"I hereby declare that I have read through this report entitle camera tracking human movement using image processing and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Mechatronics)"

Signature: ………………………………………………..

Supervisor's Name : Miss Nur Maisarah binti Mohd Sobran

Date : 6 / 1 / 2016

CAMERA TRACKING HUMAN MOVEMENT USING IMAGE PROCESSING

OMER MOHAMED OMER BASLEEM

A report submitted in partial fulfillment of the requirements for the degree of Mechatronics engineering

FACULTY OF ELECTRICAL ENGINEERING

UNIVERSITY TEKNIKAL MALAYSIA MELAKA

2016

I declare that this report entitle camera tracking human movement using image processing is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: ....

Name: Omer Mohamed Omer Ba-saleem

Date : 6 / 1 / 2016

Dedicated to my beloved parents

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I would like to express my special thanks of gratitude to my supervisor Miss Nur Maisarah binti Mohd Sobran for her sincere supervision along the project.Also I would like to thank my panels, lectures and friends for their assistances into my project by giving comments and advice to improve it.

Lastly. I want to thank my beloved parents that support and motivate along my study period in UTeM. I wouldn’t be able to make my way without them

ABSTRACT

Nowadays, personal assistive robot is an active area of research in order to make robots see the person and make adjustment based on the human behaviour. However, some problems facing in this project such as the direction of the target object and the changing of the image size that occur. The target position, the mutlti-person tracking and the changing of the background can affect the result of a vision tracking system. In this project, the objectives are developing a vision system to track the movement of the human body, analyse the performance of the human tracking camera and build a graphical user interface (GUI) for the programme. For the hardware component in the methodology, there are some important component chosen for the tracking human system such as 5 Megapixel webcam, Arduino Uno as a microcontroller, and a servo motor. The method of tracking the human body consist of two stages, a detecting process and tracking process. Detecting the upper body of the human by extracted it features and tracking the feature point on the detected body. Based on the deviation angle between the centre of the camera and the centre of the detected body, the servo will rotate to track the human body. The experiments are to test the accuracy of the camera during tracking. When the body having different distance from the camera and with different angels which are 45° and 135° from while the target facing the camera at 90°. As the result, the accuracy of the camera tested at 1.5 meters and 2 meters, the camera during tracking got an accuracy reach to 93.6%.

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CHAPTER 1

INTRODUCTION

1.1 Project background:

This project is about tracking human movement using image processing approach. Robot is the invention that the human future depends on it. Especially those robots that depends on a vision system because it make the robots more interact with the surrounding environment in real life. So many researchs had been done to find ways to communicate and interact with robots using vision techniques. Human body tracking is an active area of reserch in order to make robots see the person and adjust based on the human behavior.

For the tracking system using image processing, it consists of a camera mounted horizontally on the top of the motor. The camera will track the person in real time and adjusted based on the direction of the target. Moreover, human body tracking depends on the detection as a frist stage by extracting the features of the part of the body that need to be tracked. Many researches to get the aim of the target and track the person by using images that come from the camera which have been reported based on human characteristic such as face, human body shape, background subtraction, etc.

This report is organized as follows: Chapter 2 introduce the literature review and related works of image processing techniques. Furthermore, Chapter 3 will presents the project methodology. Then Chapter 4 shows the result and the discussion. Lastly, Chapter 5 concludes this report and lists some recommendations for further research on this particular field.

1.2 Motivation:

The ability to detect and track human motion is a beneficial tool for higher-level applications. Robots based on vision can be used to detect and track human motion for some application that requires tracking process. One of the applications that could be realized with reliable human motion detection and tracking is a smart shopping cart. Nowadays, customers still pull or push the shopping cart during the shopping trip. However, to make the shopping trip more comfortable a smart shopping cart based on vision will be used to track the customer during shopping. The smart shopping cart has the ability to follow the customer inside malls and supermarkets [1]. Vision system is a suitable way to interact between the smart shopping cart and the customer. Using vision techniques for tracking the person will be more comfortable and convenient for customers at the future.

1.3 Problem statement:

Robots based on vision system interacting with the environment surrounding it by extracting the features from it. But, how can make the robot communicate and interact with human movment by tracking it. Vision system is helping to make robots more effective interacting when it comes to detecting recognizing and tracking. The camera of the robot starts tracking the target person, some problems that might occur because of the movement of the target. Direction of the target is one of the problems that occur during the tracking process. In addition the position and orientation of the human in front of the camera might be a problem due to the changing of the size of the image. Moreover, during tracking the target camera more than one target might make the camera not be able to track the target person if somebody enters the frame of tracking. Last the changing of the background of the picture and that changing because of the camera moving.

1.4 Objectives of the Project:

i- To develop a vision system that can track the movement of the human body.
ii- To analyze the performance of the human tracking camera system.
iii- To build a graphical user interface (GUI) for the system.

1.5 Project scope:

The tracking algorithm will be developed using MATLAB software. The Hardware of this project will be a camera mounted on a servo motor moving along x axis to ensure keep traking the human body. Moreover, This project will be developed for tracking human in indoor environment with good illumination condition and the testing it will by tracking single body infront of the camera with different distance between the camera and the human body.

CHAPTER 2

LITRETURE REVIEW

2.1 Related works:

Recently, there has been a great interest in tracking system in the modern following robots. In [2] automatic camera tracking system had developed in order to use for TV program production. The camera can detect and tracking the performer’s facial position using image processing. To ensure continuous real-time detection, individual algorithms are applied such as the head shape and the frontal face detection skin color and identification process.

One of the following robots applications is a robot can carry a luggage and follow the customer in [3] a robot quipped omnidirectional camera to take a panoramic image of the target and then tracked using Laser Range Finder (LRF). The picture that comes from the omnidirectional camera depends on the color histogram matching algorithm with the down sample a logarithm which both will be implemented using OpenCV to accelerate the identification and tracking process.

ApriAttenda is one of the humanoid robots that’s depends on the vision based on target detection. The idea of detecting and tracking that the body region appears in the input image so a group of feature points on the target region when the target region is moving the feature points will be detected and the region will be followed [4].

In [5] following robot using kinetic sensor. Kinetic is a sensing device can observe human and object in 3D. Kinetic sensor has two parts the first one is the RGP camera the second is 3D depth sensor. The IR emits infrared light and the projector will record the reflective spots and then collecting the reflected spot producing a depth image and according to the depth data the counterpoint of the body will be obtained.

In [7] Histogtam of Oriented Gradients used with mean shift logarithm to track a moving human walking inform of a moving camera. The paper shown if the tracking the full body of the human in a big area is not suitable for mean shift logarithm because of the variance of histogram of target, especially when the target is moving which mean taking time for calculating the histogram of the large area. However the paper showed that also using a head of the human as a target and the color of the hair a robust way to track the human target in front of the camera.

In [8] Using human segmentation beased on shape to track mutiple people in difficult situation the method use 2 stages in order to track the human which will start with the segmented the human body shape to detect the target based on the human hypothesis which produced by the human shape model and then tracking it by using the kalman filter.In[11] use using morphological method and used edge detection to get the outline shape of the human then make a tamblet using object skeleton which one of the morphological method to define human expression and then track it using the kalman tracking method.

Table 2.1 : Summarizes the past related work articles:

Article	Author	Method	Feature
Automatic tracking camera system utilizing the position of faces in the shot image [2]	T.Tsuda, M,Okuda, K. Mutou, Y.Nishida.	Viola Jones algorithm	Using shape, face and skin color as a crossfire at the same time.
Target person identification and following based on omnidirectional camera and LRF data fusion [3]	M. Kristou, A. Ohya, S. Yuta.	HOG & Laser range finder	Using the HOG for detecting the target and robust tracking using LRF
People-following System Design for Mobile Robots Using Kinect Sensor [5]	G. Xing, S. Tian, H. Sun, W. Liu, H. Liu.	Depth images	Collecting the reflected spot producing a depth image in order to detect the human body
Human Body Detection and Tracking from Moving Cameras [7]	G. Li, Y.Xu, X. Shi, S.Wu.	HOG & meanshift	Detect the upper body of the human using Histogram. Tracking in a small area using meanshift to make the tracking robust.
Segmentation and tracking of multiple humans in complex situations [8]	T.Zhao, R.Nevatia, F.Lv.	Segmentation	Detecting the human moving pixel intensities and can also detect multiple humans moving at outdoor environment.

2.2 Detection and Tracking Techniques:

There are several techniques to detect and track an object, the aim is to find a proper way to track a person such as:

2.2.1 Viola Jones algorithm:

The Haar like features is a detection method that uses to detect an object with real time rates. The basic of this method is given bounding box applied on the target that needs to track called it as a detection window.

Haar like feature consider adjacent rectangular window in the specific location inside the detection window. This method depends on the difference between the sums because to make the detection it need to sum up the pixel intestines in each region. To get better detection Viola and Jones present a four horizontal and vertical feature for better coverage area.What makes Haar like feature is a wide usage, it is because it needs a short time to detect instead of the other methods which is due to integral images.

