



AUTOMATED HUMAN RECOGNITION AND  
TRACKING FOR VIDEO SURVEILLANCE SYSTEM

BY

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## **ABSTRACT**

Recent research in video surveillance system has shown an increasing focus on creating reliable systems utilizing non-computationally expensive technique for observing humans' appearance, movements and activities, thus providing analytical information for advanced human behavior analysis and realistic human modeling. In order for the system to function, it requires robust method for detecting and tracking human from a given input of video streams. In this thesis, a human detection technique suitable for video surveillance is presented which requires fast computations in addition of accurate results. The techniques proposed include adaptive frame differencing for background subtraction, contrast adjustment for shadow removal, and shape based approach for human detection. The tracking technique on the other hand uses correspondence approach. Event Based Video Retrieval (EBVR) system is also proposed for efficient surveillance data management and automated human recognition with unique ID assignment. Proposed human detection and tracking are integrated with EBVR and motion detection into a complete automated surveillance system called Active Vis Video Surveillance Analysis System (AVSAS) which produces good result and real-time performance especially in non-crowded scene. The EBVR system also proves to be able to handle automated human recognition with unique ID assignment accurately.

## ملخص البحث

أظهرت الأبحاث الحديثة في مجال أنظمة مراقبة الفيديو زيادة في التركيز على إنشاء أنظمة موثوقة مستفيدة من التقنيات الحسابية غير المكلفة لمراقبة ظهور الأشخاص وحركاتهم وأنشطتهم. وبالتالي إعطاء معلومات تحليلية لنظام تحليل متقدم لسلوك الأشخاص ونمذجة واقعية لهم. لكي يعمل النظام، فإنه يتطلب طريقة قوية لكشف وتتبع الأشخاص من ناحية محددة من بث الفيديو. في هذا البحث، تم تقديم تقنية لكشف الأشخاص مناسبة لمراقبة الفيديو، وهي تتطلب حسابات سريعة بالإضافة إلى نتائج دقيقة. التقنيات المقدمة تتضمن تمييزاً ذا إطار مهين لإزالة خلفية الصورة، وتعديل التباين لإزالة الظل، وكذلك طريقة تعتمد على الشكل لكشف الأشخاص. في المقابل، فإن تقنية التتبع تستخدم طريقة التطابق. كذلك تم تقديم نظام استرداد الفيديو المعتمد على الحدث (EBVR) من أجل إدارة فعالة لمعلومات المراقبة ونظام تمييز آلي للأشخاص مع تعيين فريد للشخصية. نظام تمييز الأشخاص وتتبعهم و نظام استرداد الفيديو المعتمد على الحدث (EBVR) وكذلك تمييز الحركة تم جمعهم في نظام مراقبة آلي كامل يسمى نظام التحليل الفعال لمراقبة الفيديو (AVSAS) الذي بدوره يقدم نتائج جيدة وأداءً فورياً خاصة في المشهد غير المزدهم بالأشخاص. نظام استرداد الفيديو المعتمد على الحدث (EBVR) أيضاً يبرهن أنه قادر على التعامل مع تمييز الأشخاص الآلي مع تعيين فريد للشخصية بدقة.

## **APPROVAL PAGE**

I certify that I have supervised and read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Master of Science (Communication Engineering).

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## DECLARATION

I hereby declare that this dissertation is the result of my own investigations, except otherwise stated. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at IIUM or other institutions.

Fadhlan HafizHelmi Bin Kamaru Zaman

Signature .....

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**AUTOMATED HUMAN RECOGNITION AND TRACKING FOR  
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# TABLE OF CONTENTS

