LCD TV Components Detection System for Industrial Manufacturing Company

by

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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the
Computer Information Science Programme
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May 2011

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

SITI AIN NURENA BINTI MOHD NASIR

ABSTRACT

This paper describes components detection system that is capable of detecting components of LCD TV set based on the image captured. There are two contributors. The first is the pixels value calculation used for image comparison which the target image and base image is compared. Any difference on the pixel value is considered as a faulty product. For the second contributor, an edge detection emphasize on the Canny Algorithm is used to ensure the detection is more precise. The system recognizes the components on each product and ensures the positions of the components are the same as the base image i.e. the correct, standard position. The system is demonstrated on a 32 inch LCD TV set. The training and testing result have shown that the proposed method has achiever satisfactory result for components detection.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Informally, object detection is the process of determining the identity and position of a known object, whereas object analysis appends the additional requirements of estimating the object's pose and scale. Differ than object recognition, where the object's position is assumed to be known and the object is typically shown against a known, uniform background. For an example, various objects are placed on the same black cardboard as its background. The same black cardboard is known as uniform background for all those cases.

In hand, let us compare with the human vision. The human vision is capable of performing accurate object analysis. Starting from the eyes which see the object, later it sends the information through our nerves function connected from the eyes and finally to our brain as it will process all the information. It is as demonstrated by our ability to easily answer questions regarding the identity, location, pose, and scale of objects within our environment.

Hence, designing a general purpose computer vision system with performance comparable to human vision system is the goal of many researchers. Unfortunately, as mentioned in Object Detection and Analysis using Coherency Filtering; general purpose computer vision systems are beyond the state-of-the-art and the proposed system is no exception.

The project will develop a components detection system that is capable of detecting components of LCD TV set based on the image captured. Pixels value calculation is used for image comparison which the target image and base image is compared based on the pixels value. The system is focusing on components detection only and is demonstrated on a 32 inch LCD TV set.

1.2 PROBLEM WITH MANUAL INSPECTION

Manual quality inspection use human workforce to do quality check for the manufactured products. Quality inspection requires them to remain focus and precise. They need to inspect every component in the manufactured product and ensure there is no missing components or parts.

Based on the author's experience during the author's industrial internship training in one of the most prominent electronic company, they are currently holding a thick pencil and manually inspect and tick the corresponding components based on the picture attached in the standard operation procedure. However, sometimes these human manual labors may lead to poor-quality output. Human fatigue is one of the problems.

Besides, millions of product is manufactured in one day and are inspected by the same human labor for more than eight hours, which cause them to overlook the missing components. The problems are simplified as:

- Human fatigue
- Large quantity of sets produced in one day
- Continuous production

This human error leads to missing parts or components of the manufactured product. Once this human error occurs, it costs a lot of money to spend and time consuming in order to fix the problem. Hence, a great Japanese company mentioned that automation may leads to higher-quality output. Thus, as in Quality and Reliability Requirement site; whenever automation is cost-effective, it is used to replace manual assembly, handling, testing, and human inspection activities.

1.3 PROBLEM STATEMENT

Several manufacturing company already invest for automation in their product's quality inspection and some still using the traditional method; manual inspection. However, missing components of manufactured product is still reported. Hence, the author is hereby to develop a detection system, concurrent with the advancement in information technology. The Components Detection System can detect missing components of the manufactured products selected specifically for this project; LCD TV.

1.4 OBJECTIVE

- To detect missing part from LCD TV
- To propose Component Detection Model to identify missing component

1.5 OTHER SIDE-OBJECTIVES

- Reduce manpower for quality inspection
- Reduce cost for rework incomplete sets
- Reduce and avoid human error

1.6 SCOPE OF STUDY

- 32 inch LCD TV set components:

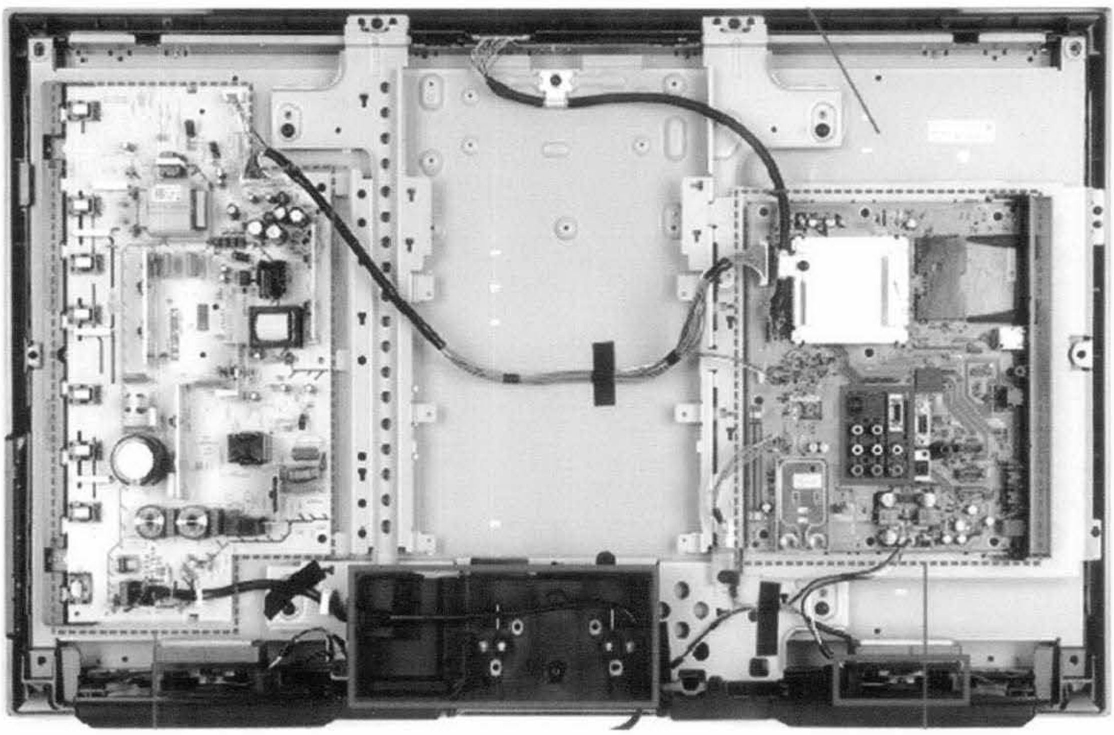
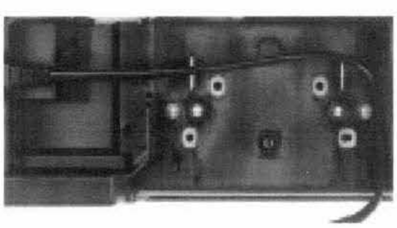


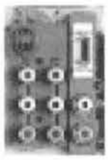
Figure 1: Components involved in the project

1. AC cord



2. Power button circuit

3. 8-input ports



For the ease of the project, assume that these items have been inspected thoroughly and are in good functional condition.