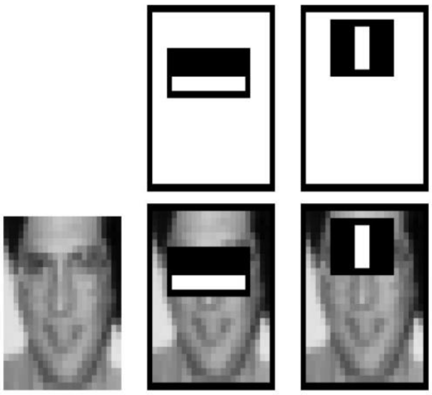

Figure 2.1: Haar like features [16]

In [16] Viola Jones algorithm has been used to detect a human parts such as frontal face, mouth, nose, eye pair and upper body. The cascade object detector has been used the algorithm to detect human upper body by indicating the head and shoulders area.

To get better detection Viola and Jones present a four horizontal and vertical feature for better coverage area. The principle of the rectangular features the values from the different from of the summation. The sum between the pixels in white rectangular subtracted from the pixels in the dark rectangular.

$$F_i = \sum(r_{i,white}) - \sum(r_{y,dark}) \qquad (2.1)$$

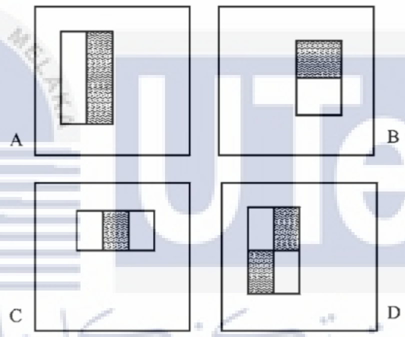

Figure 2.2: Haar-like features detectors

To find these rectangular features a weak learning algorithm is designed to select the single rectangular features which separate the positive from the negative examples. The learner will determine the best threshold for each feature.

$$h_j(x) = \begin{cases} 1 & if\ f_i(x) < \theta_i \\ 0 & otherwise \end{cases} \qquad (2.2)$$

When:

h_j= classifier

f_i=feature

θ_i=threshold

Cascade object detector using viola-Jones algorithm to detect parts of human body such as upper body.The algorithm increase the detection performance with reducing the computing time. More efficient classifiers can be constructed while rejecting as much as negative sub windows though detecting most of the positive example.

The detection process will generate a generation decision tree called a “cascade”. The cascade applies increasingly more complex binary classifiers, which allows the algorithm to rapidly reject regions that do not contain the target. If the target has not been founded in any stage of the cascade classifier, the detector immediately rejects the region and processing is terminated.

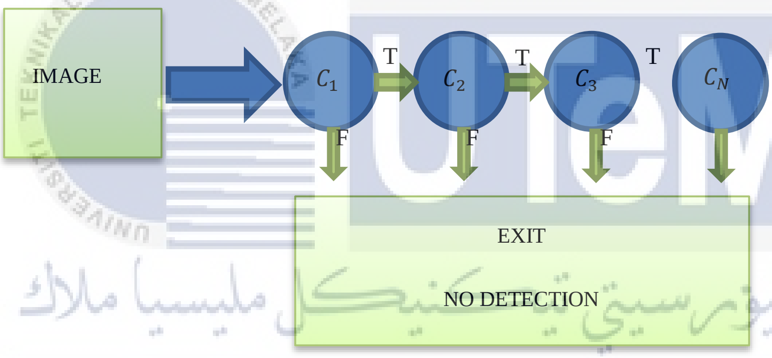

Figure 2.3: Cascade algorithm process

2.2.2 Histogram of Oriented Gradient (HOG):

Histogram of Oriented Gradient [6] is an image processing feature technique used to detect the object. The idea is to detect the object appearance and shape based on the distribution of the local image intensities gradient or edge orientation. To implement this feature the object need to divide the object that needed to detect into cells. Cells is a small region of the image that needs to be detected which will be calculated in term of the intensities gradient or edge orientation.

The advantages of the histogram of oriented gradients is its support translation and orientation of the object such as during moving which make HOG technique is the best way to detect human.

Histogram of Oriented Gradients logarithm is a powerful technique for good performance. But it has a disadvantage which it needs strong processor to run the algorithm. Moreover, even in strong processor and a low resolution image the processor will achieve a little bit frames per second. In the end we can conclude that by this method is not a suitable way to detect since the raspberry pi processor 700 MHz. Although It needs a fast and powerful processor to make the detection process done, but Histogram of Oriented Gradients consider the best way of detecting human and many vision applications had been done using histogram such as detecting pedestrian.

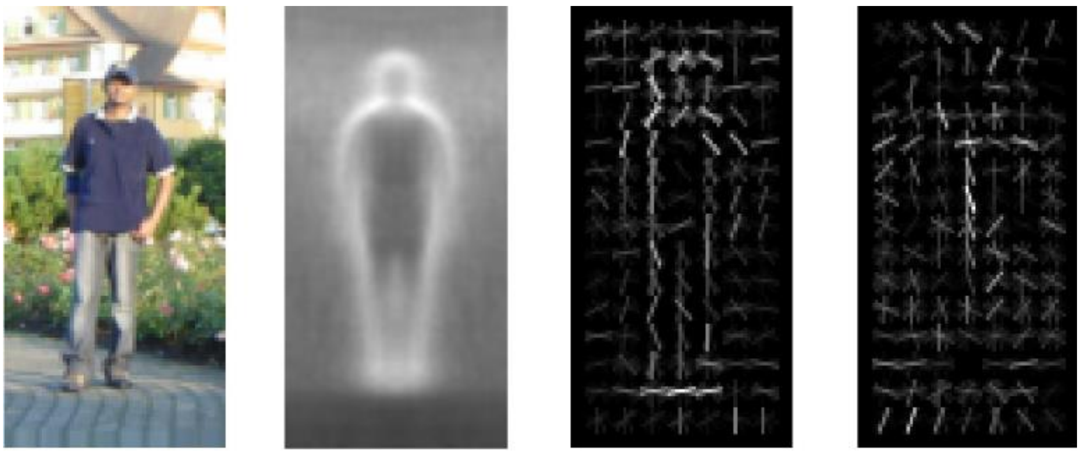

Figure 2.4: Gradient image after filtering [6]

2.2.3 Kanade–Lucas–Tomasi Tracking (KLT tracker):

In [12, 13, 14] when the camera moves, the patterns of the image intensities are changing in a complex way. However, Images are usually related to each other when they are taken in short time and that because it refers to the some scene taken from with slightly difference in the viewpoints.

By assuming the intensities of an image region unchanged when it's displaced. The image sequence satisfies. As the image motion model is not perfect and because of image noise. The image sequence formula can be written as:

$$I(x,t) = I(\partial(x), t + \Delta t) + n(x) \quad (2.3)$$

Consider an image sequence I(x, t).Where δ(x) is the motion field, specifying the warping that is applied to image points between time instant t and t+Δt and n is the noise function.The translation of motion can be approximate by the fast-sampling hypothesis. Later image at time t + Δt can be obtained by moving every point in the current image, taken at time t, by a suitable amount of the displacement vector. The tracker need to be computes the displacement d for a number of selected points For each pair of successive frames in the sequence.

$$\varepsilon = \sum_{W}[(I(x+d), t + \Delta t) - I(x,t)]^2 \quad (2.4)$$

Where W is a small image window cantered on the point for which d is computed.The control on the new position must be done when the displacement has been found and the new position of the point has been determined. The controlling of the new position given by a template window around the point in frame n and a slave window around the matched point in frame n+1, a cross-correlation coefficient ρ is computed. The corresponding feature in frame n+1 is accepted if the computed ρ. is bigger than a user-defined threshold value ρ0. Tomasi and Kanade in [13] improved the technique by tracking features that are suitable for the tracking algorithm thought using the same basic method for finding the registration due to the translation. The features can be selected if the value of the eigenvalues of the gradient matrix larger than the value of the threshold.

2.2.4 Background subtraction:

The background subtraction is a technique used for detecting an object through extracting the foreground image this method also called foreground detection. This method used to detect moving object in real time using static camera. This approach detects moving objects from the difference between the current frame and a reference frame called “background model” [10].

2.2.4.1 Frame Differencing:

The method of the Frame differencing technique is by subtracting the current frame (t+1) and the background model which is the previous frame t.

$$D(t+1) = |v(x,y,t+1) - v(x,y,t)| \tag{2.5}$$

Threshold (Th) is used to improve subtraction between frames and remove the image noise.

$$|v(x,y,t+1) - v(x,y,t)| > Th \tag{2.6}$$

The advantage of frame differencing technique is its very quick to adapt changes in lightening or camera motion. If the detected object stopped it will not be detected any longer due to comparing between the frames.