Abstract.....	ii
Abstract in Arabic.....	iii
Approval Page.....	iv
Declaration.....	v
Copyright Page.....	vi
Acknowledgement.....	vii
List of Tables.....	xi
List of Figures.....	xiii
List of Abbreviations.....	xviii
<b>CHAPTER ONE: INTRODUCTION.....</b>	<b>1</b>
1.1 Introduction.....	1
1.2 Background Of The Study.....	2
1.3 Problems Statement.....	5
1.4 Research Objectives.....	7
1.5 Research Scope.....	7
1.6 Research Methodology.....	8
1.7 Thesis Organization.....	9
<b>CHAPTER TWO: LITERATURE REVIEW.....</b>	<b>10</b>
2.1 Introduction.....	10
2.2 Human Detection Versus Human Recognition.....	10
2.3 Related Works on Human Detection.....	11
2.3.1 Gray-scale Filtering.....	12
2.3.2 Camera Noise removal.....	13
2.3.4 Background Subtraction and Background Modeling.....	14
2.3.4.1 Background Subtraction Using Single Gaussian Distribution.....	15
2.3.4.2 Texture Based Background Subtraction.....	16
2.3.4.3 Background Subtraction Using Frame Differencing.....	17
2.3.4.4 Background Subtraction Using Optical Flow.....	18
2.3.4.5 Background Subtraction Using $W^4$ method.....	18
2.3.4.6 Background Modeling Using Gaussian Mixture Model (GMM).....	19
2.3.4.7 Background Modeling Using Nonparametric Kernel Density Estimation.....	21
2.3.4.8 Adaptive Frame Differencing (AFD).....	23
2.3.5 Shadow Removal.....	23
2.3.5.1 Intensity Scaling Method.....	23
2.3.5.2 Shadow Model.....	24
2.3.5.3 Pulse Coupled Neural Network (PCNN).....	25
2.3.5.4 Wavelet Transform.....	25
2.3.5.5 Color and Texture Inspection.....	25
2.3.5.6 Shadow Confidence Score (SCS).....	26
2.3.5.7 Adaptive Bayesian Network.....	26



2.3.5.8 Contrast Adjustment Method (CAM) .....	27
2.3.6 Binarization .....	27
2.3.7 Morphological Operation .....	29
2.3.8 Human Detection .....	31
2.3.8.1 Fast Mean Shift Procedure .....	31
2.3.8.2 Support Vector Machine (SVM) Framework .....	32
2.3.8.3 Histogram of Oriented Gradients (HOG) .....	32
2.3.8.4 Patterns of Motion and Appearance .....	33
2.3.8.5 Pfinder .....	33
2.3.8.6 Shape Based Approach .....	34
2.3.8.7 Spatial and Temporal Uniqueness (F1-F2-F3) .....	36
2.4 Related Works on Human Tracking .....	36
2.4.1 Correspondence Technique .....	37
2.4.2 Part Matching Approach .....	37
2.4.3 Gait Recognition Using Geodesic Active Contour Models (GACMs) .....	38
2.4.4 Pfinder .....	39
2.4.5 Probabilistic Approach Using Kalman Filter .....	40
2.4.6 Human Color Structure Descriptor (HCSD) .....	41
2.5 Previous Works on Automated Surveillance System .....	41
2.6 Summary .....	45

**CHAPTER THREE: RESEARCH METHODOLOGY ..... 49**

3.1 Introduction .....	49
3.2 Development of Human Detection System .....	49
3.2.1 Human Detection Process Overview .....	49
3.2.2 Video Processing .....	50
3.2.3 Background Subtraction & Background Modeling .....	50
3.2.4 Image Pre-Processing .....	54
3.2.5 Segmentation .....	55
3.2.5.1 Shadow Removal .....	55
3.2.5.2 Binarization .....	59
3.2.6 Human Detection .....	61
3.2.6.1 Human Outline Ratio .....	62
3.2.6.2 Blob Segmentation and Size Filter .....	65
3.3 Development of Human Tracking System .....	67
3.3.1 Human Tracking Model .....	67
3.3.2 Human Tracking Algorithm .....	69
3.3.3 Human Tracking Cases .....	73
3.3.3.1 Human Entering Scene (HES) .....	74
3.3.3.2 Human Roaming in Scene (HRS) .....	75
3.3.3.3 Human Leaving Scene (HLS) .....	77
3.3.4 Real-Time Path .....	77
3.4 Development of Motion Detection System .....	78
3.4.1 Motion Detection Process Overview .....	78
3.4.2 Pixels Count Process .....	79
3.4.3 Merge .....	80
3.5 Development of Event Based Video Retrieval (EBVR) System .....	82
3.5.1 EBVR System Architecture .....	82