- Components detection only

CHAPTER 2

LITERATURE REVIEW

Based on the human vision as our reference, develop a vision system with same capabilities as human vision is easier said than done. For this project, a brief explanation on human vision is done. Later, several concepts have been put forward to meet the needs of the project.

2.1 HUMAN VISION

Donovan (2006) mentioned in his research; as a human, vision seems remarkably simple which we accomplish this task daily without any apparent effort (p.9). This act as a hint of how powerful the human brain is; to capture image, processing the visual information feed and later, can recognize and identify different type of object, instances, components and others.

Our brain store most of the information gains by our senses. We collect the information by seeing, feeling, touching, tasting and hearing. We do all these using our senses which we called as input sensors in the computer field.

Focusing on vision system, the object stimulates the eyes nerves and information is sent through the nerves and finally reaches our brain. The brain later process the information and compare with its existing, stored information. If any information can be retrieved from brain memory, it is already done through experience, if not, brain sends related info or clues related to that current object and the force to learn and observe the new object.

The existence of brain's memory and nerves give a very big help in our learning. In Wikipedia under the title of Optic Nerve, mentioned the eye nerves called as optic nerves composed of retinal ganglion cell axons and support cells. These always-connected axons assist the information to run smoothly and quickly.

As what we have been practicing, we can give feedback as soon as the question is been asked. A major contribution comes from the brain. Based on Warren (1994) and Cardoso (1997), memory has been variously characterized as a process of information retention in which our experiences are archived and then recovered when we recall them.

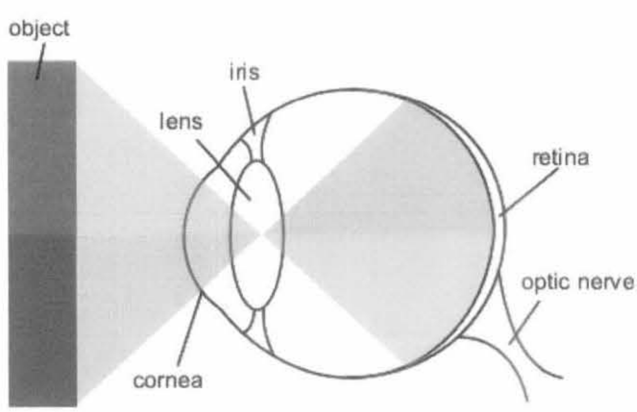


Figure 2: Human vision system, the eye

For the next two subsections, the human vision architecture is made as our reference to achieve a good computer vision system. Several concepts obtain through comprehensive research shall be discussed.

2.2 IMAGE COMPARISON

Image comparison is defined as finding the similarities or differences between two images. In this project, the system is focusing on finding the differences between two images which later, this difference will be used as the result for the system.

Philippe (2005) mentioned, simply comparing the pixels value is quite often used in object recognition but different proposed method like tangent distance and image distortion model (p.2). Briefly, pixels value calculation is a common method for image comparison.

The purpose of this concept is to find the differences between images. As if we are putting two images together, one in front of the other. Any irrelevant differences are our spot. That irrelevant difference is derived by pixels value calculation. Pixel values are described as how bright that pixel is and/ or what color it should be.

According to Wayne Fulton (1997):

Pixel is the remembered color value of each one of these color samples representing tiny square areas. The size of the image is dimensioned in pixels, X columns wide and Y rows tall. When all of this image data (millions of numbers representing tiny color sample values, each called a pixel) is recombined and reproduced in correct row and column order on printed paper or a computer screen, our human brain recognizes the original image again.

For this paper, we denote an original image as X and the pixel value is calculated at the position (x, y) by $X(x, y)$. By hand, we denote a real-time image captured by the input sensor as Y and the pixel value calculated using the same algorithm as the original image, $Y(x, y)$. If there are any differences in pixel values after comparing with the real-time image, an error happened.

The concept applied is the same as the common game, spot the difference, between two pictures which are put side by side. However, that one is using our vision system, the eyes. Easy for us to spot and circle any differences. We should ask ourselves, what do the computer see and how do they know where are the spots of difference.

Donovan (2006) is very definite: "Distance between an object and the viewer determines the scale of the object. An object detection or analysis system must be able to detect the object despite this variation in scale and the resulting loss of object detail that occurs as the size of the object decreases" (p.2). However, in this project the distance between input sensor and target image is remain fixed. Hence, distance calculation method or technique is not applicable for the project.

The pixels value calculation is very useful to calculate any difference on the pixels value between images. This is how the computer vision system knows where to spot the differences. Computer vision is based on the databases, algorithms and calculations. It is how the computer thinks and learns. This concept comes as the first step after the input sensor captured an image, sends it and then, compare with the reference image or based image retrieved from the database.

Later, after learning to compare between images, the computer vision system learn how to identify certain object, in this project scope is how the computer learns how to identify the components. The concept of detection is discussed later.

2.3 OBJECT DETECTION

Common to hear the term recognition paired with detection. However, in this project we give main focus on detection. Donovan mentioned, object detection and recognition fall in the hierarchy of computer vision system.

Object recognition is generally assumed that the object of interest has been segmented from the background and the position is known. The goal of this method is to determine the identity of the object. Meanwhile, object detection does not make use of any prior information. This method will recognize and identify the identity and location of all objects within a query image.

Based on this project scope and requirements, the system will detect all highlighted components, mentioned in Chapter 1, of the LCD TV set. Donovan (2006) mentioned "the detected object is considered correct only if the estimated position of the object in within Δ_R pixels of the object true position." (p.10,104).