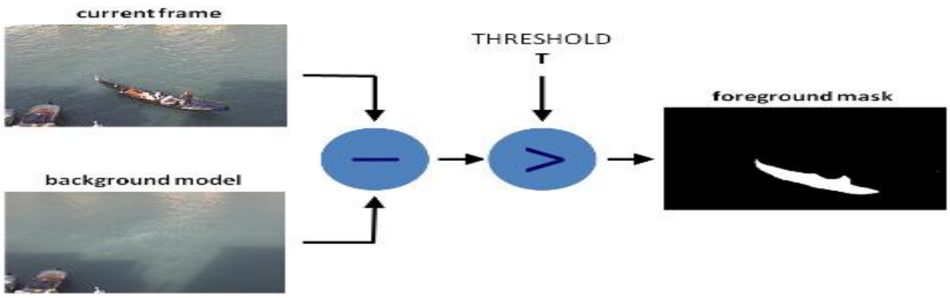

Figure 2.5: Frame differencing diagram

2.2.4.2 Mixture of Gaussian:

In [18] Stauffer and Grimson implemented with a type of adaptive background method called mixture of Gaussian with many improvements later. This method is working by assuming that every pixel of intensity in the image can be model. Gaussians are evaluated using a simple heuristic to determine which pixels are mostly like to match to the background .However, pixels than are not correspond to the background considered or classified as foreground. After that, pixels that are classified as foreground will be grouped together using 2D connected component analysis.

Which make this method better in than frame differencing that each pixel have a threshold adapting by time which can improve the noise. Also, this method has a good performance despite of the mathematical complexity for human.

2.3 Summary:

In the end, HOG is the most method use of human detection. However, because of the time it needs for calculation and processing make it not a robust method. And since the background subtraction method use of a static camera. Haar classifier can be the suitable technique to use for the tracking camera because the short time it need to detect but its weak classfire. Furthermore, back ground substraction technique is its very quick to adapt changes in lightening or camera motion but its situable only for the application that used a fixed or non moving camera. However, using cascade as a detector and KLT good features tracking together is more situable for human tracking camera. Table 2.1 presents some of the differences and similarities phases among the three different techniques.

Table 2.2: Detection and tracking techniques comparison

Method	Advantages	Disadvantages
Cascade object detector [16]	Short time to detect	Weak detector
Histogram of Oriented Gradient (HOG) [6]	Strong detector	Needs strong processor to run the algorithm
Background subtraction [10]	Very quick to adapt changes in lightening or camera motion	Use for static camera
KLT tracker [13]	Simple, fast and gives accurate results	Gives False features to track due to changing of the position

CHAPTER 3

METHODLOGY

3.1 Introduction:

This chapter first review the system requirements and tools that used in this project. Then, explains the overall flow of tasks in this project as shown in the flowchart. In addition describes in full details the procedures taken to reach the final results represented by tracking the upper body of the target human in front of the camera sensor. It explains the process of tracing human starting from detecting the human upper body feature before tracking it. Moreover, calculate the deviation between the centre of the detected image and the centre of the image to get the angle of the position of the human according to the positon of the camera. Afterthat, transmit angles from Matlab to the controller to rotate the servo that holds the camera to the position of the human.

3.2 System Requirements:

3.2.1 Web cam:

For the video acquisition a 5 Megapixel Logitech web camera are used to capture and process video farams from the webcam in a loop to detect and track the human upper body. Resolution is the capability to observe the slightest features in the image .Furthermore, having a high resolution camera is essential to ensure getting more Image details while extracting the features of the human upper body.

Figure 3.1 : Logitech web camera

3.2.2 Arduino Uno:

Servo motor is responsible the movement of the camera during tracking process. The Arduino microcontroller selected to control the angle of the servo based on the informations that will be transmitted from MATLAB.

Figure 3.2 : Arduino Uno

3.2.3 Servo motor:

Servo motor rotation gets controlled according to the changing of the pulse width that send to the servo motor. Given the rotation constraints of the servo, the position where the servo has exactly the same amount of potential rotation in the clockwise direction same as in the counter clockwise direction.

The pulse width modulation means that the angle is determined by the duration of a pulse. The servo expects to get a pulse every $20 \times 10^{-3}\ s$. The length of the pulse will determine how far the motor turns. For example, a $1.5 \times 10^{-3}\ s$ pulse turns the servo motor to the 90 degree position which is (neutral position).

The command for servo to turn a valid position is function of each servo come from the maximum width and the minimum width of pulse. If the sent pulse is more than $1.5 \times 10^{-3}\ s$ the servo rotates to a position and holds its output shaft some number of degrees clockwise from the neutral point. However if it less than $1.5 \times 10^{-3}\ s$ the opposite will occur.

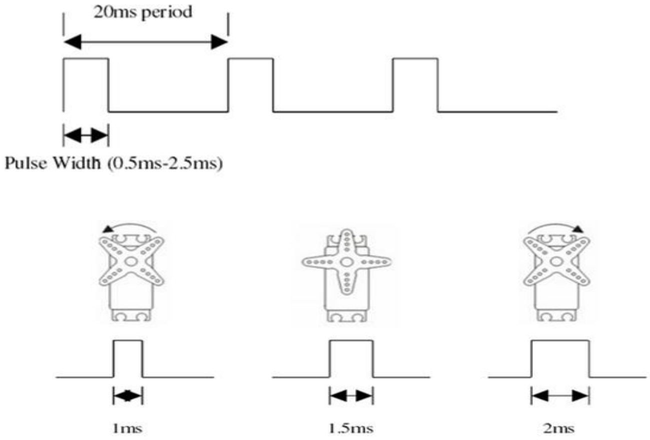

Figure 3.3: Relation between PWM duty cycle and servo angle

3.2.4 Matlab software:

Matlab 2013 software has been used for this human tracking camera system. Matlab software has the ability to numeric compute images that get it from the camera.

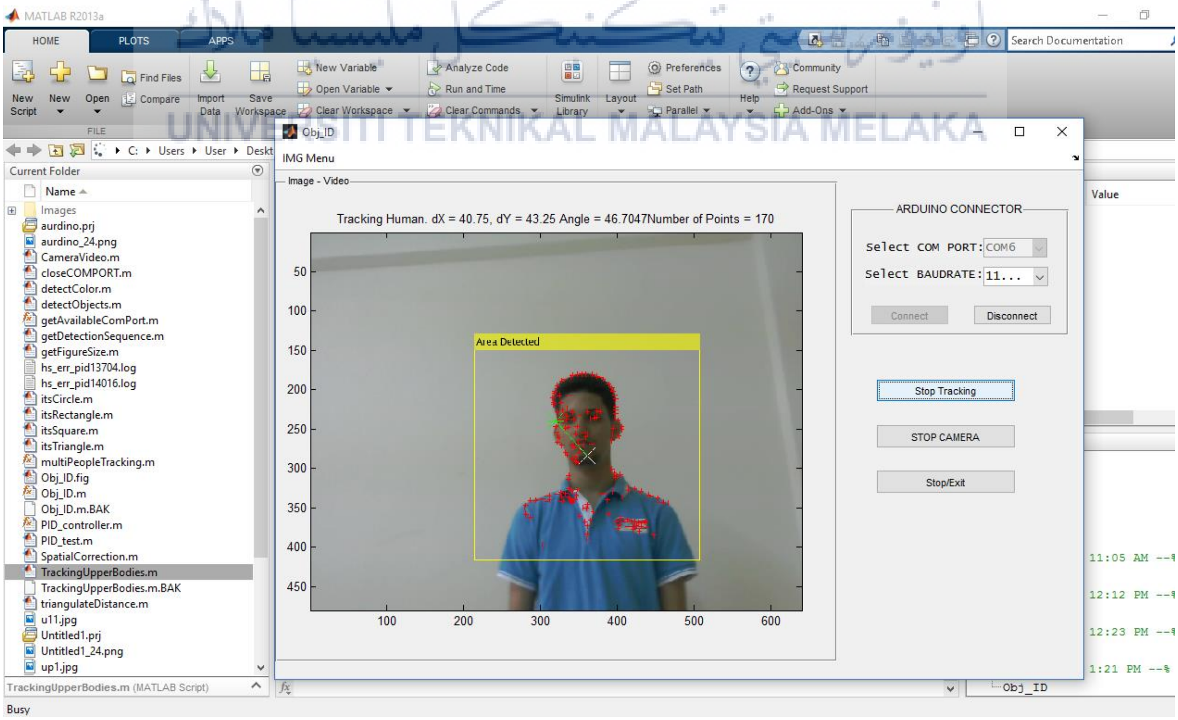

Figure 3.4: MATLAB GUI during tracking

3.3 System flow chart:

As shown in the following flow chart of the human tracking System, It starts by searching about a human body in front of the camera. When the camera detect a human body using cascade algorithm it start searching about good feature to continue tracking process. Then get the deviation between the camera and the image center to get the angle that will be sending to the Arduino to keep the update the servo position based on the target moving.

