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PERFORMANCE COMPARISON OF OUT-OF-PLANE FACIAL DETECTION USING SPEEDED UP ROBUST FEATURES (SURF) AND SCALE INVARIANT FEATURE TRANSFORM (SIFT)

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SUPERVISOR ENDORSEMENT

"I hereby declare that I have read through this report entitle "Performance Comparison of Out-Of-Plane Facial Detection Using Speeded up Robust Features (SURF) and Scale Invariant Feature Transform (SIFT)" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Control, Instrumentation & Automation)""

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A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering, (Control, Instrumentation & Automation)

Faculty of Electrical Engineering

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2015

STUDENT DECLARATION

I declare that this report entitle "*Performance Comparison of Out-Of-Plane Facial Detection Using Speeded up Robust Features (SURF) and Scale Invariant Feature Transform (SIFT)*" 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 : Nor Ain Zuzila Binti Zolkifly

Date : 24/06/2015

To my beloved mother and father

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Alhamdulillah, thanks, to the Almighty Allah Most Gracious, Most Merciful for the blessing and grace, I have been able to implement undergraduate project which is Final Year Project (FYP). I would like to take this opportunity to express appreciation to all those who have helped me along the implementation of this project especially my supervisor, Madam Norhaslinda Binti Hasim on giving me a lot of advices, ideas and support me. My gratitude also goes to my fellow friends for all the helps and ideas provided during this project. Last but not least to my parents and family for their patience, understanding and support during the whole period of the project.

Thank you.

ABSTRACT

Nowadays, SURF and SIFT become a popular method for facial detection due to its advantages in detecting and recognizing of features. The aim of this research is to implement an algorithm for face detection using SURF and SIFT as well as to test an algorithm for face detection using SURF and SIFT. As SURF and SIFT has their own steps, the different algorithm is used to evaluate the performance of time and the number of feature point detection using SURF and SIFT. The research is started with implement the algorithm of both techniques. Then, the facial image has been captured by using camera with different pose that indicate the out-of plane rotation. After that, the facial image has been tested through MATLAB software. Finally, the performance comparison of out-of-plane facial detection using SURF and SIFT has been evaluated. In general, SURF and SIFT are scale invariant. SURF uses Haar wavelet and it is the fastest feature detector and descriptor. Meanwhile, SIFT uses Difference of Gaussian over various scales of an image and it is the most accurate feature detector and descriptor. It is expected that SURF is better in terms of speed, while SIFT is the best for accuracy. The parameters that have been evaluated from both techniques are time and the number of feature point detection. As a conclusion the performance of technique chosen between SURF and SIFT will be compared.

ABSTRAK

Pada masa kini, SURF dan SIFT telah menjadi kaedah yang popular untuk pengesanan muka berikutan daripada kelebihannya dalam mengesan dan mengenal pasti ciri-ciri muka. Tujuan kajian ini adalah untuk melaksanakan algoritma untuk mengesan muka menggunakan SURF dan SIFT serta untuk menguji algorithm untuk mengesan muka menggunakan SURF dan SIFT. SURF dan SIFT mempunyai langkah-langkah yang tersendiri, algoritma yang berbeza akan digunakan untuk menilai prestasi masa dan bilangan pengesanan titik ciri menggunakan SURF dan SIFT. Kajian ini akan bermula dengan melaksanakan algoritma bagi kedua-dua teknik. Kemudian, imej muka telah ditangkap menggunakan kamera dengan gaya yang berbeza yang menunjukkan imej keluar-putaran satah permukaan. Selepas itu, imej muka telah diuji melalui perisian MATLAB. Akhir sekali, perbandingan prestasi di luar putaran satah pengesanan muka yang menggunakan kaedah SURF dan SIFT telah dinilai. Secara umum, SURF dan SIFT merupakan skala yang tidak berubah. SURF menggunakan *Haar wavelet* dan ianya adalah pengesan ciri dan penghurai muka yang paling cepat. Sementara itu, SIFT menggunakan Perbezaan *Gaussian* yang lebih kepada skala imej yang pelbagai dan ianya adalah pengesan ciri dan penghurai yang paling tepat untuk imej. Hasil kajian dijangka bahawa SURF adalah lebih baik dari segi kelajuan, manakala SIFT adalah yang terbaik untuk ketepatan. Parameter yang telah dinilai dari kedua-dua teknik ini adalah masa dan bilangan pengesanan titik ciri. Kesimpulannya prestasi teknik yang dipilih antara SURF dan SIFT akan dibandingkan.

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LIST OF ABBREVIATIONS

SURF	-	Speeded-Up Features Transform
SIFT	-	Scale-invariant Features Transform
SUSAN	-	Smallest Univalue Segment Assimilating Nucleus
3D	-	Three Dimensional
2D	-	Two Dimensional
ROI		regions of interest
CCTV	-	Closed Circuit Television
MATLAB	-	Matrix Laboratory
SNoW	-	Sparse Network of Winnows
DoG	-	Difference of Gaussians
RGB	-	Red Green Blue
FKE	-	Fakulti Kejuruteraan Elektrik

CHAPTER 1

INTRODUCTION

This chapter will give an overview of the project such as project introduction, project objective, project scope, project methodology and summary of this project. This chapter will explain briefly about the work from the beginning until the project is implemented.

1.1 Research background (Motivation and significance of research)

Facial detection becomes a quandary in the way to analyse the identity of a person. Nowadays, there are many technique and method that are utilized extensively for in-plane facial detection such as Harris corner, SUSAN, Hessian-Laplace and others [1]. As for Speeded-Up Features Transform (SURF) and Scale-invariant Features Transform (SIFT) [2] it is consider to be a popular method for facial detection.

This study focuses on out-of-plane facial detection. The method that will be used are SURF and SIFT while comparing their performance on out-of-plane facial detection. Based on experiment on out-of-plane facial detection, the parameter settings utilized in both algorithms are combined, adjusted, and developed in this system.

By referring to the journal written by (Yasir and Amelia, 2012). The point predicated delegacy of patch feature cause the out-of-plane detecting is possible happen. For more precise espial that represents the object of interest surface, the features must be mapped to a 3D model and then they can be rotated to the desired angle of sentiment. However, the features can be mapped to a flat plane for simplification of the out-of–plane rotation detection [3].

In the other hand, SURF algorithm and SIFT algorithm are including in representative feature extraction and matching algorithms. SIFT is invariant to scale, but with high computation involution SIFT has more preponderant performance in features number and precision. Furthermore it has modicum of calculation with great speed and the number of features is withal felicitous. SIFT has been widely applied and researched [4].

The Figure 1.1 shows the several of the normal and in-plane rotation detection results. Most of the researchers only focus on in-plane rotation and the scale invariance. However, when the situation has considerable out-of-plane rotation [5] as shown in Figure 1.2 it is become a problem to them. This will cause the accuracy to decrease. Hence, it is important to compare the two method between SURF and SIFT to show which is better in their performance of out-of-plane rotation facial detection.

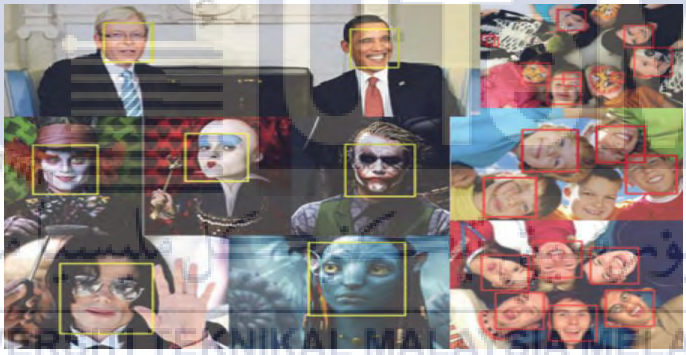


Figure 1.1: Several frontal and in-plane rotated face detection results [3]

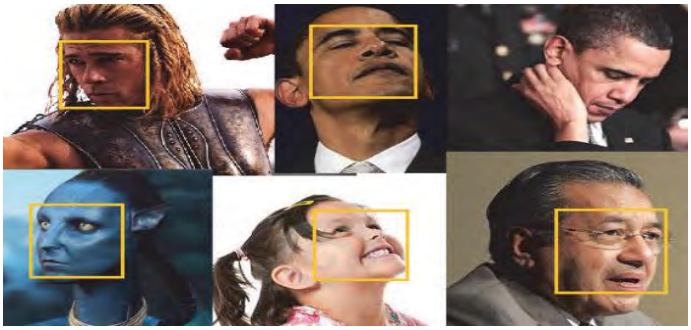


Figure 1.2: Several out-of-plane rotated face detection results [3]

1.2 Problem Statement

In 3D object position, the captured images which are coming from the CCTV can be directly matched to the out-of-plane rotated detection with the flat plane. Hence, face movement position detection has become a challenge in determining their image details. As the face position is uncontrollable, the desired powerful algorithm is highly required to determine the match of someone identity with different facial positioning. As the rotated images are normally harder to detect compared to static images, the level of accuracy in the rotated image is decrement [3]. Hence, the SURF and SIFT algorithms are developed in detecting an object of interest and their performance are compared.