3.5.2 Event Classifier .....	83
3.5.3 Data Indexing & ID Allocation.....	84
3.5.4 Data Storage .....	87
3.5.5 Data Retrieval Sink .....	88
3.6 System Implementation And Architecture.....	89
3.6.1 System Overview .....	89
3.6.2 Camera Subsystem.....	90
3.6.3 Detection Subsystem.....	91
3.6.4 Tracking Subsystem.....	92
3.6.5 Alert Subsystem .....	92
3.6.6 Recording Subsystem.....	93
3.6.7 Retrieval Subsystem.....	94
3.7 Summary .....	95
<b>CHAPTER FOUR: RESULTS AND DISCUSSIONS.....</b>	<b>96</b>
4.1 Introduction .....	96
4.2 Camera Placement And Effective Detection Area (EDA).....	96
4.3 Classification of Human Detection & Tracking Result .....	98
4.2.1 True Positives.....	99
4.2.2 False Positives.....	100
4.2.3 False Negatives .....	101
4.2.4 EBVR Result for Human Recognition.....	102
4.3 Accuracy of Human Detection & Tracking .....	103
4.3.1 Non-crowded Scene .....	103
4.3.1.1 OneStopEnter2cor.mpg (CAVIAR 1).....	104
4.3.1.2 OneLeaveShopReenter2cor.mpg (CAVIAR 2) .....	105
4.3.1.3 OneStopNoEnter1cor.mpg (CAVIAR 3).....	106
4.3.1.3 Video 63_mpeg1video.mpg (IIUM Video 1) .....	108
4.3.1.4 Overall Result for Non-crowded Scene .....	109
4.3.2 Crowded Scene .....	112
4.4 Performance of Human Detection & Tracking .....	115
4.6 Accuracy of Motion Detection Technique.....	119
4.6 Results Comparison of Proposed Human Detection.....	121
4.7 Summary .....	122
<b>CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS .....</b>	<b>124</b>
5.1 Conclusion.....	124
5.2 Contribution of The Thesis .....	126
5.2 Recommendations .....	127
<b>BIBLIOGRAPHY .....</b>	<b>128</b>
<b>PUBLICATIONS .....</b>	<b>136</b>
<b>APPENDIX A: CAMERA SUBSYSTEM C# CODE .....</b>	<b>137</b>
<b>APPENDIX B: HUMAN DETECTION SUBSYSTEM C# CODE.....</b>	<b>141</b>
<b>APPENDIX C: HUMAN TRACKING SUBSYSTEM C# CODE .....</b>	<b>145</b>
<b>APPENDIX D: AVSAS GUI.....</b>	<b>150</b>

## LIST OF TABLES

<u>Table No.</u>		<u>Page No.</u>
2.1	List of some techniques discussed in Chapter Two	45
3.1	Result of human outline ratio experiment	64
3.2	Properties' change under matched and unmatched case	72
3.3	Human tracking cases identification	74
3.4	Surveillance data and their categories association	85
3.5	ID types and their allocation rules	86
4.1	Approximate EDA depending on camera placement	98
4.2	CAVIAR Datasets video contents	103
4.3	IIUM video's contents and information	104
4.4	Human detection and tracking result for CAVIAR 1	105
4.5	Human recognition from EBVR for CAVIAR 1	105
4.6	Human detection and tracking result for CAVIAR 2	106
4.7	Human recognition from EBVR for CAVIAR 2	106
4.8	Human detection and tracking result for CAVIAR 3	107
4.9	Human recognition from EBVR for CAVIAR 3	107
4.10	Human detection and tracking result for IIUM 1	108
4.11	Human recognition from EBVR for IIUM 1	109
4.12	Human detection and tracking result for non-crowded scene	111
4.13	Human recognition from EBVR for non-crowded scene	112
4.14	CAVIAR Datasets video contents	112

4.15	Human detection and tracking result for CAVIAR 4	113
4.16	Human recognition from EBVR for CAVIAR 4	113
4.17	Accuracy of proposed motion detection	120
4.18	Performance comparison in 384x288 pixels video	122