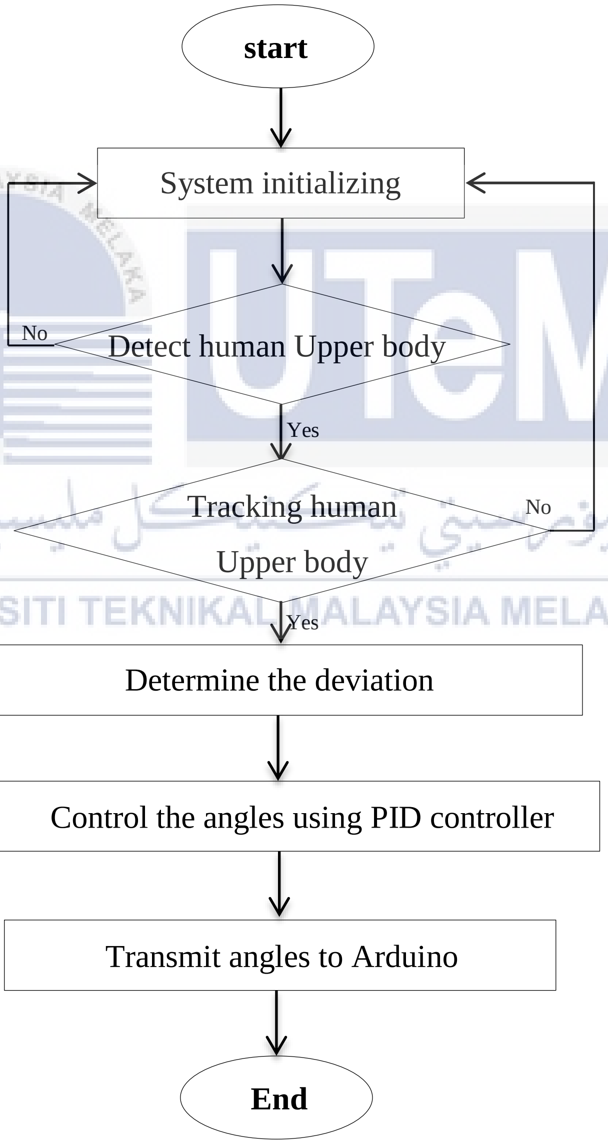

Figure 3.5: Human tracking System Flow Chart.

3.3.1 Detecting human Upper body:

Cascade object detector using viola-Jones algorithm to detect parts of human body such as upper body.The algorithm increase the detection performance with reducing the computing time. More efficient classifiers can be constructed while rejecting as much as negative sub windows though detecting most of the positive example. In addition, Figure 3.7 shows an upper body detection using Cascade algorithm.

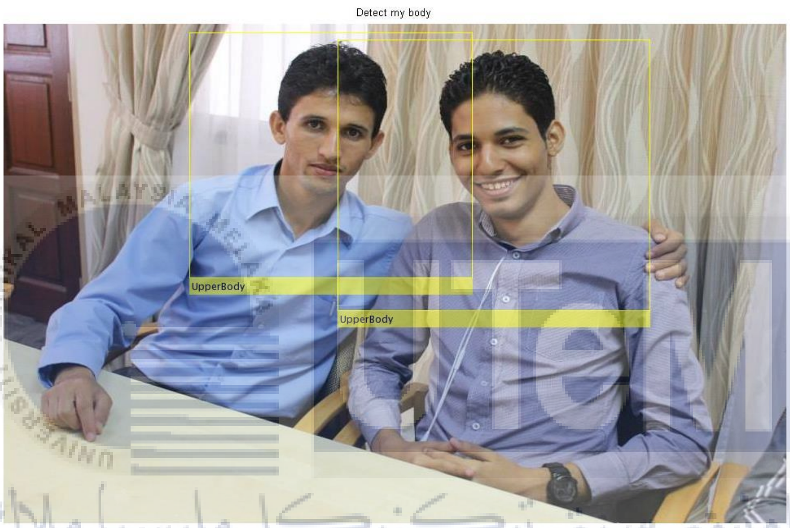

Figure 3.7: Upper Body detection

To detect upper body features first of all a cascade object detector need to be created: upperBodyDetector = vision.CascadeObjectDetector('UpperBody');

Next, upper body Minsize and Maxsize properties need to be set up to limit the size of the object during detecting by estimating the object size. The Minsize and Maxsize properties are used to reduces the computional time of processing the image from filtering the detection result based on the object size. Then, determine the scale factor which is the searching window size that slide start from the the upper left corner of the image scaning and scaled the image to locate the object which is the upperbody. The scale factor incrementally scales the detection resolution between MinSize and MaxSize.

```
handles.upperBodyDetector.MinSize = [220 220];
handles.upperBodyDetector.MaxSize = [380 380];
handles.upperBodyDetector.ScaleFactor = 1.05;
```

3.3.2 Tracking Upper Body:

Cascade algorithm can detect the upper body but cascade is a week classifier that needs trainer to make detection process stronger However, if the body turns or title a little bit this leads to fail to detect the upper body of the target human in live video stream.In addition using the point tracker will insure keep tracking the body even when it moves. Jianbo Shi and Carlo Tomasi proposed in “good features to track" by using Kanade-Lucas-Tomasi Tracking algorithm (KLT tracker). When the detection is locates the upper body the algorithm identifies feature points and tracks them as shown in Figure 3.9.

Figure 3.8: Kanade-Lucas-Tomasi (KLT) good features algorithm tracking Upper body

The tracking process it starts by identifying the features points in the upper body detected region. Afterthat, initialize a tracker to track the points by creating a point tracker: pointTracker = vision.PointTracker('MaxBidirectionalError', 2);

Point tracker must be identified using constructor. The constructor Forward-backward error threshold has been used to configure the tracker object properties. The object tracks each point from the previous to the current frame then tracks the same points back to the previous frame.

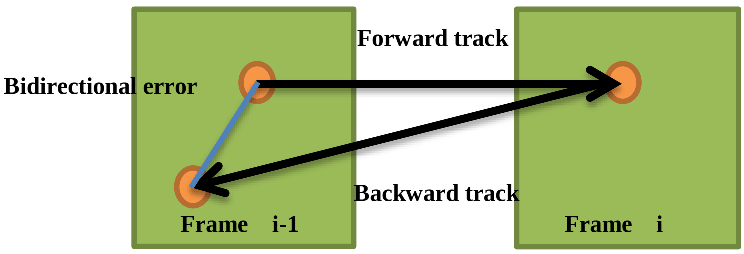

Figure 3.9: Forward-backward error threshold

3.3.3 Determine the deviation:

The human body will be moving in front of the camera. In order to keeps the camera tracking the moving human the deviation change between the centre origin of the camera to the center of the bounding box need to be determined. The image center in xy image coordinates in pixels, where x corresponds in the image and y corresponds to row number. The coordinates of the camera image center are given by:

$$d_x = \frac{x_{max} - x_{min}}{2} \tag{3.1}$$

$$d_y = \frac{y_{max} - y_{min}}{2} \tag{3.2}$$

Where x_{max} x_{min} y_{max} and y_{min} are the maximum and minimum column and row numbers respectively. After that, getting the deviation of in y axis and x axis by substrack the cerntre of the x in y of the bounding box from the x axis with the cenrtre of x and y for camera image.

```
dY = bboxCenterY - (axesY(2)/2);
dX = bboxCenterX - (axesX(2)/2);
```

3.3.4 Control the angles using PID controller :

PID (proportional, Integral, Derivative) control is a method used to achieve and maintain a process position of the servo motor during tracking process. The PID control equation expressed by a general formula:

$$Drive = KP * Error + KI * \sum Error + KD * dP/dT \qquad (3.5)$$

While KP is the proportional coefficient, KI the integer coefficient and KD is derivative coefficient are the gain coefficient. ∑error is the previous error values summation and dP/dT is the rate of change of the servo position.

The PID will control the error that happeneing because the change in deviation centre.Moreover, from getting the error value by calualted in the PID drives equation the Pulse width modulation will be generated. pulse width modulation is generated by PID output based on the standard formula for calculating PID.

```
Error(idx) = devCenter(idx);
            Integral(idx) = Integral(idx) + Error(idx);
            Derivative(idx) = Error(idx) - Last_Error(idx);
            PWM(idx) = (Kp * Error(idx)) + ...
                       (Ki * Integral(idx)) + ...
                       (Kd * Derivative(idx));
```

The condition for PWM to allow the camera to track is between -2000 to -3000 if the the PWM value is greater than -2000 the pulse output will be substructing by 1 from the current axis angel to the right position. However,if the generated PWM is less than -3000 the pulse output will be more increasing by 1 puls to the left side but if the value of the generated PWM have a bigger value then the output will be decreasing by 1 pulse.

3.3.5 Transmit angles to Arduino:

The rotation angels of the servo motor transmit form the Matlab to the Arduino as a serial data through the USB cable. This data will be transmit from the after connect it with the com port In other meaning as long the COM PORT is open the data will be send to the Arduino. Information is transmit as bits zeros (0) and ones (1). The baud rate (The communications transfer rate) must be set. Choosing the buad rate as 115200 will provide a quick data transfer.

3.4 Analysis setup:

Traking human camera implemented in this project requires hardware such as a camera.LED, Arduino microcontroller board ,servo motor and a laptop equipped with MATLAB software.

