Development of an X-ray System for High-resolution and tomography imaging with a laboratory X-ray source at Pusan National University

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1. Introduction

Since 1895, Roentgen found some kind of beam which called X-ray, penetrates the inner part of object, it has been used a lot of area like industrial and medical for NDT(Nondestructive testing) and medical diagnosis using radiography imaging, respectively. This kind of radiography imaging skill has important factors; resolution is the most important one among them. Many researchers are already studying for making better resolution of an imaging system. We also set up the X-ray experiment system for various radiography imaging tests via X-ray at NRSL (Neutron and Radiological Science Lab) in Pusan national university. As the first step, X-ray imaging system has been installed and evaluated for X-ray high resolution and tomography imaging. In this study, we drive all steps to get high resolution X-ray images from components of system installed to the performance of system.

2. High resolution X-ray imaging system

The picture of experimental set up for high-resolution and tomography imaging at Pusan national university is in Fig. 1. The key components are an X-ray source, a detector, and sample stages. This system has been installed on the anti-vibration optical table to conduct numerous X-ray imaging experiments.

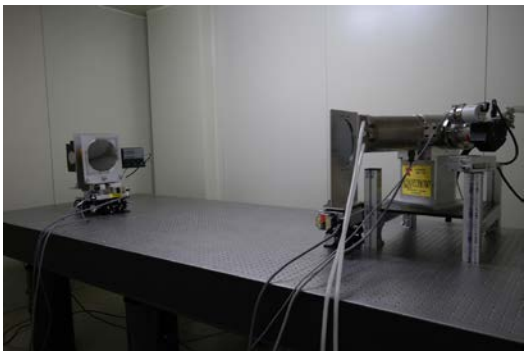

Fig. 1. The X-ray experimental system at Pusan national university

2.1 X-ray source

The X-ray source (MOS160.1000.5-D, SEC.) were used in this study. X-ray source has micro focal spot size smaller them 10 ㎛ for getting high resolution images. It can operate wide range of tube voltage and current for various conditions of experiments. Table 1. represents details of the source.

Table 1 Characteristics of X-ray source

Item	Specification
Tube type	Open stainless steel tube
Target design	Rod target/Tungsten
High voltage range	30 to 160kV
High current range	10 to 1000 ㎂
Max. Tube power / Target power	160W / 100W
Focal spot size	5 ㎛
Beam cone angle	Approx. 40°
Min. FOD (focus-object-distance)	6 ㎜
Standard filament	0.2 ㎜ tungsten hairpin

2.2 Detector

This X-ray grating interferometer system has 2 types of detector system consisted with CCD camera and CMOS flat panel detector. CCD camera(Cascade: 1K) is made 1004x1002 front illuminated CCD with 8x8 ㎛ pixels. It has a readout amplifier charges multiplication gain. Another detector is CMOS FPD (RadEye1) has 24.6x49.2 mm active area CMOS with 512x1024 pixels. Resolution is 48 ㎛, max frame per second is 2.7.

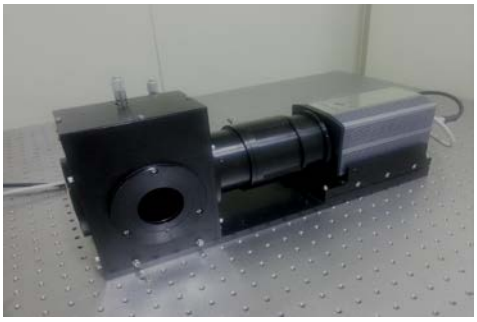

Fig. 2. CCD camera detector

Fig. 3. CMOS flat panel detector

2.3 Sample stage

The motorized linear, rotational, and tilting stages make comfortable to steer a sample which is interested to observe via X-ray. The stages for movement of sample are consisted of 2 groups. Stages are connected motor controller (SC-410, Kohzu.) controls distances and angles of sample within micro scale. Sample is also delivered as large linear distance of sample up to 300 ㎜ by stage(M-IM300PP, Newport.) and controller (ESP 301-1N, Newport.).

3. Performance of X-ray imaging system

High resolution and tomography experiments were conducted in X-ray set up. First of all, spatial resolution of the X-ray system is tested using the phantom. Spatial resolution is the distance possible to classify between the other objects or the minimum size of particle can be distinguished in digital images. It is expressed quantitatively as modulation transfer function (MTF) by ASTM. We checked the spatial resolution of the system, calculate the MTF of the system, and compare experimental result and theoretical.

Several biological samples were studied in the next experiment follows the resolution test. Here only Jujube is presented.

The boundary between seed and flesh demonstrates that a resolution of several ㎛ is achievable with this image system. The effective pixel size of the X-ray image system is about 1 ㎛.

4. Conclusion

In the experimental setup presented, a high resolution X-ray imaging system based on open type micro focus X-ray tube variable tube voltage and current, detector system with CMOS flat panel detector and CCD camera, stage translate a sample in micron was tested for getting X-ray high resolution and tomography imaging. We checked this X-ray system represents good performance on high resolution and tomography imaging taking radiography imaging of small fruit. In addition, by using this system, more experiments like X-ray phase contrast imaging, two pair X-ray and detector system and so on will be operated via flexibility of X-ray system at NRSL.

REFERENCES

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