Single Pixel Imaging by Use of Retro-reflector

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1. Introduction

Single pixel imaging is a technique to obtain an image by use of a single pixel detector [1-3]. In the conventional single pixel imaging, light is converged by a lens. Detectable object size is limited by the lens. Thus, when the objects are large, a large-scale lens is required. In this paper, we propose a method of single pixel imaging that collect lights by use of a retro-reflector instead of a lens.

2. Principle

Random pattern is emitted from a pico-projector that is small size and has a small lens. A single pixel detector is placed on the lens of the pico-projector. Random pattern impinges an object. Then, transmitted or scatted light is reflected by a retro-reflector reversely toward the same direction to the incident light. Retro-reflected light returns to the light source. Because the retro-reflector is not perfect, the returned light is blurred. Because the single pixel detector is placed close to the lens of pico-projector, the blurred light is detected by the single pixel detector. When random patterns are emitted at n times and the position of random pattern is (x,y), the optical intensity distribution is $I_1(x,y,n)$, the average of optical intensity distribution until n times is

$$\langle I_1(x,y,n)\rangle = \frac{1}{n}\sum_{k=1}^{n} I_1(x,y,k).$$

The optical intensity by gained single pixel detector in n times is $I_2(n)$. So the average of optical intensity until n times is

$$\langle I_2(n)\rangle = \frac{1}{n}\sum_{k=1}^{n} I_2(k).$$

In n times, the correlation function of optical intensity distribution of random pattern and optical intensity of single pixel detector is

$$G(x,y,n) = \langle I_1(x,y,n) I_2(n)\rangle - \langle I_1(x,y,n)\rangle\langle I_2(n)\rangle.$$

By using $\mathrm{G(x,y,n)}$, we can obtain a reconstructed image.

Here is one problem. Random pattern impinged objects is reflect and optical intensity is influenced. The solution to block the reflected light on the object is shown in Fig. 2. We use polarization film and λ/4 sheet. Random pattern emitted from the pico-projector is only P polarization or S polarization. Light impinged retro-reflector is transmit the λ/4 sheet two times, so the direction of polarization is rotated by 90 degrees. The single pixel detector detects light transmitted through the polarizer (only P of S polarization). Thus, detecting the light reflected on the object is avoided and the reflection on retro-reflector is detected.

3. Results

The size of random pattern is 50×50 pixel. We put a box to hide a half of random pattern. The reconstructed results are shown in Fig. 3. The shape of the object becomes clearer when the number of random pattern is increased.

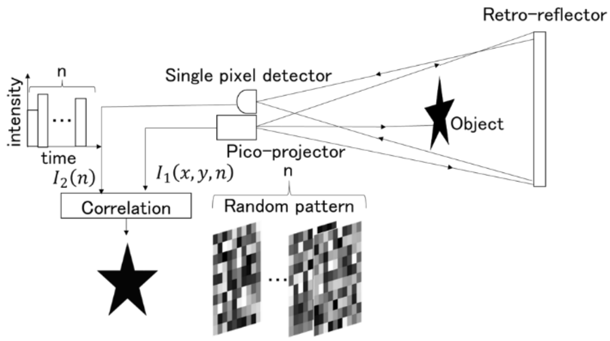

Fig. 1 Principle of our single pixel imaging.

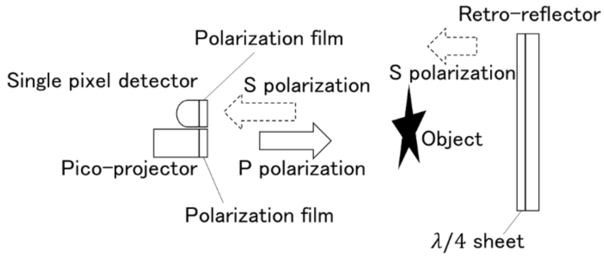

Fig. 2 Eliminating the reflected light on object.

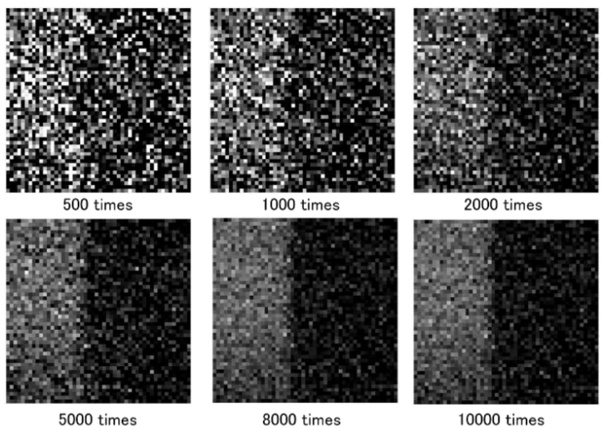

Fig. 3 Reconstructed image.

4. Conclusions

We have succeeded in obtaining an image in our proposed single pixel imaging that employs a retro-reflector instead of a lens to collect light.

References

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