INTELLIGENT ADS

By

NUR SYAFIQAH BT AHMAD

FINAL PROJECT REPORT

Submitted to the Department of Electrical & Electronic Engineering
in Partial Fulfillment of the Requirements
for the Degree
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

INTELLIGENT ADS

by

Nur Syafiqah bt Ahmad

A project dissertation submitted to the
Department of Electrical & Electronic Engineering
Universiti Teknologi PETRONAS
in partial fulfilment of the requirement for the
Bachelor of Engineering (Hons)
(Electrical & Electronic Engineering)

Approved:

_____

(Dr. Noohul Basheer b. Zain Ali)
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK

May 2013

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.

_____

(Nur Syafiqah bt Ahmad)

ABSTRACT

Advertisements are essential in today's industry. They play an important role in connecting the producer and consumers. However, today's advertisements are general advertisements. The advertisements displayed do not focus on certain group of people. This will cause a waste in the billboard energy and the advertiser's investment. Adult and children will have to look at the same advertisement regardless of its contents and appropriateness. The aim of this project is to design a system that could measure human height and be able to distinguish between adults and kids. Studies had been conducted on several methods to measure human height. It's working principle and limitations had been discovered and through that, the best method to measure human height was developed. A prototype consists of a laptop with an installed Matlab software and a webcam had to be set up. This project has been successfully completed. The system designed has achieved the objectives set for this project.

ACKNOWLEDGEMENTS

Praised be to Allah, with His willingness I have successfully completed the Final Year Project (FYP) course in Universiti Teknologi Petronas. Upon completing the course, I owe thanks to many people for their help and support, as well as their contribution in time, effort, advise, supervise, discussions, guidance and comments during the period when I am completing the course.

First and foremost, I would like to express my deepest gratitude to my supervisor, Dr. Noohul Basheer b. Zain Ali for his guidance and teachings during these two semesters. Without his supervision, I would not be able to successfully complete this project.

Last but not least, I would like to thank my fellow friends and family who have supported me throughout the project period.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

INTRODUCTION

1.1 Project Background

Digital billboard ads are effective due to its attractiveness. However, it is expensive. Usually, one billboard would display only one advertisement for the period time of two to three months [1]. The advertisement only targeted towards one group of people for as long as it runs. This method of advertising is not very efficient because anyone outside of the aforementioned ad's target market will be left un-entertained. This is a waste of the billboard's energy, time and the advertiser's money.

Billboard advertising would be much better off if a billboard can display advertisements according to the targeted-audience of those advertisements. This can ensure the optimal usage of the billboard's energy and also makes it economical that several advertisers can share a billboard to advertise their products. This can be done by designing a system that could differentiate human's physical trait and categorize them into groups that they belong to. That is, an 'intelligent ads' that can categorize a person to either adult or children group and then display advertisement according to the group. This project will focus on designing a system that could measure human's height, categorize them into adult or children group and then display the advertisement accordingly. This will not only improve the advertising method's effectiveness, become more economical and it could also prevent inappropriate advertisements from being seen by children. By this, advertising can be much more efficient and age-appropriate.

1.2 Problem statement

Digital billboard advertisings today are more general in the sense that advertisers do not take into account the individuals that will be looking at their advertisements. This will cause a waste in the billboard energy and the advertiser's investment. Hence, to make billboard advertising a more group targeted-advertising and also economical, a billboard that could display an age-appropriate advertisement is needed.

1.3 Objectives and scope of study

From the earlier mentioned problem statement, a few objectives have been listed out for this project which is:

1. To design a system that could measure human height and be able to distinguish between adults and kids.

2. To setup a display that could show ads according to the age of the captured audience.

For this project, the scopes of study are limited to certain areas which are:

- To understand the concept of measuring human height using image processing.
- To design a system for measuring the human height.
- To test the system using Matlab software.

1.4 Relevancy of the studies

This project is relevant because advertisements and industries are correlated. Industries needed advertisements to market their product and to make their brands known. As the industries grow, the need to design a group-targeted advertisement and

also economical is required. Besides, the technology is moving towards intelligent advertising that a personal advertising is expected to be seen in the future [2].

1.5 Feasibility of the project

There are many studies that have been done about measuring human height thus, finding a method to measure human height that is related to this project is possible. Furthermore, this project is achievable with the aid of all the facilities in Universiti Teknologi Petronas such as the laboratory and also with the help of post-graduate students. Based on the proposed Gantt chart, this project should be able to be completed within the given time period.

Chapter 2

LITERATURE REVIEW

This chapter consisted of the information related to this project and also a review of the data collection that has been conducted for the project.

2.1 Digital billboard

A digital billboard displays advertisement that served for marketing and public service purposes. The advertisement displayed is controlled by a host computer which is connected to the digital billboard [1].

Digital billboard displays an advertisement for about 6 to 8 seconds [1]. There are many benefits of digital billboard advertising compared to other method of advertising. Amongst them are:

- Cost-effectiveness

The amount for displaying an advertisement on a billboard for a month is about $1000 to $3000. This is the same amount for a full-page advertising in any newspaper for a day [1]. This shows that the billboard advertising is a more reasonable option for advertisement.

- Coverage

Advertisements on billboard are usually on display for about two-three months . Thus, it ensures reaching a larger audience in a longer period of time [1].

- Attention-grabbing

Human's attention span is approximately 8 seconds [3]. As digital billboard display advertisement for about 6 to 8 seconds , the audience could pay attention to them [1]. Furthermore, the attractiveness of the advertisement will draw the audience's attention to it. Television advertisements air for about 10 to 30 seconds [1], therefore there are less chances of viewers paying attention to the advertisement shown.

2.2 Height Measurement

Studies have been conducted on the method to measure human height from an image. One of the methods is using single view metrology algorithm. It estimated height by obtaining the distance between two parallel planes. This method works by choosing some objects whose edges appear as parallel lines as the reference plane of the scene. These parallel lines converged to a vanish point in the image plane. Parameters such as vanishing point, vanishing lines, offset are obtained from the image plane and they are required for the development of the algorithm [4]. Vanishing point which is defined as a point in a perspective drawing to which all parallel lines, which are not parallel to the image plane, appear to converge, is crucial in this algorithm [5]. Horizontal vanish line is defined by at least two vanish points, which are found from two perpendicular reference planes in the scene. The basic geometry consists of vanish line and vanish point are shown in figure below.

