THE DEVELOPMENT OF OBJECT DETECTION SYSTEM FOR INDUSTRIAL LINAC PROJECT AT SLRI

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INTRODUCTION

Synchrotron Light Research Institute (SLRI) has been developing a prototype of linear accelerator for industrial applications. One of the main purposes of this new project is for food irradiation application. There are three key elements in this system, an accelerator system that delivers the energetic beam, a scanning system that provides uniform beam coverage of the product, and a material handling system that moves the product through the beam in a precisely controlled manner [1]. The primary goal of the irradiation facility is to deliver the specified amount of required radiation to the products without unnecessary, wasteful, and excessive dose. Thus, monitoring and control of the process parameters and the information of objects to be scanned are important. Applying machine vision system to the irradiation facility is one way to detect object information on the conveyor belt. This system can support the material handling system in order to improve the efficiency of the facility.

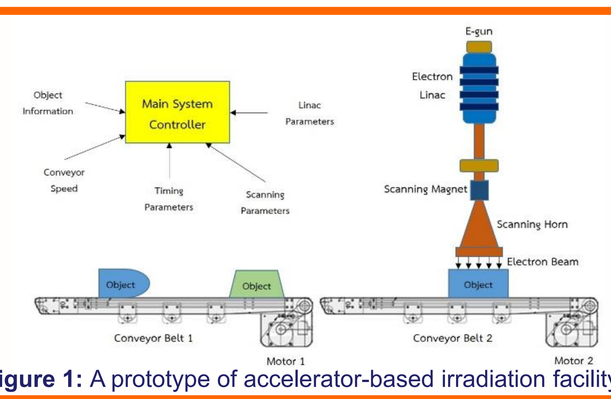

Figure 1: A prototype of accelerator-based irradiation facility.

SYSTEM DESIGN

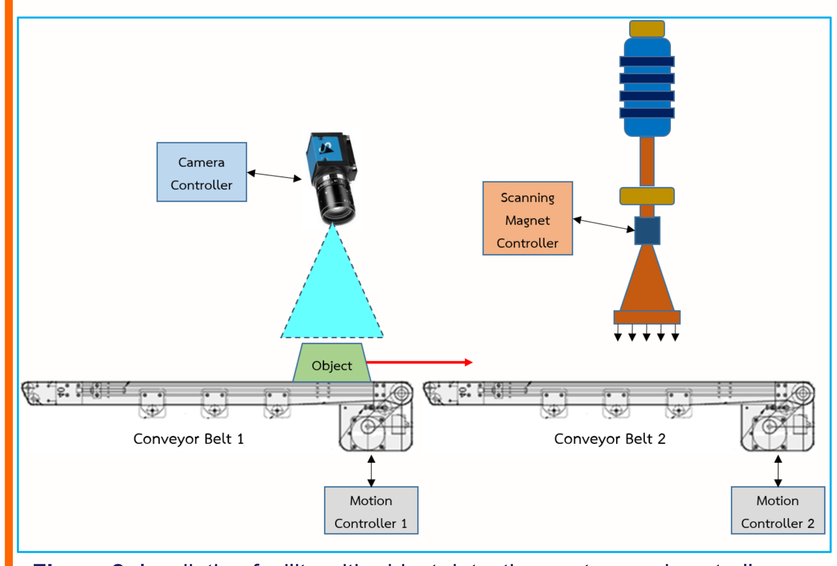

Figure 2: Irradiation facility with object detection system and controllers.

Figure 3: Vision camera and single board computer.

Vision camera specifications

Definition	Value/Type
Resolution [pixels]	720 x 540
Frame Rate [fps]	70
Acquisition Mode	Continuous
Interface	USB 3.1

Software design

- Visual C# running OpenCV and digital image processing algorithms.
- Detecting boundaries of an object moving on the conveyor belt.
- Drawing appropriate contour around an object.
- Splitting image of an object into vertical slices (perpendicular to the moving direction of the conveyor belt).
- Finding the top and bottom parts of the object in each slice of the image in order to find the object size.

