AN INTERGRATION OF THERMAL AND OPTICAL FLOW TECHNIQUE FOR HUMAN AGGRESSIVE MOVEMENT DETECTION

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ABSTRACT

There is growing interest in intelligent video surveillance as for public security has become more and more important especially after the attack of 11 September. The goal in developing intelligent video surveillance is to replace the traditional passive video surveillance that is proved to be ineffective as the number of cameras exceeds the capability of human operators to monitor them. In this real world, being able to identify the signs of imminent aggressive behaviours such as aggression or violence and also fights, is of extreme importance in keeping safe those in harm's way. This research proposes an approach to figure out human aggressive movements using two methods which are movement based and colour based. For the movement based, Horn-Schunck optical flow algorithm is chosen in order to find the flow vector for all video frames. Optical flow is a popular method to detect the object and can calculate the motion of each pixel between two frames, and thus it provides a possible way to get a velocity of the object movement. The video frames are collected using the digital camera and thermal camera. This research guides and discovers the patterns of body distracted movement so that suspect of aggression can be detected automatically without body contact. Using this method, the aggressive and non-aggressive video frames are then analysed and utilised to define the aggressiveness of humans. This research embarks on the following objectives which are to extract the suitable features that can represent aggressiveness, to develop an algorithm that can discriminate between aggressive and non - aggressive features for human movement detection and to adapt into the digital and thermal video images. The experiments conducted carried out to compare the Horn-Schunck algorithm under different types of images. Overall the combination of thermal images and Horn-Schunck optical flow proves to be able to accurately distinguish, detect and track the human aggressiveness. In future work, the intelligence system for human movement detection that can be applied at the Malaysia border area as a virtual guard system.

ABSTRAK

Terdapat peningkatan tumpuan dalam pengawasan video pintar dalam keselamatan awam telah menjadi lebih penting terutamanya selepas serangan 11 September. Matlamat dalam membangunkan pengawasan video pintar adalah untuk menggantikan pengawasan video tradisional pasif yang terbukti tidak berkesan kerana bilangan kamera melebihi keupayaan pengendali manusia untuk membuat pemantauan. Dalam dunia yang nyata, proses mengenal pasti tanda-tanda tingkah laku agresif yang berlaku seperti pencerobohan atau keganasan dan juga pergaduhan, adalah sangat penting dalam memastikan seseorang yang dalam bahaya selamat. Kajian ini mencadangkan satu pendekatan untuk mengesan pergerakan agresif manusia menggunakan dua kaedah iaitu berasaskan pergerakan dan warna. Bagi kaedah berasaskan pergerakan, algoritma aliran optik *Horn-Schunck* dipilih untuk mencari vektor aliran bagi semua bingkai video. Aliran optik adalah satu kaedah yang popular untuk mengesan objek dan boleh mengira pergerakan setiap piksel antara dua bingkai gambar, dan menyediakan cara yang mungkin untuk mendapatkan halaju pergerakan sesuatu objek. Bingkai video yang dikumpul menggunakan kamera digital dan kamera termal. Penyelidikan ini memberi panduan dan menemukan corak pergerakan yang terganggu pada badan supaya suspek pencerobohan dapat dikesan secara automatik tanpa sentuhan badan. Dengan menggunakan kaedah ini, bingkai video agresif dan tidak agresif kemudiannya dianalisa dan digunakan untuk menentukan keagresifan manusia. Objektif dalam kajian ini adalah untuk mengeluarkan ciri-ciri yang sesuai yang boleh mewakili agresif, membangunkan algoritma yang boleh mendiskriminasikan antara ciri-ciri agresif dan bukan agresif bagi mengesan pergerakan manusia dan untuk digunakan dalam imej video digital dan termal. Eksperimen yang telah dijalankan adalah untuk membandingkan algoritma Horn-Schunck menggunakan dua jenis imej yang berbeza. Keseluruhannya, gabungan antara imej termal dan algoritma aliran opktik *Horn-Schunck* membuktikan bahawa ia mampu membezakan, mengesan dan mengawal keagresifan manusia secara tepat. Pada masa hadapan, algoritma pengesanan pergerakan agresif ini diharap mampu diintegrasi dengan sistem perisikan di kawasan sempadan Malaysia bagi membentuk satu sistem pengawal maya yang pintar.

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APPROVAL

I certify that an Examination Committee has met on **14th July 2017** to conduct the final examination of **Tuan Khalisah binti Tan Zizi @ Tuan Zizi** on her degree thesis entitled **'An Intergration of Thermal and Optical Flow Technique for Human Aggressive Movement Detection'**. The committee recommends that the student be awarded the Master of Science (Computer Science).