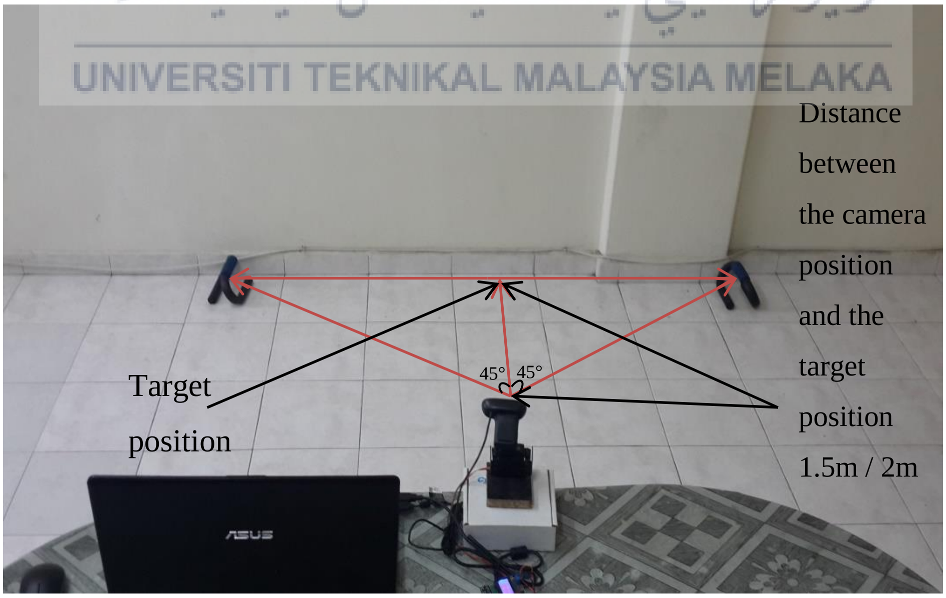

Figure 3.10: camera setup

Figure 3.11: Position of the tracking camera from human

Figure 3.11 shows that the position of the camera in the 90° and the analysis space and the destnations which is 45° to the left and 45° to the right. In addition, Figure 3.12 shows the position of the camera from human. The camera distance from the human target will be changing between 1.5 and 2 meters. The camera is puts 1 meter from the ground. Moreover, testing of the tracking algorithm done in good illumination conditions.

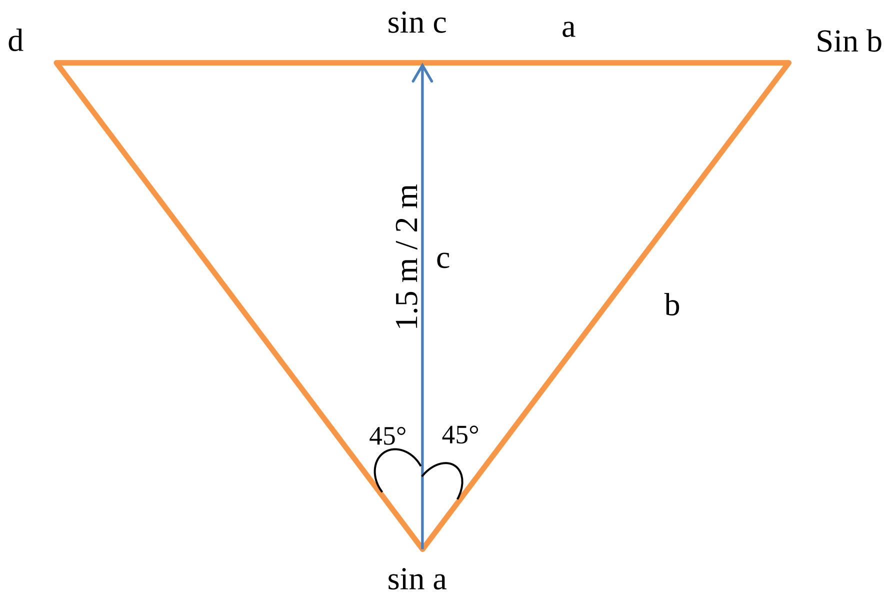

Figure 3.12: Camera triangulation and geometry

Figure 3.12 shows the camera triangulation and geometry. In order to get the distance of (a) which is the distance that needed from the target position to walk to make the camera move by 45° or 135° .when sin a= 45°, while the sinc c = 90°.

$$\frac{a}{sina} = \frac{b}{sinb} = \frac{c}{sinc} \tag{3.6}$$

For example, when the distance is 1.5 meter:

$$\frac{a}{sin45} = \frac{150\ cm}{sin90} \tag{3.7}$$

The distance of (a) when the the camera 1.5 meter far from the human body will be 106 cm and when its far 2 meter from the target the distance of (a) will be 141.42 cm.

For the human tracking camera the camera will be mounting on servo motor. LED screen will be connected to the controller to get the values of servo angles rotation.

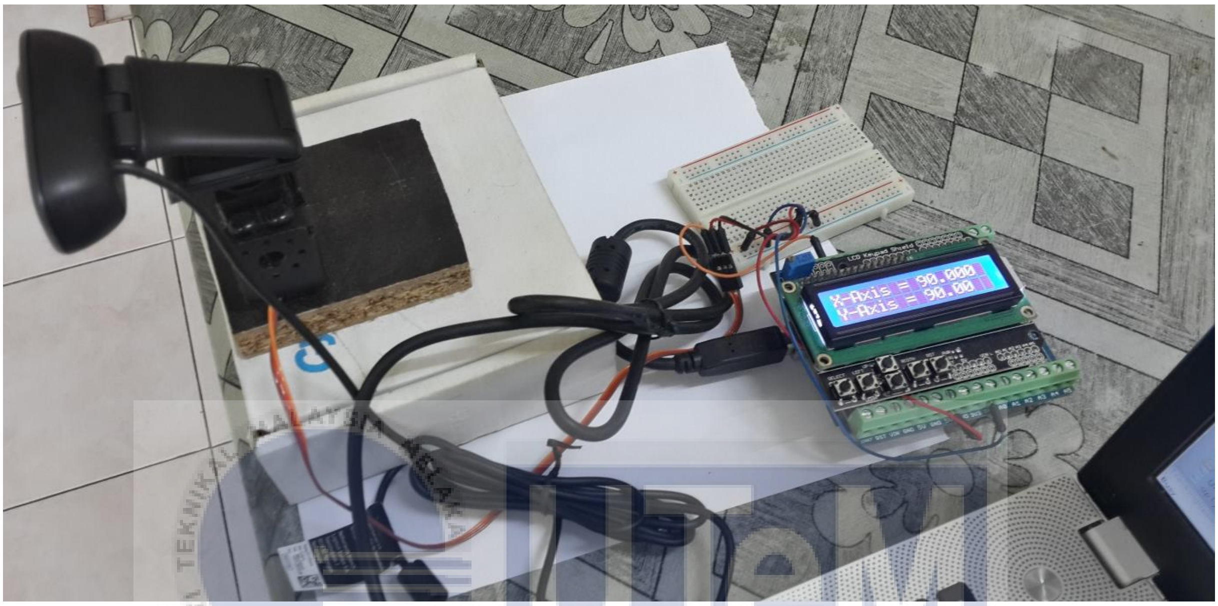

Figure 3.13 : LED shows the angels of the servo rotation

3.7 Creating Graphic User Interface (GUI):

GUI known as graphical user interface which is a medium that is used for users to handle the system. In addition, GUI interface layout editor consist of push buttons, pop_up menu and monitor to show the tracking process.

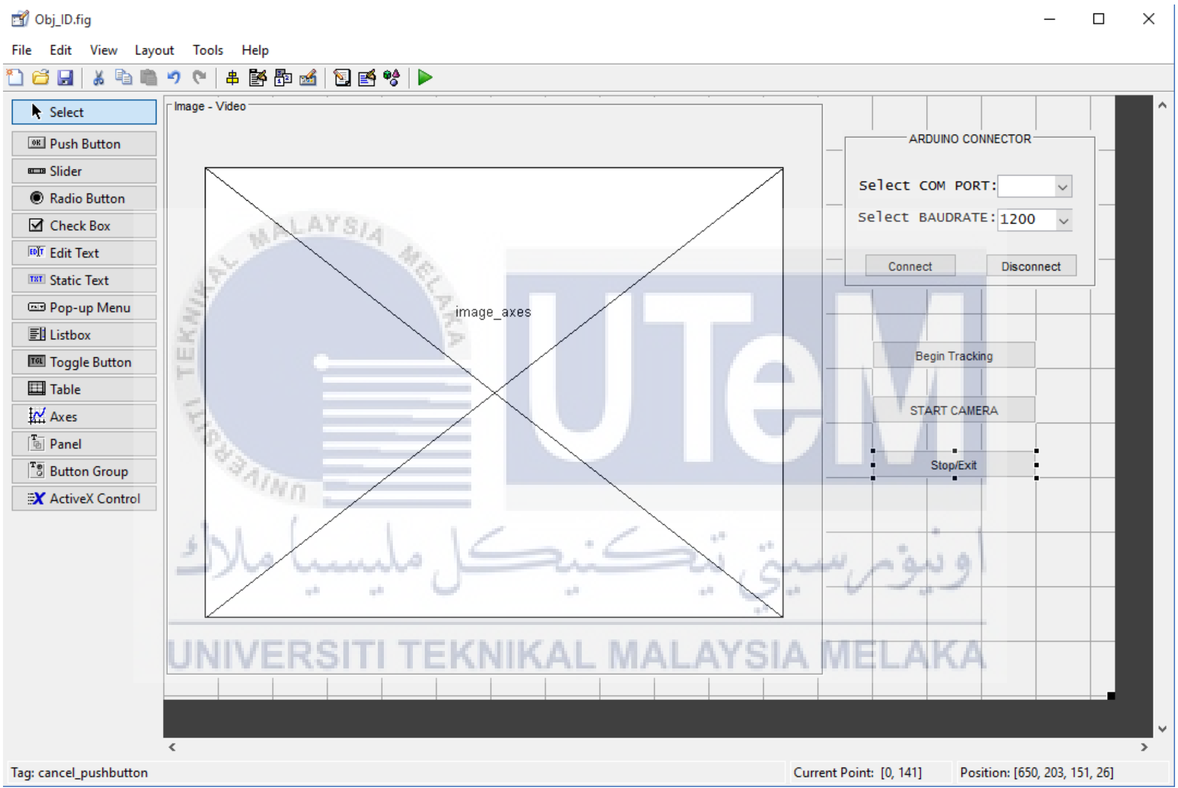

Figure 3.14 : Developing GUI

On the left side of Figure 3.14, there is a list of user interface control tools that can be used by users while running the program such as pushbuttons, axes, etc. Three push buttons were selected as start camera to open the camera and begin tracking button to start tracking process and a stop button to terminate the tracking process. Moreover, one axes is used to show the body during camera tracking process. In addition, two listboxes one of them for selecting the com port that link between the Arduino and the Laptop and the other one selection the buadrate or the communication transfer rate.