1.3 Objectives

1. To implement an algorithm for face detection using SURF and SIFT
2. To test an algorithm for face detection using SURF and SIFT
3. To evaluate the performance of time and the number of feature point detection using SURF and SIFT

1.4 Scope of work

1. Focus on research about face detection in SURF and SIFT methods by using MATLAB 2013 programming.
2. To use image capture by using camera which is input is the known out-of-plane face image and output is feature point detecting result. Analyses the facial image by

comparing their performance of time of feature point detect and the number of feature point detect. The matching of feature point will not cover in this project.

1.5 Expected project outcome

The expected project outcomes of this project are:

1. New Finding / Knowledge
    a. Image detection algorithm with ability to accurately out-of-plane rotated image detection
2. Research Publication in conferences and journal.

1.6 Thesis outline

This thesis consists of five chapters that have been outlined in the table of content. Chapter 1 will cover on the introduction of the project. A bit of explanation will be done in order to complete this project. It also presents the readers with objectives, problem statements, scope of works, and the thesis outlines of the project. Chapter 2 discusses about literature review. This section reviews on previous researchers work about SURF and SIFT from Institute of Electrical and Electronics Engineers (IEEE) journal, articles, book, technical paper and others. Chapters 3 cover the methodology of the project and describe the flow chart of project activities. The result and discussions will be reviewed in Chapter 4. This chapter will highlight the initial results achieved from data collection and simulation. Finally, the conclusion and recommendations on future research will be enlightened in Chapter 5.

CHAPTER 2

LITERATURE REVIEW

The literature review is some sort of review discusses on information in a specified area and sometimes a detail on a particular topic. A literature review will be a simple summarizing from the references, however generally has an organizational pattern and includes both summarizing together with the synthesis. A synopsis has been usually a recap from the importance of the references, although the synthesis is known as a re-organization, of researcher"s own idea. It might produce a brand new interpretation of past research material. (The Writing Center, 2012)

2.1 Theory and basic principles

In this section of this chapter, the literature review used in developing the facial detection will be discussed.

2.1.1 Digital Image Processing

A computer readable binary format consisting of logical 0s and 1s is converted from the pictures that are coming from digital images. Customarily, a video evolves with time and generally contains moving and/or transmuting objects, whereas by an image we mean a still picture that does not transmute with time. Digital format, albeit "direct digital"‟‟‟ systems is converted from continuous signals are becoming more prevalent to obtain the digital images. Diverse exhibit media is utilized to view the digital images that included digital printers, computer monitors, and digital projection contrivances [6].

In the other hand, a digital image is a 2D signal in essence, and is the digital version of the 2D manifestation of the authentic-world 3D scene. Although the world‟‟s picture and image are quite synonymous, the subsidiary distinction that „‟picture‟‟‟ is the analogue version of „‟image‟‟‟ is made. A function of two authentic variable is an image, for example, *a*(x,y) with *a* as the amplitude (e.g., effulgence) of the image at the authentic coordinate position (x,y). Sub images are considered contain an image, which is sometimes referred to as regions or regions of interest (ROIs). The amplitudes of a provided for picture will essentially dependably a chance to be whichever legitimate numbers or integers. The last will be generally those outcome of a quantization transform that proselytes a culprit extend (verbally express, the middle of 0 Furthermore 100%) with an discrete number about calibers [7].

2.1.2 MATLAB to Process an Image

An picture will be exactly a set about values sorted out in the manifestation of a grid. Since MATLAB is ideal for grid operations, it makes a plenty from claiming sense will use MATLAB for image-cognate operations. To a large portion of the preparing needs, those MATLAB"s image transforming toolmaker (images) will be used. Other than authentic-time procurement about images, this toolmaker need every last one of necessary executes on perform sundry geometric, arithmetic, logical, and also different higher gauge transformations on the pictures. The toolmaker will be also fit for taking care of both colours Furthermore grayscale pictures. However, a large portion of the image transforming will be focused looking into a grayscale pictures. Considerably for the shade images, the preparing may be completed on the changed over image, which may be gotten by mapping those RGB colour space under grayscale space [7].

In spite of the fact that structural similarity may be an incredible inspiration on use MATLAB for picture processing, there would a few different purposes behind completing along these lines. Practically scientists in the region of image transforming use MATLAB Similarly as their principle stage for product implementation, which therefore provides for a common dialect with look at distinctive calculations furthermore outlines. Withal, those speeds about sundry calculations might moreover make compared once a common platform, which might make laborious if distinctive individuals were using distinctive modifying dialects that fluctuate extensively as far as pace about operations. Another intriguing reason with use MATLAB, the majority fascinating with the individuals building understudies who don't relish plenitude about coding, may be the curtness for code previously in MATLAB. Table 2.1 compares a percentage samples from claiming rudimental operations in MATLAB what's more C similarly as a reference. Particular case cam wood envision from the examination how sensational those distinction will make to involutes operations for example, such that convolution, filtering, Furthermore grid reversal. Convolution may be the heart from claiming basically every one of the sifting what's more time furthermore recurrence web-domain transformations done picture processing, what's more must make finished as speedy likewise conceivable. Those MATLAB capacity conv() may be withal a standout amongst the

well-kept privileged insights of MathWorks and is those heart about these operations. Those work need been optimized to the grid operations and, hence, operations to MATLAB ended up additional speedy and more effective over coding to different dialects. [7].

Table 2.1: Comparison of MATLAB and C Code for simple Matrix Operation [7]

Operation	Part of Code	MATLAB statements

Addition of two matrices A and B	for (i= =1, i<=M, i++)
	{
	for (j= =1, j<=N, j++)
	{
	D [i] [j] = A [i] [j] + B [i] [j] ;
	{
	}
		D = A + B ;

Multiplication of two matrices A and B	for (i= =1, i<=M, i++)
	{
	for (j= =1, j<=N, j++)
	{
	for (c= =1, c<=N, c++)
	{
	for (r= =1, r<=M, r++)
	{
	D [i] [j] +=A [i] [c]*B [j] [r] ;
	}
	}
	}
	}
	}
		D = A * B ;

There is a restraint of the convenience about MATLAB. In spite of the fact that it will be wondrous to algorithm testing, it is not altogether lucky for ongoing imaging requisitions because of the gradualness about transforming. This gradualness emanates starting with a greater amount levels for accumulation Furthermore translation contrasted with alternate languages, and also from iterative methods the place loops are used every now and again over authentic-world requisitions. The best result might make on test those rationales Also calculations clinched alongside MATLAB initially since this will support the introductory

advancement pace. Once those algorithms may be finalized, it ought to a chance to be translated under C's et cetera aggregated under an executable document for authentic-time alternately close authentic-time requisitions.

2.1.3 Face Detection

Face identification will be performed predicated on the idea of meager organize for Winnows (SnoW). SnoW may be an taking in building design what's more will be used to consigning different classes. It may be concretely customized to enormously titanic scale taking in errands also for domains for which the number for characteristics taking piece in choices may be prodigiously what's more sizably voluminous. SnoW need been utilized prosperously on an assortment for sizably voluminous scale taking in errands clinched alongside domains similar to those common dialect processing, visual transforming furthermore numerous others. For routine SnoW predicated face identification the characteristics used to transfer need aid the animated pixel intensities inside the hopeful district. Pixel power toward every area (x, y) may be communicated done boolean qualities concerning illustration demonstrated over Figure 2.1. [8].

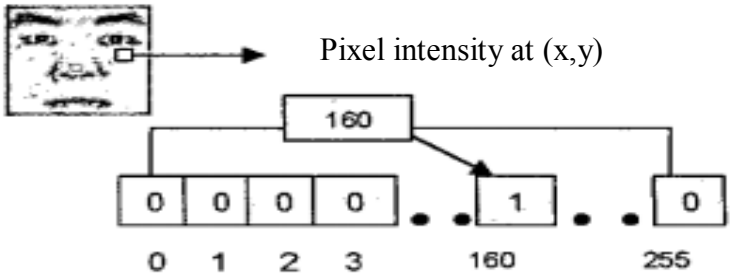


Figure 2.1: Active pixel representation [8].

2.1.3.1 Integrated skin extraction and face detection

Many colour spaces have been utilized in segmenting skin regions in colour images. Literature survey shows that the YcbCr colour space is one of the prosperous colour spaces in segmenting the skin colour accurately, mainly because the chrominance components are virtually independent of luminance component in the space. Although skin colour vary from person to person and they incline to get clustered into a compact region in CbCr space. So the skin colour distribution information in a human face can be utilized as a supplemental feature in relegating the objects into faces and non faces. Chrominance blue component is more prominent around the ocular perceivers in a human face and at the same time the Cr component is less. The chrominance red is more prominent in the mouth area. This information which is typical to human face is withal integrated as a feature in relegation process. This ameliorates the precision of the detection method in colour images at the same time reduces the mendacious positives at marginal increase in computational involution. Figure 2.2 shows the distribution of Cr pixels at the ocular perceiver region and the mouth region in a human face [8].