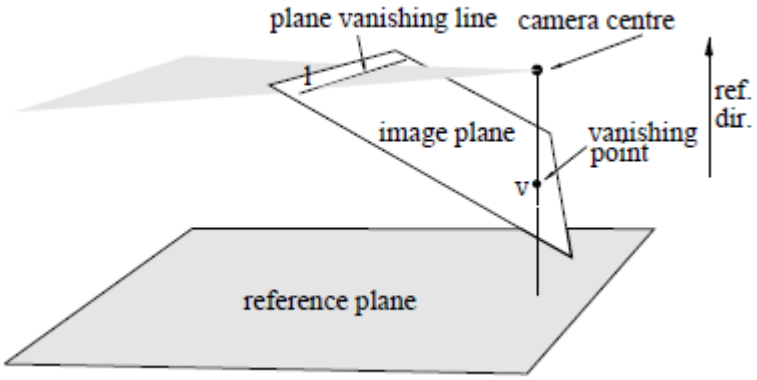

Figure 1

This method depends on the measurement of the distance between any of the plates which are parallel to the reference plane, measurements on these planes and the camera's position in terms of the reference plane and the direction. When all these measurements and the camera's position are determined, cross-ratio of the four points marked in the figure above provides an affine length ratio. The absolute distance can be obtained from this distance ratio once the camera's distance from π is specified [6]. The cross ration of vanish point, vanish line, t and b, the distance between two parallel planes is shown in figure below.

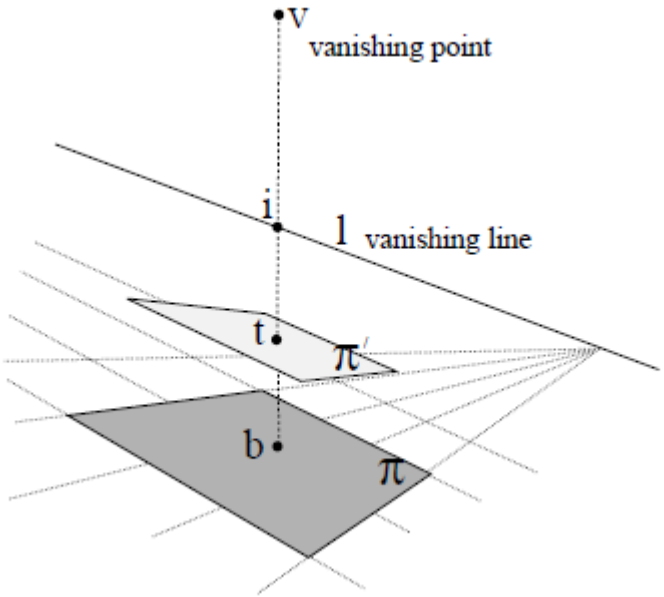

Figure 2

This method has a limitation in which the algorithm developed only works for that particular location. It cannot be utilized in other places. Since advertisements should be placed at many locations to ensure it could cover a wide coverage of audience, this algorithm is not efficient since it cannot be used directly at any other place. The algorithm must be custom made to cater for that particular place.

2.3 Image Processing

For the image processing technique, edge detection method is used to process the image taken. Edge is the area where the intensity of an image changes abruptly [7]. Whereas edge detection is a mathematical algorithm that detects edge in an image [8]. Edge detection is an essential tool in image processing. It works on the grayscale

image only. This simplifies the process of processing the image because there is only one channel to work with rather than three [9]. Thus, all image need to be changed to grayscale first before processing the image. There are few methods that can be used for the edge detection which are Canny, Sobel, Prewitt, Roberts, Laplacian of Gaussian and zero- cross method. Only Sobel method is used in this project as the built-in function edge in Matlab uses Sobel at its default method.

Sobel is commonly used in edge detection algorithm. Sobel operator evaluates the gradient of the image concentration at all point, giving the course of the largest possible increment from light to dark. The result therefore shows how the image changes at that point whether smoothly or sharply, and therefore how possible it is that the part of the image signify an edge, and how that edge is expected to be positioned [10]. Sobel is better than the other edge operator because it smoothen the noise of the image. Sobel's edge is thicker and brighter due to the enhancement of the parts of the edge that resulted from the differential of two rows or two columns [11].

An experiment on measuring height using edge detection had been conducted. The program developed allowed the built-in function 'edge' in the Matlab to process the image captured by detecting changes in the intensity of the image and then find the maximum height of the person in the image using the function 'min( )' since the graph in Matlab is upside-down. The objective for this experiment is to test whether the top of the head is recognized as the maximum height of the person in the image. Experiments conducted using 10 different images of adults and kids standing in a plain white background. Example:

Figure 3: Adult

Figure 4: Kid

The images used are all similar in size which is 640x480 pixel. This will ensure the height measurement will not be affected by the size of the images. Results obtained are as shown below. Trials refer to the 10 sample images, 'Yes' means the value for 'min ( )' obtained are for the top of the head of the person in the picture whereas 'No' means the value for 'min ( )' obtained are not for the top of the head of the person in the image.

Trials	**Adult**	**Kids**
1	Yes	No
2	Yes	No
3	Yes	No
4	Yes	No
5	Yes	No
6	Yes	No
7	Yes	No
8	Yes	No
9	Yes	No
10	Yes	No

Table 1

From the result shown above, initial conclusion can be deduced that the edge detection is not an efficient method to measure height. It could not clearly differentiate the height for adults and kids. To further examine its efficiency and reliability in measuring height, more experiments had been carried out involving:

a) An image with a person with an elaborate background
b) An image with a person holding an umbrella
c) Capturing a real-time image using a webcam

The three cases chosen are from different situations that happened in real live. The results for this experiment are shown in figure below.

a) Image with a person with an elaborate background.

Figure 5

This image is chosen to test whether the program will detect other things that existed in the picture apart from the person and then calculate their height. The result is as shown below.