CHAPTER 4

RESULT AND DISCUSSION

Tracking human camera using image processing techniques have been developed. In addition the source code in MATLAB is generated as well and servo motor that responsible of the movement of the camera during tracking getting controlled using an Arduino microcontroller. This algorithm able to detect and track the upper body section for human body.

4.1 The accuracy of the Tracking camera with human body at 1.5 meters :

4.1.1 Accuracy of the camera at 45°:

Figure 4.1: Testing the tracking camera at 45°

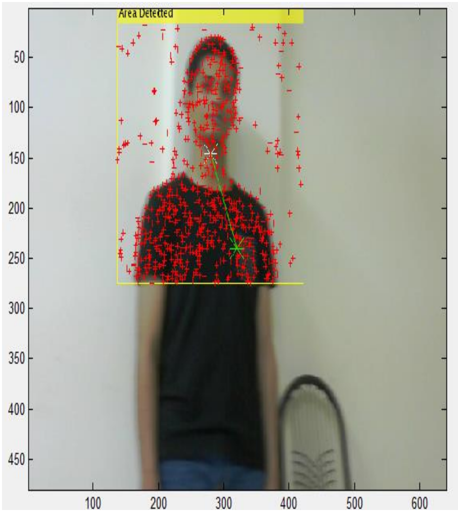

Figure 4.2: Upperbody tracking during movement to the right side when distance 1.5 meters

Figure 4.1 shows the picture of the human body during movment from the orginal position to the right position.The body facing the camera for extracting the upper body features during tracking. Figure 4.2 shows the bounding box for the detected body. The accuracy of the camera performance was mesured by setting the distance length between the human body and the camera to 1.5 meters. The test will repeated 10 times to get the accuracy percentage for the camera at that distance.

Table 4.1: Data comparison between desired and actual value at 1.5 meters

No	Desired value	Actual value	Percentage error %
1	45	50	11.11
2	45	47	4.44
3	45	48	6.66
4	45	49	8.88
5	45	50	11.11
6	45	48	6.66
7	45	47	4.44
8	45	49	8.88
9	45	48	6.66
10	45	47	4.44
Mean percentage error = ∑e/10			7.328%

Those 10 readings of accuracy test were repeated 10 times while the humen body far 1.5 meters from the camera. Farthermore, The human were moving 45 degree to right direction during the testing of the camera movment refer to the target moving at the same time. To get the accuracy of the tracking percentage error calculated for every trial.

$$percent\ of\ error = \frac{|reading\ value - real\ value|}{real\ value} \times 100\% \quad (4.1)$$

$$Mean\ accuracy = 100\% - Mean\ percentage\ error \quad (4.2)$$

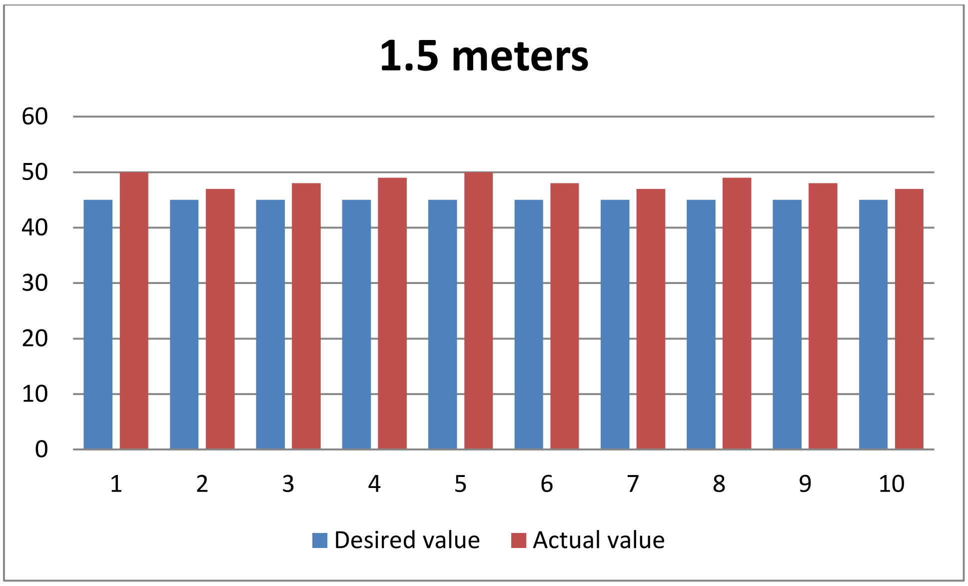

Figure 4.3: Desired and actual angles for 45 degree to the right

Figure 4.3 shows the accuracy of angles between the desired angle which is 45° and the mesured angle. Furthermore, There is a mean pecentage error by 7.328 % and the accuracy of the camera during tracking process reach to 92.67% . The error ratio can be reasoned to the changing of the position of the body in front of the camera during tracking process. Also, the error can be reasoned to the width of the human body when the body reach to the stop point of the tracking destination.

4.1.2 Accuracy of the camera at 135° :

Figure 4.4: Testing the tracking camera at 135°

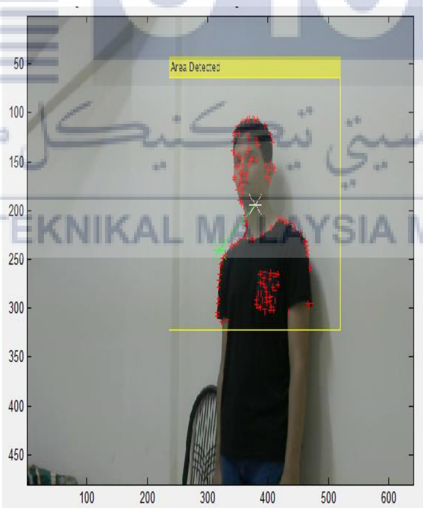

Figure 4.5: Upper body tracking during movement to the left side when distance 1.5 meters

Figure 4.4 show the target human moving from the camera position at 90° to 135°. In addition figure 4.5 show the bounding box on the target body during tracking it to the left position. Morover, The camera performance was mesured on 1.5 m distance between the camera and the the human target to check the accuracy for the device if it can detect the target at that distance and track it. The accuracy test have been repeated 10 times as shown in table 4.2. The table following table shown the readings from tracking the human target in front of the camera from 90° to 135°.

Table 4.2: Data comparison between desired and actual value at 1.5 meters

NO	Desired value	Actual value	Percentage error %
1	135°	131	2.96
2	135°	130	3.7
3	135°	130	3.7
4	135°	130	3.7
5	135°	130	3.7
6	135°	132	2.22
7	135°	132	2.22
8	135°	133	1.48
9	135°	131	2.96
10	135°	130	3.7
Mean percentage error = ∑e/10			3.034%

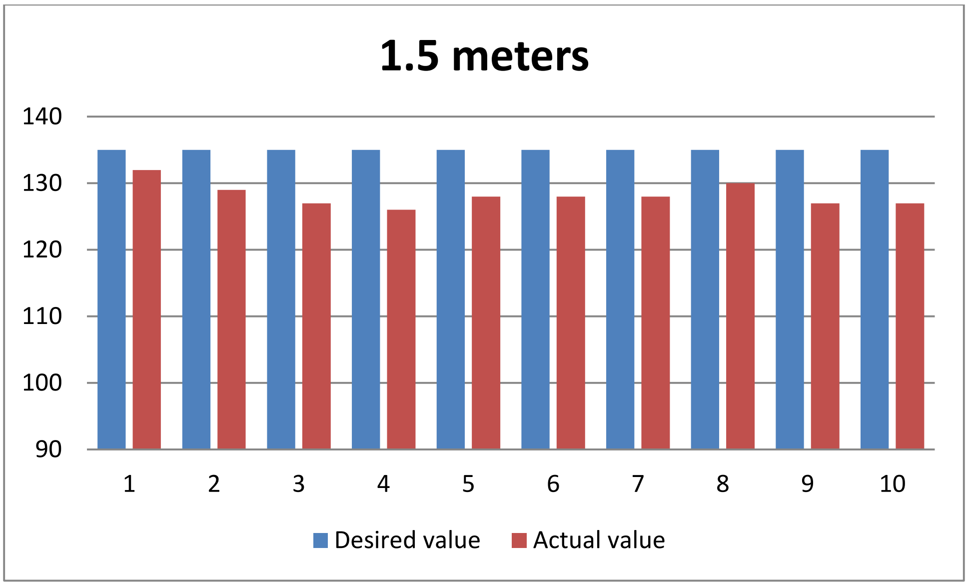

Figure 4.6: Desired and actual angles for 135° degree

Figure 4.6 shows the desired and the actual angels got from the camera when the camera moves from 90° to 135°. Moreover. the test have been repeated 10 times to collect the estimate the error between the desired and the actual angle then get the accuraccy from it. As shown in table there are a mean percentage error by 3.034% and acccuracy percentage of 96.97%. Howerver, the error percentage can be reasoaned to the changing of the body during its movment also the rotational of the target infront of the camera which can increase the value of angle.

