UNIVERSITI PUTRA MALAYSIA

BEHAVIOR RECOGNITION IN VIDEO SURVEILLANCE SYSTEM FOR INDOOR PUBLIC AREAS USING ARTIFICIAL IMMUNE SYSTEM

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By

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April 2008

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Behavior recognition and predicting the activities of people in public areas are still a major concern in image processing and artificial intelligence science. Artificial intelligence systems are widely used to extract and analyze the complicated human actions through logical and mathematical rules.

This study has explored an intelligent video surveillance system, presented by real time moving detection, object classification and interpreting the activity of the people by employing image segmentation and new approach in artificial intelligence called artificial immune system. The new system was compared with the previous methods in two level processing such as preprocessing for pixel manipulation and high level processing for behavior description.

It was discovered that the new system required less processing time to apply filters in pixel level and higher data accuracy with less time complexity to generate training data and monitoring phase. This study further improved the performance of object tracking. The improvement was achieved by simplifying the previous algorithm without applying mathematical or probabilistically formulas and selects the effective filters to create a clearer foreground pixel map. Also, the robust algorithm with hands of artificial immune system rules like binary hamming shape-space and advance detector structure with fast decision making to detect three abnormal behaviors such as entering the forbidden area, standing more than threshold and running was implemented

The result obtained showed the improvement in the duration for each phase when compared with previous methods in image segmentation like mixture of Gaussian and behavior recognition like and/Or tree or neural networks.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Master Sains

KENALAN KELAKUAN MENGGUNAKAN VIDEO PEMERHATIAN DI TEMPAT AWAM TERTUTUP

Oleh

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Mengenalpasti gerak-geri manusia dan pengandaian aktiviti mereka di tempat awam masih lagi menjadi satu kesukaran dalam bidang kecerdasan buatan dan pemprosesan imej. Sistem kecerdasan buatan digunakan dengan meluas sekali untuk menghurai dan menganalisis aksi manusia yang rumit melalui logik dan hukum matematik.

Kajian ini telah meniliti sebuah sistem pengawasan video pintar , dengan pengenalpastian pergerakan masa nyata, pengklasifikasian objek dan penterjemahan aktiviti manusia menggunakan segmentasi imej dan pendekatan baru dalam kecerdasan buatan yang di panggil “artificial immune system”. Sistem baru ini di bandingkan

dengan sistem-sistem yang sedia ada yang menggunakan pemprosesan dua tahap iaitu tahap pertama pra proses untuk manipulasi piksel dan tahap kedua untuk proses memberi gambaran tingkah laku.

Didapati sistem baru ini mengambil masa yang lebih singkat untuk proses tahap satu melibatkan piksel dan menghasilkan data yang lebih tepat untuk maklumat latihan dan fasa pengawasan. Kajian ini di perkemaskan lagi dengan maklumat pengenalpastian objek. Ini dilakukan dengan mempermudahkan algoritma yang sedia ada tanpa menggunakan pedekatan matematik atau formula kebarangkalian dan memilih penapis yang sesuai untuk menghasilkan peta piksel yang lebih jelas. Ini juga di bantu oleh algoritma kebal yang mengunakan “binary hamming shape-space” dan struktur pengesan yang cekap untuk mengambil keputusan yang pantas untuk mengesan tiga tingkah laku abnormal seperti memasuki kawasan larangan , berdiri lebih lama daripada yang sepatutnya dan berlari.

Hasil yang dikumpul menunjukan kemajuan dalam setiap fasa jika di bandingkan dengan kaedah yang sedia ada dalam segmentasi imej seperti “mixture of Gaussian” dan rangkaian neural.

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I certify that an Examination Committee has met on 28 April 2008 to conduct the final examination of Azad Abad on his Master of Science thesis entitled"BEHAVIOUR RECOGNITION IN VIDEO SURVEILLANCE SYSTEM FOR INDOOR PUBLIC AREAS BY APPLYING ARTIFICIAL IMMUNE SYSTEM" in accordance with Universiti Pertanian Malaysia (High degree) Act 1980 and recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously and is not concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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LIST OF ABBREVIATIONS

CCTV	Close Circuit Television
RGB	Red, Green, Blue
HSV	Hue, Saturation, Value
RFB	Radial Basis Function
MDL	Minimum Description Length
FSM	Finite State Machine
HMA	Human Motion Analyze
MHI	Motion History Image
MEI	Motion Energy Images
NN	Neural Network
HMM	Hidden Markov Model
CHMM	Coupled Hidden Markov Model
VLMM	Variable Length Markov Model
DTW	Dynamic Time Warping
VSIP	Video Surveillance Interpreter Platform
AIS	Artificial Immune System

CHAPTER 1

INTRODUCTION

Video surveillance is becoming a popular feature of modern life. The objective in most of the systems was basically security; however they are practically being implemented for other purposes. These systems have some desired effects such as video surveillance systems employed in improving efficiency in the public areas, observation of workflow, resource management, dealing and controlling critical situations, and making connection between services and information. Surveillance cameras are installed in many public places to improve safety and help the operators to manage surveillance systems. Application of artificial intelligent (AI) algorithm can change the aspect of video surveillance to intelligent video surveillance.