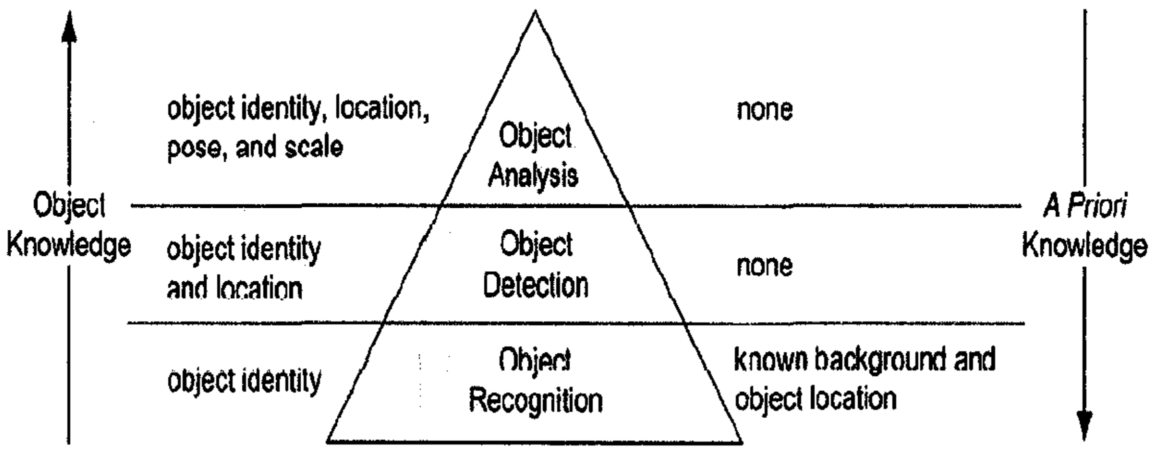


Figure 3: Hierarchy of computer vision systems showing the decrease in a priori knowledge and increase in knowledge gained about an object as one moves from an object recognition system to an object analysis system.

However, there are some factors affecting the system ability to recognize an object, or in this project scope, component. As stated by Donovan (2006), "an object's appearance results from the combined effects of its shape, reflectance properties, pose, distance from the viewer (i.e., relative size or scale), and the illumination properties of the environment." (p.12) Detection requires ability to identify the location of the object which sometimes, object may be partially occluded into the scene or background.

For this project, some assumptions have been highlighted:

- The position and pose of the components are fixed

  The positions of the components remain the same within the manufactured product for entire manufacturing. The difference comes only on different models and size. However, for the project presented, we are focusing on the 32 inch set only. The poses of the components remain as the product is placed horizontally on the production lines.

- Distance between input sensor and target image is fixed

  For quality inspection, the input sensor is placed above the running production line. Hence, no movement is applicable for the input sensor. Meanwhile, the distance between the input sensor and the running product always remains.

- The lighting used for the quality inspection area is unchanged

  Lighting is crucial for the quality inspection. Hence, major attention is given to provide sufficient light to this area.

- The pixels and resolution used to capture target image and base image is set unchanged

  The image captured for base image and real-time image are using webcam with the capacity of 8 megapixels.

2.4 RECENT PROJECT ON DETECTION SYSTEM

2.4.1 Object detection and analysis using coherency filtering

According to Donovan (2006):

> ***Local appearance method***, termed ***coherency filtering***, which allows for the robust detection and analysis of rigid objects contained in heterogeneous scenes by properly exploiting the wealth of information returned by a k-nearest neighbors (k-NN) classifier. A significant advantage of k-NN classifiers is their ability to indicate uncertainty in the classification of a local window by returning a list of k candidate classifications. Classification of a local window can be inherently uncertain when considered in isolation since local windows from different objects or the background may be similar in appearance. In order to robustly identify objects in a query image, a process is needed to appropriately resolve this uncertainty. Coherency filtering resolves this uncertainty by imposing constraints across the color channels of a query image along with spatial constraints between neighboring local windows in a manner that produces reliable classification of local windows and ultimately results in the robust identification of objects. (p.ii)

Donovan (2006) mentioned there are two common ways of detection, by grid search or interest point (p.11). By using grid search, the system will search using a systematic function to all over image. Example, going row by row until all pixels has been considered by the system. This method consumes more time than the later one, interest point. By using interest point, areas within an image with relevant information are used for detection.

The system developed by Donovan (2006) can identify objects contained in test images focusing on pose, scale, illumination, occlusion, and image noise. Does not matter how the object is, the system is capable of recognizing it. As a conclusion, the system can identify objects under a greater range of viewing conditions.

2.4.2 An improved template matching method for object detection

Nguyen (2010) develops an improved template matching method that combines both spatial and orientation information in a simple and effective way (p.1). ***Generalized Distance Transform (GDT)*** and ***Orientation Map (OM)*** are proposed to ensure the system is able to take into consideration the edge's strength and orientation for reliable and robust matching.

In GDT, it takes into account the horizontal and vertical gradients of the image with a control of a positive constant variable. Later, the GDT computed not only based on the spatial distance but also on the strength of the edges.

In OM, additional information is provided in order to match an image with a test image. The usage of sin in the algorithm is to encode the distance orientation. However, the difference in orientation is considered only for acute angle.

The template matching method detects humans, cars and maple leaves from images in order to evaluate the system. For human detection, they use images in upper right standing poses from front and rear view points. For car detection, images of car from side view and under different resolution and low contrast with highly textured background are used. Images scanned with steps of five pixels and two pixels in horizontal and vertical direction. For maple leaves, only one leaf per image is used throughout the dataset.

Briefly, the performance of proposed template matching method in detecting humans, cars and maple leaves is improving the detection performance by increasing the true positive and negative rate.

CHAPTER 3

METHODOLOGY / PROJECT WORK

3.1 PROJECT METHODOLOGY

This project uses prototyping-based methodology which allows the analysis, design and implementation phases to be done concurrently. All these three phases are performed repeatedly as a cycle until this system complete. The reason of choosing this type of methodology is to let the system to be improved for a better system in a future with comments from the users.

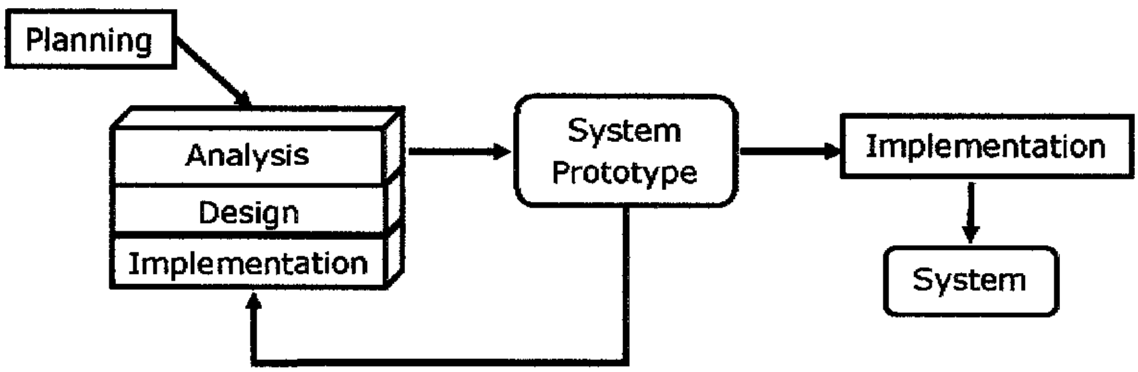


Figure 4: RAD Prototyping methodology

3.1.1 PLANNING

Planning phase is the fundamental process of understanding on why the project should be built and to determine how the management process of the project would go. Apart from that, in this stage the project title is determined. Later, the outcome of the project to the target user is examined thoroughly.

