DEVELOPMENT AND ANALYSIS OF FACE RECOGNITION SYSTEM ON A MOBILE ROBOT ENVIRONMENT

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I declare that I have read through this report entitled “Development and analysis of face recognition system on a mobile robot environment: and has found that it has comply with the partial fulfillment for awarding the degree of Bachelor of Mechatronics Engineering

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Name : …….

Date : …….

To my beloved mother and father

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ABSTRACT

Surveillance technologies has become more and more common especially in household due to its versatility and applicability however traditional surveillance technology such as the CCTV camera suffers from its traditional problems such as having blinds spots around the area outside of the camera. Many approaches has already been made to solve said issue mainly by giving multiple degree of freedom but it is clear that some levels of said problems still maintain thus our approached in solving said issue is mobilizing said camera itself and giving it face recognition abilities. However, the main problem with this idea is that face recognition algorithm although extensively developed is done almost exclusively on a static base thus its performance in terms of accuracy and speed of detection on a mobile environment is mostly unknown. The main difference between static and stationary is the effect of blur which is a form of noise usually ignored due to the stationary state of the camera. Said blur can cause issues especially when it comes to doing detailed feature analysis such as face recognition because the blur would increase the size of the boundary line causing camera to may or may not detect the face at all or detect it as something entirely alien. Thus from this it is safe to hypothesize that the performances of said face recognition algorithm may it be eigenvalues or fisherface weight map's performance would differ negatively when comparing its results of a static base to a mobile base and to prove it, we have run performance analysis in terms of range of capture for face identification and recognition by moving the robot while trying to identify faces at different duty cycles. The results from this research shows that when there is an increase in mobile robot speed from 0 ~ 65% duty cycle there seem to be a reduction in performance in terms of range of capture of approximately 30% for both face recognition and face identification which is a clear reduction in performance.

ABSTRAK

Teknologi pengawasan telah menjadi sesuatu kebiasaan terutama di dalam rumah tangga kerana keserba bolehannya tetapi system pengawasan tradisional seperti kamera CCTV akan mengalami masalah tradisional seperti mempunyai jurang penglihatan yang terhad. Banyak pendekatan telah dibuat untuk menyelesaikan isu berkata terutamanya dengan memberi pelbagai darjah kebebasan tetapi ia adalah jelas bahawa masalah yang dihadapi masih gagal diselesaikan, oleh hal demikian, idea utama project ini untuk menyelesaikan masalah ini adalah dengan memberikan system pengawasan kebolehan untuk bergerak dari tempat ke tempat. Walau bagaimanapun, masalah utama dengan idea ini adalah bahawa algoritma pengecaman wajah walaupun berkembang pesat dilakukan hampir secara eksklusif pada asas statik itu prestasinya dari segi ketepatan dan kelajuan pengesanan pada persekitaran yang mudah alih kebanyakannya tidak diketahui. Perbezaan utama antara statik dan dinamik adalah kesan kabur yang merupakan sesuatu pengacauan yang biasanya diabaikan kerana keadaan pegun kamera. Kesan kabur boleh menyebabkan isu-isu terutama apabila ia datang untuk melakukan analisis ciri terperinci seperti pengecaman muka kerana kabur akan meningkatkan saiz garis sempadan menyebabkan kamera mungkin tidak mengesan muka pada semua atau mengesan ia sebagai sesuatu yang asingoleh hal demikian, ia adalah selamat untuk membuat hipotesis bahawa prestasi algoritma pengecaman wajah boleh ia menjadi nilai eigen atau fisherface analisis prestasi berat prestasi peta ini akan berbeza negatif apabila membandingkan keputusannya daripada asas statik kepada pangkalan mudah alih dan untuk membuktikannya, kita telah menjalankan dari segi pelbagai menangkap untuk pengenalan wajah dan pengiktirafan dengan menggerakkan robot ketika cuba untuk mengenalpasti wajah-wajah di kitar tugas yang berbeza. Hasil daripada kajian ini menunjukkan bahawa apabila terdapat peningkatan dalam kelajuan robot mudah alih dari 0 ~ 65% kitar tugas nampaknya ada pengurangan prestasi dari segi pelbagai menangkap kira-kira 30% untuk kedua-dua pengiktirafan muka dan pengenalan wajah yang pengurangan yang jelas dalam prestasi.

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CHAPTER 1

INTRODUCTION

1.1 MOTIVATION

This project was made base on various motivations which focus on the fact that the regular security surveillance camera has too many flaws due to its immobility and inflexibility [1] which again all boils down to its limited area of vision as seen in Figure 1.1.1 which shows the maximum area if vision for a camera corresponding to the size of the lens.