4.2 The accuracy of the Tracking camera with human body at 2 meters:

4.2.1 Accuracy of the camera at 45°:

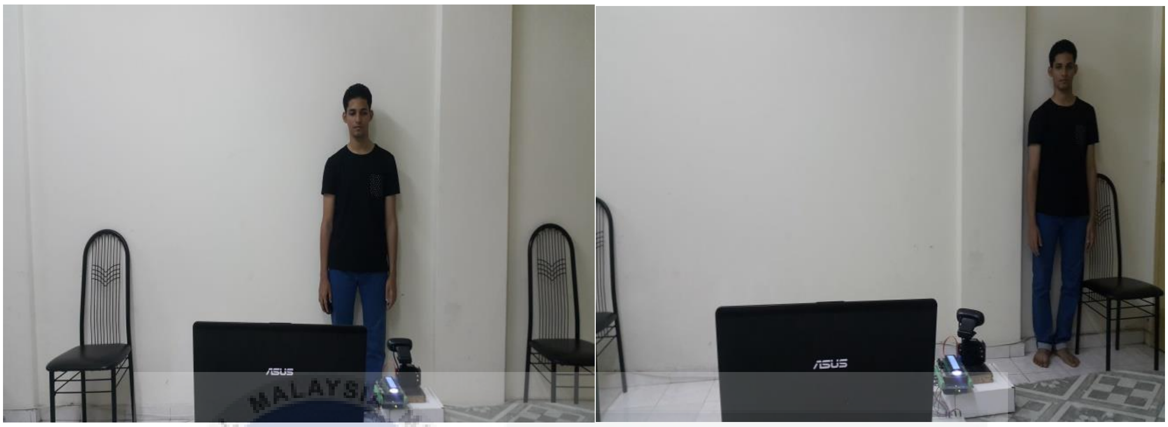

Figure 4.7: Testing the tracking camera at 45°

Figure 4.8: Upper body tracking during movement to the right side when distance 2 meters

In this time the camera was mesured at 2 meter far from the body to check the accuracy for the device at that distance. As shown in figure 4.7 the camera tracking the upper body of the human body from the orginal position to the right. The servo motor will keep tracking the human body to the right position from 90° to 45° at the right side. Figure 4.8 shows that camera can detect and track the target. In addition, The following table show the readings of the camera during tracking the body to the right position and compare it to the acutal reading to get the accuracy percentag.

Table 4.3: Data comparison between desired and actual value at 2 meters

No	Desired value	Actual value	Percentage error %
1	45°	50	11.11
2	45°	50	11.11
3	45°	47	4.44
4	45°	53	17.78
5	45°	49	8.88
6	45°	50	11.11
7	45°	48	6.66
8	45°	48	6.66
9	45°	50	11.11
10	45°	51	13.33
Mean percentage error = $\sum e/10$			10.219%

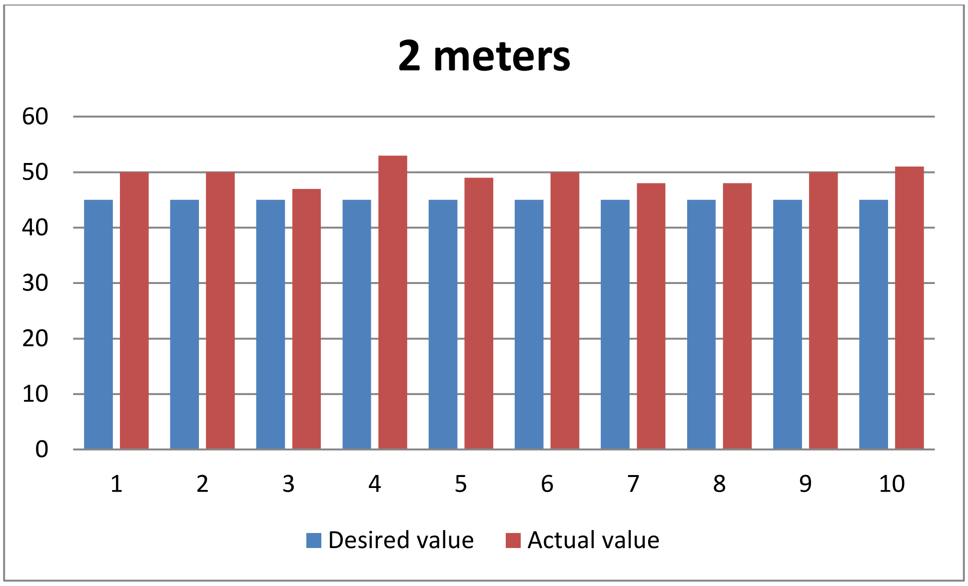

Figure 4.9: Desired and actual angles for 45 degree

Figure 4.9 a chart shows the actual and the desired angles for 45 degree to the right with 2 meters distance between the camera and the target body. The test have been done to check the accuracy of the camera when the distance increases to 2 meters. The mean error was 10.2% and the accuracy of the tracking process reach to 89.8% when the camera far 2 meters from the target and that due to the changing of the body position during tracking process.

4.2.2 Accuracy of the camera at 135°:

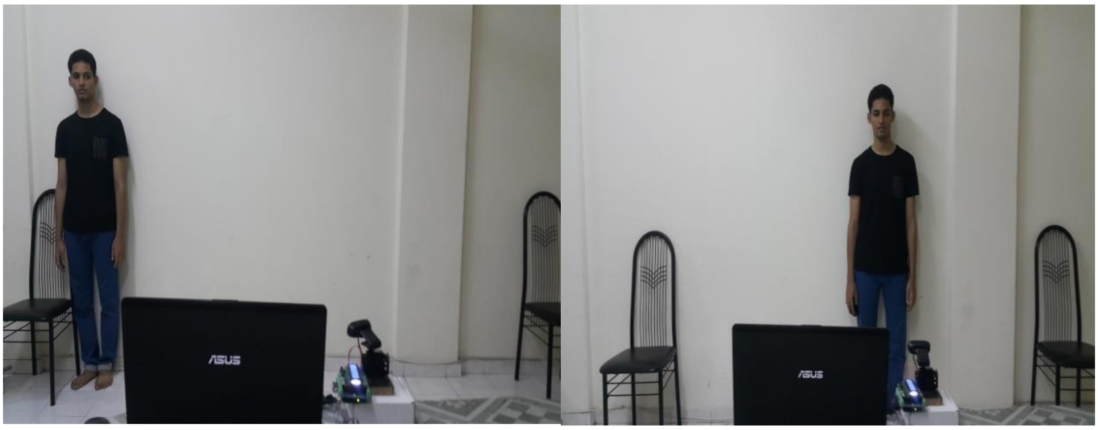

Figure 4.10: Testing the tracking camera at 135°

Figure 4.11: Upperbody tracking during movement to the left side when distance 2 meters

In this time camera was mesured when its 2 meter far from the human body. Figure 4.7 shows the area space of tesing while the camera tracking the body to the left side. When the camera is 2 meter far from the target body. Figure 4.8 shows the bounding box detecting the upper body of the target during tracking it from 90° to 135° position. The following table show the readings of the servo motor acording to the movement of the body while it move to the left side.