In recent years, video surveillance has become one of the most popular fields in image processing. Many practical applications have been developed based on successful methods in visual surveillance such as control special areas, human identification, behavior recognition, detecting abnormal activities and so on. What differed this phenomenon from simple function observational tools is its implementation of robust and complicated logical algorithms, which makes it able to carry out its hidden task of analyzing raw data and making intelligent decisions.

1.1 Introduction of Video Surveillance System

The duty of these systems is to warn the operator when they detect abnormal events

which may require human intervention. This system is useful for the surveillance of public areas, crime prevention, and forensic evidence. Many extended “eyes” are being installed at an unprecedented pace, yet the intelligence needed for interpreting video surveillance events by computers is still rather unsophisticated.

Detecting unusual behavior can be challenging because it does not happen often so its modeling would be difficult. For example, actions like entering forbidden area, falling, stopping more than normal time in a place, graffiti, and unattended baggage in stations can be controlled by real-time action detection and prevent serious problems or irreparable mistakes.

These warnings can be reliable if the system can detect human behavior and especially abnormal actions correctly in real-time. To obtain these goals the method should follow a robust algorithm for detection and tracking.

The final purpose of the design and use of the intelligence surveillance system is to reduce human fault and human observation from monitor and analyze the visual data in real time. We cannot solely rely upon human efforts to watch and sift through hundreds and thousands of video frames for crime alerts and forensic analysis.

1.2 History of Video Surveillance

Video surveillance has been used for security purposes and monitoring areas for a long time now. Oberti et al. (1999) have classified the generation of video surveillance into

three categories: 1GSS, 2GSS, and 3GSS.

The first generation of video surveillance belonged to analog systems and image acquisition, sending information and processing them (1960-1980). These systems worked in a way where several cameras send an output to the control room for human resource to consider and analyze. Some difficulties this generation faced will be presented below.

This system has features such as requirement of wide bandwidth, difficulty in archiving, and saving the data in a large amount of video tapes to retrieve later. Aside from this, it is very hard to detect events on-line and performance of this system, which completely depends on the proficiency of operators.

In the next generation, digital technology combined with the analog system started to help operators in resolving some drawbacks from its predecessor. They used basic digital video processing to assist operators by filtering out counterfeit events. The emphasis of this generation is detecting on-line events (1980-2000).

The third generation works with end-to-end digital processing, image acquisition from sensor level communicating through broadband networks, and digital image storage with low cost digital infrastructure. The main goal of this generation is to make an on-line alarm to help operators in on-line detection situation.

To attain this aim, this generation provided an intelligent system that generates real-time alarm defined on a complex system. The features of video surveillance are intelligent, reliable, and robust algorithm for moving detection, classification, tracking objects and activity recognition. It started from 2G and many researches have been done on it.

Briefly, these steps are described below:

Detection of moving objects is the first step in this complex algorithm. It can handle segmentation of movement which is also a fundamental step in intelligent video surveillance system. Many methods were also suggested for this step such as background subtraction statistical method, temporal differencing, and optical flow. In some special situation like changing illumination, shadows, and dynamic background such as moving leaves because of the wind in outdoor environments, several mathematical filters like Gaussian or Kalman have been applied (McIvor, 2000).

Object classification divided objects into expected categories like human, vehicle (in outdoor), groups, clutter and so on. In this step, it is crucial to distinguish an object correctly to be able to feed correct data to the next steps, especially human and group features for this research. The suggested methods for this step are motion-based and shape-based (Wang et al., 2003) which will be discussed more in chapter 2.2.

The next step in intelligent video surveillance system is tracking. This step provides temporal identification of segment region and generates information about the objects

such as speed, velocity, trajectory and direction. The feedback of this step which will be used in behavior recognition is a main factor. The performance and reliability of application strongly depends on this step.

The last and final step in this research is behavior recognition through output of previous algorithm, which provides a high-level data to make a decision for the system to recognize abnormal behavior in public areas.