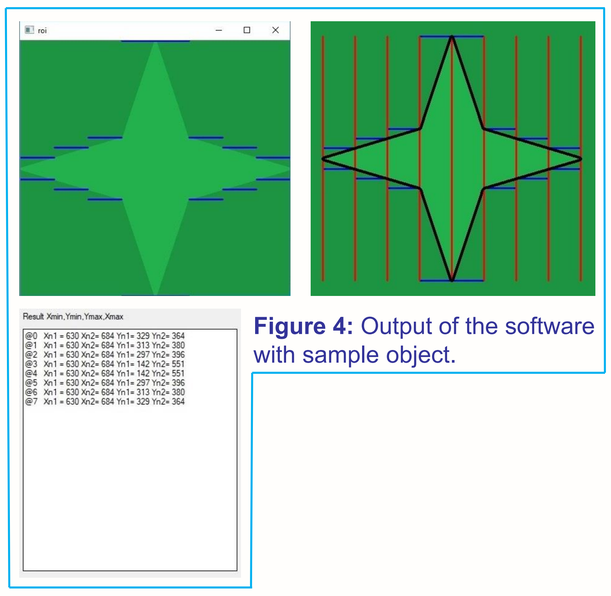

Figure 4: Output of the software with sample object.

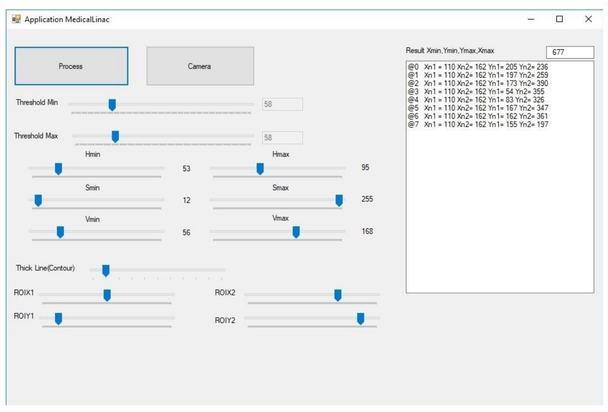

Figure 5: GUI for software settings and reporting results.

RESULT AND DISCUSSION

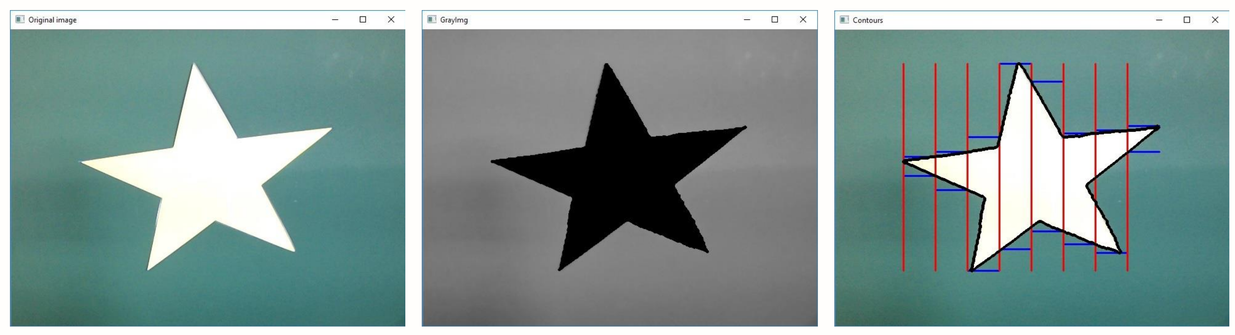

Figure 6: Hardware and software test.

Performance test

- The chosen object is placed in the middle of the conveyor and the image is captured.
- The algorithm converts the original image into grayscale and binary images.
- Contour detection, image splitting, and object size detection are performed.

Note: Since the color of a transporting belt of the conveyor is uniformly distributed with green color, the result of this design is very satisfactory.