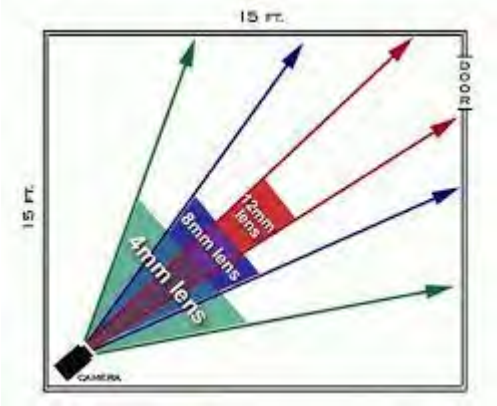

Figure 1.1: Figure showing the area of vision for a camera corresponding to its lens size

When the camera is looking in front, its view of vision is merely to the front thus giving it a blind spot to everywhere it is not looking at that very moment and even with the added ability

of any amount of degrease of freedom, the camera is still truly limited to where it is looking and a person who truly wishes to avoid being detected can easily do so by precise timing and moving around the camera's blind spots[2]. It is worth noting that to bypass this issue, most people simply employ even more security camera's around the house to cover all possible blind spots but said counter measure is not only an expensive solution (each security camera being added would mean an addition of RM100) especially when considering the quantity of cameras to install base on the quantity of rooms and size of each room and even after all that, said cameras can still be avoided by the person simply avoid looking into the camera at all times hence disabling the purpose of having said camera which is to capture the act of crime in action and the identity of the person committing it.

Hence base on the problem, a simple solution to tackle said issue is by firstly mobilizing the security camera. Having a mobile remotely or artificially controlled security camera would enable us to capture footage of the perpetrator easier and reduce the chance of said perpetrator from avoiding our camera. Secondly once the robot has been successfully mobilized, the second goal is to implement face recognition and identification abilities to the camera. Having said abilities would firstly allow for more complex movement algorithm allowing said surveillance camera to either follow a person until image is capture or instantly identify and cross-reference said person to an internal database to know if said person is an intruder, a criminal or merely a normal citizen. Secondly having the ability of face recognition would enable the camera to keep a log of all those whom the robot have came in contact with alongside with the time place and frontal image of said person (captured by the security camera) which would prove useful when going through the footage to find for a specific person.

By completing this project, it will be one step further in the creation of a mobile security device that will not only stop people from trying to avoid the camera by chasing said suspicious people until their image is taken as well as save the time of investigators and people whom wants to comb through the video file to extract the responsible culprits by just looking into the log for the faces for said suspicious people at the given time.

1.2 PROBLEM STATEMENT

Face recognition and identification by itself is already a well and extensively research area of image processing however this is only true if the subject of interest is about face recognition and identification with respect to a static base. When it comes to a mobile environment, there is no specific research that has been done to see the effects of motion towards the ability of the face recognition algorithm to detect and recognize faces. The closest study to what this project aims to do is researches on image processing techniques for various applications on a mobile robot such as posture identifying human tracking robot where the main issues in the image processing for mobile environment is the noise from the motion itself of the robot causing blurs on the image. This thus becomes an issue when trying to integrate face recognition system on a mobile robot base as a form of mobile security robot thus its ability to accurately and quickly detect and identify faces as well as its effective range while in motion are crucial to whenever said system can be apply currently available face recognition algorithm to the robot or would there be a need to developed a new face recognition algorithm to solve said issue.

1.3 OBJECTIVE

The objective of which is to be achieve by the end of the time period of this research cycle or final year project is to:

a) To develop a mobile robot platform that is reliable for the analysis of face recognition algorithm performance on mobile robot base
b) Develop, design and implement a face recognition and identification software to the available hardware from the previous research cycle
c) Analyze the performance of said face recognition algorithm In terms of speed of capture, distance of capture and its corresponding accuracy while on a mobile environment.

1.4 SCOPE

For this research, the scope would be:

a) The research would be done to a static camera mounted on a mobile robot base to reduce variation of results due to angle of detection.
b) The light intensity of the room would be controlled via experiments being done in a fully lit room without any other form of external source of light to reduce the variation in results due to illumination.
c) The image sample which will be detected is limited to only full frontal image of a person as the objective of the system is to capture full frontal image of the subject thus for now the side view of the person is ignored.
d) Analysis will be done with different subjects from both male and female as well as all dominant races in Malaysia namely Malay, Chinese and Indian to not only reflect the diversity of the country (Malaysia) but also because a truly diverse participants would mean a wider range applicable countries said research can be applied to.
e) It should be noted that the speed of the mobile robot while running the experiments is controlled by the battery power but the amount of current supply via battery can change in time thus the performance might vary with time even with the same power output
f) Limit the age group of the image samples to individuals of the age 18~24 years old only due to the limitation of participants obtainable within the university premise. This is to reduce the noise that may occur due to the deformation of the face feature due to age.

CHAPTER 2

LITERATURE REVIEW:

2.1 OVERVIEW OF SYSTEM

The system that was designed encompasses many sectors of studies ranging from security surveillance technologies, biometric identification technologies, mobile robot technologies as well as image processing specifically image recognition algorithms. Each individual parts is explored and described below:

2.1.1 SURVEILLANCE TECHNOLOGY

Surveillance technology similarly to every other form of technology in the world is experiencing a rapid development in this current day and era where it was once used as monitoring tools[2] of a secured area has evolve and branched into many other fields such as law enforcements with the AES (automated enforcement system) and healthcare with the invention of the baby camera. But in the world of security where the technology evolved from, the advancements in terms of complexity of feed is severely lacking as most focus security surveillance technologies are focused on the encryption strength of the feed as well as the mode of the feed transfer from camera to server.