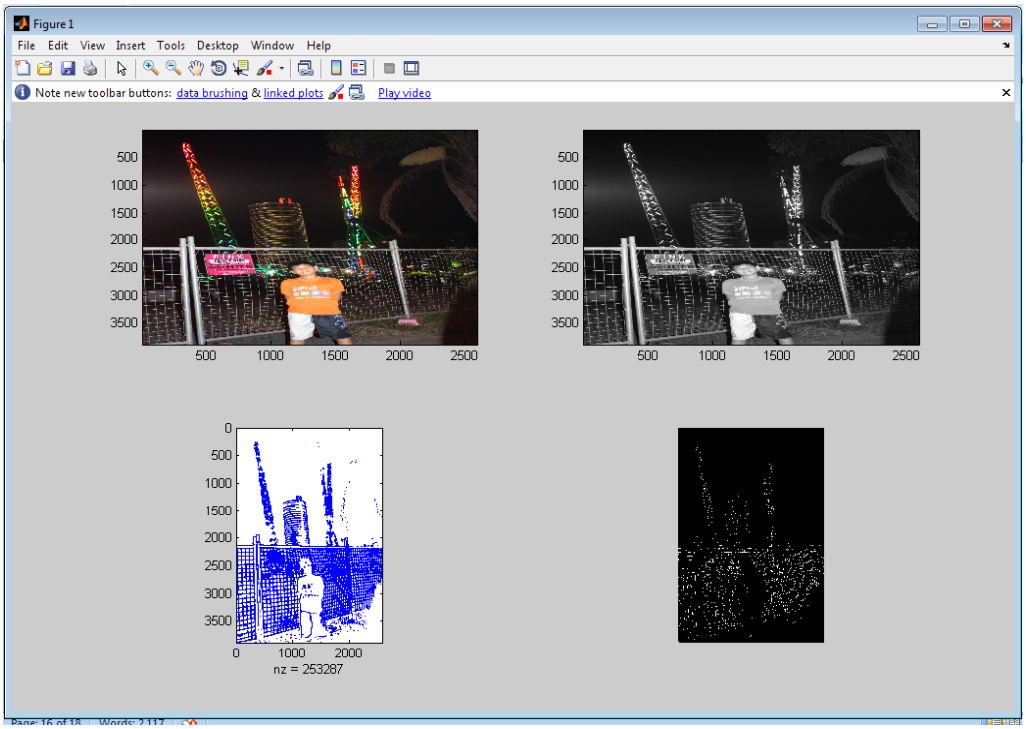

Figure 6

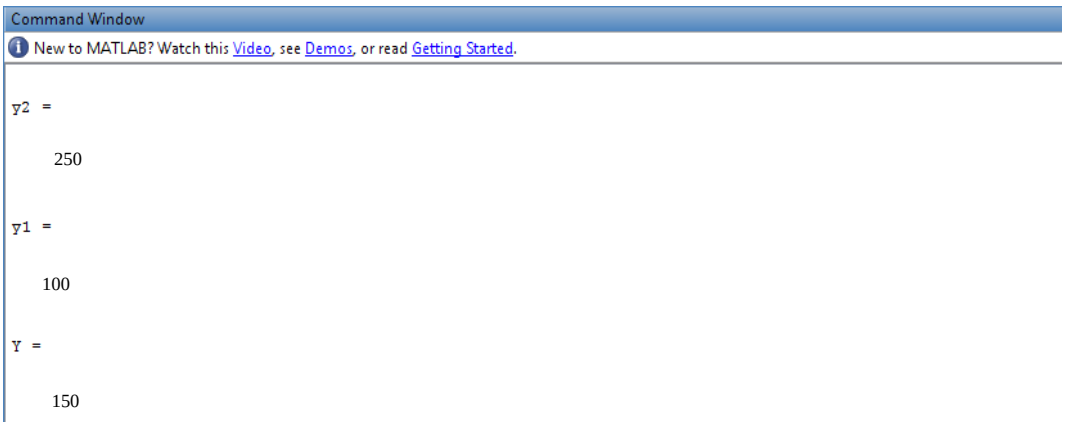

Figure 7

Based on the result obtained, it can be seen that the tall rail is detected as the highest point in the image.

b) Image with a person holding an umbrella

Figure 8

This image is chosen to test whether the umbrella will be detected as the highest point for the image. The result is as shown below.

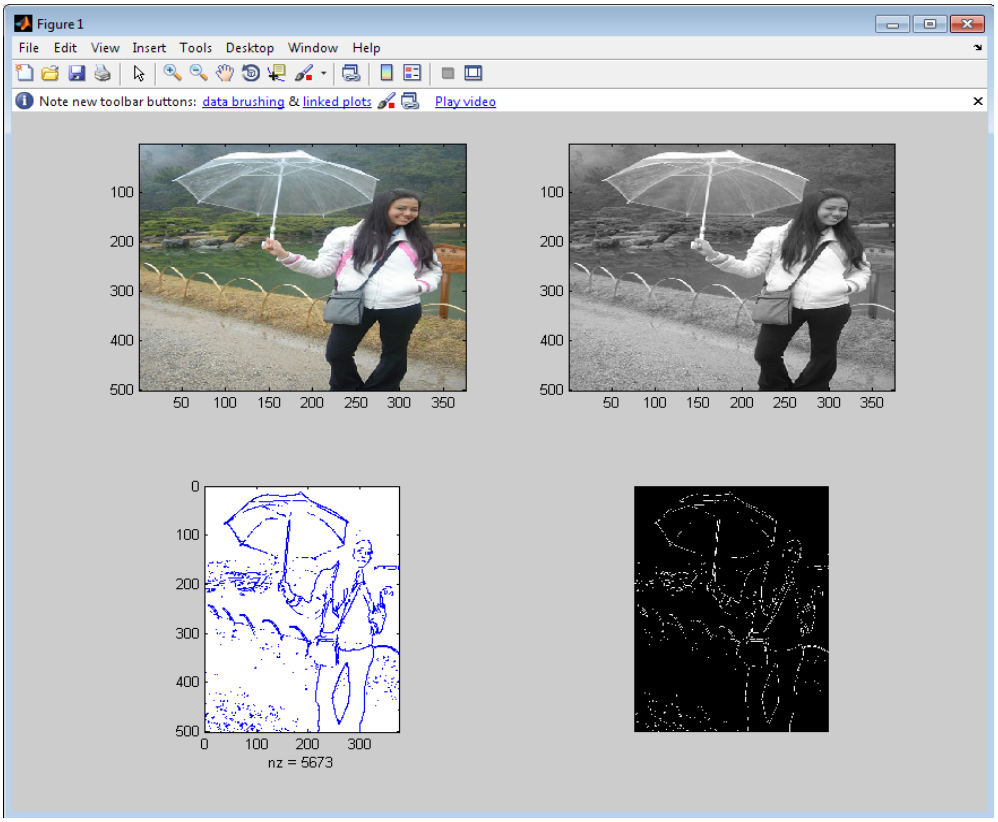

Figure 9: Image processing to measure the height

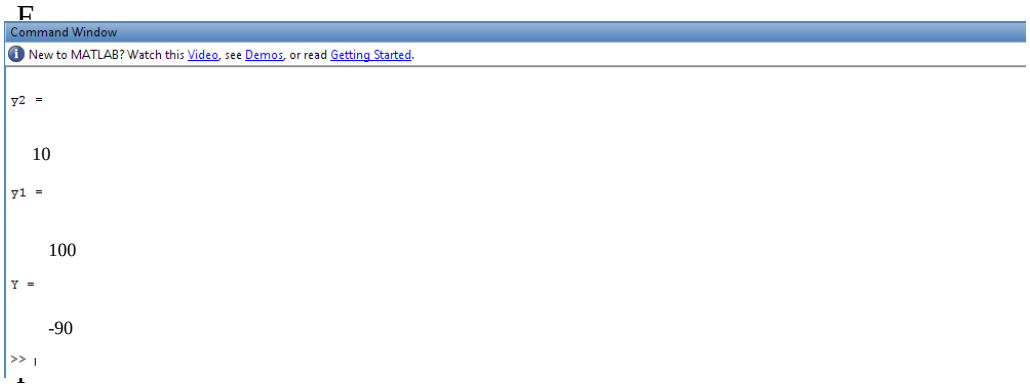

Figure 10

Based on the result obtained, it can be seen that the umbrella is detected as the maximum height in the image.