For this, brainstorming and problem identification of current automation for quality inspection and object detection are identified. Based on the identified problem, clear objectives had been derived and the project title is proposed. Literature review had been primed and the project timeline and milestone had also been developed (the Gantt chart of the project).

3.1.2 ANALYSIS

The analysis phase is the first phase of the iterative phases of the prototyping methodology. Analysis phase is where some researches done on current system; identify improvement from the current system and concepts on developing the system.

In the context of this project, researches on object detection and current situation of quality inspection are done. Besides, requirements gathering through a recorded informal interview had been conducted with a staff from industrial manufacturing company to gather information on quality inspection by human manual labors and upcoming automation to enhance quality inspection.

Basically, we develop a training set. We extract the image received by the input device. The real-time image is designed to be robust to shape variances and background clutters. For the current research, only a few training examples are sufficient to encode local shape information of the components. Differences between the actual images with based image are using the pixels value calculation.

Later, recognition hypothesis is generated by matching the actual, real-time image features to the training set. An identification of the components' identity is retrieved from the database.

3.1.3 DESIGN

The design phase decides how the system will operate, in terms of hardware, software and network infrastructure, the user interface, forms and the specific programs, databases and files that will be needed.

In other word, the steps in design phase determine exactly how the system will work. The components are inspected thoroughly and are in good functional condition. This is to reduce any upcoming error that may happen after building the system.

Also, the initial structure of the whole component detection system is drawn. Besides, the integration between the hardware, software and database is tested. Most important is the integration between the input sensor and database.

The captured image is compared with the based image from the database for recognition and detection. The electronic components connecting between the input sensor to the database and the production line is also tested. Any hardware faulty happened should be identified during this phase.

3.1.4 IMPLEMENTATION

This is the final stage in the iterative phase of prototyping methodology before the first prototype is delivered. All the programming, code-generating and the system improvement as per user requirement will be done throughout this phase. The prototype is build based on the deliverables in the design phase such as the architecture design. In the prototype based methodology, the 'quick and dirty' program that provides a minimal amount of features is delivered at the end of this phase. The project will keep enhancing and updating based on gathered requirements and until enough features implemented, also after the review from users.

After implementing the draft system to adapt the actual situation, users gave their feedback for improvements. For example, the first prototype has malfunction to differentiate between the AC cord and the surface of the LCD set. Hence, the system is embedded with an edge detection algorithm to differentiate the AC cord apart from the LCD surface. Later, the enhanced first prototype is still under training with supervision.

3.1.5 TESTING

Component testing shall be done to ensure each component and algorithm embed in the coding is functional. At this moment, any faulty caused by the system shall be recognized and recorded for future use. After the first prototype is built, the system is practically applied to the quality inspection area. Manual inspection and automation by the system are working concurrently.

Basically, this phase is done iteratively with the implementation phase as the testing need to be conducted when the prototype is enhanced or upgraded. The test is conducted within the quality inspection area to ensure the system is adaptable to the actual situation. Any faulty happened is recorded.

3.1.6 INSTALLATION / FINAL SYSTEM

When the project reached this phase, there will be no more iterative process. In other word, this is the last phase where there will be no more prototypes. Finished, complete system shall be delivered. However, there will still be minor enhancements to uphold the system reliability.

As for final year project, this project is developed until first prototype of the system. The first prototype aims to deliver the function of component detection. If the time and cost are permitting, the project shall be continued until the component recognition. The algorithms that the system uses will be discussed under the result and discussion chapter in this document.

3.2 PROPOSED COMPONENT DETECTION MODEL

Image comparison and detection based on computer vision are implemented in this project.

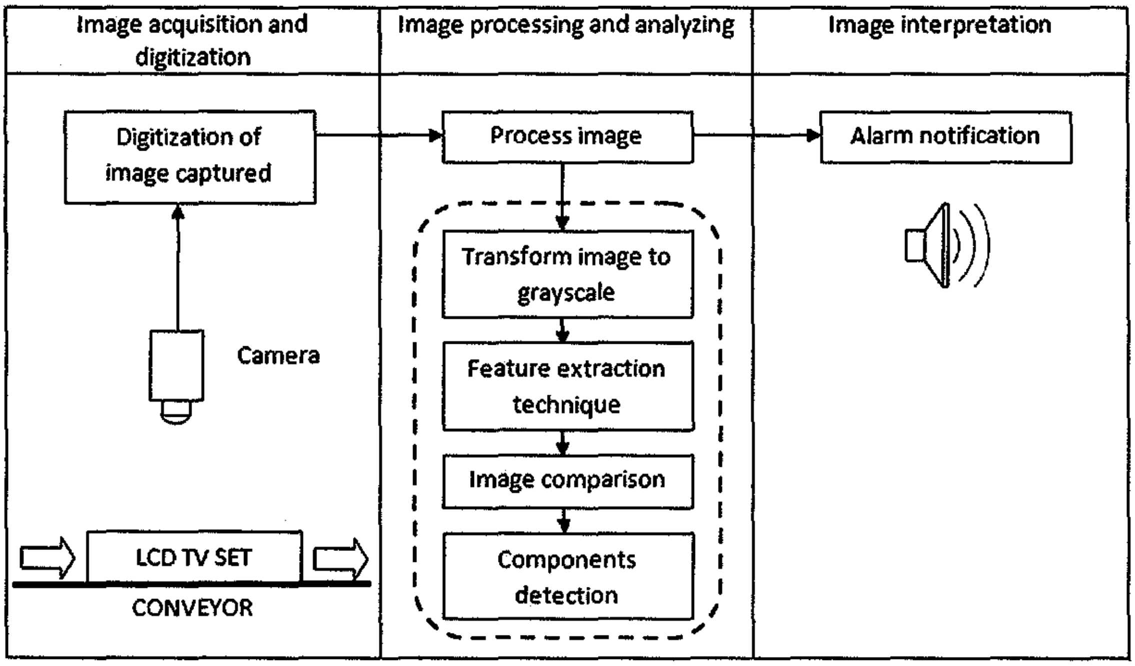


Figure 5: Proposed Component Detection Model

3.2.1 Image acquisition and digitization

A camera is placed above the LCD TV on the conveyor in the quality inspection area. Once the LCD TV goes to the inspection area, a stopper located at the end of the quality inspection conveyor hold the LCD TV for a few seconds for image acquisition. The image is captured by the camera. Image digitization happens when the image captured is stored as JPEG format.