Table 4.4: Data comparison between desired and actual value at 2 meters

No	Desired value	Actual value	Percentage error %
1	135°	132	2.22
2	135°	129	4.44
3	135°	127	5.93
4	135°	126	6.67
5	135°	128	5.19
6	135°	128	5.19
7	135°	128	5.19
8	135°	130	3.70
9	135°	127	5.93
10	135°	127	5.93
Mean percentage error = ∑e/10			5.039%

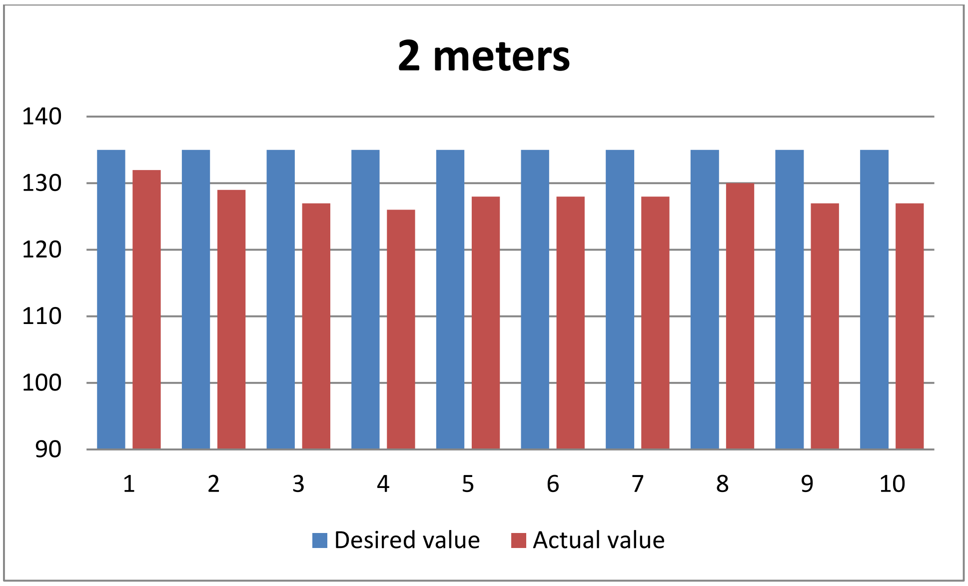

Figure 4.12: Desired and actual angles for 135° degree

Figure 4.4 shows the desired and the actual angles for 135 degree movment to the left from the orginal position of the camera with baselength 2 meter. The mean error was 5.039% and with 94.96% accuracy. However, the percentage of error in 2 meter is slighly increasing form the percentage error of the 1.5 meter and that can be eleminated be reduce the distance between the camera and the target.

4.3 Summary:

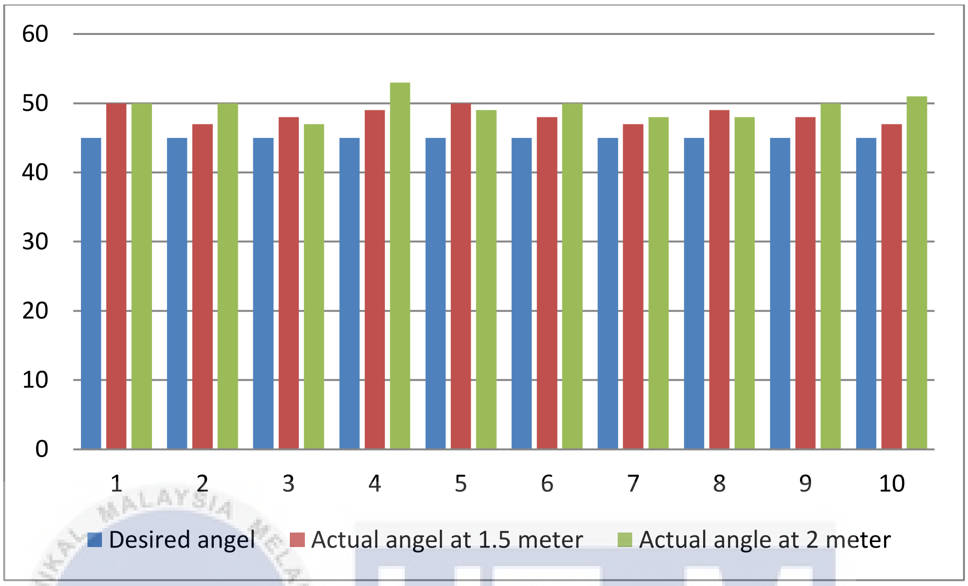

Figure 4.13: Comaparison between desired and actual angles for 45° for different distance

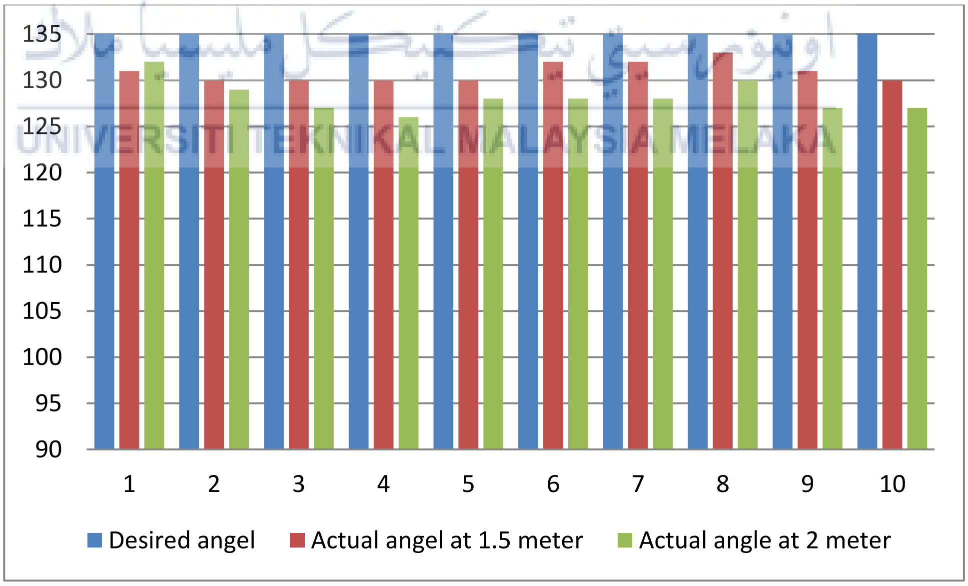

Figure 4.14: Comaparison between desired and actual angles for 135° for different distance

Figure 4.13 shows the comaparison between desired and actual angles with different distance value . The compersion is about tracking the human body on the 45° to right side of the camera . Moreover, the readings when the distance between the camera and the body 1.5 meter got less percentage error which means its more accurate. However, The readings shows even a good percentage of accuracy when the camera far 2 meters from the body during the tracking with 89.8%.

Figure 4.14 shows the comparison between desired value and the actual angle that come from the camera when it moves 135° or 45° to the left side starting from the orgin. The orgin will be at 90°. However, two test have been done to test the accuracy of the tracking process of the camera and the rotation of the motor to the right position.Moreover,the tracking reading for the left side when the distance between the camera and the body is 1.5 meters will be more accurate with 96.97%. However, when the distance is 2 meters the accuracy percentage reach to 94.96% which is less than the accuracy percentage comparing to the base line of 1.5 meter

To sum up, the camera was tested with difrrent distances starting 1.5 meters ans 2 meters and with different angels 45° and 135° while the orgin position of the camera on the 90 degree. The algorithm tested during the tracking process and it gave different reading of the accuracy. The performance of the camera was better when the distance between the camera and the body was less about 1.5 meters. However, the performance of the camera during tracking got an accuraccy reach to 93.6%.

4.4 Graphic User Interface (GUI) :

Figure 4.15: GUI when the tracking process is on

Figure 4.15 shows the the developed GUI of the system. Consist of three push buttons which are start camera to open the camera and begin tracking button to start tracking process and a stop button to terminate the tracking process. Moreover, functions for the tracking camera such as COM port selection to select the COM port and the buadrate selection. Also in the GUI the video display and algorithm reading such as deviation in both x axis and y axis and the number of features points.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusions :

In short, satisfying results are achieved for all the objectives that were set previously.

Tracking human alogarithm has been developed and implemented in MATLAB. As shown in the report algorithm was developed and tested with different distance and able to detect and track the human upper body. However, if the background changing or the light intensity was not sufficient the alogrithm can lose the detction due to fail in extracting the upper body features of the human upper body.

The camera perfomance was tested and analysed in the result part of this report. As it shown it the result part of this report the camera was tested to get the total accuracy of the camera during tracking the human body movement. The camera was tested with different base line length 1.5 meters and 2 meters between the camera and the traget body and in the right and left position for each base line length. The camera successed tracking the body.

The Graphical User Interface (GUI) was developed successfully. GUI allowing the user of the camera to interface the tracking process in real time.While the camera follow the movement of the body. Moreover, The GUI was developed to make connection between Matlab and the Arduino Uno microcontroller board by selecting the baud rate in the serial port to connect the controller with the computer.

In conclousion, all objectives of this project have been successfully met.In addition a tracking human movment camera has been developed and tested.

5.2 Recomondation :

For future work of this project, It is recommended to use a modern camera like depth camera which can use to extract and enhance the the features of human body. Moreover, In topics realted to image or video processing a strong processer consider a strong solution reduce the execution time which will achieve high performance targets detection and ropust tracking process. Moreover, tracking alogarithm can be developed and trained to tracking a specific target when there are similar humans in the same place during tracking and prevented the losing of detection when the background change behind the target human body. In addition, different tracking algorithm should compared to the existing algorithm in this report to ensure better results to be applied in a real application.

Moreover, there are several other problems which need to be addressed in the future. The tracking algorithm in this report can be deleoped to build a strong and ropust human tracking system.

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APPENDIX:

Appendix A:

GANTT CHART:

Project planning List of project major activities								
	2014				2015			
Tasks	Sep.	Oct.	Nov.	Dec.	Sep.	Oct.	Nov.	Dec.
Literature Review								
MATLAB exploration								
Preparation of PSM1 report								
Experimental Setup								
Algorithm Design								
Testing & Troubleshooting								
Preparation of PSM2 report								