Development of X-ray Stereo Scanner Simulator for Cargo Inspection

Ohsung Oh [a], Youngjoo Kim [a], Seho Lee [a], Sun Young Lee [a], Seung Wook Lee [a*]
[a]*School of Mechanical Engineering, Pusan National University, Busan, Republic of Korea*
[*]*Corresponding author: seunglee@pusan.ac.kr*

1. Introduction

Due to the increase of cargo volume and the danger of terrorism, the importance of cargo scanner is increasing day by day. There are two methods of scanning cargoes; inspecting the cargoes with opening by hand, and without opening using the X-ray. Especially, the scanning method using X-ray has been mainly used for smuggling monitoring because it can search cargoes quickly, and its use is expanding at present. And compared to 2D measurements, it has advantageous to 3D measurements because it can obtain more information. There are several methods for acquiring 3D images using the X-ray, in this research, stereo scanning method was used shown in fig. 1. Stereo scanning method can acquire information according the depth of the object, and it is advantageous in that it can be searched at a high speed compared to an image acquired with 3D-tomography. Therefore, we developed a stereo scan cargo scanner simulator before installing a practical cargo scanner.

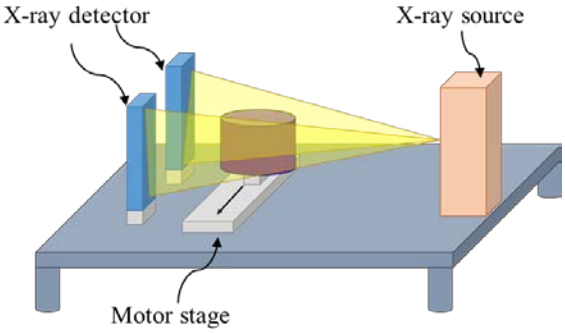

Fig. 1. The schematic of x-ray stereo scanner

2. Methods and Results

2.1 Simulation software model

In this simulation, three types of parameters were set. The three types of parameters are divided into the mechanical part, the object part, and the detector part, respectively.

The mechanical part consists of parameters related to the overall system. This part includes the distance from the x-ray source to the object, the distance from the object to the detector, and the overall system size.

The object part consists of parameters related to the object required for the stereo scanning method. This part includes the object size, shape, position, and the movement speed in the overall system.

The detector part consists of parameters related to the detector. For the stereo scanning method, the two 1D detectors are needed. This part includes the position and size of the two 1D detectors, and the angles at which the detectors are located on the overall system. The specifications for simulation software model are shown in Table 1.

Table 1. The specifications of cargo scanner simulator software parameters

Classification	Items	Specifications
Mechanical parts	Source-to-object Distance	50 cm
	Object-to-detector Distance	50 cm
	Overall system size	100 cm
Object parts	Shape	Rectangular, spherical, cylindrical (2)
	Size	10×20×10 cm^3
	Depth	Variable (3)
	Speed	0.025, 0.05, 0.1 cm /pixels (4)
Detector parts	Size	24 cm
	Number of pixels	512
	Angles	0˚,3˚, 5˚(1)

To implement this simulation, MATLAB was used. Fig. 2 ~ fig. 5. shows the results of stereo scanning simulation software under various conditions. As a result, we can create the projection images with different angles, different object shape, different depth, different object movement speed.

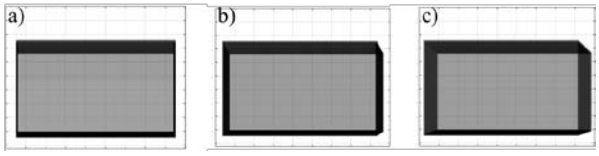

Fig. 2. The result images by different detector angles; a) 0˚, b) 3˚, c) 5˚

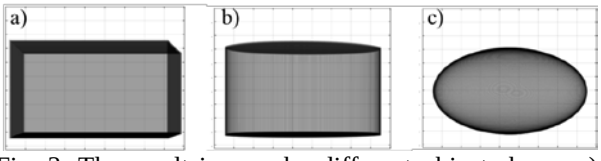

Fig. 3. The result images by different object shape; a) Rectangular, b) Cylindrical, c) Spherical

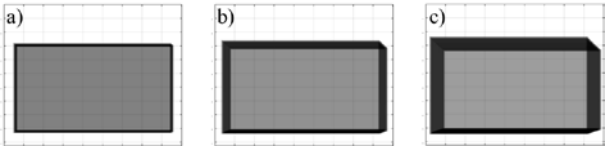

Fig. 4. The result images by different object depth; a) 1 cm, b) 5 cm, c) 10 cm

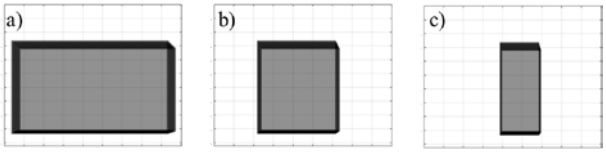

Fig. 5. The result images by different object movement speed; a) 0.025 cm /pixels, b) 0.05 cm /pixels, c) 0.1 cm /pixels

2.2 Hardware setup

To build the hardware, we need the x-ray source, the x-ray detector, the object, and the linear motor stage shown in fig. 6. The object was selected as a cylindrical object with a diameter of 3 cm and a length of 4 cm shown in fig. 7. And the linear motor stage was set to move by 0.1 mm. Detector angle was set to 0° and 5°. The obtained images were implemented as stereo images through image processing. The result images are shown in fig. 8. In this result, stereo images are successfully obtained.

Fig 6. The stereo scanning simulator hardware setup


Fig 7. The object used in stereo scanning simulator

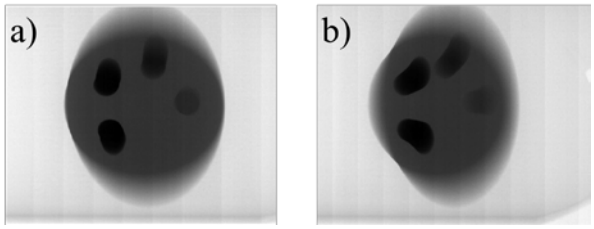

Fig. 8. The stereo image result using stereo scanning simulator hardware setup

3. Conclusions

Since the practical cargo scanner is expensive to operate, the developed simulator is worth using. This simulator can be used as a test and feedback before starting the practical cargo scanner. And system optimization and material identification through dual X-ray energy will be done in further works.

REFERENCES

[1] Zhigang Zhu,Li Zhao,Jiayan Lei, 3D Measurements in Cargo Inspection with a Gamma-Ray Linear Pushbroom Stereo System ,IEEE Workshop on Advanced 3D Imaging for Safety and Security, 2005.

[2] Zhigang Zhu,Yu-Chi Hu,Li Zhao, Gamma/X-ray linear pushbroom stereo for 3D cargo inspection, Machine Vision and Applications Vol.21, p.413-425, 2010.

[3] De Man B,Basu S, Distance-driven projection and backprojection in three dimensions, Physics in Medicine and Biology, Vol.49, Num.11, p.2463-2475, 2004.