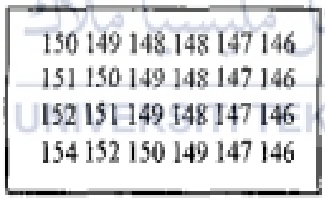


Figure 2.2 (a): Cr values around the eye [8]

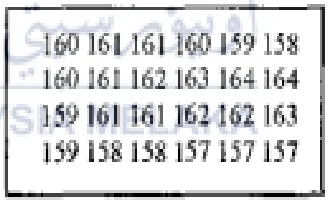


Figure 2.2(b): Cr values around the mouth region [8]

2.1.4 SURF and SIFT for facial detection

2.1.4.1 SURF Detector

SURF, additionally kenned as approximate SIFT, employs integral images and efficient scale space construction to engender keypoints and descriptors very efficiently. SURF uses two stages namely keypoint detection and keypoint description. In the first stage, rather than utilizing DoGs as in SIFT, integral images sanction the expeditious computation of approximate Laplacian of Gaussian images utilizing a box filter. The computational cost of applying the box filter is independent of the size of the filter because of the integral image representation. Determinants of the Hessian matrix are then used to detect the keypoints. So SURF builds its scale space by keeping the image size the same and varies the filter size only [9].

2.1.4.2 SIFT Detector

The SIFT detector has four main stages namely, scale-space extrema detection, keypoint localization, orientation computation and keypoint descriptor extraction. The first stage uses Difference of Gaussians (DoG) to identify the potential keypoints. Several Gaussian blurred images at different scales are engendered from the input image and DoGs are computed from neighbours in scale space. In the second stage, candidate keypoints are located by finding extrema in the DoG images that are locally extremal in space and scale. Spatially unstable keypoints are eliminated by thresholding against the ratio of eigenvalues of the Hessian matrix (unstable edge keypoints have a high ratio, and stable corner keypoints have a low ratio), low contrast keypoints are eliminated and the remaining keypoints are 11ocalized by interpolating across the DoG images. The third stage assigns a principal orientation to each keypoint. The final phase computes a highly distinctive descriptor for each keypoint [9].

2.1.5 Formula for Facial Detection using SURF and SIFT

2.1.5.1 SURF

SURF uses the Fast Hessian detector. It derived from the determinant of Hessian matrix at scale σ as follows:

$$H(x, y, \sigma) = \begin{bmatrix} Ixx(x, y, \sigma) & Ixy(x, y, \sigma) \\ Ixy(x, y, \sigma) & Iyy(x, y, \sigma) \end{bmatrix} \quad [2] \ (2.1)$$

In SURF, simple box filters will be utilized as the approximation of the convolution of second order Gaussian smoothed image derivatives, as shown in Figure 2.3. Thus the box filters can be computed in constant time utilizing the integral image. The approximate determinant of Hessian matrix yields

$$Det[H(x, y, \sigma)] \approx DxxDyy - (0.912Dxy)^2 \quad [2] \ (2.2)$$

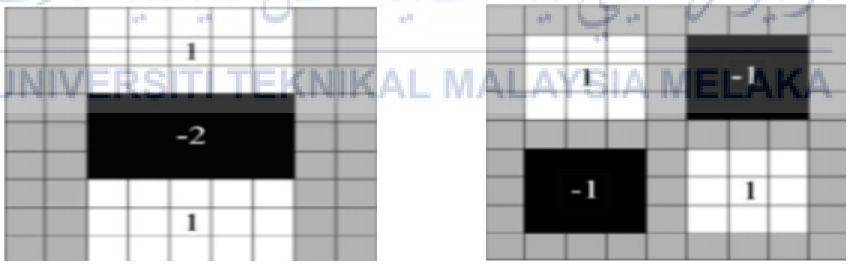


Figure 2.3: Box filters used by Fast Hessian as approximations to second order derivatives of Gaussians [2]

2.1.5.2 SIFT

In feature detection stage, SIFT algorithm proposed to detect local extrema of the image filtered with differences of Gaussians (DoG). The convolution of the input image with a variable-scale Gaussian will engender the scale-space of an image *L(x,y,σ)*. The differences of Gaussian are calculated as follows:

$$D(x, y, \sigma) = L(x, y, k\sigma) - L(x, y\sigma) \qquad [2] (2.3)$$

Figure 2.4 shows the keypoint descriptor"s computation. The image gradient orientations and magnitudes are sampled around a keypoint, by utilizing the scale of the keypoint to cull the caliber of Gaussian blur for the image. The gradients are then pre-computed for all levels of pyramid as illustrated as minuscule arrows on the left side.

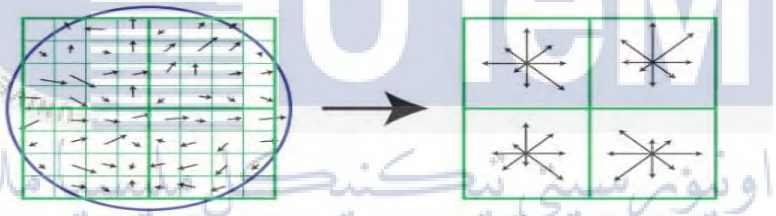


Image gradient Keypoint descriptor

Figure 2.4: A 2x2 array of descriptor determined from an 8x8 set of samples [2]

2.2 Review of previous related works

An alternative approach using SIFT and SURF is presents in [2], where it focus in on performance evaluation between the steady and existing feature detectors and descriptors named SIFT and SURF in detecting and matching features. The visual odometry is a real time process hence, the feature detection and matching should be fast to compute. However, the result shows that SURF is outperform than SIFT in term of rate of matched points and also in computational time.

In the other hand, another approach that using SIFT and SURF is presents in [4], where the paper focus on analysis and comparison of feature detection and matching algorithms for rovers vision navigation. The result shows that SIFT can extract a great deal features and has the highest correct matching rate, but also has the longest computing time. SURF is much faster than SIFT, simultaneously having the same performance, which is the best approach considering comprehensive performance.

Besides, in [10], the method also focuses on evaluation of SIFT and SURF features in the Songket Recognition. The matching score and distance measure and number of key point, are evaluated corresponding with the SIFT and SURF method. Hence, result shows that SIFT method has been better than SURF method in term of key point detection, but SURF has been extremely faster than SIFT in term of matching time.

2.3 Summary and discussion of the review

The incrementing consequentiality of image analysis has magnetized numerous researches work. Research with out-of-plane rotated object detection, however is still destitute. Many subsisting techniques up to now that have been developed algorithms with the subsistence of robust object detection engender inaccuracy that requires to be ameliorated. The system consists of development stages to reduce the region in camera image, followed by face detection by utilizing SIFT and SURF method. Hence in this research a perspicacious system for face detection that interoperated several different algorithms is proposed in order to yield more preponderant precision performance. Finally, the detection rate of out of plane rotated face detection will be counted to reduce mendacious positive images to analyse its precision performance. Table 2.2 shows the summary of previous research.

Table 2.2: Summary of previous research

Authors	Title	Year	Methods	Results
N.m. Suaib, M.H. Marhaban, M.I. Saripan,and S.A Ahmad	Performance Evaluation of Feature Detection and Feature Matching for Stereo visual Odometry Using SIFT and SURF	2014 IEEE	SIFT and SURF	SURF is outperform than SIFT in term of rate of matched points and also in computational time
X. Bai, X. Ning, and L. Wang	Analysis and Comparison of Feature Detection and Matching Algorithms for Rovers Vision Navigation	2012 IEEE	Harris, SIFT and SURF	Harris has the highest execution efficiency, while its false match rate is higher in large scale changes. SIFT can extract a great deal features and has the highest correct matching rate, but also has the longest computing time. SURF is much faster than SIFT.
D. Willy, A. Noviyanto, and A. M. Arymurthy	Evaluation of SIFT and SURF Features in the Songket Recognition	2013 IEEE	SIFT and SURF	SIFT method has been better than SURF method, but SURF has been extremely faster than SIFT

CHAPTER 3

RESEARCH METHODOLOGY

Methodology is the method used throughout the study and is conducted to obtain data and information as possible to meet the original objectives of the study.

3.1 Principles of the methods or techniques used in the previous work

This section briefly explain the principle of operation of SIFT and SURF. The selected approach or technique used in developing out-of-plane facial detection will be discussed. The techniques used in developing facial detection are SURF and SIFT method.

SIFT detect paramount point in a very different image, scale and rotation invariant, and relatively invariant to lighting. SIFT calculated as follows. First, points of intrigues are examined more scalable representation and image space difference in the Gaussian function is utilized to identify fascinating things, which do not vary with scale and orientation. Points of interest are subject to 3D quadratic function to determine the location and scale. The main points of each assigned to one or more depending on the orientation on local image gradient directions around this paramount point and that is very different 128-bit descriptor is calculated [11].