3.2.2 Image processing and analyzing

The image captured as JPEG format is processed by the system. First, the image is transformed to grayscale image. We use grayscale image which is convenient for programming, image processing etc. Grayscale image is composed exclusively of shades of gray, varying from black at the weakest intensity to white at the strongest. It is an image with two colors, black and white, also called as binary image.

Later, feature extraction technique is applied. Feature extraction is special form of dimensionality reduction. The input data is transformed to a reduced representation set of features. If the correct feature is extracted, the set shall contain relevant information in order to perform the desired task. For this, we adapt Canny Edge Detection algorithm which a function embedded in MatLab. The noise reduction stage in Canny Edge Detection algorithm is helpful to the system. This method used to overcome the same color as for the AC cord and LCD surface for the enhancement of the system's first prototype.

Then, the image captured is compared to the original image obtain from the database. Pixels value calculation is done for both images to see any pixel value difference. If there is any difference occurs, the system triggers the alarm indicate that the current LCD TV on the conveyor is not complete or has an unidentified error. For future work, the error will be segmented based on type of error happened.

Last, the system proceeds to detect three components from the image captured if it passed the image comparison stage. If one of the components is detected missing, alarm is triggered. If not, the product is considered passed and the stopper at the end of the conveyor will release the LCD TV set.

3.2.3 Image interpretation

In this stage, there is a binary decision made by the system, either alarm is triggered or not. The alarm is triggered starting at the third stage of the image processing and analyzing stage. At the third stage of the image processing and analyzing stage, if the product pixels value calculation is differ than the original, the alarm is triggered indicate an unidentified error happened or vice versa. Later, at stage four, if the system detects one of the three components are missing, the alarm is triggered and vice versa.

For future work, the sound of the alarm will depend on the type of error occurs. Hence, a definite type of error will be set.

3.3 DEVELOPMENT TOOLS (HARDWARE AND SOFTWARE)

a) 8 megapixels PC camera

- Acts as 'the eye' to capture input picture

Figure 6.1: ALOHA PC camera

b) 32 inch LCD TV set

- Main subject for the project
- Used as the base picture and as input to 'the eye'

Figure 6.2: 32 inch LCD TV set

c) MatLab

- High-level language and interactive environment that enables to perform computationally intensive tasks faster
- It also equipped with image processing toolkit

Figure 6.3: MatLab used for image processing

CHAPTER 4

RESULTS AND DISCUSSION

4.1 STUDY – INTERVIEW

The purpose of the interview is to identify the exact problem happened in the quality inspection area. It is conducted at the very beginning of the project proposal. For further details of the interview, please refer to **Appendix 03.**

The study was conducted by interviewing Mr. Dzulrizal bin Dzukaffli, the author's former plant supervisor and senior engineer in Process Engineering, LCD Production at one of the famous industrial manufacturing company in Malaysia.

Prior to the interview, a set of questions is prepared. During the interview, any relevant information was recorded for further research and reference. He has been asked several questions in order for the author to gather relevant and sufficient information regards to the system development.

The questions are:

- Problem that might occur during the product's manufacturing process.

- Background of the problem.
- Solutions and steps taken to overcome the problem.
- Related issues when faulty happened.
- The need of automation for quality inspection.

4.2 SYSTEM SET-UP

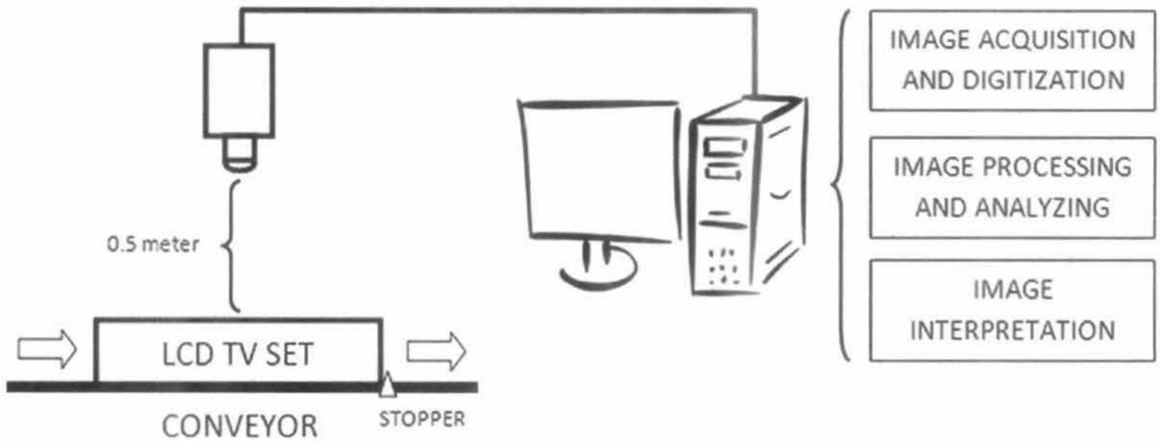


Figure 7: Hardware attached to a computer installed with Component Detection System, in quality inspection area.

The LCD TV set is placed on the conveyor equipped with a stopper at the end of the inspection area conveyor. The LCD TV is put upside down for inspection after done with the assembly process. A camera is placed 0.5 meter above the LCD TV to capture the actual image. The camera resolution is eight megapixels and the image is stored in JPEG format. The camera is attached with a computer. The Component Detection System is installed and will process the image. Any error occurrence will trigger the alarm.

