Digital Nature Group

University of Tsukuba, Yoichi Ochiai Laboratory

Unphotogenic Light:

High-Speed Projection Method to Prevent Secret Photography by Small Cameras

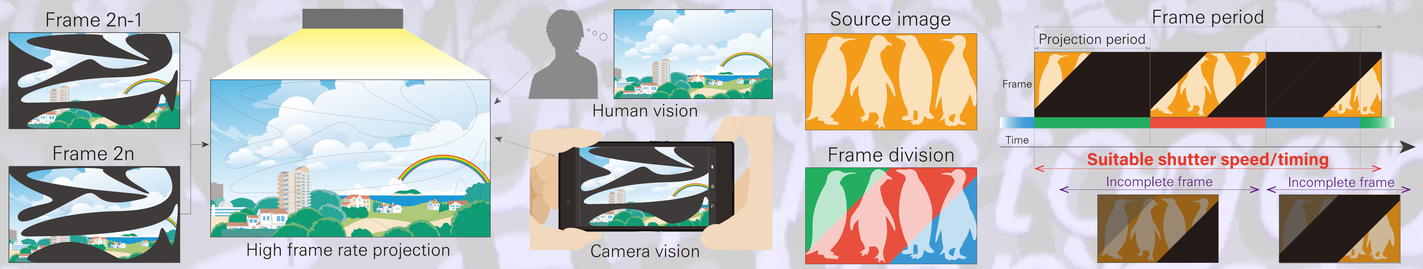

Figure 1: *Left: overview of unphotogenic light. We project entire images by switching each divided image at high frame rate. Humans can observe an entire image whereas cameras cannot capture complete photo. Right: theory and effect of the proposed method. The image is divided into multiple parts and projected in turns. We must synchronize camera shutter speed with frame period to capture the entire image correctly.*

Problem

Protection techniques for digital copies have been discussed over many years from the viewpoint of data protection. However, content displayed by general display techniques is not only visible to the human eye but also can be captured by cameras. Therefore, **projected content is, at times, secretly taken by malicious small cameras even when protection techniques for digital copies are adopted**.

Our Approach

We **exploit the difference between the human vision system and the camera vision system**. Notably, humans cannot recognize the high-speed changes of light. We were inspired by previous work that used these properties to show on-screen invisible markers. There are several studies that aim to present imperceptible on-screen markers using high-speed projection between the afterimage effect of human eyes and shutter speeds of digital cameras. From another point of view, these techniques show specific content only to the human eye while showing different content to a camera. Thus, **we can project images that can be seen by human eyes whereas cameras only capture an incomplete frame** as illustrated in Figure 1. Therefore, this means the projected light is unphotogenic.

Implementation

We use a high-speed programmable projector (DLPa Light Crafter 4500, Texas Instruments Inc.) that projects divided images with high speeds. If we attempt to capture the entire image with the camera, we must match the projection period of the system and exposure period of the camera, as shown in Figure 1.

Evaluation

We evaluate our system with the vision of a camera, as shown in Figure 3. First, we used DSLR cameras to evaluate the shutter speed threshold in which the proposed method is most effective. The results are shown in Figure 3 (Camera A and Camera B). When the shutter speed is faster than 1/60, the effect of our method is noticeable in the picture.

Next, a smartphone (iPhone 6, Apple Inc.) was used to consider the scene of practical secret photography. We used a camera application that can control the shutter and ISO speeds as shown in Figure 3 (Camera C). Please note that the f-stop of the smartphone is not controllable. If the brightness of the screen is sufficiently high, the camera speeds up the shutter speed to avoid blowing out highlights. Because small cameras tend to have this limitation, the proposed system is effective to prevent secret photography by small cameras.

Applications

Protection of screen content

The main purpose of this method is to discover **protection techniques to prevent secret photography**. For example, it can be applied to **secret pages in a presentation**. Speakers then do not need to caution the audience members about taking photos.

As another example, our system can be used in theme parks as shown in Figure 2 (c). There is a system that takes a picture of passengers in the middle of an attraction such as a roller coaster in theme parks. Pictures are previewed on a screen near the exit, and a passenger has the option to purchase the picture. However, a passenger can also take photos of the screen with a smartphone. By using the proposed method, these photos are prevented. In addition, if the shape is divided into the silhouette of a character, people will be able to enjoy theme parks even more.

Protective illumination

The proposed system also can be used as a lighting system. For example, the system can be installed **in an art gallery as a spotlight**, as shown in Figure 2 (d).

It is worth noting that photos with DSLR cameras may still be taken. Therefore, the next example is a situation in which a visitor cannot use a DSLR camera, as shown in Figure 2 (e). Because the showcase surface has reflections, it is difficult to shoot with a camera with a large lens such as that of a DSLR camera. In this case, a small camera such as a smartphone will be used; however, the proposed method prevents this when installed as a spotlight.

As another example, the proposed system can be used in restaurants. If a restaurant chef dislikes the photography of food by smartphones, the proposed system can be used as lighting. Because the customers cannot take photos with their smartphones as shown in Figure 2 (f), they can instead concentrate on eating the food.

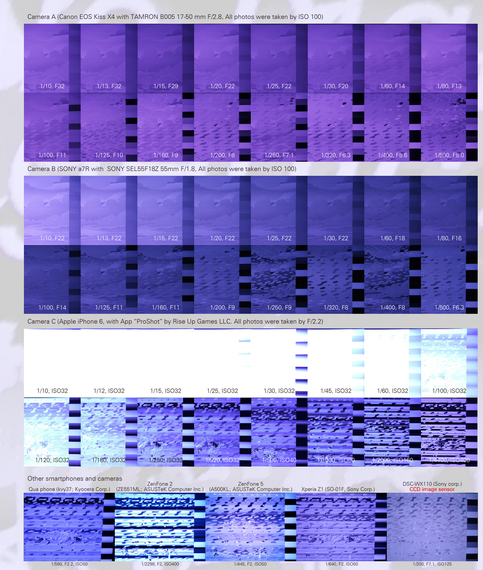

Figure 3: *Images from different camera vision. Images are divided into three parts. Projection period (see Figure 1 Right) is 4166 microseconds (approximately 240 Hz).*

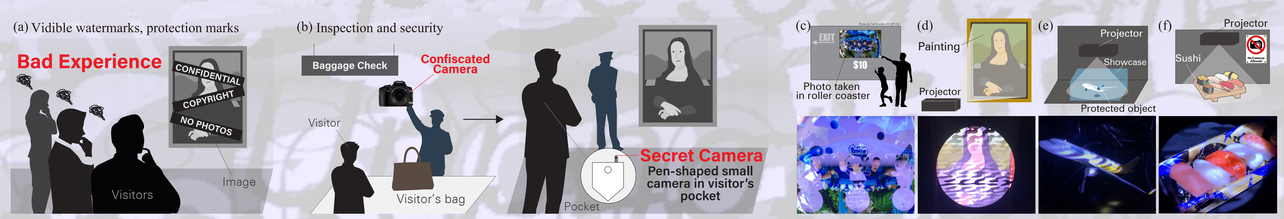

Figure 2: *Practical stories of the proposed method. **(a)** Visible watermarks are simple and an effective method. However, it creates bad experiences for visitors. **(b)** Inspection and security are other solutions; however, secret photography by small cameras is still feasible. The proposed method aims to prevent secret photography in this situation. **(c)–(f)** Application examples; top: schematic diagrams, bottom: applications taken by the smartphone.*

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