed. In addition, the software installed in each system can be easily upgraded. This means that this social structure can lead to very interesting research subjects and applications for software research, such as research involving image processing, security systems, and artificial intelligence.

If the security cameras are to be connected to the Internet, the protection of the privacy of the ordinary citizen has to be considered very seriously. A different social structure, including increased social awareness and a revised legal system, will be required for the society; in this structure, every outdoor location will be monitored by security cameras, but the privacy of ordinary citizens will be highly protected, being understood and accepted.

If the appropriate legal, social, and administrative systems are established, most residents will allow appropriate third parties, such as the police department and the city hall, to access their PCs and the saved information through the Internet in the case of a community emergency. In such a case, it will be necessary to ensure that the access rights to the images saved on the PCs can be separately, strictly, and flexibly defined and given to the appropriate third parties by the owner of each system.

If the security cameras are connected to the Internet and can be accessed by the police in the case of serious crimes, the real-time chasing of criminals and rescue of kidnapped children will be possible. A single control station manned by the police, where many operators can access images from cameras spread throughout the nation, is required to realize such a social system.

6. Conclusions

We are asking citizens to compare the responsibility of watching what happens around their houses with the risk of violation of their privacy. In the meanwhile, we are trying to increase the advantages of the security camera such as crime prevention and identification of suspects and to reduce its disadvantages such as violation of privacy. We are now commencing tests to assess the true contribution of our concept toward the realization of a safer and more comfortable community.

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