Image Inspection System for Electronic Circuit Board Assembly Using Image Processing

Sudasawan Ngammongkolwong[1], Chaovarit janpirom[2], Ekarat Suksukon [3], Ratisorn Pritisalikorn [4]
Apichit Semsri[5], Suwej Yoonoi[6]

[1]Department of Business Computer, Faculty of Science and Technology,
Southeast Bangkok College, Bangkok, Thailand.
Email :lukmoonoy_ping@hotmail.com.

[23] Department of Computer Technology, Faculty of Science and Technology,
Southeast Bangkok College, Bangkok, Thailand.
Email: ekk_ele@hotmail.com

[456] Department of Industrial Management Technology , Faculty of Science and Technology,
Southeast Bangkok College, Bangkok, Thailand.
Email :ratisorn@southeast.ac.th, aphichit@southeast.ac.th
suwech@yahoo.com

Abstract—This research article aims to; (1) develop image inspection system for electronic circuit board assembly using image processing and; (2) Identify performance efficiency of image inspection system for electronic circuit board assembly using image processing. The sample included 5 computer technology experts for system efficiency testing selected by purposive sampling method.

The research instruments consist of; 1. an image inspection system for electronic circuit board assembly using image processing and; 2 . a performance efficiency evaluation form of inspection system for electronic circuit board assembly using image processing.

The results are as follows. 1) The image inspection system for electronic circuit board assembly using image processing could detect errors and reduce production cost of electronic circuit board assembly enabling quality products that meet customer needs. And 2) According to the results of efficiency test of the image inspection system for electronic circuit board assembly using image processing, the experts provided

Suggested that there should be innovation testing for real system for 1 consecutive month to evaluate the efficiency in the light environment in the actual operation.

Keywords - Information technology; image processing; electronic circuit board assembly

I. INTRODUCTION

Image processing refers to a process of having an image processed or calculated using a computer to get the data needed in terms of quality and quantity. There are important steps including sharpening an image, eliminating noise from an image and segmenting interesting objects from an image for quantitative analyzation such as size, shape and direction of movement of objects in the image. Then such quantitative data is analyzed to create a system to use in various fields [4].

Image processing is a method to perform some operations on an image, in order to get an enhanced

Image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too. Image processing basically includes the following three steps:

A. Importing the image via image acquisition tools;

B. Analysing and manipulating the image;

C. Output in which result can be altered image or report that is based on image analysis.

There are two types of methods used for image processing namely, analogue and digital image processing. Analogue image processing can be used for the hard copies like printouts and photographs. Image analysts

use various fundamentals of interpretation while using these visual techniques. Digital image processing techniques help in manipulation of the digital images by using computers. The three general phases that all types of data have to undergo while using digital technique are pre - processing, enhancement, and display, information extraction [4].

At present, an inspection method of electronic circuit board assembly in production process mainly uses humans to inspect which can cause error inspection. That is, errors cannot be detected. As a result, no quality product is released to customers. Inspection problems are caused by human error such as eye fatigue due to long work hours, carelessness of inspectors, etc. In addition, the inspection problems caused by human error cannot be controlled. Such problems in industrial plants can be solved by using image processing to facilitate inspectors to work more easily.

From the above reasons, the researcher has an idea to develop an image inspection system for electronic circuit board assembly using image processing in order to facilitate an inspection of electronic circuit board assembly to be accurate and quick and to reduce inspection time when compared to the existing system according to the set objectives.

II. OBJECTIVES

A. To develop an image inspection system for electronic circuit board assembly using image processing.
B. To identify performance efficiency of an image inspection system for electronic circuit board assembly using image processing.

III. THE SCOPE OF RESEARCH

A. The scope of content applied image processing in system development.
B. The scope of population and sample for efficiency testing of the image inspection system for electronic circuit board assembly can be divided into 2 parts as follows.
   - The performance efficiency testing of the image inspection system for electronic circuit board assembly was performed by 5 computer technology experts selected by purposive sampling.
   - The performance efficiency testing of the image inspection system for electronic circuit board assembly was performed according to the following principles.
     1. Test of accuracy and preciseness
     2. Test of processing speed
     3. Test of distance and light intensity of camera

IV. RESEARCH CONCEPTUAL FRAMEWORK

- Independent variable
  The image inspection system for electronic circuit board assembly using image processing
- Dependent variable
  The efficiency of the image inspection system for electronic circuit board assembly using image processing

V. RESEARCH METHODOLOGY

A. Research process

The research applied the development of image inspection system protocol for electronic circuit board assembly using image processing. The principle of System Development life (SDLC) was employed to develop the system, starting from investigating the feasibility to the installation.