Scanning system

The beam with uniformly distributed output is desired in scanning the product. If the object has rectangular shape, the time varying magnetic field strength shown in Figure 7 is typically desired to give the scanning action that can be used to effectively spread the beam across the product.

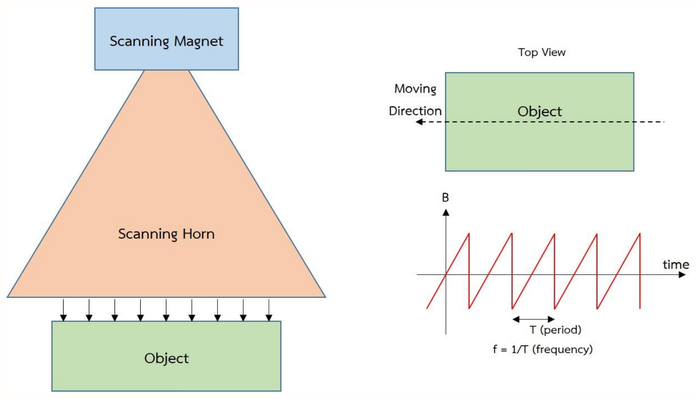

Figure 7: Beam scanning magnet system and time-dependent variation of the magnetic field.

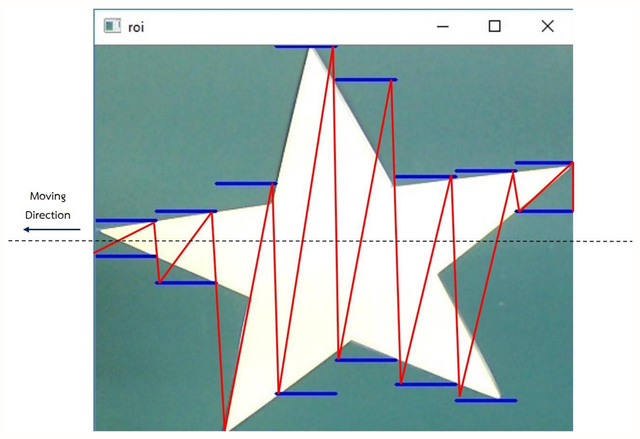

Figure 8: Expected time-dependent magnetic field for the tested object.

Appropriate time-dependent magnetic field output is shown in Figure 8. The object size for each splitted image (top and bottom parts in vertical axis), the number of splitted images (scanning magnet frequency-dependent), and boundary of the object (along moving direction) are outputs of this system. This magnetic field variation is expected to provide full coverage for irradiation. Nevertheless, for real-time operation, scanning magnet control and conveyor belt velocity control are needed. Motion control system of the prototype is discussed in [4].

CONCLUSION

The proposed real-time object detection system is developed for the prototype of linear accelerator for industrial applications, specifically for food irradiation application using x-ray. The primary purpose of the system is to provide detailed information of the object or product to be scanned in order to generate a precise time-dependent magnetic field shape out of the scanning magnet. The system design, both hardware and software, is described in detail. The output of the image analysis algorithm is achieved as desired. This result will be further applied as the input to the beam scanning magnet system in order to control magnetic field efficiently. Moreover, the system is expected to be used for real-time motion control of the material handling system of the project.

REFERENCES

[1] WHO (1988). Food Irradiation: A technique for preserving and improving the safety of food. Geneva, Switzerland: World Health Organization, https://apps.who.int/iris/bitstream/handle/10665/38544/9241542403_eng.pdf

[2] Canadian Food Inspection Agency "Food Irradiation", http://www.inspection.gc.ca/food/information-for-consumers/fact-sheets-and-in-fographics/irradiation/eng/1332358607968/1332358680017

[3] R. Miller, Electronic Irradiation of Foods: An Introduction to the Technology. Springer Science + Business Media, Inc, NY, USA, 2005.

[4] R. Rujanakraikarn, P. Koonpong, S. Tesprasitte "Motion Control Development of the Material Handling System for Industrial Linac Project at SLRI", presented at ICALEPCS19, NY, USA, October 2019, paper MOPHA143, this conference.

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