c) Capturing a real-time image using a webcam

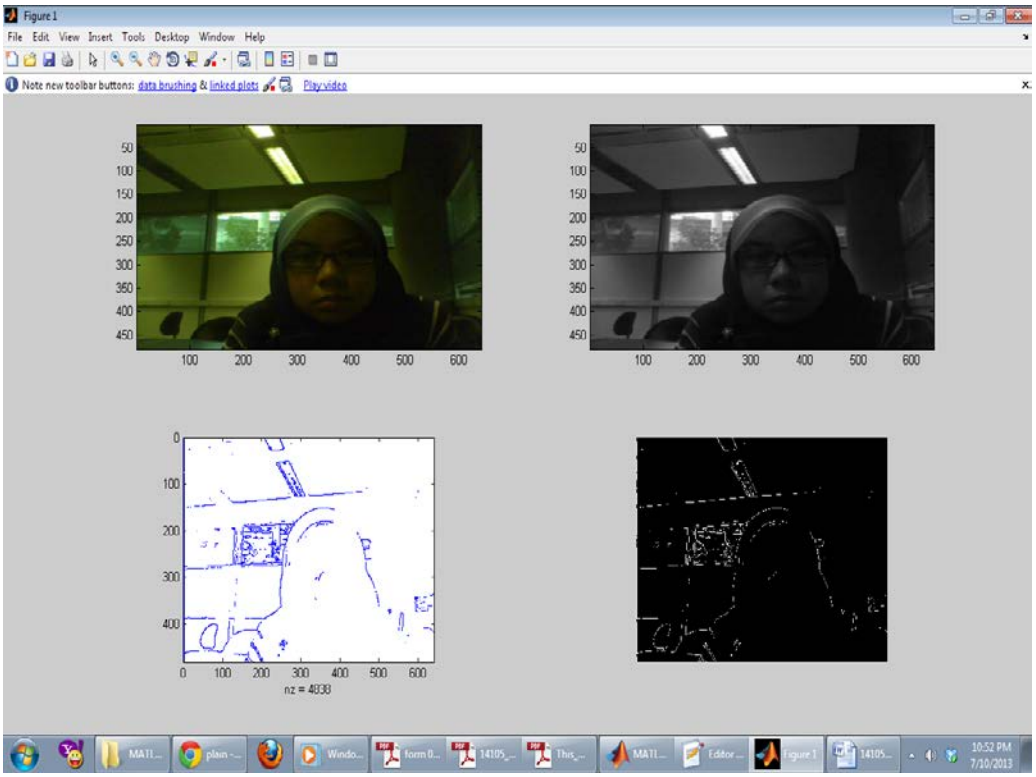

Figure 11

Figure 12

Based on the picture captured and the result obtained, it is shown that the lamp is the highest point detected by the program.

This shows that this method has some limitations in which it does not measure human height only. When the function 'min ( )' is called, it detects the tallest object in the picture as the maximum height instead of the human's height. This method is not reliable since the image captured needs to be in plain background and no other objects should exist in the picture or else it could disrupt the human height measured.

2.2 Face Detection

In this project, face detection serve as the medium to recognize the target, which is the input. After face is detected, the image captured is processed to determine the highest point of the person's height. In this case, the highest point of the person captured is the top of the head which is defined by the bounding box drawn from face detection.

The algorithm used is the Viola-Jones face detection algorithm. In Matlab, this algorithm is included in the toolbox called the Computer Vision System Toolbox. To detect face, pre-trained classifiers have to be trained first and then, a window will

slide over an image to detect the object of interest. A cascade classifier is used to determine whether the window enclosed the object of interest. The window size changes according to the size of the objects detected, however its aspect ratio remains unchanged [12].

The cascade classifier is made up of parts, where each part is a set of weak learners. Each part is trained by boosting, a method to train a very accurate classifier by summing up an average decisions the weak learners produced.

Each part of the classifier marks the area at which the sliding window is currently located as either positive or negative. Positive specifies an object was identified and negative specifies no object. If the mark is negative, the classification of this area is completed, and the detector will move to the next location. If the mark is positive, the classifier passes the region to the next part [12].

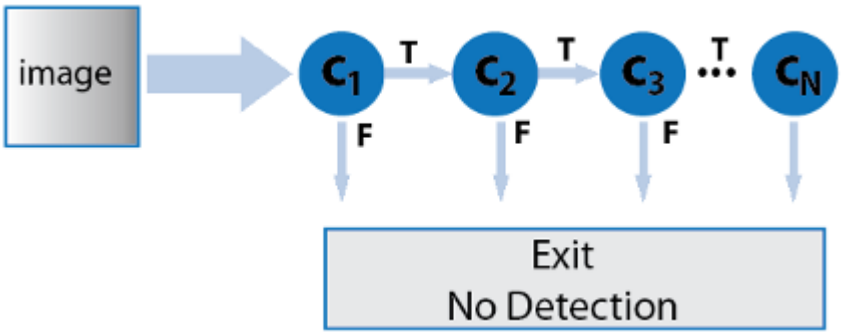

Figure 13

The parts are created to discard negative samples faster. It is assumed that the rest of windows do not enclose the object of interest. A true positive sample is a sample that is classified correctly. A false positive sample is a sample that is incorrectly classified as positive. A false negative sample is a sample incorrectly classified as negative. For the system to work right, each part in the cascade should have a small false negative rate. If a part mistakenly marks an object as negative, the classification stops, and that mistake cannot be undone. However, each part may have a high false positive rate. Even if it mistakenly marks a non-object as positive, the mistake can be corrected by succeeding parts [12].