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LIST OF ABBREVIATIONS

.avi	Audio Video Interleaved
CCTV	Closed-circuit television
CPU	Central Processing Unit
Eq.	Equation
GPU	Graphic Processing Unit
FLIR	Forward-Looking Infrared
HSI	Hue, Saturation, Intensity
HSV	Hue, Saturation, Value
IR	Infra-Red
LRT	Light Rail Transit
LWIR	Long-wave infrared
MATLAB	Mathematic Laboratory
MLP	Multilayer Perceptron
MSE	Means Square Error
NN	Neural Network
OF	Optical Flow
RGB	Red, Green and Blue
ROI	Region of Interest
SBC	Single Board Computer
TTS	Tempur Tanpa Senjata (military unarmed combat training)
UPNM	Universiti Pertahanan Nasional Malaysia

CHAPTER 1

INTRODUCTION

1.1 Introduction

A thermal camera meant for imaging is a type of thermographic camera which is most commonly used during firefighting. Where by the contribution of an infrared radiation in the form of a visible light, these types of cameras provide firefighters the vision to view the areas of heat produces (Nivedithaet al., 2014). There have been many related works which are on going, relating to thermal imaging and human recognition in the past few years however there are none about the aggressive movement of a human. Thermal imaging is a process of transforming imperceptible infrared radiation to a visible image. Every object in the universe emits infrared radiation as long as the object is above absolute zero (-273ºc). The temperature of an object governs the amount of infrared radiation emitted. By using thermal imager, a pictorial representation is produced to represent the detected heat without visible light content (Ramli et al., 2015; Zainudin, 2014).

The pattern of the distinct movement of objects, surfaces, and edges in a visual scene caused by the relative movement between an observer and the scene is defined as

optical flow (Ramli et al., 2015). Optical flow is the distribution of apparent velocities of movement of brightness patterns in an image. Optical flow can arise from relative movement of objects and the viewer. Consequently, optical flow can give important information about the spatial arrangement of the objects viewed and the rate of change of this arrangement. Discontinuities in the optical flow can help in segmenting images into regions that correspond to different objects. Attempts have been made to perform such segmentation using the differences between successive image frames (Ramli et al., 2015). Optical flow block estimates the direction and speed of object movement from one image to another or from one video frame to another using either the Horn-Schunck or Lucas-Kanade method.

In this research, an approach to figure out the feature extraction of aggressive movement of human will be proposed. Most of the social psychologist have focused on aggression as a negative form of social behaviour among members. Therefore, to avoid fighting and aggressive behaviour occurring in the public areas for example hospital, airport, LRT station and in an elevator (Shu, Fu, Li, & Geng, 2014), this paper proposed an aggressive behaviour detection method based on movement detection and thermal infrared. Firstly, the corners of the video sequences were detected and the Horn-Schunck algorithm was used to calculate the optical flow to obtain velocity vector information. Secondly, this algorithm established a feature vector combining the colour based using a thermal camera with movement characteristics of targets as the basis of aggressive behaviour detection. Finally, this algorithm was constructed to identify the aggressive behaviours.

Episodes of violence in psychiatric wards are more frequent among young patients with schizophrenia, patients with neurological problems, and in crowded settings; the victims are usually members of the nursing staff, and the consequences are rarely serious (Ramli et al., 2015). Besides that, based on previous research by (Volavka, 2014), they also found that the presence of a psychotic disorder, severe symptoms, a young age, substance abuse, and a history of violent episodes increase the risk of violence and aggression, although circumstances (overcrowding, provocations, and inexperienced or intolerant staff) and structural variables (changes in mental health strategies and fewer resources) are also involved. The altered emotion and feeling in the person would be recognised with the changing of a frequency of heat in the body. This type of emotion also would be recognised with their abrupt or distracted movement.

Apart from that, this study will be able to guide and discover the patterns of body heat and distracted movement so that people will be able to investigate the suspect of aggression without body contact. The crowd will be able to get a notification if a person has the probability to be violent or commit suicide by the system predict actions from the aggression detection databases. This research will be conducted during military unarmed combat training (*Tempur Tanpa Senjata-TTS*). All the candidates' images will be captured from a difference angle which are frontal and side view. The analysis will focus on the most relevant heat point of the body and integration of abrupt movement ahead to reflect aggression.

1.2 Background of the Research

Recently, tracking humans has become an important research topic in surveillance system especially in public areas. Public safety and security have become the most significant issue in public areas such as playgrounds, malls, banks, hospitals and also light rail transit (LRT) stations. The increase of crowds occurrence in these public places may increase the probability of aggression or violent cases occurred and unnecessary injuries or fatalities. Over few years, video surveillance systems were introduced and widely used in the public places.

From the sight of the human view can see the movement of ordinary people as well as people with aggressive behaviour. It is even better if a surveillance system is produced to detect the movement of people without any body contact. Thus, the need for the automated system becomes important. Most of the researchers focused on automated surveillance system to detect the aggressive behaviour in a crowd.