## LIST OF FIGURES

<u>Figure No.</u>		<u>Page No.</u>
2.1	Perspective projection geometry example	29
2.2	Dilation of a grid image by a cross structuring element	30
2.3	Example of human body shape	35
2.4	Example of 2 separate blobs (Sossa Azuela et al, 2001)	35
2.5	Video Analytic System Configuration (Bigdeli et al, 2007)	43
2.6	Architecture of generic multi-scale tracking system in automated video surveillance system	44
3.1	Overall human detection process	50
3.2	Initial background (left) and foreground (right)	51
3.3	Pixel scanning order method used in this research	51
3.4	Example of background subtraction using frame differencing	52
3.5	Effects of shadow, illumination changes, and moving trees to the background in static camera	52
3.6	AFD example from outdoor scene	54
3.7	Original Image (left), and gray-scale image (left)	54
3.8	Process of gray-scaling and noise removal	55
3.9	Shadows detected as foreground objects	56
3.10	Graph representation of contrast adjustment	57
3.11	CAM applied to foreground objects	57
3.12	Heavy shadow removed using CAM illustrated in binary images	58

3.13	Effect of different value of contrast adjustment factor to the same image in binary	58
3.14	Binarization using brightness thresholding	59
3.15	Effect of different value of $T$ to the same gray-scale image	60
3.16	The morphological operation	60
3.17	Human shape model used for human detection	61
3.18	Several blobs located in a single binary image	63
3.19	Human outline ratio of images taken from different angle and distance from camera	63
3.20	Non –human objects outline ratio	64
3.21	Blob Segmentation and Size Filtering process flow	65
3.22	Example of human detection result	67
3.23	Human detection process flow	66
3.24	Human model shown in blob with pixel coordinate	68
3.25	Human tracking process flow	69
3.26	Human tracking flowchart	70
3.27	HES Case: No initial human	74
3.28	HES Case: No initial human with $D < Tc$	75
3.29	HRS Case	76
3.30	HLS Case	77
3.31	On-screen real-time human path	78
3.32	Motion detection process	79
3.33	Background update process	79
3.34	Moving region detected as foreground object	80
3.35	Final motion detection process	81

3.36	Motion detection flowchart	82
3.37	EBVR system architecture	83
3.38	Databases attributes	87
3.39	Software architecture	90
3.40	Camera subsystem architecture	90
3.41	Detection subsystem architecture	91
3.42	Tracking subsystem architecture	92
3.43	Alert subsystem architecture	93
3.44	Recording subsystem architecture	93
3.45	Retrieval subsystem architecture	94
4.1	CBS, EDA and NDA from the whole camera focus area perspective	97
4.2	EDA and NDA from on-screen perspective	97
4.3	True positives in detection of human	99
4.4	True positives in tracking of human	99
4.5	False positives in human detection	100
4.6	False positives in human tracking	100
4.7	False negatives in human detection and tracking	101
4.8	Human recognition from EBVR shown in Human Database	102
4.9	Example of human detection and tracking from CAVIAR 1	104
4.10	Example of human detection and tracking from CAVIAR 2	105
4.11	Example of human detection and tracking from CAVIAR 3	107
4.12	Example of human detection and tracking from IIUM 1	108
4.13	Graphical representation of human detection result for the four test videos	109

4.14	ROC curves for human detection obtained by evaluation of the four test videos	110
4.15	Graphical representation of human tracking result for the four test videos	110
4.16	Graphical representation of the result of human recognition from EBVR for the four test videos	111
4.17	Example of human detection and tracking from CAVIAR 4	113
4.18	Graphical representation of human tracking result for the crowded scene (CAVIAR 4)	114
4.19	ROC curves for human detection obtained by evaluation of CAVIAR 4	114
4.20	Graphical representation of human recognition result from EBVR for the crowded scene (CAVIAR 4)	115
4.21	Time taken for complete human detection per single frame.	116
4.22	Time taken for complete human tracking per single frame.	116
4.23	Time taken for complete human detection and tracking per single frame.	117
4.24	Frame rates after detection and tracking are applied.	117
4.25	Video frame rates drop after human detection and tracking are applied	118
4.26	Distribution of overall processing time consumption by Detection, Tracking and EBVR System	119
4.27	Examples of motion detection result	120



4.28	ROC curves for human detection of proposed method obtained by evaluation of CAVIAR Datasets compared with result from Lin et al (2007), and Beleznai and Bischof (2009)	121
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## LIST OF ABBREVIATIONS