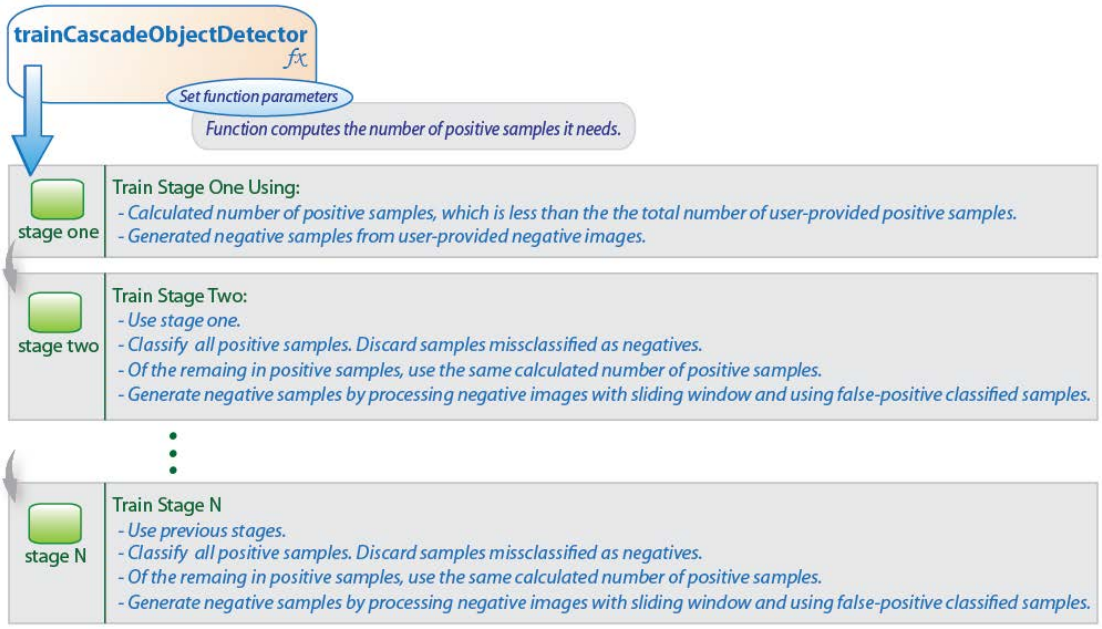
trainCascadeObjectDetector
fx
Set function parameters
Function computes the number of positive samples it needs.
stage one
Train Stage One Using:
- Calculated number of positive samples, which is less than the the total number of user-provided positive samples.
- Generated negative samples from user-provided negative images.
stage two
Train Stage Two:
- Use stage one.
- Classify all positive samples. Discard samples missclassified as negatives.
- Of the remaing in positive samples, use the same calculated number of positive samples.
- Generate negative samples by processing negative images with sliding window and using false-positive classified samples.
stage N
Train Stage N
- Use previous stages.
- Classify all positive samples. Discard samples missclassified as negatives.
- Of the remaing in positive samples, use the same calculated number of positive samples.
- Generate negative samples by processing negative images with sliding window and using false-positive classified samples.

Figure 14

Chapter 3

METHODOLOGY

3.1 Research methodology

The data needed for this project is collected through readings of various technical and research papers taken from the internet and library. There are many studies that have been done on the topic of measuring human height using image processing thus, making the process of data collection for this project easier.

3.2 Project Activities

After choosing the project title, data for this project is gathered for literature review. The research that had been conducted is on the project background, the importance of billboard advertising to industries, its price compared to other kinds of advertising and advantages. After all the data have been collected, research about the methods to measure height is carried out. Through various technical and research papers found on the internet and in the library, few methods for measuring human height have been found. These methods were compared for how it measure height and also limitations. Based on the research that has been performed and after taking up all considerations, the best method to measure height is developed. The method used in this project is the face detection method. The algorithm used for this method is the Viola-Jones face detection algorithm. This algorithm is built in the Computer Vision System Toolbox in Matlab. A program has been designed using the built-in function to measure height. After the program has been tested and experiments have been carried out to assess its efficiency, a prototype consists of a laptop with an installed

Matlab software and a webcam is set-up to carry out the project. The results are as shown in Chapter 4, Results and Discussion section.

The research methodology flow chart for this project is as shown below:

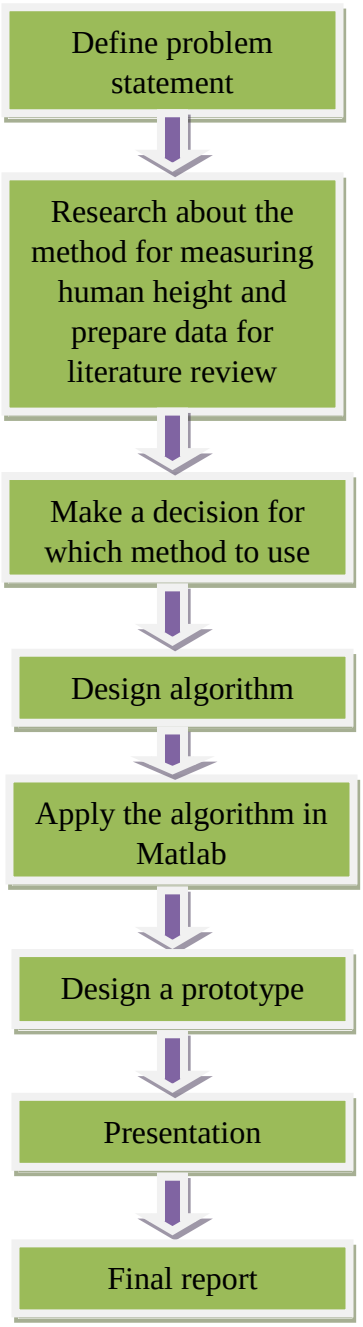

Figure 15

The process flow chart for this project is as shown below:

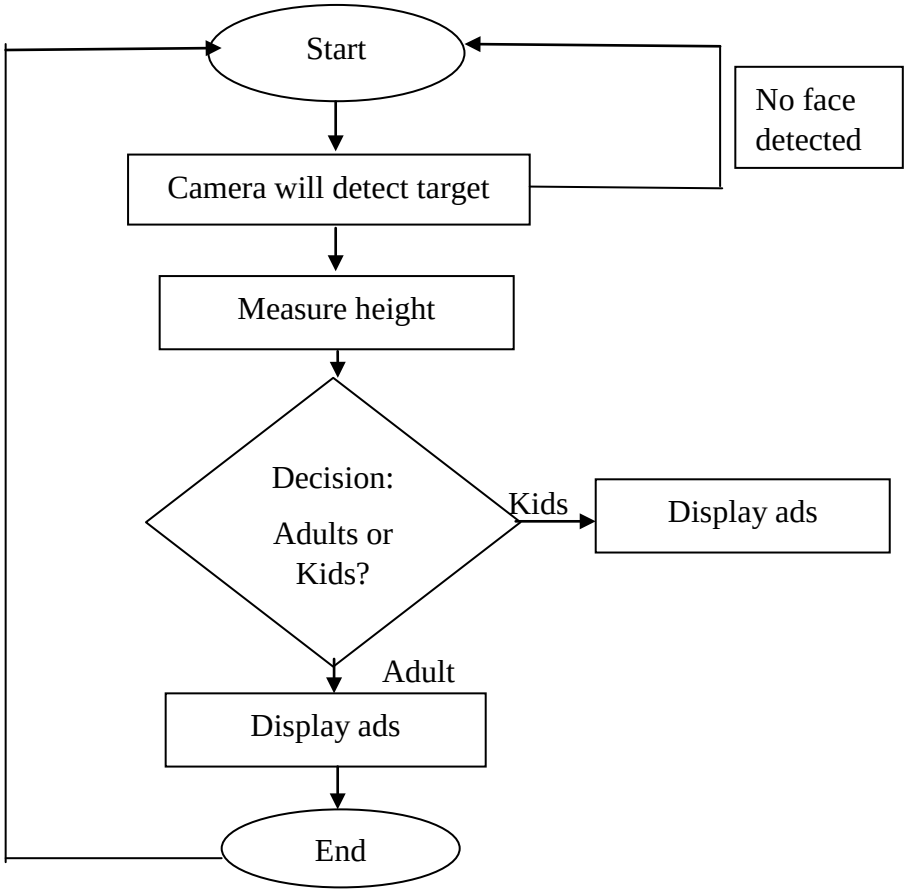

Figure 16

A program has been developed based on the flow chart shown above. As mentioned earlier, a prototype consisting of a laptop with a built in Matlab software and a webcam had been used. This program works by capturing an image first. Then, the face detector will run to see whether there is any face captured in the image. If there is, the height measurement will start. If there is no face detected, the program will return to its start point. For height measurement, the top part of the box represents the maximum height of the person inside the captured image. Function 'bbox(1,2)' is used to get the value for the maximum height [13]. A value for the ground has been selected and is constant. Thus, the top part of the box will be subtracted with the ground to get the estimated height of the person. The height measured is in pixel thus, it does not represent the real height of that person. After height has been measured, the program will determine whether the person captured is

an adult or a kid from the threshold set earlier. Then, an advertisement will come out depending on whether the height measured is an adult or a kid.

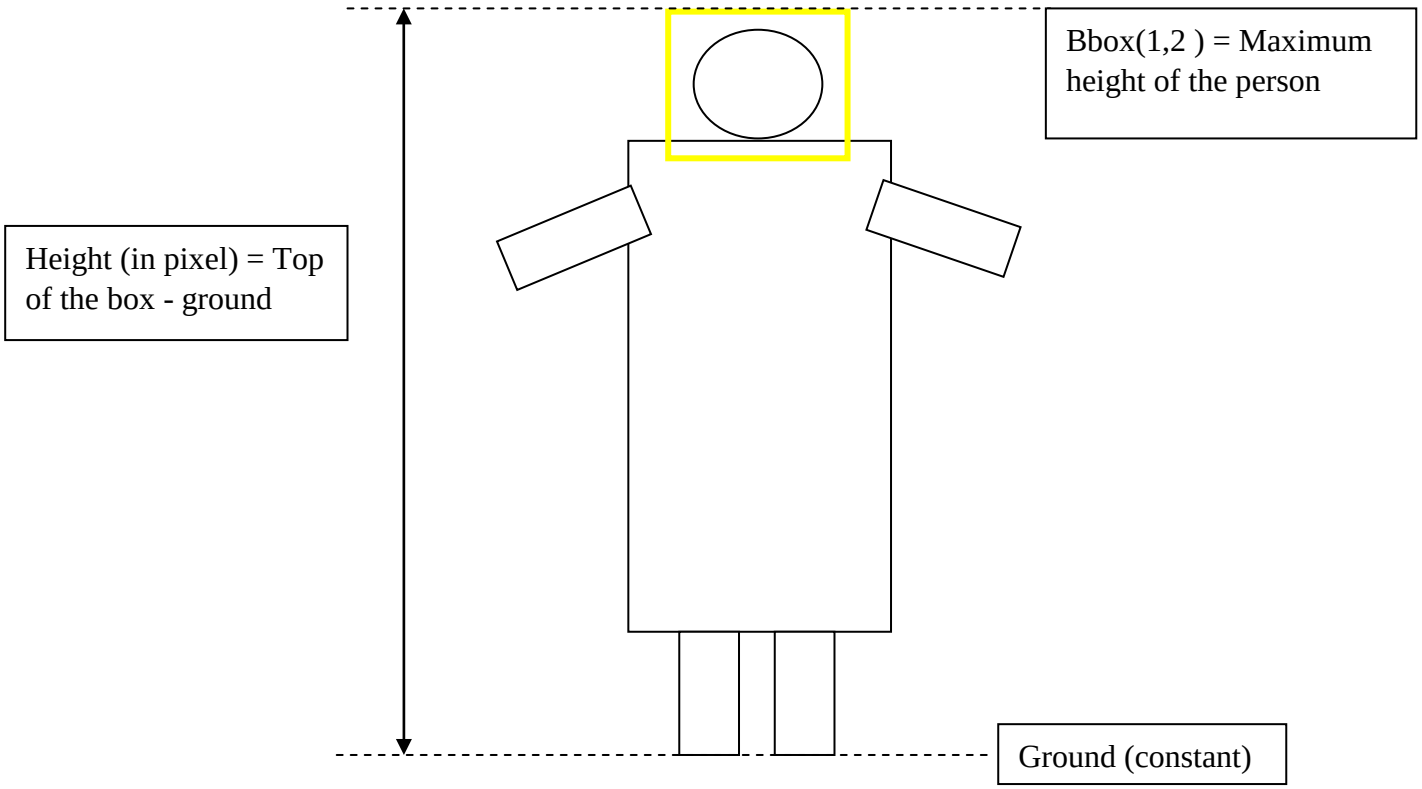

Figure 17: Illustration of the measurement of the human height

3.3 Key Milestone

Based on this project, there are few key milestones that have been outlined which are:

1. Designing a system that could measure human height and be able to distinguish between adults and kids.
2. Setup a display that could show ads according to the age of the captured audience.

3.4 Gantt chart

- FYP I

Week Number / Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Title selection														
Consult the supervisor														
Data collection for proposal and preparing a draft proposal														
Proposal Submission														
Further research about the simplest method to measure human height														
Viva :Proposal defense														
Draft report submission														
Interim report submission														
Preparing on prototype design														

Table 2

- FYP II

Week Number / Activities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Develop program for detecting human and capture the image.															
Develop program for measuring human height based on the image captured.															
Develop program for displaying ads according to age.															
Testing the program on actual situation and make amendment on the program anywhere necessary.															
Develop the prototype and testing the overall aspects (software + hardware) on actual situation.															
Submission of progress report															
Pre-EDX															
Submission of draft report															
Submission of final report and technical report															
VIVA															

Table 3

3.5 Tools/Software required

- Webcam

As a mean to capture the image of a target.