SURF utilizes a novel scheme for the detection and description, which mainly fixate on reducing the computational time. Integral image is calculated and points of interest are

derived predicated on Hessian matrix approximation. Utilizing scale space representation, points of interest examined more several scales and levels. Translation is carried out utilizing interpolation space. This is paramount because some fascinating things in and turn on the layer of different scales are immensely colossal. The parser built utilizing content distribution intensity the points of interest. SURF utilizing distribution first order Haar wavelet replications in both x and y direction. Additional measures are predicated indexing Laplace mark to increment the robustness and matching speed [11].

3.2 Overview

Project methodology can be defines as the flow of the planning process and guide to producing a good planning project. Besides, the project methodology selected will describe the activities that have taken at all levels. Hence, the planning of steps or flow is very important in order to achieve this project. Without a smart flow, the project will not success properly and may cause repetition. For this project, there are several methods has been used such by theory and simulation and flowchart. The theory methods is getting the journal or conference paper and also from the books to collect the information about the research, while the simulation is by using the MATLAB software.

For the information, the data of facial images collected are student from FKE. Ten students have been chosen from different brightness of skin color scaled from one to ten. The first stage is to insert of facial images of ten students with different brightness of skin color and angle into a database. The size of collections of the image will be constant to (100x100). Then the second stage is software implementation. Here, the MATLAB software is used to construct code in order to fulfill the objective. The facial image will be extracted using SURF and SIFT and the algorithm will be developed. After that, the algorithm must be run or test to make sure there is no error. If there is error happens, the algorithm will not be able to run. This is the fourth step for testing the algorithm. The final step is performance evaluation. The process is done when the time for detect feature point and number of feature points detect is evaluated using SURF and SIFT.

3.3 Modelling and Simulation Implementation

Each step was illustrated in flow chart to more clearly about the activities during developed this project. Every stage of the flow chart was explained. The Figure 3.1 shows the stage for developing the facial detection using SURF and SIFT method.

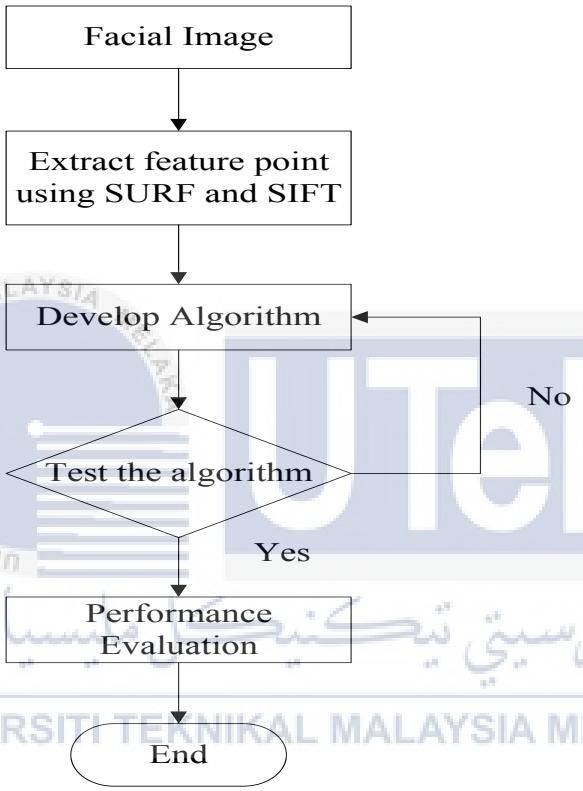


Figure 3.1: Overview of the proposed facial detection method

3.4 Data Collection

The facial images are collected of ten students with different brightness of skin colour and angle by using a mobile phone. The following constructs are used for data collection:

- Place: Outdoor
- Camera Resolution: 5MP

- Expression: Normal/Smile

Using the above constructs five images for each subject was captured. Figure 3.2 below shows the training image that has been used in this project scaled from one to ten according the brightest and the darkest with different pose of angle.

Figure 3.2 : The training image

After the data collection, the image sizing is done by cropping the images and fixed the image size to 100 by 100 and converting them to grayscale (2D image) from RGB (3D image). From all the images are captured "Test set" contain total of 50 facial images to test.

For face detection, the main function of this stage is to determine whether feature points appear in a given facial image, and where these points are located at. The expected outputs of this stage are each face containing the feature point of SURF or SIFT. If the feature point is larger than five, then the box rectangle will appear on the facial image to detect face.

The operation of descriptor extraction, the first square locale was based on the interest focuses and orientated along the introduction of interest focuses. The square area was part up to consistently into 4 × 4 square subregions. For every subregion, Haar wavelet channels are utilized to channel each example point at x and y-heading. At that point, the reactions at x and y-course are summed up over every subregion. To build the uniqueness, without a doubt the estimations of reactions at x and y-heading are summed up over every subregions once more. In this way, the descriptors are shaped by 4 × 4 × 4 = 64- dimensional vectors. After a considerable measure of trials, Haar wavelet reaction indicates great execution in enlightenment change, yet it has not great execution in turn. Since Haar wavelet channel is rectangle channel, it is not entirely obvious some particular and less unmistakable. For the reason, a circle is removed around interest focuses. Examples of such circles are shown in Figure 3.3. The separated circle is sifted by Gaussian channel in mathematical equation state in literature review for SURF.

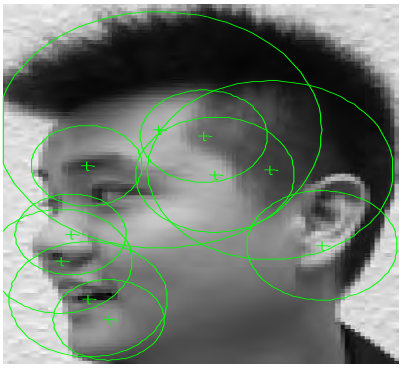


Figure 3.3 : The size of circles at different scales

The circle is part up frequently into littler 2 × 2 subregions along the introduction of interest focuses. A sample is represented in Figure 3.4.

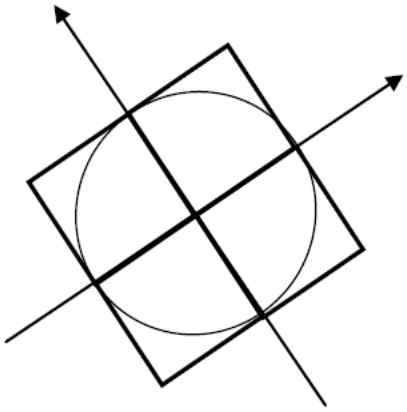


Figure 3.4 : The 2 × 2 subregions (the direction along the orientation of interest points) [12]

In SIFT, The descriptor is framed by summing eight qualities for every pixel. For instance, a subregion has 4 pixels and each pixel has eight qualities, wholes 4 pixels all the worth in diverse course in Figure 3.5. In this way, one piece of descriptor is shaped by the total of this subregion in diverse heading. Some details in pixels in the circle are shown in the Figure 3.6.

Figure 3.5 : Feature point in diverse course

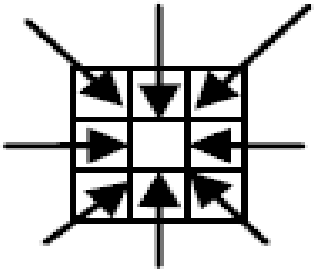


Figure 3.6 : The influence in pixel‟s neighbourhood [12]

CHAPTER 4

RESULT & DISCUSSION

This chapter will include the result and analysis of the project. Besides that, the results were directly corresponding to the objective of the project, which has been stated in the chapter 1.

4.1 Simulation Result

Two technique are used for comparison purposes which are SURF and SIFT. The facial image containing 50 images for 10 persons with 5 images per person. There are different brightness of skin colour and pose angle for each subject. The image size is 100×100 pixels. This section only show the best result for the performance of time and the number of feature point detection using SURF and SIFT. In term of time of feature point detection, Table 4.1 shows sample 6 of facial images for SURF which is faces with SURF features shown as crosses and circle. While Table 4.2 to shows sample 6 of facial images for SIFT which is faces with SIFT features shown as crosses. In the other hand, in term of number of feature point detection, Table 4.3 shows sample 5 of facial images for SIFT while Table 4.4 shows sample 5 of facial images for SURF. The other results for the performance between SURF and SIFT can be illustrated as in the appendices.