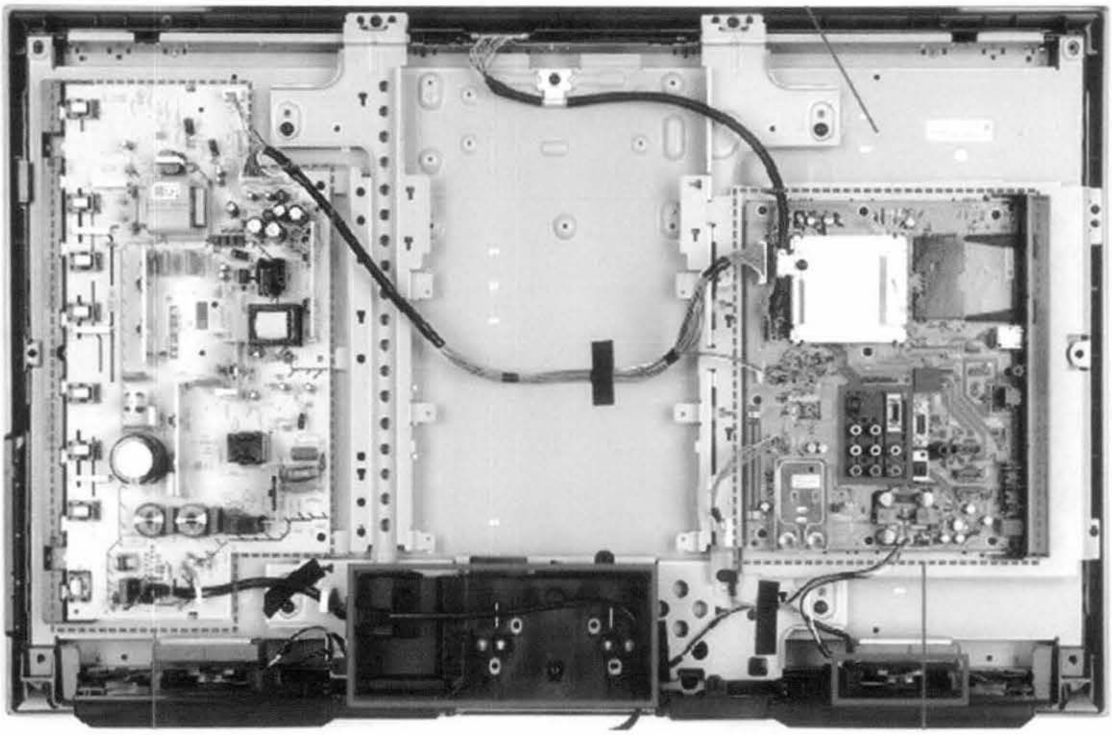


Figure 8: Complete components detected by Components Detection System

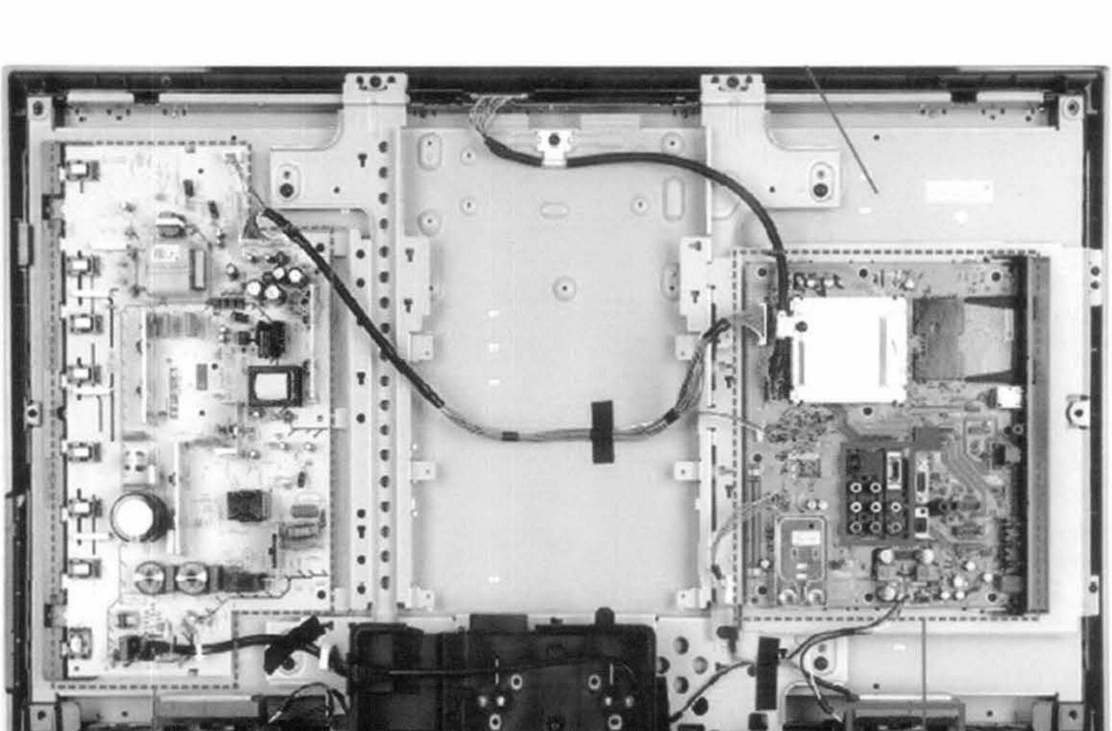


Figure 9: AC cord is detected as missing by Components Detection System.

4.3 SYSTEM TRAINING

For system training, a total of 12 actual JPEG images of LCD TV are used apart from 20 actual JPEG images of LCD TV sets. The recognized samples calculated based on the completeness of the components detected.

Based on the training set, we find differences between the actual images with based image using the pixels value calculation and detect intended components. If difference is found during the image comparison using the pixels value calculation, the system will act by triggering an alarm indicate one of the product's components is not enough.

Table 1: System recognition rate for training

Data	No. of samples	Recognized samples	Recognition rate (%)	Error rate (%)
Training	12	5	41.67	58.33

Based on the training given, the system only recognized five samples out of twelve set intended for the training purpose. There are four set which the system detect missing of the AC cord but it is there in actual product while the others, none of the components are detected. Hence, the recognition rate for the system during the training is 41.67 percent and the error rate is 58.33 percent. This tells us that the system needs further enhancement in algorithm used or the environment setup in the quality inspection area.

Previously, the first prototype has malfunction to differentiate between the AC cord and the surface of the LCD set. This is due to same color, black, for both AC cord and the

LCD back surface. Hence, the system is enhanced by embedding an edge detection algorithm to differentiate the AC cord apart from the LCD back surface. Currently, the enhanced first prototype is still under training with supervision.

4.4 SYSTEM TESTING

For system training, a total of 8 actual JPEG images of LCD TV are used apart from 20 actual JPEG images of LCD TV sets. The recognized samples calculated based on the completeness of the components detected.

As for the testing, an enhancement made to the coding of the system using MatLab.

Table 2: System recognition rate for testing

Data	No. of samples	Recognized samples	Recognition rate (%)	Error rate (%)
Testing	8	4	50.00	50.00

Based on the recognition rate table, any enhancement to algorithm used is necessary to improve it. Out of eight samples dedicated for testing, only four samples are recognizable by the system. The result is not as expected.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The initial stage of this project has given the idea and understanding of the manufacturing company's operation. As the project goes on, there are lots of concepts and methods used by researchers all over the world. As for the object recognition and detection, it is spreading vastly among those researches.