The process is as follows.

- System analysis

The researcher studied the problems caused by human during electronic assembly production process. When working continuously for a long period, people would have fatigue and find errors in forgetting to assemble some parts.

The summary of system analyzation brought about the use of image processing to facilitate electronic part inspection and to show that all electronic parts are completely assembled. The data was collected for designing the system in the next step.

- System design

It is a model development and innovation based on the collected and analyzed data. The researcher used a webcam to import image data and it was developed to be a language processing application called Microsoft visual studio 2017 C#. The coordination of X , Y on an original image was identified and compared with RGB values of an original image and a work image in production process. The result was displayed as PASS or MISSING.

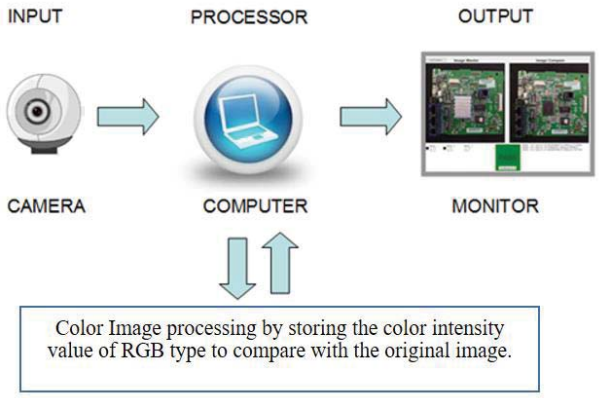

Figure 1. Device connections and system performance

- System development and testing

The researcher applied the conceptual framework of design and innovation. The system began with turning on the developed ADMPEA (ADMPEA:

Auto-Detection Missing Part Electronic Assemble). After that, a webcam was connected to a computer through Port USB. The operational process is as follows.

1. A user create an original image by identifying the coordination of X, Y on the original image and record as an original image.

2. When having the original image, the accuracy of other circuit boards in the same models were inspected. The original image and the recorded coordination of X, Y of were downloaded.

3. The electronic board was placed on the specified position under the webcam on enable the webcam to record the image. The data was compared with the original image to locate the coordination of X, Y specified under the original image.

4. The result was displayed on the screen as PASS or MISSING.

- PASS refers to an electronic board which is compared to the original image has the same parts as the original, i.e. the circuit board assembly is completed.

- MISSING refers to an electronic board which is compared to the original image does not have the same parts as the original, i.e. the circuit board assembly is incomplete or some parts are missing.

B. Research instruments

- The image inspection system for electronic circuit board assembly using image processing
- The performance efficiency test performed by the technology specialist. The statistics used for data analysis included mean and standard deviation [2]. The criteria for evaluating the system performance was a rating scale which determines the weight of the assessment in 5 levels with the following criteria [1].

5 refers to highest satisfaction
4 refers to high satisfaction
3 refers to moderate satisfaction
2 refers to low satisfaction
1 refers to least satisfaction

- This research is Research & Development (R&D). The efficiency was tested. The statistics used in the research included percentage, frequency and standard deviation. The scores given by the 5 experts were calculated for the average by comparing to the following criteria [6]. Criteria for evaluating quality of lesson plan

4.51 - 5.00 refers to highest appropriation
3.51 - 4.50 refers to high appropriation
2.51 - 3.50 refers to moderate appropriation
1.51 - 2.50 refers to low appropriation
1.00 - 1.50 refers to least appropriation

VI. RESULTS

A. The results of the development of image inspection system for electronic circuit board assembly using image processing can be demonstrated as follows.