Table 4.1 : Sample 6 for SURF technique

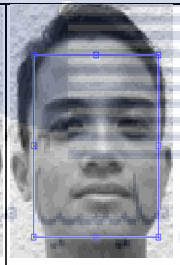
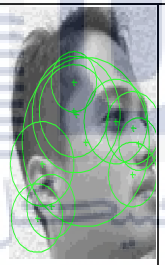
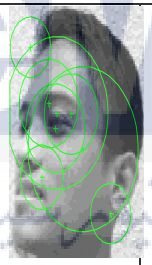
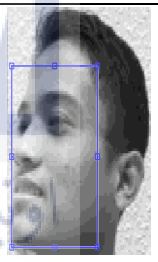
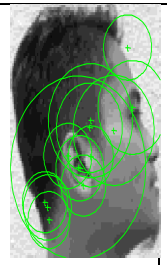
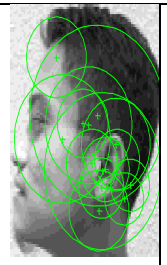
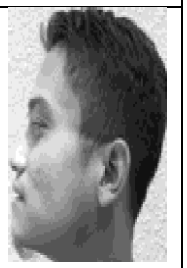
Angle (°) / Parameter	0	45	-45	90	-90
	 	 	 	 	 
Time (Sec)	0.252554	0.203515	0.109264	0.045809	0.200059
Total Number of feature point detect on image	16	11	8	12	14
Total number of feature point detect on face	16	7	7	2	3

Table 4.2 : Sample 6 using SIFT technique

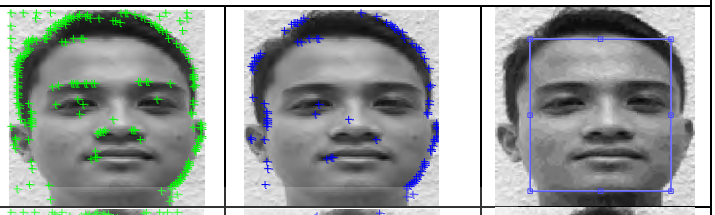
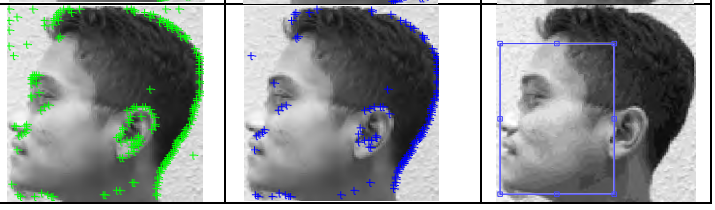
Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.415696	120	52	
45	0.413596	117	42	
-45	0.546588	199	64	
90	0.428200	130	45	
-90	0.429816	136	20	

Table 4.1 shows sample 6 for SURF technique and Table 4.2 shows Sample 6 using SIFT technique. Comparison between both techniques will be compared with the performance at 90 degree for time of feature point detection. The performances include the maximum and minimum values of simulation result. From the comparison, the performance of the SIFT technique is bad which is 0.428200 seconds because the time taken for detect feature point of the facial image is very long. But, the performance of SURF technique is very good which is 0.045809 seconds because the time taken for detect feature point of the facial image is very short. Among the sample, sample 6 at 90 degree shows the fastest time for feature point detection for SURF and the slowest time for feature point detection for SIFT. So, it is clear that time of feature point detect for SURF is faster than the time of feature point detect for SIFT.

Table 4.3 : Sample 5 using SIFT technique

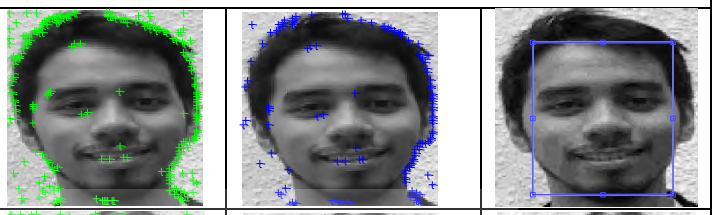
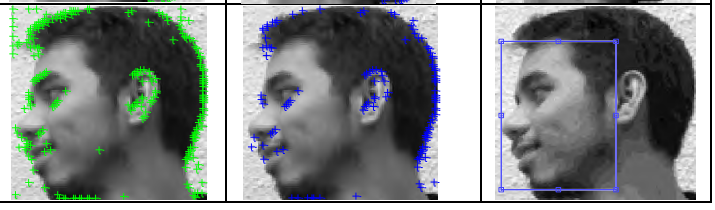
Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature on face	Image
0	0.458782	144	43	
45	0.453728	134	65	
-45	0.597625	189	57	
90	0.380210	130	94	
-90	0.448738	140	39	

Table 4.4 : Sample 5 for SURF technique

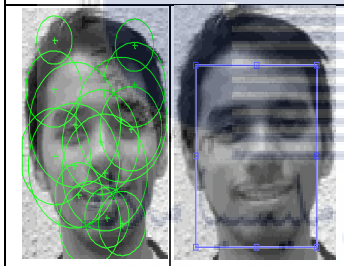
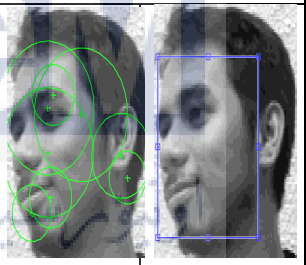
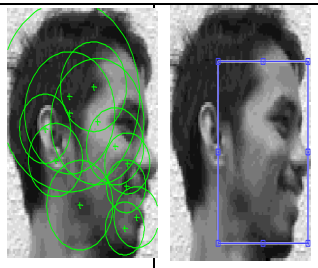
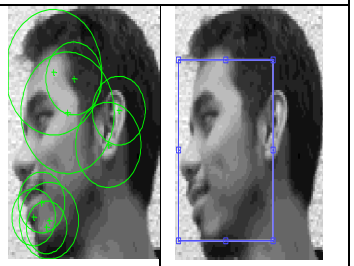
Parameter \ Angle (°)	0	45	-45	90	-90
					
Time (Sec)	0.117416	0.156218	0.106691	0.145059	0.115572
Total Number of feature point detect on image	15	12	8	12	9
Total number of feature point detect on face	13	9	6	7	6

Table 4.3 shows sample 5 for SURF technique and Table 4.4 shows Sample 5 using SIFT technique. Comparison between both techniques will be compared with the performance at 90 degree for number of feature point detection. The performances include the maximum and minimum values of simulation result. From the comparison, the performance of the SURF technique is bad which is 7 because the number for detect feature point of the facial image is low. But, the performance of SIFT technique is very good which is 94 because the number for detect feature point of the facial image is very high. So, it is clear that SIFT is the best for accuracy because SIFT technique can detect more feature point than SURF technique.

4.2 Performance evaluation

In order to assess the time of feature point detect an image, several experiments were performed using SURF and SIFT features. Figure 4.1 shows the results for performance in term of time of feature point detection.

