

## **DEVELOPMENT OF A COST EFFICIENT VISION SYSTEM FOR DEFECTS DETECTION**

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### **ABSTRACT**

*Vision system is one of the most approached systems in industrial automation for replacing manual inspection procedure done by human inspector. A machine vision system is use in many applications such as parts sortation, defect detection, object recognition and parts counting. A vision system consists of image acquisition and image analysis procedure to obtain and manipulate the image into a decision. Programming software is required in order to execute the image acquisition and image analysis algorithm. In this project, MATLAB platform is used to program the entire algorithm furthermore implementing Graphical User Interface to communicate between the vision system and the user. A full programming documentation was done based on programming body modification and improvement. This need to be done due to the fact that further improvement of this project will need the coding history on how the algorithm being developed thus documentation is the common practice in programming stage. Enhancement on image processing algorithm can greatly contributes to improvements. The further improvements can be made through lighting design, adding image enhancement algorithm and decision algorithm.*

**Keywords:** *Machine vision, vision system, image acquisition, MATLAB.*

### **INTRODUCTION**

A vision system can be defined as the automatic acquisition and analysis of images to obtain desired data for controlling a specific activity. The vision system is a new trend to advanced sensory either in robotics and manufacturing processes. By studying and understanding how the system works and the programming method, one can enhance their knowledge on the new state of the art technology. Machine vision system is implemented in automated processes of in line inspection and quality control.

The MATLAB platform has complicated algorithm embedded in functions that ready to be call in programming body. Other advantage of the MATLAB is capability to program both in textual programming environment and visual programming environment as well. Hence this will simplify the process of coding the machine vision software. The image acquisition toolbox and image processing toolbox are the toolboxes commonly use to assist the image acquisition and image analysis.

This project will present development of vision system using MATLAB as the programming platform. This system used low cost instrumentations which is cheap to build and easy to be implemented. This system will capable of conducting online inspection procedures on a product going through conveyor at the end of a process.

## **OBJECTIVES**

The main objectives of this project is to develop a vision system with webcam as image acquisition through digital image processing using MATLAB as coding platform and to develop Graphical User Interface (GUI) and suitable algorithm to maximise inspection accuracy.

## **METHODOLOGY**

This project will undergo 3 stages in project design which are image analysis and decision, system integration and interfacing and Graphical User Interface (GUI).

Image analysis and decision stage is the most critical part of the system. The vision inspection process will inspect the quality of the part's surface and the edge shape and determine if the part is acceptable or otherwise. In advance, the product may be classified as various levels of defects by the requirement. The entire algorithm will be defined using MATLAB workspace with intensive testing using entire image processing toolbox function to determine the best image processing algorithms such as edge detection and image segmentation for enhancement.

System integration and interfacing is an automated module that will be integrating machine elements, electronics and software. While for the vision inspection, a webcam with 640X480 pixels will be connected to a computer using USB port. All the decision making are made by software that will be built based on MATLAB toolboxes. The software will have a GUI to show options for user to assist with desired options.

Graphical User Interface (GUI) will be developed intensively using user friendly options and interfaces. This includes the capability to obtain template matching display and analysis result. Few options will be added so that the GUI will preview the image analysis step by step of the image analysis to give an idea how it was done.

## **RESULTS AND DISCUSSION**

In the development stage, webcam has been choose as image acquisition. Even though it has the lowest resolution, but it possessed several advantages such as low-cost, easy to obtain and it does not require frame grabber as digitization medium. The CMOS type webcam uses plug-and-play function that uses USB port for communication with computers. Then the image capture will undergo edge detection, thresholding and few image analysis operators in MATLAB algorithm coding platform for the defects detection inspection. The algorithm or image analysis operators mentioned will be use to gather and manipulate the image into desired decisions. A GUI will be developed along the development of algorithm for delivering the image analysis steps in monitoring mode by the user.