- Laptop

To serve as the billboard that is going to display the advertisement.

- Matlab (Computer Vision System toolbox)

To carry out the face detection and measure the height.

Chapter 4

RESULTS AND DISCUSSION

The program has been improved and it can now detect face using Computer Vision System Toolbox in Matlab, capture real-time image using a webcam, process the image, display height measured in pixel then display the advertisement according to the height measured. A number of experiments had been carried out in order to test the efficiency of the program.

4.1 Data Gathering

Countless experiments has been carried out to test the program and to gather the data on how to improve the efficiency of the program. The experiments that had been performed including:

a) 10 samples of different images of adults and kids

b) An image with a person standing (adult)

c) An image with a person sitting (kids)

The results for these experiments are included in section 4.2 Experimentation below.

4.2 Experimentation

Experiments similar to the one conducted for edge detection was carried out using face detection. Samples of images and sizes are similar, the only difference is that the method used. Example of images can be seen in figure 3 and 4. Results obtained are as shown below. Trials refer to the 10 sample images, ‘Yes’ means the value for ‘bbox(1,2)’ obtained are for the top of the head of the person in the picture

whereas ‘No’ means the value for ‘bbox(1,2)’ obtained are not for the top of the head of the person in the image.

Trials	Adult	Kids
1	Yes	Yes
2	Yes	Yes
3	Yes	Yes
4	Yes	Yes
5	Yes	Yes
6	Yes	Yes
7	Yes	Yes
8	Yes	Yes
9	Yes	Yes
10	Yes	Yes

Table 4

The results shown above proved that face detection is reliable in detecting faces and measure height from the top of the head of the person inside the images as compared to edge detection. The height measured did not depend on the image’s background and the changes in intensity of the image. It is a more efficient method to measure height. However, through continuous experiments conducted, it is observed that the height measured using face detection method is affected by several factors which are the distance between the webcam to the person and the placement of the webcam. Since a webcam is used in this project and the webcam is built-in the laptop, the laptop placement is important. An ideal setting that would give the best result for the height measured is shown in figure below. This setting has to be followed so that the height measured will not differ from the actual height.

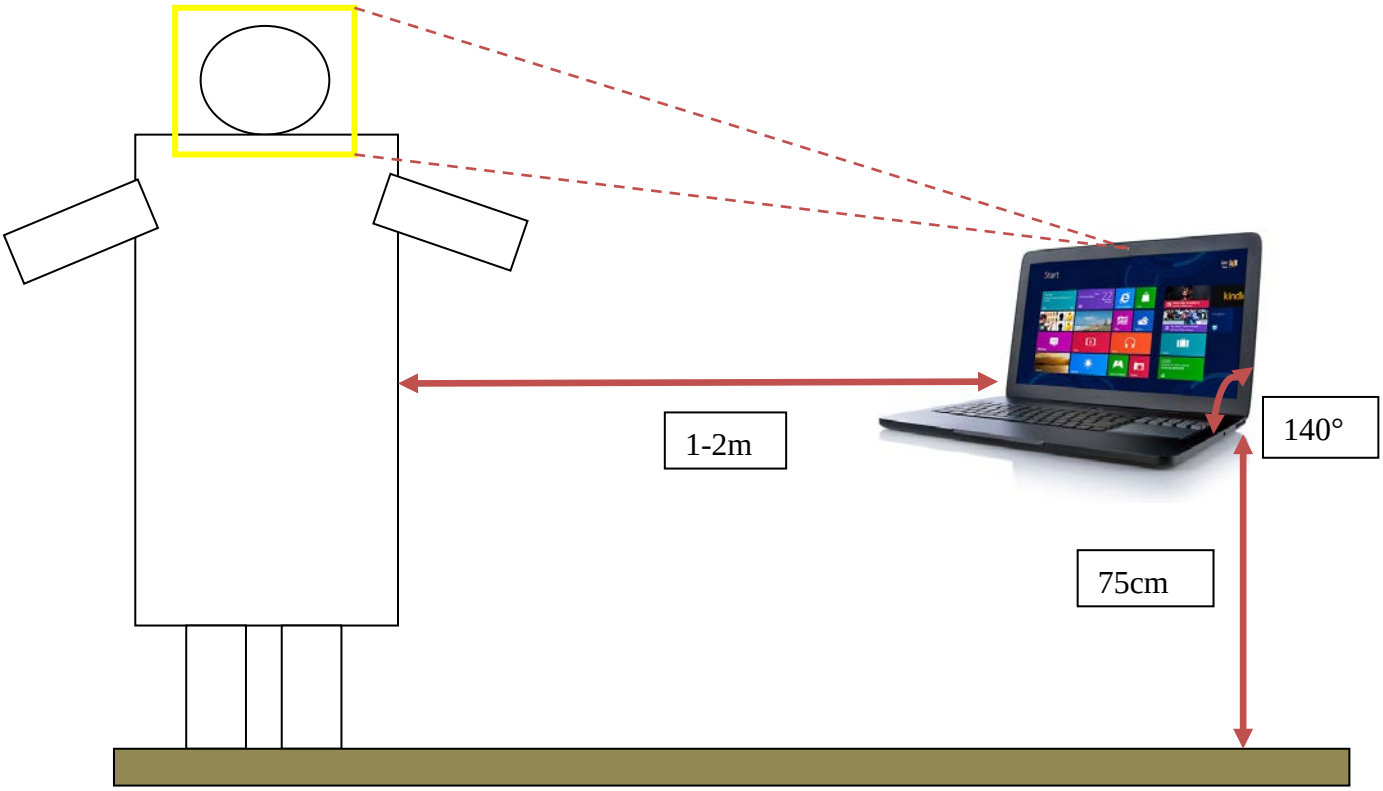

Figure 18

Two experiments had been conducted using the setting shown above, to test the efficiency of the program developed. These two cases representing the different group of audiences. To differentiate adults and kids, a threshold of height has been chosen which is 120cm. However, the reading obtained from the program is in pixel unit and it is not a representation of real height.

b) Image with a person standing (adult)