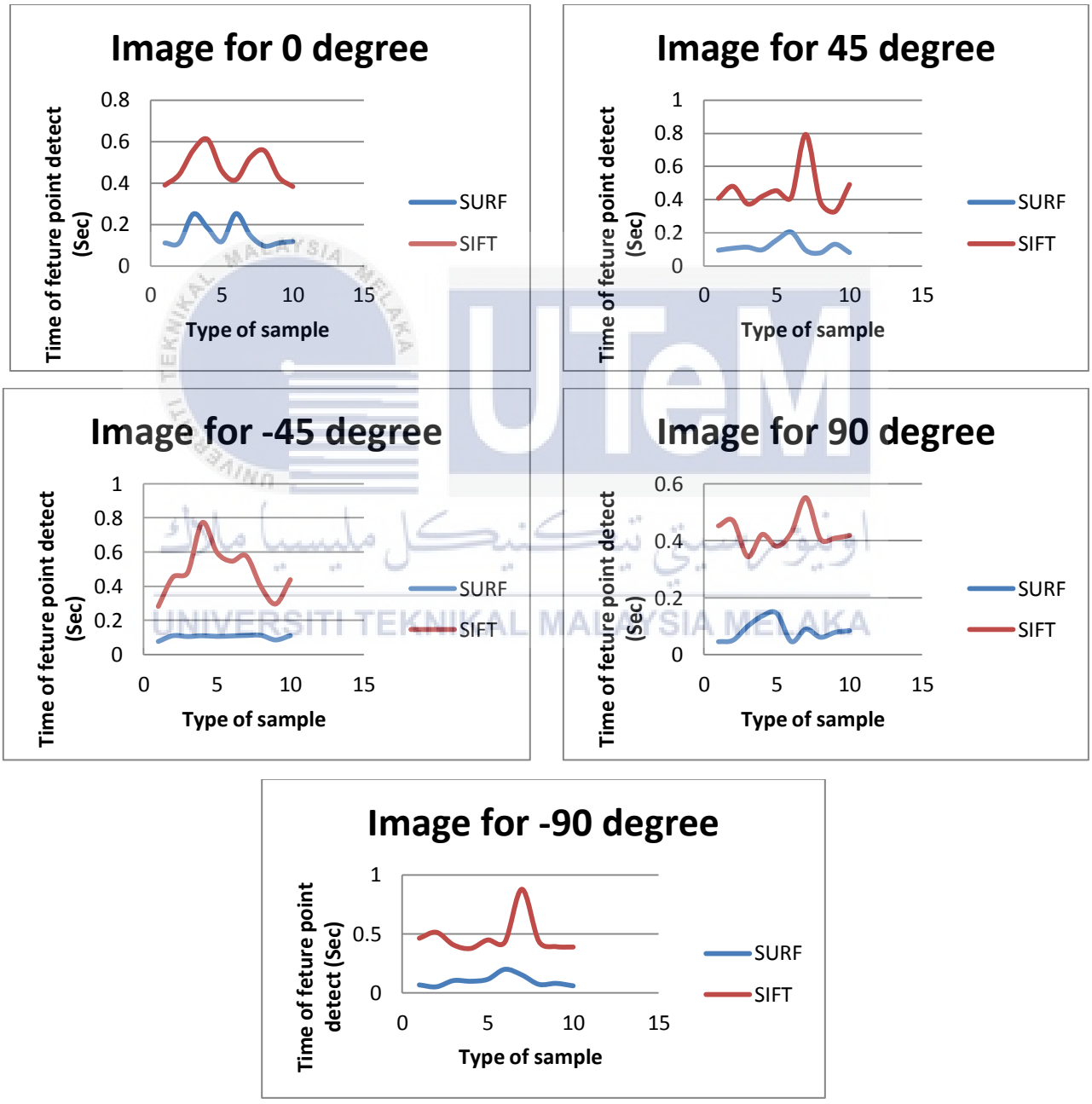


Figure 4.1 : The results for performance in term of time of feature point detection

The performance of the time of feature point detect was compared between SURF and SIFT with the different brightness of skin colour and pose angle. It is clear that time of feature point detect for SURF is faster than the time of feature point detect for SIFT. The types of sample and different of pose angle in this experiment not influence the time taken to detect the feature point. This is because from the Figure 4.1, it is clear that the sample 1 which is the brightest and sample 10 which is the darkest have fluctuated graph. Overall it can be see that SURF is faster than SIFT in term of time of feature point detected. This is because SURF uses Haar wavelet and it is the fastest feature detector and descriptor.

In the other hand to assess the number of feature point detect an image, several experiments were performed using SURF and SIFT features. Figure 4.2 shows the results for performance in term of number of feature point detection.

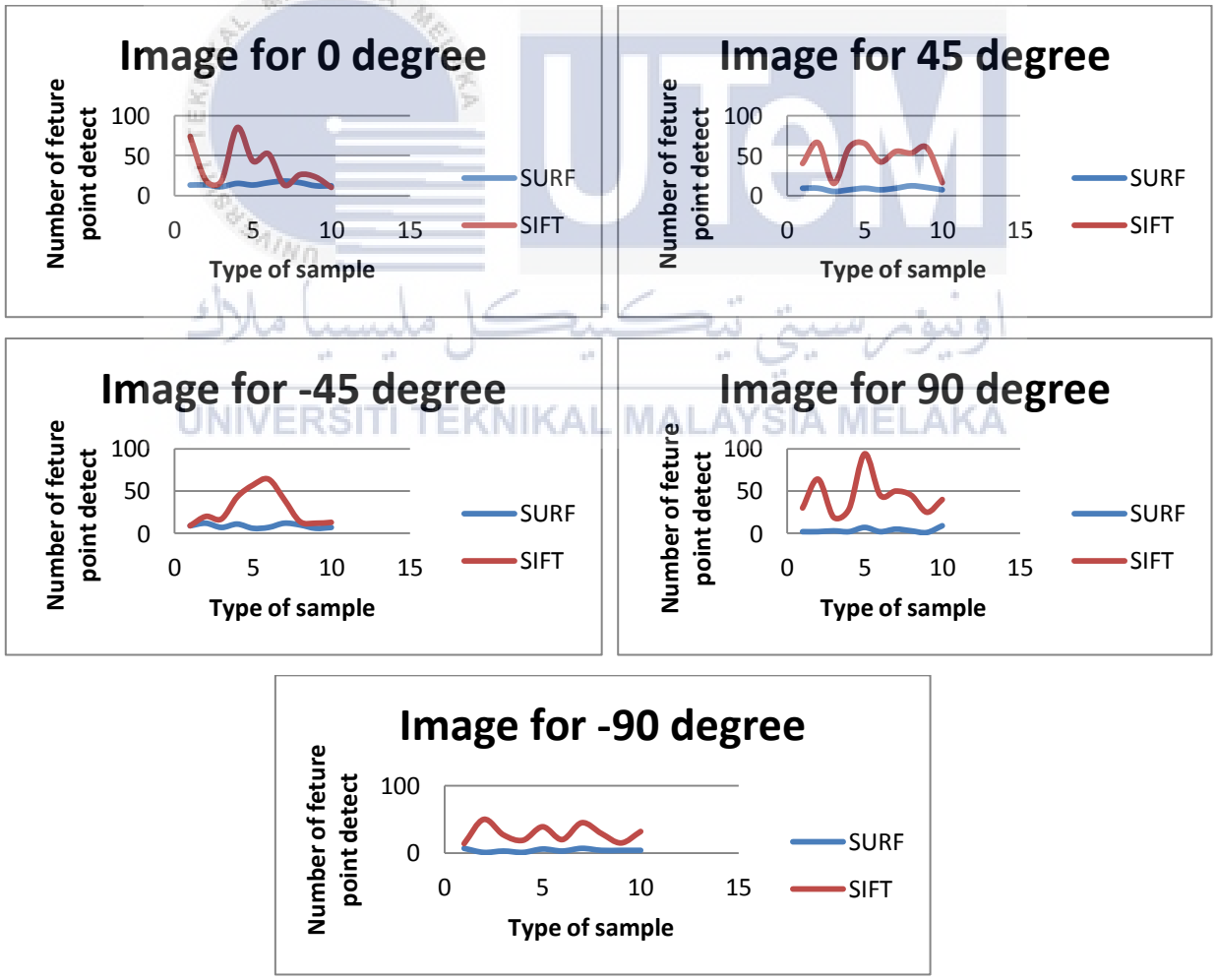


Figure 4.2: The results for performance in term of number of feature point detection.

SURF is seemed to get confused in textured images with different brightness of skin colour and pose angle. Because of this, it did not have its best performance in detect feature point. The image with most features detected by SURF was the corresponding second one for SIFT because of less feature detection occurred. This proves that SURF being texture-based algorithms, do not perform well when tested on planar images.

. SIFT detected the most feature points on image. This was expected because of the large amount of texture of facial image. This can be also checked by looking at the results for the other images. SIFT is not a good tool to check similarity of images with different brightness of the skin colour. This can be seen from observing the results as feature point an outdoor image came out to be only 94 feature point which is the highest value for medium brightness of the skin colour. Hence, SIFT is the best for accuracy because SIFT detected the most feature points on image.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

As a conclusion, the performance comparison of out-of-plane facial detection using SURF and SIFT had achieve the objectives which are to implement an algorithm for face detection using SURF and SIFT as well as to test an algorithm for face detection using SURF and SIFT. The performance of time and the number of feature point detection using SURF and SIFT are evaluated. From the research, it can be concluded that by computing image processing toolbox as the sensing element in MATLAB, can carry out various type of application such as for image detection. By doing more study about image processing will produce a better result and by computing efforts, more complex problem may settle.

As a recommendation, the comparison of performance out-of-plane face detection can be more effective by eliminating the unwanted images. Besides that, do additional researches for the out-of-plane facial image with different type of skin colour and pose of angle. Lastly, others method instead of feature description (i.e.: HAAR) can also be applied.

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APPENDIX A

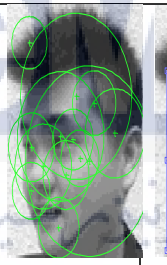
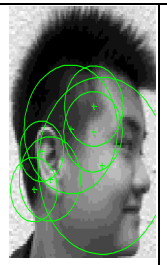
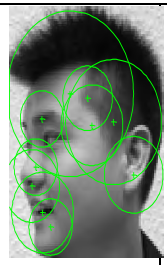
Project Gantt chart and key milestones

No	Task	2014				2015					
		Sept	Oct	Nov	Dec	Jan	Feb	Mac	Apr	May	Jun
1	Choose title -Prepare chapter 1										
2	Literature review -Study the past related project in journal and reference book.										
3	Methodology										
4	Result - Development algorithm.										
5	Report FYP 1 and FYP 2 preparation -Submitted the report FYP 1 and FYP 2										
6	Testing the algorithm.										
7	Evaluate the system performance -Analysis the result										
8	Final report preparation -Submitted the final report										