2D	Two Dimensional
3D	Three Dimensional
AFD	Adaptive Frame Differencing
ATM	Automated Teller Machine
AVSAS	ActiveVis Video Surveillance Analysis System
BMP	Bitmap
C#	C Sharp
CAM	Contrast Adjustment Method
CAVIAR	Context Aware Vision
CBS	Camera Blind Spot
CBVR	Content Based Video Retrieval
CCD	Charge-Coupled Device
CCTV	Close Circuit Television
DWT	Discrete Wavelet Transform
EBVR	Event Based Video Retrieval
EDA	Effective Detection Area
FPS	Frame per Second
GIS	Geographical Information System
GMM	Gaussian Mixture Model
GUI	Graphical User Interface
HCSD	Human Color Structure Descriptor
HES	Human Entering Scene
HLS	Human Leaving Scene
HOG	Histogram of Oriented Gradients
HRS	Human Roaming in Scene
HSV	Hue, Saturation, and Value
ID	Identification Number
JPEG	Joint Photographic Experts Group
LPP	Locality Preserving Projection
MAP	Maximum A Posteriori
MPIH	Most Probable Initial Human
NDA	Non-effective Detection Area
PCNN	Pulse Coupled Neural Network
PFINDER	Person Finder
PNG	Portable Network Graphics
RBF	Radial Basis Function
RGB	Red, Green and Blue
ROC	Receiver Operating Characteristics
SCS	Shadow Confidence Score
SVM	Support Vector Machine
TV	Television
W <sup>4</sup>	Who? When? Where? What?
YCbCr	Luminance, Blue-difference, Red-difference
YUV	Luminance, Chrominance, Value

# **CHAPTER ONE**

## **INTRODUCTION**

### **1.1 INTRODUCTION**

Video surveillance is an important tool to enhance public safety and privacy protection. According to Hosik et al (2009), surveillance cameras as in CCTV systems for instance are widely deployed in strategic places such as airports, banks, and public transportation facilities, as well as in public places such as stores, elevators, and hallways. Hosik et al (2009) added that the surveillance cameras in London provided key photos of the men who bombed the underground system in July 2005 while the latest terrorist attack in London was foiled in 2007, partly thanks to the millions of surveillance cameras that London authorities have installed across the city. In order to fight crimes, video surveillance is also used in commercial locations such as banks, automated teller machines (ATMs), supermarkets, and parking areas to prevent and track criminal activities whereas consumer adoptions of video surveillance also have soared in recent years due to the increasing concern on privacy protection (Limin et al, 2009).

According to Li-Qun (2007), the reduction in unit cost, seemingly easy to use and more versatile functionalities of the emerging video surveillance infrastructure have played a key role for the now widespread deployment of surveillance systems by various vertical industry sectors like government, transport, retail, banking and finance concerning safety, security and business intelligence analysis. This is further prompted by the currently acute political and socioeconomic drive in view of increasing level

and complexity of criminal acts and frequency and severity of other disastrous incidents / events.

The widespread use of video surveillance has then demanded new technologies and functionalities leading to smarter surveillance systems. These concern mainly research on visual scene understanding algorithms, enabling a variety of generic, scene adaptable, or domain specific functions such as multi-object detection, tracking and occlusion handling, event detection and visualization, visual scene characterization and segmentation, abnormal behaviours analysis, crowd scene analysis, multi-camera cooperative situation awareness, the structuring and search of large archived video databases, and so on (Li-Qun, 2007).

## **1.2 BACKGROUND OF THE STUDY**

This research generally aims to integrate computer vision into video surveillance system in order to increase its accuracy, robustness and efficient data management. Computer vision broadly refers to the discipline where extraction of useful 2D and/or 3D information from one or more images is of interest (Rama Chellappa et al, 2005). Since the human visual system works by extracting information from the images formed on the retina of the eye, developments in computer vision are inevitably compared to the abilities of the human vision system. One of the basic tasks of the human visual system is to recognize humans and objects and spatial relationships among them. Similarly, one of the main goals of computer vision researchers is to develop methods for localization and recognition of objects in a scene.

Rama Chellappa et al (2005) also added that traditionally, problems in computer vision have been grouped into three areas that have vaguely defined boundaries. At low level, the goal is to extract features such as edges, corners, lines,

segmented regions, track features over a sequence of frames or to compute optical flow. At the intermediate level, using the output of the low-level modules, one is interested in grouping of features, in estimation of depth using stereopsis, and in motion and structure estimation. At the high level, the intermediate-level outputs are combined with available knowledge about the scene, objects and tasks so that descriptions of objects can be derived.