Figure 1 shows the initial start-up of defect detection vision system. The main GUI will load first and then the live video window will come out later (refer to Figure 1 at top right). The program will upload when executed through m-file command at the command window in MATLAB.

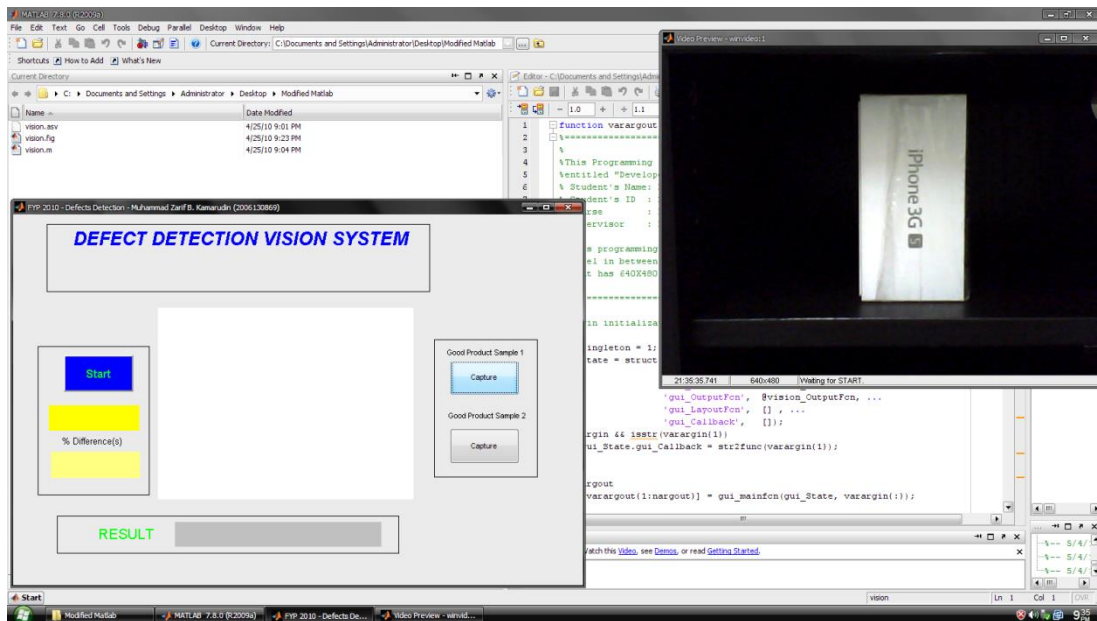


Figure 1 Initial Start-up

Before any inspection task, good sample 1 and good sample 2 must be captured first in order to provide data for decision algorithm to compare with the inspection product. Refer to Figure 2 the good sample 1 and good sample 2 buttons are pressed in order to obtain the data. The buttons are located at the left side of the GUI layout. After the capture of good sample 1 and 2 are pressed, the image captured will be displayed at the centre of the GUI (refer to Figure 2).