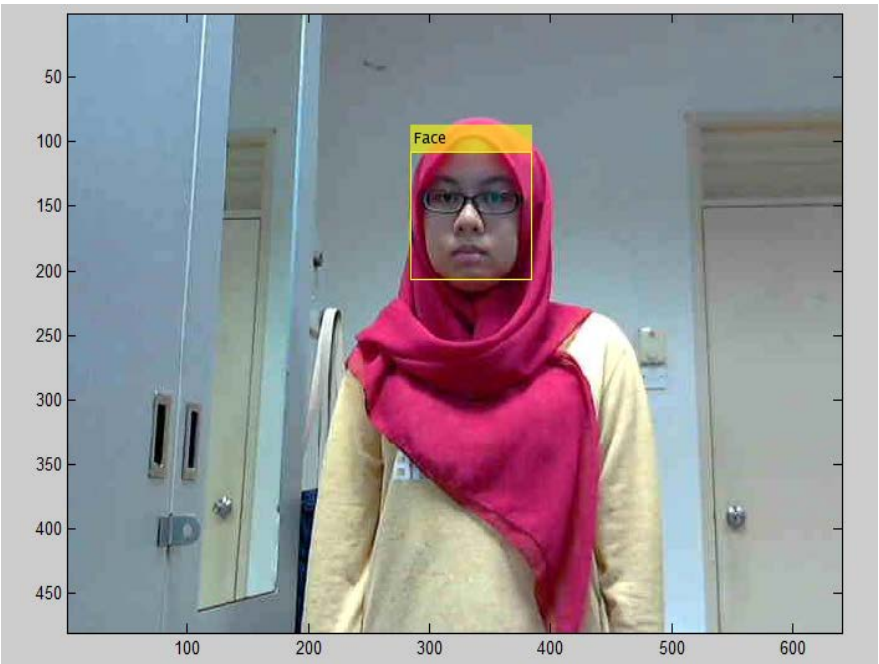

Figure 19

Figure 20

c) Image with a person sitting (kids)

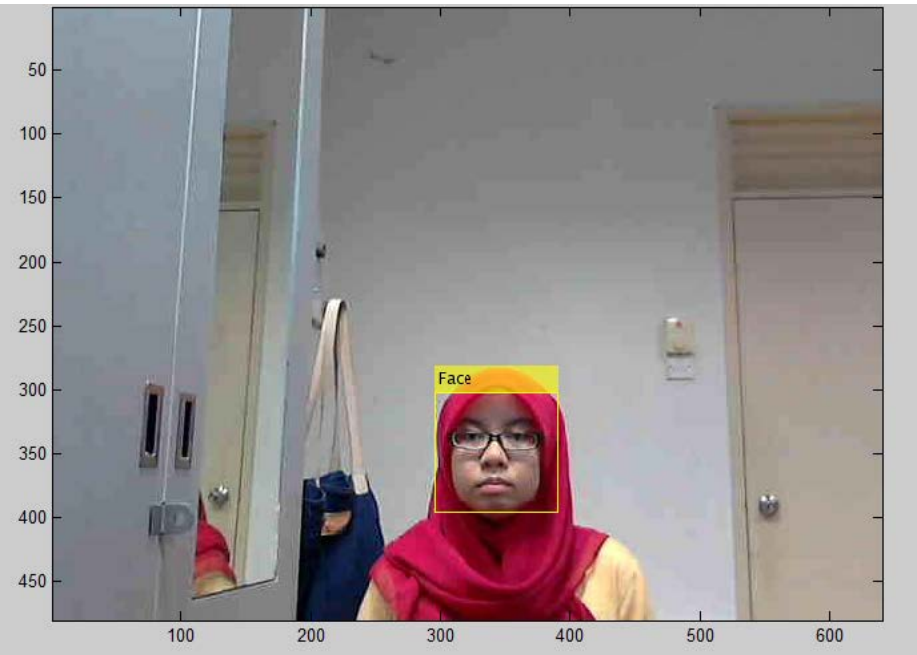

Figure 21

Figure 22

Based on the result obtained for both categories, it shows that the height measured was not affected by any external factors compared to edge detection method. Contrary to single view metrology algorithm, it could also be used directly regardless of the locations. This method could work well in detecting faces and then

measure human height from it. This shows that the program is successful in achieving the objectives of this project. It could measure the human height and then display the advertisement according to the height measured.

However, this method has some limitations in which, it could detect non human face and still proceed with the rest of the program making it a less efficient target advertisement. Also, the target has to look straight into the webcam or else the face detector could not detect the face.

CHAPTER 5

CONCLUSION

The aim of this project is to design an advertisement board that could display advertisement according to the age of the audience captured. The program that has been designed is able to detect face in the image captured, measure the height of the captured person, which in effect will differentiate between adult and children. After the program has been completed, the prototype can be utilized using laptop as the advertisement board and a webcam to capture the image of the audienc.

RECOMMENDATION

The project could be improved in many areas to enhance its efficiency and accurateness in measuring height. The program designed could be more robust in terms of working principle. It could be better if the height measured does not depend on the placement of the camera and the distance between the camera and the person standing. Furthermore, the program could also be improved in terms of the orientation of the face captured. Currently, the face detector could only detect face that looks straight to the camera. The detector could not work when the face looks sideways or does not look straight to the camera.

REFERENCES

[1] *Billboard Advertising Effectiveness*, Buzzle, November 2012, http://www.buzzle.com/articles/billboard-advertising-effectiveness.html

[2] *'Intelligent' ads can see the kind of person you are*, The Independent, February 2012, http://www.independent.co.uk/news/media/advertising/intelligent-ads-can-see-the-kind-of-person-you-are-7179539.html

[3] *Attention span statistics*, Statisticbrain, http://www.statisticbrain.com/attention-span-statistics/

[4] Hui Liu, "Single view metrology applied for dynamic control of sink height for children", August 2010.

[5] *The vanish point*, Wikipedia, http://en.wikipedia.org/wiki/Vanishing_point.

[6] A.Criminisi, "Singe-view metrology: Algorithms and applications", *Proceedings of DAGM-Symposium on Pattern Recognition*, Sept. 2002, pp. 224-239.

[7] *Edge Detection*, Slideshare, 15 May 2012, http://www.slideshare.net/contactsarbjeet/image-processing-edge-detection

[8] *Edge Detection*, Wikipedia, 22 March 2013, http://en.wikipedia.org/wiki/Edge_detection

[9] E. Nadernejad, S. Sharifzadeh, H.Hassanpour, "Edge Detection Techniques: Evaluations and Comparisons", *Applied Mathematical Science*, Vol 2, 2008, pp. 1507-1520

[10] *Sobel operator*, Wikipedia, 10 April 2013, http://en.wikipedia.org/wiki/Sobel_operator

[11] W.S.Gao, X.G.Zhang, L.Yang, H.Z.Liu, "An improved sobel edge detection", *International Conference on Innovative Computing Technologies (ICICT)*, 2010, pp. 67-71

[12] *Train a cascade object detector*, Mathworks, http://www.mathworks.com/help/vision/ug/train-a-cascade-object-detector.html

[13] *Vision.cascade object detector system object*, Mathworks, http://www.mathworks.com/help/vision/ref/vision.cascadeobjectdetectorclass.html