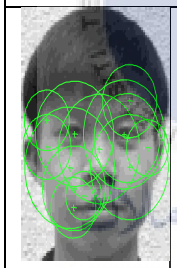
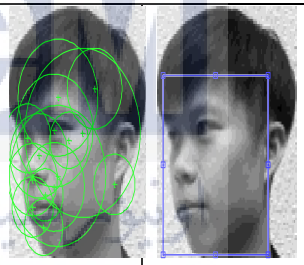
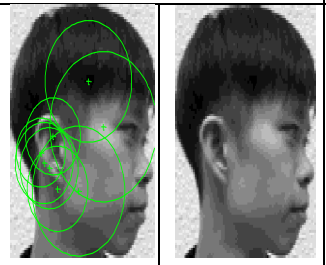
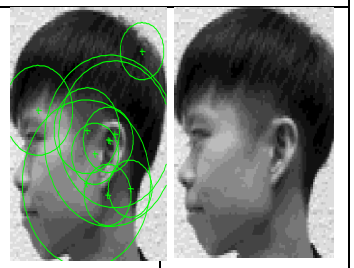
No.	Task	Date
1.	To complete and collect faces image through camera	Jan 2015
2.	To complete develop algorithm of the system	May 2015
3.	To complete project and performance analysis of the system	Jun 2015

APPENDIX B

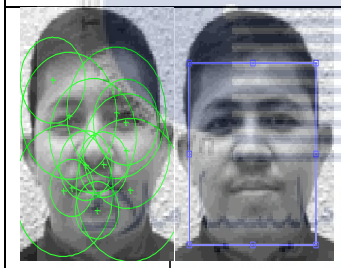
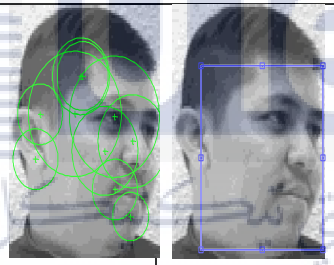
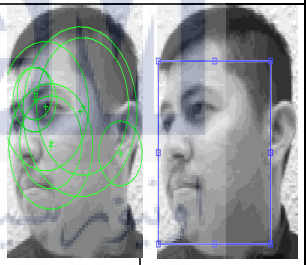
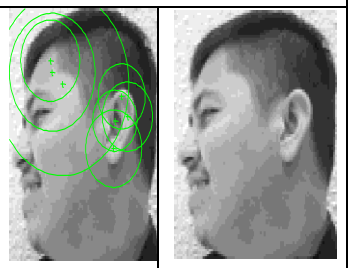
Sample 1 for SURF technique

Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.110710	0.094475	0.076744	0.045273	0.068036
Total number of feature point detect on image	13	11	13	7	10
Total number of feature point detect on face	13	9	9	2	7

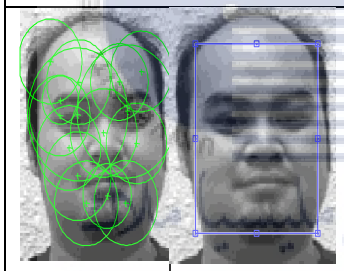
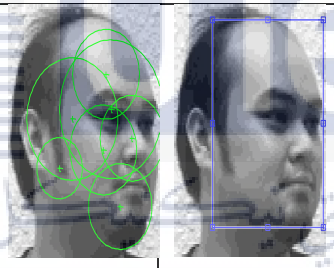
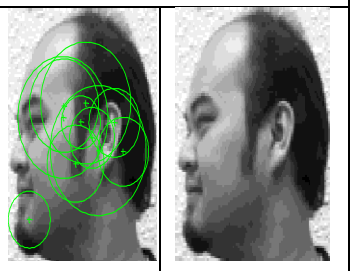
Sample 2 for SURF technique

Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.110722	0.106545	0.110555	0.050512	0.052007
Total Number of feature point detect on image	13	11	14	8	10
Total number of feature point detect on face	13	9	12	2	1

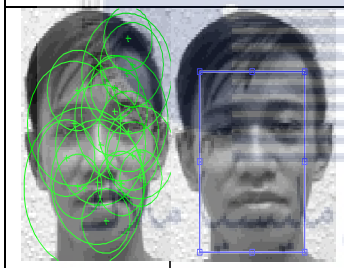
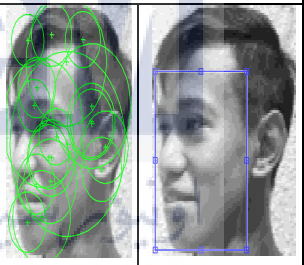
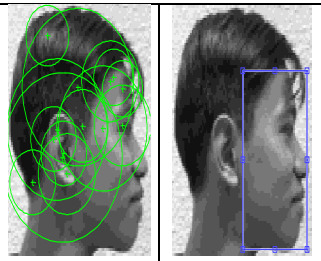
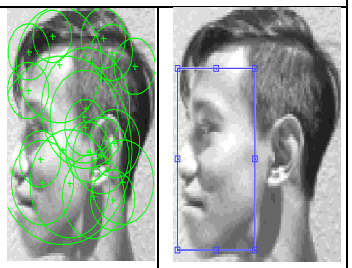
Sample 3 for SURF technique

Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.250767	0.112589	0.105763	0.099318	0.104841
Total Number of feature point detect on image	11	8	8	7	7
Total number of feature point detect on face	11	5	7	3	3

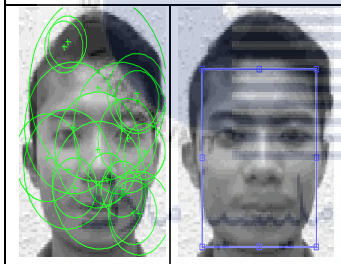
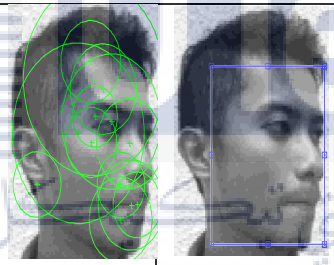
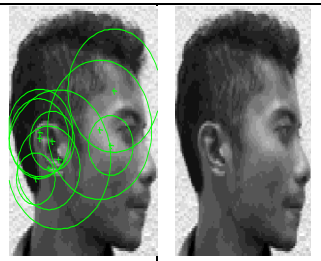
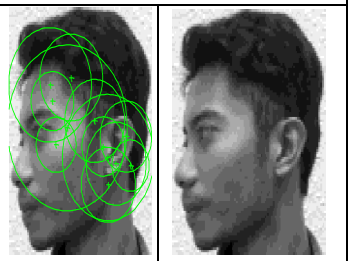
Sample 4 for SURF technique

Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.183334	0.097130	0.110369	0.135325	0.098981
Total Number of feature point detect on image	15	7	14	9	10
Total number of feature point detect on face	15	7	11	2	1

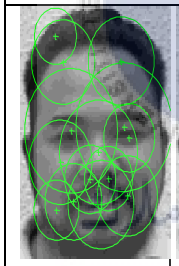
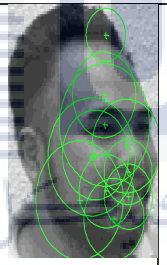
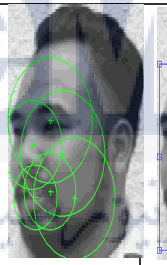
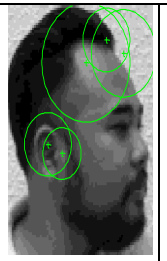
Sample 7 for SURF technique

Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.147624	0.093759	0.111953	0.089748	0.152514
Total Number of feature point detect on image	19	13	20	15	20
Total number of feature point detect on face	18	9	12	5	7

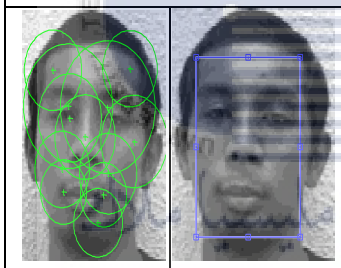
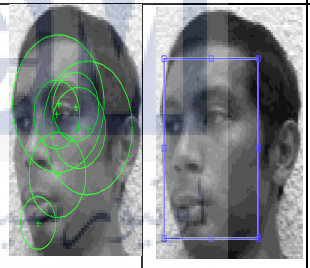
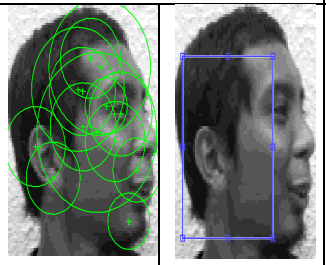
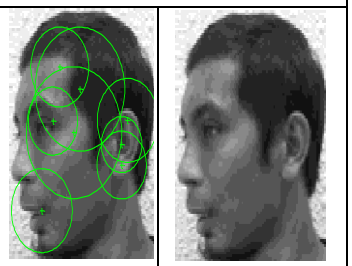
Sample 8 for SURF technique

Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.096090	0.078979	0.112802	0.060932	0.072455
Total Number of feature point detect on image	18	13	11	9	12
Total number of feature point detect on face	16	12	10	3	4