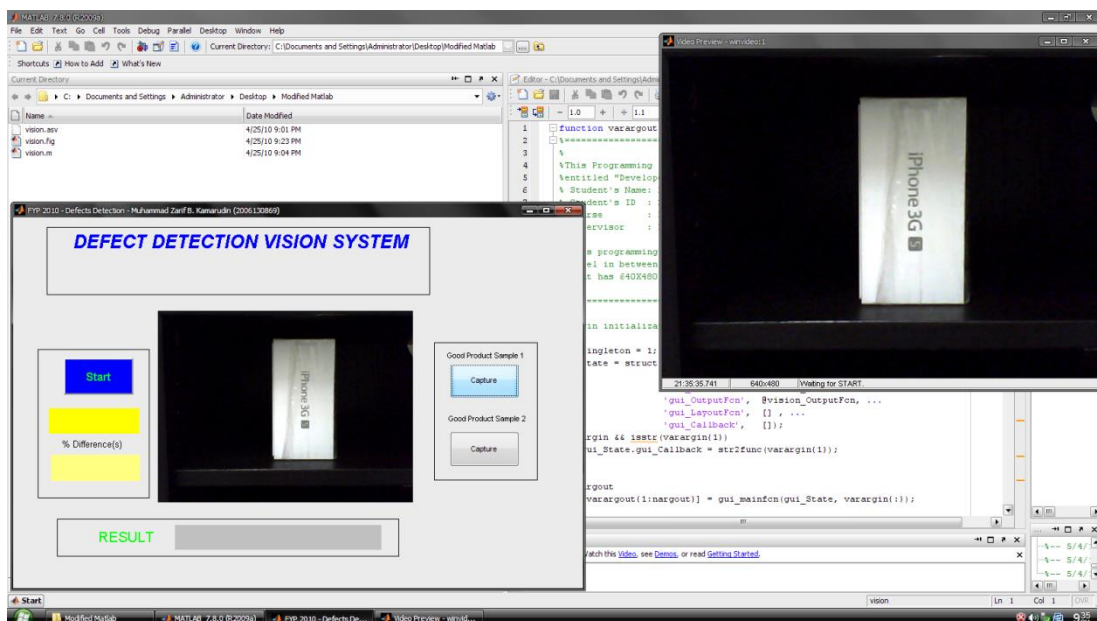


Figure 2 Good sample 1 and 2

Both the good sample are then analysed to ensure that they are in good condition. Figure 3 shows that both good sample produce match difference at 6% which means they are in good condition.

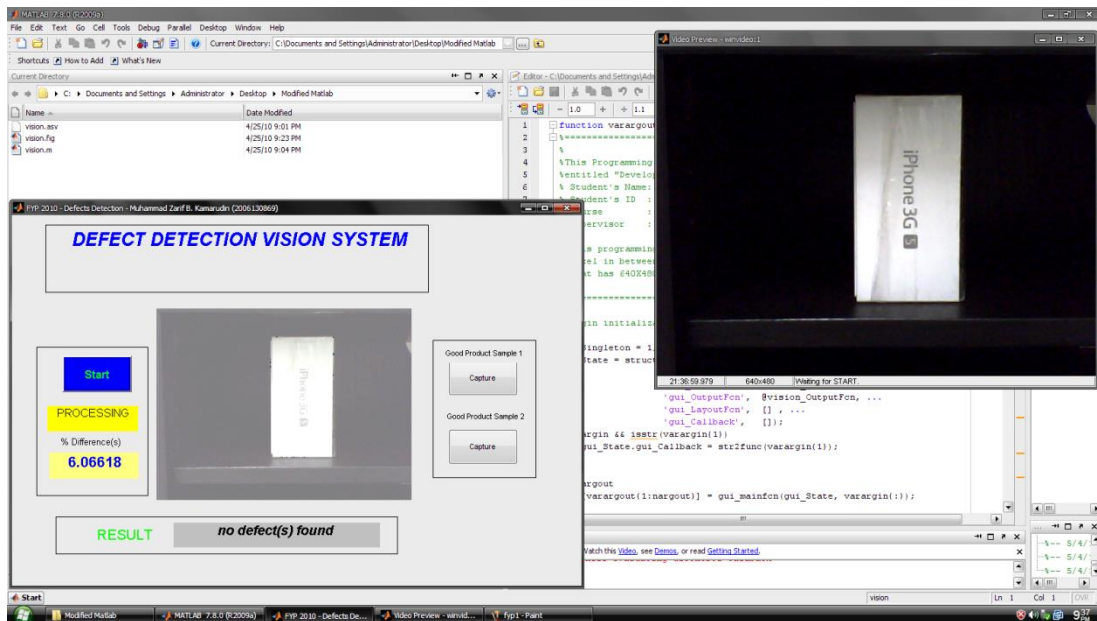


Figure 3 Inspected good sample (6% match difference)

Real time captured still mage of the inspected product will come out on the axes at the centre of the GUI window. In order to capture the inspection product, the Start button is pushed and the result will come out later. The Figure 4 shows the product inspected. The blue colour line indicates that there are defects at the location. In Figure 4, the good sample is a box placed in a cabinet. Then the box was removed from the cabinet indicating defects. The blue line shows that the box is not present at the moment.