Being able to recognize different actions can help find suspicious behavior or predict when an antisocial behavior is about to occur. It can be achieved via several methods like neural network (Rosenblum et al., 1994), HMM (Yamato et al., 1992), or artificial immune system, which was used in this methodology (De Castro and Von Zuben, 1999).

The result of this research can be employed in real environments similar to the surveillance of indoor areas like offices, lobbies, halls, banks, and shopping areas to avoid robbery, unattended baggage at the airport, monitoring people in lobbies and hotels also with training the system, it is able to customize it for employing it in subways and LRT stations. In general, it is possible to classify this thesis into several sections as shown in Figure1.1

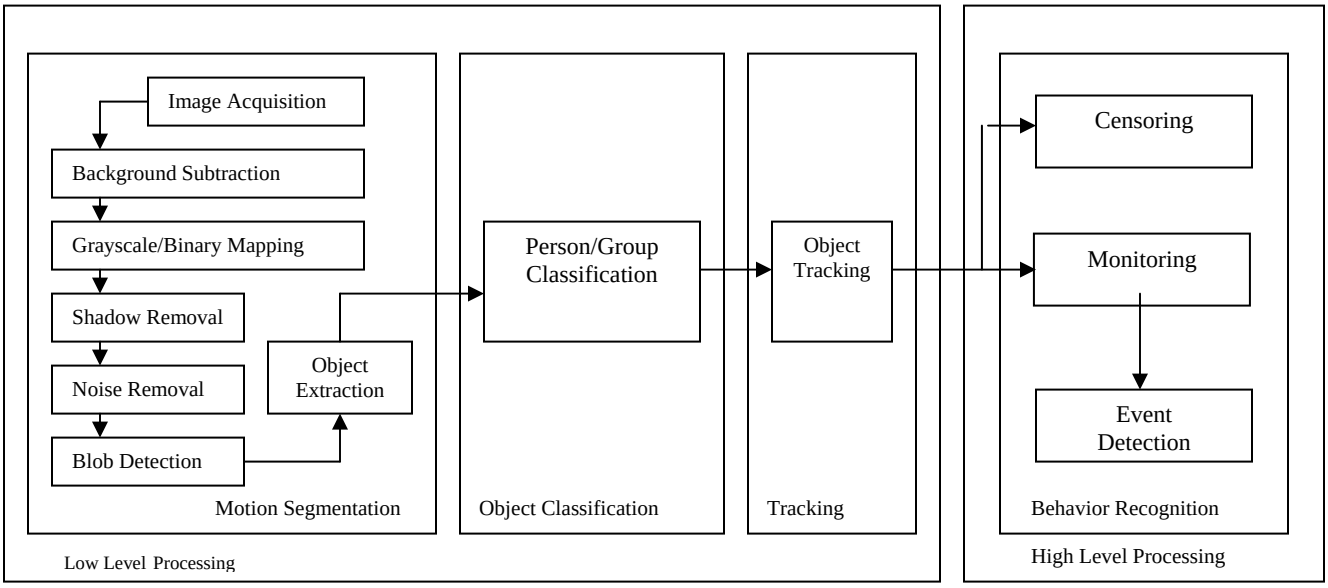

Figure 1.1: General Scheme of Object Movement Detection Method

1.2 Problem Statement

Neural network algorithm needs a lot of training data to provide reliable data set as a reference for behavior recognition (Yang et al., 1999). This model cannot process sequence of frames in real time observation, because of that it may not be applicable for real time behavior recognition with high-level data accuracy.

In pixel processing level, by applying complex formula in movement segmentation like Optical Flow (Wang et al., 2003) or Mixture of Gaussian (Grimson, 1999) and object classification (Mohen et al., 2001), the system involves time consuming processes and these are the main problems in real time behavior recognition.

1.3 Objectives of Study

This study aims to:

I - Decrease the time complexity in pixel level processing.

II - Real Time object detection.

III- Increase the data accuracy in behavior recognition.

The initial basic ideas for this study were:

By increasing the number of unnecessary filters in low level processing and applying an effective image filtering like HSV conversion either changing the parameters calculation for binarization, also by applying new methods for blob detection and object classification it would be possible to decrease the time processing for arrival frames in total.

By decreasing the time complexity in low level processing, this method might keep the entire system alive in sequences of frame processing through the time.

In behavior recognition, in decision-making module, negative selection derived from artificial immune system algorithm provided an opportunity to avoid going through complicated mathematical time-consuming calculation but keeping the high rate of correct answers in decision-making.

By applying further techniques like permutation mask and dynamic detector generation, it would be possible to get the higher result for behavior interpretation.