The focus of the research is mainly on low level feature extraction algorithms in detecting movement in the crowd and analysing the crowd's behaviour whether it is an aggressive or a non-aggressive behaviour. The features are extracted from optical flow computation in a sequence of video frames. This research is done to analyse movement of a group of people in a stable condition compared to those with aggressive movement when they are on angry mode.

1.3 Problem Statement

Currently, there are a lot of ongoing research on movement detection mostly on motion detection rather than aggressive movement detection. Some of them are using a similar approach by using the Horn-Schunck method optical flow (Mohd Hanafi et al., 2010; Ramli et al., 2015; Wan Samsudin, Ghazali, & Mohd Jusof, 2013; Zizi, Ramli, Ibrahim, Zainudin, & Abdullah, 2015). Nowadays, there is a movement detection that can detect the motion of human and non-human, unfortunately, this system only detects the movement of human or non-human based on ordinary camera and not an aggressive movement. Moreover the future suggests detecting aggressive movement using thermal imaging camera. Besides that, the frequency of occurrence uncontrolled violence and aggression in public area such as LRT stations, bus stop, bank, mall, playground, and the market is highly increasing. Next is the lack of verification in aggressive detection in Malaysia at surveillance area due to the high cost of equipment maintenance, human factor (labor) and usage of old technology.

Last but not least, no early detection for any aggression and violence. There are only ordinary CCTV used to monitor and not to prevent the aggression behavior (Ibrahim et al., 2010; Joubert, 2014; Lavers et al., 2005; Santosh E & E, 2014; Zajdel, Krijnders, Andringa, & Gavrila, 2007). Aggression in public area causes the destruction of property as well as mental and physical harm to humans. To prevent aggression in public areas, usually security department equipped some places with surveillance cameras. To maintain a safe place, human operators need to monitor the camera images

and take actions when necessary. All the cameras are therefore connected to a central control room where human operators can keep watch.

As the number of the cameras is expected to increase over time, it is expected that human operators will have difficulty to keep up with the ensuing data explosion. Another problem with humans is that they lack the ability to concentrate on repetitive and monotonous tasks for a lengthy period, such as monitoring camera images. Computers do not suffer from this concentration problem. Thus, from this perspective, computers seem to be better candidates for the surveillance function. However, object detection tasks that seem easy or even basic for humans, proves to be difficult even for the state of the art object detection algorithms. Making sense of situations and predicting possible aggressive outcomes of situations poses an even greater challenge. Therefore, this research will explore the opportunities and possibilities for computer assisted aggression detection.

1.4 Purpose of the Research

The purpose of this study is to detect aggressive movement based on temperature and optical flow abrupt movement flow from the thermal video sequence. This study will be able to guide and discover the patterns of the body heat and distracted movement so that people will able to investigate the suspect of aggression without body contact. Insight acquired through this study is expected to be useful for the social

physiologists, which focus on aggression as a negative form of behaviour that causes problems between individuals, groups, and societies. Therefore this research will design an algorithm to detect human aggression movement.

1.5 Objectives of the Research

This study embarks on the following objectives:

- To extract the suitable features that can represent aggressiveness.
- To develop an algorithm that can discriminates between aggressive and non – aggressive features for human movement detection.
- To adapt into the digital and thermal video images.

1.6 Scope of the Study

There are few scope and limitation that will be highlighted, which are:

i. This study will collect two types of video images that are digital images and thermal images. Then, both video images will convert into image frames for the next phase.

ii. Due to the time frame of the survey done, two approaches based on optical flow and thermal images have been taken into consideration in the development of feature vector representation issue. For movement based approach, Horn-Schunck algorithm was used, while for colour based approach, methods of calculating the number of pixels in each thermal image is performed.

iii. An Optical Flow-based approach using Horn-Schunck method is suggested in movement detection as this method can detect minor motion of objects and could provide 100% flow field.

iv. The experiments were done during military unarmed combat training (*Tempur Tanpa Senjata-TTS*) in UPNM which is nearest locality to the researcher due to limited financial sources. Thus, convenience results produced really fit to the requirements to sample aggressiveness of human and was justified in the methodology.

1.7 Impact on Society, Economy, and Nation

This study will be able to guide and discover the patterns of altered emotion and feeling reflect to aggression behaviour using thermal image, so that people will be able to investigate the suspect of the aggression person without body contact and people will be able to get notification if the person has the probability to be violent or commit suicide using the system predict actions from aggression detection pattern.

1.8 Conclusion

This research will be covering on an integration of thermal and optical flow techniques for human aggressive movement detections. A new algorithm will be proposed for human aggressive movement recognition. An aggressive movement based on temperature and optical flow abrupt movement from both digital and thermal video sequence.