In retrospect, with all the fancy ways a security cam can transmit its feed to the server computer and no matter how strong the encryption of the feed to fend off hacking attempts to hijack the feed, police would still have to scroll through hours and hours of footage just to find the suspect that they are looking for and even with the fast forward, the task is tedious and time consuming. With an addition of automatic biometric identification methods such as face recognition on the security camera, the process mentioned above can easily be cut short via saving ones image and identity into the system database all set with time and location to ease the job of investigators. In fact , via incorporating the security camera onto a mobile platform and fitted with face recognition technology, further improvement of the security in the compound can be achieved as security camera in a fix surface can only do so much and as long as the perpetrator knows the location of the camera, the can easily avoid the camera[1] but a randomly moving security camera can catch the perpetrator off guard easily and if fitted with biometric identification technologies, he could be further identified and apprehended.

2.1.2 BIOMETRIC IDENTIFICATION

In today's technology, there exist many methods of personal identification such as the traditional username and passwords and the more advance biometric identification such as voice recognition, iris recognition, fingerprint recognition and face recognition which by all means is more secure than any the traditional methods mentioned prior because every individual biometrics is unique to the individual and its already imbedded to our skin thus making it almost impossible to fake or forge [3]. It is said that although biometric security surpasses standard traditional security by a mile however a fully infallible security does not exist as there will always be ways to bypass it and the same can be said with biometric security however with that said, biometric security is still the way to go in terms of individual identification and even more so with the speed of improvements in performances for the field of biometric security and the variety of environments the system is being developed in, truly shows the potential of said system [4][3][5][6]

2.1.3 FACE RECOGNITION

Among all the applications of image processing, face recognition can be considered to be one of the most successful and advance uses for said technology and even more so in the field of biometrics security where the demand of the usage of face recognition and face identification far surpasses any other form of biometric identification such as iris scan or fingerprints due to the reduced requirement of the participation of the identifiable person where for example the system would require the participation of the person to get his fingerprints and iris scanned however on the other hand the system could instead just simply scan said persons image through our system for an identification which would ease the process of identification greatly[7].

In terms of face recognition on the other hand, the focus of the technology has been broken into two sections which is basic face recognition which identifies the presence of a face without the need to identify the identity of the person which has brought forth various advancements in applications such as family search programs and online image searches (Apple iPhoto, Microsoft Photo Gallery, and Google Picasa) [8][9] and the second section focusing on face recognition for the purpose of identification of said person or face identification which has its uses in biometric identification technologies for security purposes[7].

However even with the advancement of technology, face identification technologies is plague by various issues which reduces the accuracy of said system and such issues are lighting which is the direction of which the source of light is pointing at our target individual may affect the identification of the individual as the same individual under different lighting conditions can come off as different individuals or a face under extreme lighting conditions may blur off the line of definition thus obstruction the system to map out face of the individual and the next issue would be posture where a same person with different face expressions may come off as a different individual to the face recognition system [10][11][7]. With all that said about issues,

various methods has been derived to solve said issue, each method having its own pros and cons, such methods are for example simple comparison method, eigenface method, linear subspaces method and finally fisher analysis method.[10]

2.2 STATE OF THE ART

For this section, insights into the current advancement of technology will be obtained and then compare our system to the currently available technology to come to a conclusion whenever it would be more viable to just adapt said technologies or to start anew.

2.2.1 MOBILE ROBOT SURVEILENCE TECHNOLOGY

Figure 2.1: Figure showing Mobile robot used for surveilence

There already are existing robots with image processing systems implemented on the robot itself either to identify objects to accomplish certain preprogramed task such as the human tracking robot [6][12] such as the one seen in Figure 2.1. These robots will feed back images to the central computer [12] or run it through a locally integrated mask [6] to then run the preprogrammed task such as tracking and following individuals. The characteristics of said robots are as seen in Table .

Table 2.1: table comparing properties of mobile robot with onboard camera and image processing abilities

	Mobile robot for surveilence[25]	**Human tracking mobile robot[24]**
Robot Control System	Robot controlled using TCP/IP protocol	Robot controlled using TCP/IP protocol
Compiler	GCC compiler	Eclipse
Sensors used	Sound sensor, camera	Camera only

However the main takeaways from this is that this systems does not have an integrated face recognition capabilities on the mobile robot itself comparatively to the one that this project intends to create. Each of the robots above does improve the ability of surveillance by covering dead angles which exist for traditional cameras via tracking of the human [12] however by also integrating face recognition on said system would also give ease to investigators and police when going thought the videos in search for suspicious elements as they would only need to go through the log for the day and acquiring the image of captured image of everyone present during the day itself rather than going through the whole 24 hour video to acquire the image of the suspect.