At this point, there are some questions remained unanswered, e.g. same color for overlapping components which canny algorithm is expected to improve the error rate is still unsatisfied. The best achieved error rate is 50 percent. Nevertheless, this result is promising because only simple webcam without any environment restriction has been used and some image samples are visually detected complete by the system.

The usage of canny algorithm to overcome the overlapping colors for AC cord and the LCD TV surface is quiet helpful. The best achieved recognition rate is 50 percent and can be improved with future work.

5.2 RECOMMENDATION

To further speed up the detection process, the enhancement of the canny algorithm and the pixels value calculation for image comparison will be our future work. Besides, error type segmentation should be implemented in the future. The system can also embed with additional function; to recognize the detected components. The recognition process will give details about the components detected by the system.

REFERENCES

1. Donovan H. P. August 2006, *Object Detection and Analysis using Coherency Filtering.* Degree of Master of Engineering, Department of Electrical and Computer Engineering, McGill University, Montreal, Canada. Page 2 – 104.

2. *Quality and Reliability Requirement.* <http://www.wtec.org/loyola/ep/c6s2.htm>

3. Pablo S. 2010 *A recognition system for symbols of electronic components in hand written circuit diagrams.* Department of Computer Science, University of Toronto, Canada.

4. Alan D., Barbara H. W., David T. 2005 *System Analysis and Design with UML Version 2.0: An Object-oriented approach,* Second Edition by John Wiley & Sons, Inc. Page 9-12

5. *Definition of project framework* <http://sites.google.com/site/pmpbank/glossary>

6. Philippe D., Daniel K., Thomas D., and Hermann N. *Gesture Recognition Using Image Comparison.* Computer Science Department, Aachen University, Aachen, Germany. Page 2-3

7. Steven J. S., Margaret S., and Jason S. A. *Comparison of Image-based Functional Monitoring through Resampling and Compression.* Report Number HPL-2009-145 HP Laboratories.

8. Sanjiv K. and Martial H.. *Multiclass Discriminative Fields for Parts-based Object Detection.* The Robotics Institute Carnegie Mellon University, Pittsburgh. Page 2-8.

9. Sharma V. 2008 *Simultaneous Object Detection and Segmentation using Top-down and Bottom-up Processing.* Degree Doctor of Philosophy, Graduate School of The Ohio State University. Page 19-46

10. Paul V., Michaels J. July 13, 2001. *Robust Real-time Object Detection.* Second International Workshop on Statistical and Computational Theories of Vision, Vancouver, Canada. Page 4-6.

11. Paul V., Michaels J. 2001. *Rapid Object Detection using a Boosted Cascade of Simple Features.* Accepted Conference On Computer Vision And Pattern Recognition 2001. Page 3-5.

12. Ashraf S., Erel A., Keshav D., Muhammad S., Rajkumar R.. *Soft computing in Industrial Applications Recent and Emerging Methods and Techniques* by Springer

13. Dreaming 5GW Part III: Lessons from Software Development <http://www.tdaxp.com/archive/2007/07/28/dreaming-5gw-part-iii-lessons-from-software-development.html>

14. *Optic Nerve* <en.wikipedia.org/wiki/optic_nerve.html>

15. Warren S. *Remember this: memory and the brain.* <serendip.bryanmawr.edu/biology/b103/f97/projects97/warren.html>

16. Cardoso S. H. *Human memory: What it is and how to improve it.*

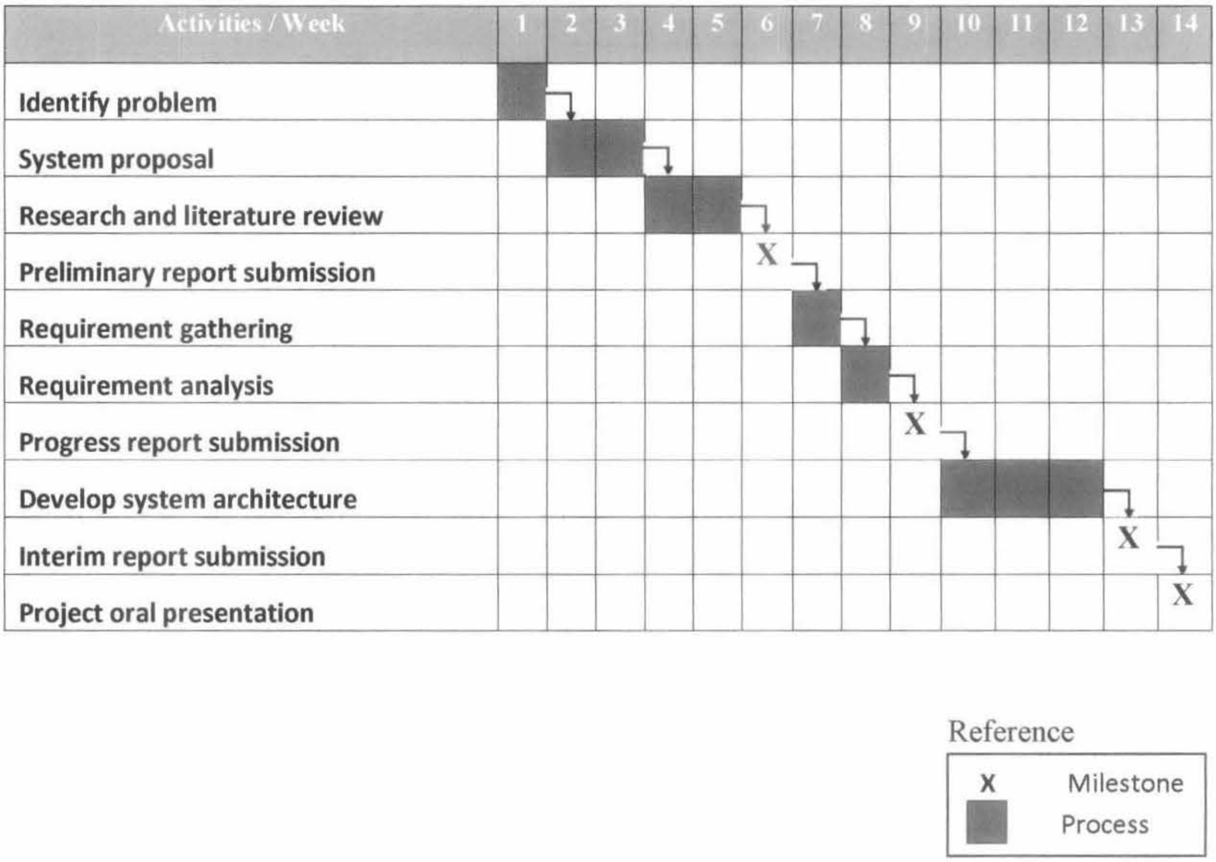
17. Fulton W. *What is a digital image anyway?* <www.scantips.com/basics1b.html>

18. L. Wang, G. Song, I. Shen. 2007 *Object Detection Combining Recognition and Segmentation.* Eighth Asian Conference on Computer Vision (ACCV) 2007.