- Software
  - Microsoft visual studio 2017 C#
  - Operating System, Windows 10 Pro
- Hardware
  - CPU Intel(R) Core(TM) i5-5300U CPU @2.30GHz computer
  - RAM 8.00 GB 64-bit
  - Webcam with HD 1080p or above

Figure 2. A computer

Figure 3. A webcam

Figure 4. A sample of electronic circuit board (PCB board)

An electronic circuit board used to compare between the original electronic circuit board (PCB) and the electronic circuit board (PCB) used in the experiment.

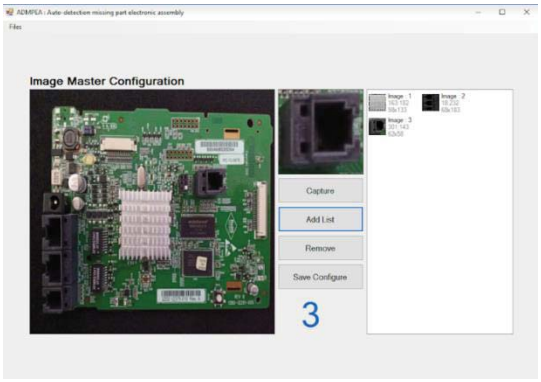

Figure 5. Creating an original image by identifying the coordination of X, Y of original image and recording as an original image

Figure 6. Show PASS result

Figure 7. Show MISSING result

B. The results of performance efficiency testing

The image inspection system for electronic circuit board assembly using image processing

- The results of efficiency testing of image inspection system for electronic circuit board assembly

Table I. The summary of performance efficiency testing of image inspection system for electronic circuit board assembly A

No.	Number of inspected positions	Accuracy of inspection device (%)
1	3	100%
2	5	100%

Table II. The summary of performance efficiency testing of image inspection system for electronic circuit board assembly B

No.	Number of inspected positions	Accuracy of inspection device (%)
1	3	100%
2	5	96%

- The results of efficiency testing by the experts with academic knowledge and more than 5 years of experience in technology

Table III. The average, standard deviation of the results of performance efficiency testing of the image inspection system for electronic circuit board assembly using image processing by the computer technology experts

Content	Results		Level
	$\bar{X}$	SD.	
1. Accuracy of work inspection	4.8	0.45	Highest
2. Easy to use	4.2	0.45	High
3. Speed of results displayed	4.2	0.45	High
4. Stability of software	3.8	0.45	High
5. Speed of system performance in overall	3.8	0.45	High
Total	**4.16**	**0.45**	**High**

VII. SUMMARY

The development of the image inspection system for electronic circuit board assembly using image processing employed the application of information technology to support production process to reduce errors in work before delivering work with quality and to meet customer needs. This design focuses on being able to be easily used which is designed to work well. It is one of the charateristics of software system [3].

The development of the image inspection system for electronic circuit board assembly using image processing applied information technology to assist production process to provide more convenience in working that meets the needs of system users. The system was divided into 5 parts including; 1. inspecting

workpiece position; 2. displaying PASS and MISSING results. 3. simplifying workpiece inspection. 4. reducing workpiece inspection time and; 5. reducing production cost.

The results of performance efficiency testing of the image inspection system for electronic circuit board assembly using image processing showed that the computer technology experts gave the overall acceptance at the highest level with the statistical significance of 0.05. The most important issue accepted by the assessors at the highest level was the accuracy of overall workpiece inspection ($\bar{X}$ = 4.16, SD. = 0.45).

This research proposes the concept of the development of the image inspection system for electronic circuit board assembly using image processing. The performance efficiency testing performed by the computer technology experts using a performance efficiency evaluation form of inspection system for electronic circuit board assembly using image processing was at high satisfaction. The research will further develop the system.

VIII. SUGGESTIONS

A. The image inspection system for electronic circuit board assembly using image processing can be developed to detect a position and read a barcode by connecting to the database to verify barcode accuracy.

B. The image inspection system for electronic circuit board assembly using image processing can be developed to be an automation system. When showing PASS, a workpiece can be transferred to the next step. When showing MISSING, a workpiece must be returned for reinspection.

C. The image inspection system for electronic circuit board assembly using image processing can be developed to have a notification system for workers related to production to analyze problems and improves production process in order to have quality products that meet customer needs.

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