Sample 9 for SURF technique

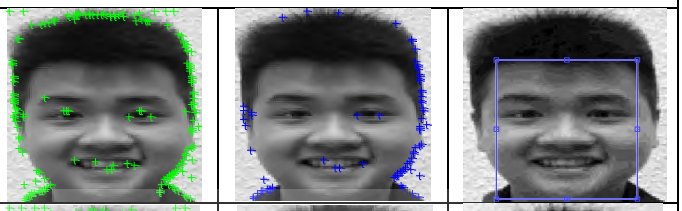
Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.110603	0.130794	0.085863	0.077857	0.080930
Total Number of feature point detect on image	13	11	6	5	9
Total number of feature point detect on face	12	10	6	1	4

Sample 10 for SURF technique

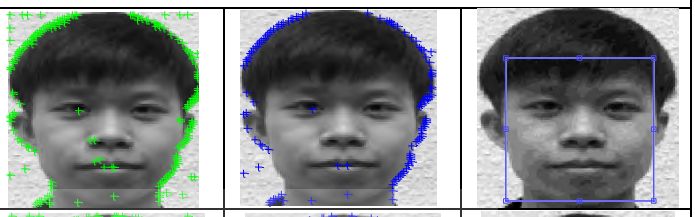
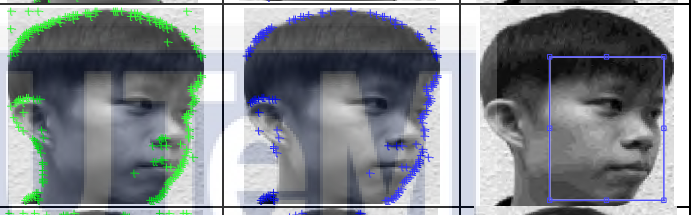
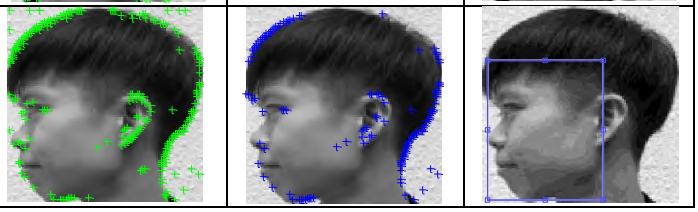
Angle (°) / Parameter	0	45	-45	90	-90
					
Time (Sec)	0.117803	0.080517	0.111035	0.083885	0.060215
Total Number of feature point detect on image	12	10	7	13	12
Total number of feature point detect on face	12	7	7	9	4

APPENDIX C

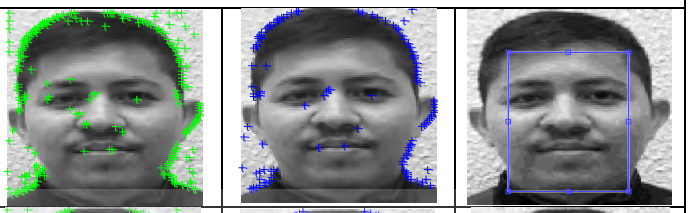
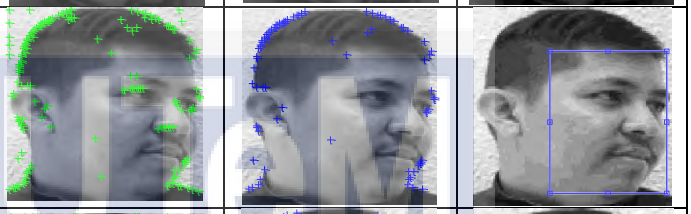
Sample 1 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature on face	Image
0	0.389804	74	26	
45	0.407366	93	40	
-45	0.282239	68	9	
90	0.452147	92	30	
-90	0.463572	97	14	

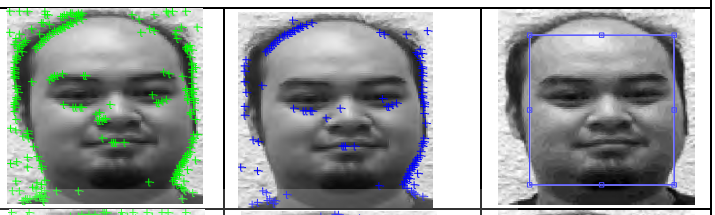
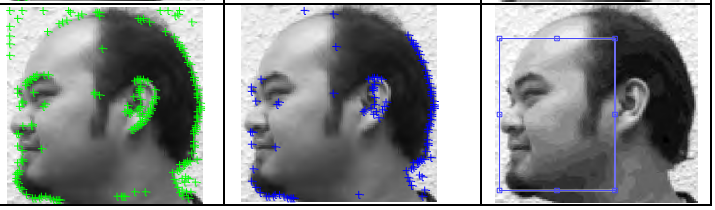
Sample 2 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.440859	113	19	
45	0.479955	140	66	
-45	0.453640	117	20	
90	0.469923	127	64	
-90	0.513529	142	50	

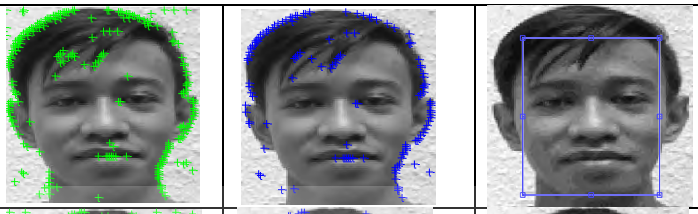
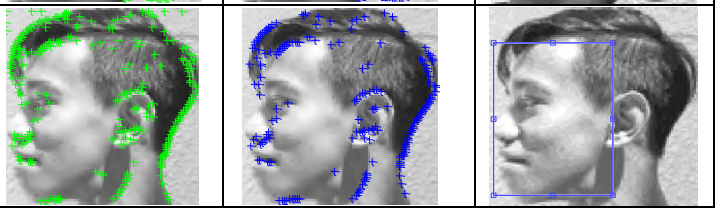
Sample 3 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.559087	117	18	
45	0.373579	84	15	
-45	0.479951	135	17	
90	0.343927	83	19	
-90	0.406887	124	27	

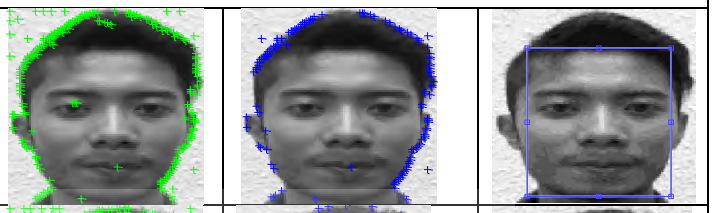
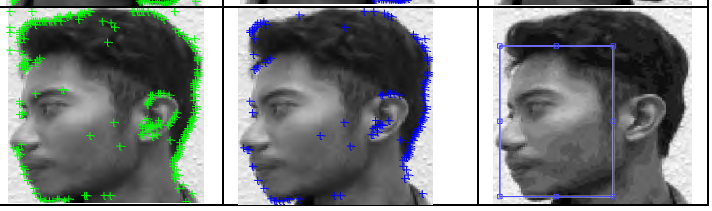
Sample 4 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.610540	117	85	
45	0.419626	106	60	
-45	0.772574	135	43	
90	0.421869	113	29	
-90	0.376870	104	19	

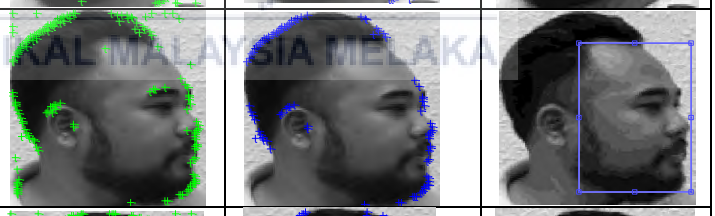
Sample 7 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.523050	184	13	
45	0.793336	193	55	
-45	0.577045	130	40	
90	0.550957	127	50	
-90	0.878641	199	45	

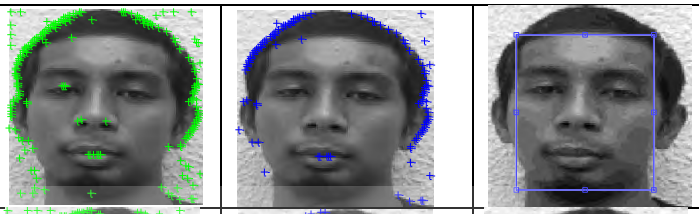
Sample 8 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.556169	151	26	
45	0.387096	103	53	
-45	0.397087	114	14	
90	0.405957	130	45	
-90	0.435100	143	29	

Sample 9 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.428968	135	23	
45	0.327297	111	60	
-45	0.296364	109	12	
90	0.408912	121	25	
-90	0.392169	119	15	

Sample 10 using SIFT technique

Angle (°)	Time (Sec)	Total number of feature point on image	Total number of feature point on face	Image
0	0.382863	159	10	
45	0.491311	163	16	
-45	0.438409	110	13	
90	0.418242	107	40	
-90	0.388828	130	32