19. Nguyen D. T., Li W., Ogunbona P. 2010 *An improved template matching method for object detection* Advanced Multimedia Research Lab, ICT Research Institute, School of Computer Science and Software Engineering, University of Wollongong, Australia. Page 195-201

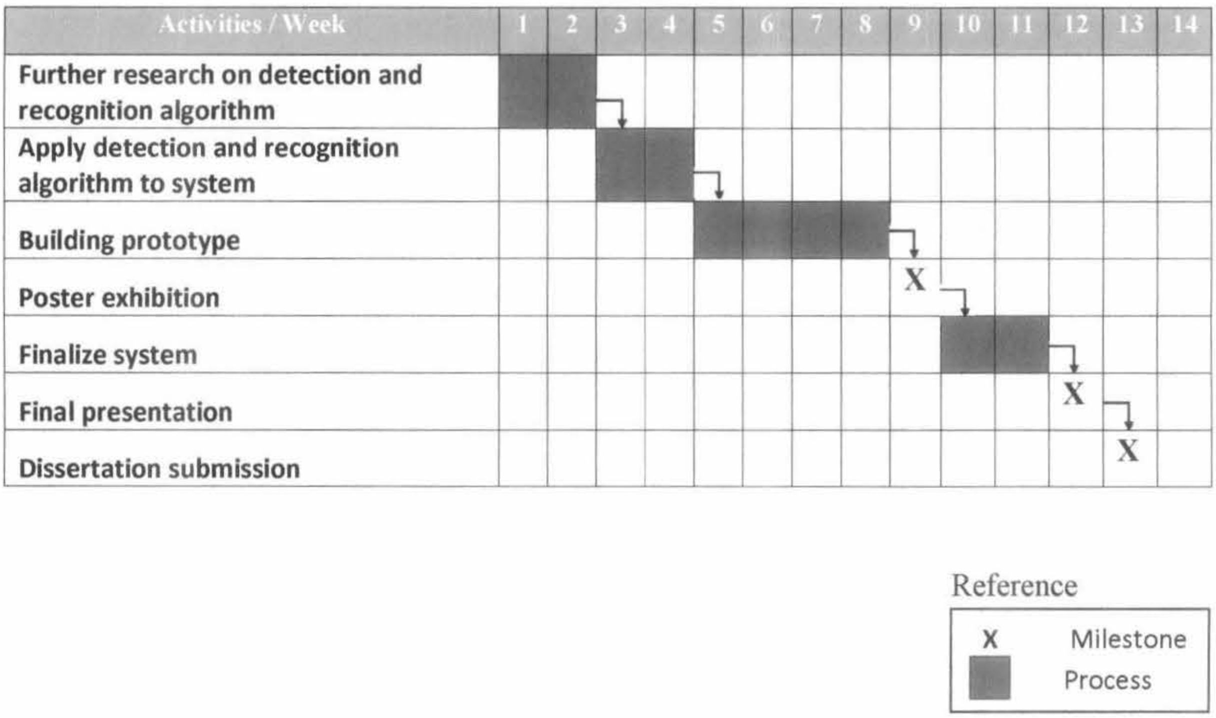
Appendix 01

Gantt Chart for first phase of project development



Appendix 02

Gantt Chart for second phase of project development



APPENDIX 03 : INTERVIEW

This informal interview has been conducted verbally. However, it is documented for the project proposes. The person involve is Mr. Dzulrizal Dzukaffli, the author's former plant person-in-charge and senior engineer in Process Engineering, LCD Production at one of the industrial manufacturing company in Malaysia.

The author: Good day sir. It is a pleasure to have you to assist me for my final year project.

Mr. Dzulrizal: Thank you. It is my pleasure to help.

The author: Without further a due, I would like to ask the first question. Sir, can you state the problems that might occur during the manufacturing process?

Mr. Dzulrizal: There are many problems may occur. For instance, wrong parts or components' product code, wrong use of parts or components, miss-installed and missing parts or components. However, normally these problems will be solved internally by our staffs.

The author: I am interested to know about the parts or components missing in final manufactured product. Can you comment on the matter?

Mr. Dzulrizal: Basically, parts or components missing in manufactured product are common internal problem. This type of problem happened daily but of course, internally. It is a critical quality issue whereas missing one of these may cause defect and market claim which we are trying to avoid.

The author: You have said that it is a common internal problem. How it happened and how do your company solve it?

Mr. Dzulrizal: We did inspections for each manufactured product. Quality control team is responsible for the inspections. Then, the problem comes along when there are thousands finished product that we need to deliver in one single day which cause the team to make mistakes. We call it human error. Well, for the solution, I could not give the exact answer because it involves the secrecy of the company. But generally, the company will fully responsible if there is market claim happened all over the world. Every company does. We will send a group of experts to do rework.

The author: The quality control team will inspect each and every product manually?

Mr. Dzulrizal: Yes.

The author: Their eyes must be very tired at the end of the day. Sir, I would like to know how exactly they do the rework process. Does it consume time and money?

Mr. Dzulrizal: For sure it incurs money and consumes lots of time. Let us assume the market claim is from India. Hence, we need to send a group to India to do rework. It does take weeks to months to finish, depending on the quantity of the claimed sets. While the group is busy to do rework, we still need to manufacture our products according to the schedule. Normally for the rework process, you need to open up the back cover of the set, installed the missing part or component, do inspection to ensure the product is function and put the pieces back together.

The author: Have you ever crossed your mind to have a system to do inspection process, replacing the manual inspection done by the staffs?

Mr. Dzulrizal: Yes, I do. It will be a great help if such system exists. We may reduce the manpower and the manufacturing process can be speed up. Besides, we may avoid the human error from happened.

The author: Exactly sir. Well, thank you for your help. I really appreciate it.

Mr. Dzulrizal: Sure, no problem at all. I am glad to help. Good luck with your project.

The author: Thank you sir.