Image Stitching System for High-Resolution X-ray Imaging

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1. Introduction

High-resolution X-ray imaging system is composed of a scintillator and an optical detector coupled with lens. Spatial resolution is the one of most important parameters of high-resolution X-ray imaging. When this optical detector has an effective pixel size from nano to micro meter, X-ray images are developed with micron spatial resolution.

Field of View (FOV) is defined as the maximum diameter of X-ray image. The magnification of optical lens and sensor size of optical detector effect the FOV. X-rays that reach the scintillator are converted into light, and the light is magnified 5 to 10 times by an optical lens. This magnified image is developed onto CCD or CMOS based optical imaging camera with a commonly used 048x2048 pixel array that pixel size is typically 5-10 μm. Thus, 2048x2048 pixel array of the camera has small size of FOV (about 1x1mm^2). [1]

Small FOV of X-ray image is impossible to be utilized in many applications. So the author design the image stitching system in high-resolution X-ray imaging system. Image stitching is the process of overlapping two or more images taken at different viewpoints and different times to generate a wider viewing panoramic image. [2] Finally, for design testing, DDR5 semiconductor images were acquired by developed system.

2. Methods and Results

2.1 Developed System

Image stitching system was designed into a high-resolution X-ray imaging system. This X-ray system consists of a micro-focus X-ray tube (P030-24-12F100W, Petrick GmbH, Bad Blankenburg, Germay), an optical lens, and a scientific complementary metal-oxide-semiconductors (sCMOS) detector (pico.edge 4.2, PCO, Kelheim, Germany). The operating voltage and current of micro-focus X-ray tube are 50 kVp and 1 mA. The focal spot size is 30–55 μm. A 10x optical lens is used to magnify the X-ray image on scintillator film, and a sCMOS detector is used to develop this image. The sCMOS detector has 6.5 μm suqaure pixel size. The effective pixel size of this system coupled with optical lense is 650 nm. The image stitching system moves an sCMOS camera equipped with an optical lens as shown in Fig. 1. The step size of image stitching system is 500 nm.

The finally developed system is shown in Fig. 2.

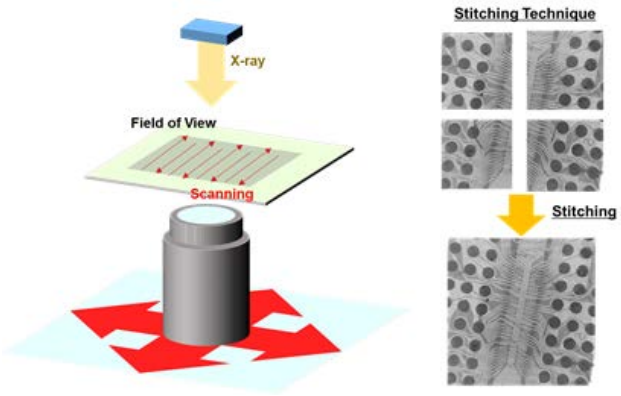

Fig. 1. Schematic of image stitching system

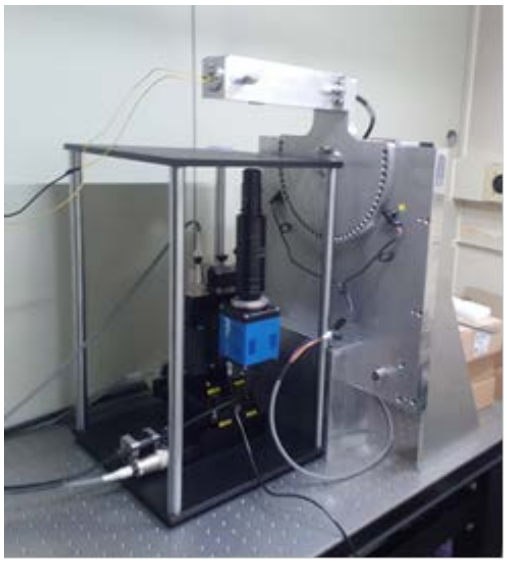

Fig. 2. Developed system

2.2 X-ray Image

The high-resolution X-ray image of DDR5 (Samsung, South Korea) was developed using image stitching system. These images is shown in Fig. 3. Using the image stitching system, the entire structure of DDR5 could be observed in micro units.

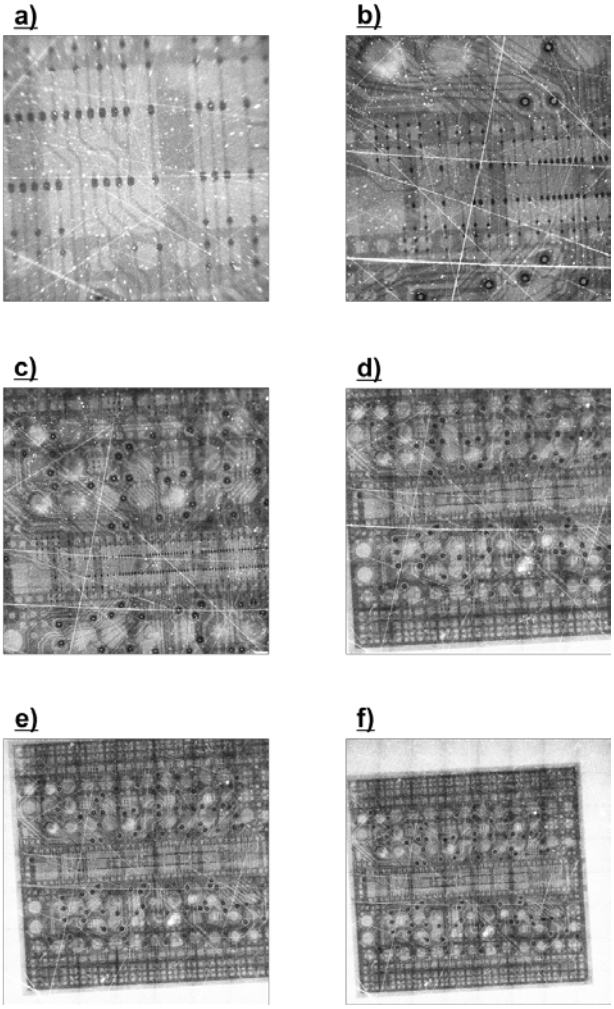

Fig. 3. X-ray images of DDR5 which the size is a) 0.1x0.1 cm^2, 0.3x0.3 cm^2, 0.5x0.5 cm^2, 0.8x0.8 cm^2, 1.0x1.0 cm^2 and 1.2x1.2 cm^2.

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3. Conclusions

Through the above experiments, it was evaluated that the maximum FOV can be extended to 1.2x1.2 cm^2 using the high-resolution X-ray imaging system equipped with image stitching system. As a result of the previous MTF evaluation, the resolution of the high-resolution X-ray image system was 230 lp/mm. [3] Through the above results, a high-resolution X-ray system with a large-area FOV was developed.

REFERENCES

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