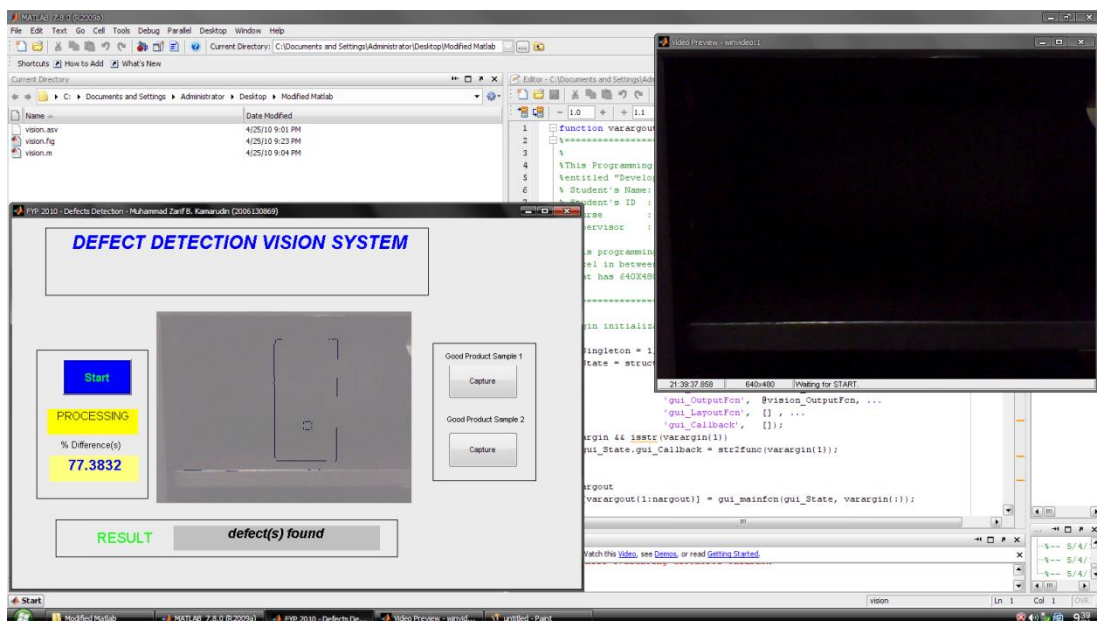


Figure 4 Inspected product (77% match difference)

The GUI not only shows the match difference but will also show the location of the defects. Furthermore the GUI will inform the user whether the parts inspected found defects or not. This will ease the user to make decision on the inspected parts and thus reducing time of inspecting.

## **CONCLUSION**

Vision system is a sensor that can be manipulated in many ways. It can be used in many applications from detecting defective product to part orientation. Throughout completing this project, several keys of developing a vision system programming using MATLAB was recognize. The vision system can be divided into five categories when developing using MATLAB. There are GUI, communication programming, image acquisition programming, image processing and decision algorithm that combined together to perform the inspection.

However, the image processing and the decision algorithm are the major roles in determining the system accuracy and efficiency. The type of camera being used, the lighting design and computer's speed are the external factors that can directly affect the vision system accuracy and efficiency.

The sequence of triggering webcam to capture images is controlled by user. It can be further improved by integrating switch or infrared sensors at end of conveyer to initiate defects detection.

The development of vision system using webcam achieved the objectives stated earlier but there are certain aspects of the image processing algorithms can be added to further improve the system capabilities and increase the rate of accuracy. Enhancement on image processing algorithm can greatly contributes to improvements.

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