Recent research in computer vision has increasingly focused on building systems for observing humans and understanding their appearance, movements, and activities, providing advanced interfaces for interacting with humans, and creating realistic models of humans for various purposes (Ogale, 2006). For the last decades, video analysis and understanding has been one of the main active fields in computer vision and image analysis where applications relying on this field are various, like video surveillance, object tracking and traffic monitoring. (Allili et al, 2007). The ability of computer vision to recognize human from the image and works similar to human eye has made computer vision to be used widely in various applications especially in video analysis.

The capability of computer vision to also perceive image and shape in various physical conditions and constraints which might not be suitable for human eye can in fact enhance visual surveillance's accuracy and performance. Video surveillance systems are indeed becoming increasingly intelligent; thanks to the deployment of computer-vision an algorithm for detecting suspicious movement and identifying people and objects (Hosik et al, 2009). These intelligent applications help monitoring public area, counting interested objects passing through, reporting any suspicious behaviour, and so on. As more and more intelligence is sought by video surveillance

applications, there is an increasing demand for more robust real-time human recognition and tracking systems (Yuk, 2006)

Beleznai and Bischof (2009) suggested that reliable human detection is a key algorithmic component of many application-oriented computer vision systems, for instance in automated visual surveillance, automotive safety, human-computer interaction and multimedia processing. To realize more robust and secure video surveillance system, an automated human recognition and tracking system is needed which can analyze video streams fed by several surveillance cameras in real time, by utilizing fast-computation techniques without compromising the accuracy and performance of that particular surveillance system. The system also needs to be able to analyze past recorded events, store the video data, and manage the search for archived video data effectively. Dalal and Triggs (2005), Qiang (2006) and Qing Jun (2008) suggested however, detecting humans have been proven to be a challenging task because of the wide variability in appearance due to clothing, articulation and illumination conditions that are common in outdoor scenes

Another important aspect of video surveillance is the data management. Thi-Lan et al (2008) suggested that the increasing number of cameras provides a huge amount of video data and therefore, video data retrieval facilities become very useful for many purposes. He added while some approaches have been proposed for video retrieval in meetings, movies, broadcast news, and sports, very few work has been done for surveillance video retrieval. Current achievements on automatic video understanding such as object detection, object tracking and event recognition, though not perfect, are reliable enough to build efficient surveillance video indexing and retrieval systems.

Although a tremendous amount of work has been done in computer vision to enhance existing visual surveillance system, there are many issues still open and deserved further research. Among those issues as discussed earlier, are the precision and performance of moving human detection and tracking especially in real-time system currently available in the market, as well as the surveillance video and event data management which are being tackled in this research.

### **1.3 PROBLEMS STATEMENT**

According to Li-Qun (2007), in the UK, the surveillance cameras are a familiar phenomenon (street sight), which appears in almost every town centre, public space, shopping mall, and event venue. There are, however, various practical problems associated with this rapid market expansion of CCTV systems.

According to Yoo and Park (2008), there has been a sudden increase in the number of cameras being deployed lately, and it gives rise to the problem of insufficient monitoring staff. Moreover, the monitoring of a wall of displays by human operators for a prolonged time is an impractical and improbable task, and a security guard might find himself unable to monitor large numbers of surveillance monitors without slipping any unwanted activities past him (Fang et al, 2008). McLeod (1996) also suggested that the reliability of human operators is a question of major significance. He added even the best and most conscientious operators will suffer from boredom and lose of concentration. A guard or human operator may be unaware of minute details, develop fatigue, and has sight limitations.

Another associated video surveillance problem, is the very existence and still on the increase of the overwhelming volume of raw video data that needs to be monitored lives on display, captured and transmitted through a network, stored in

medium and re-examined whenever a certain request arises. Yan et al (2009) claimed that large volume of information makes the manual observation and evidence extraction from video surveillance systems are extremely difficult. Hence, the manual search for a piece of evidence or an incident from terabytes of video data collected from multiple sources is painfully slow, laborious and expensive. This is true since an effective video surveillance system usually operates 24 hours a day and 7 days a week, which in turn would accumulate gigabytes if not terabytes of data in just one month.

There also regulations for large buildings or business surfaces that requires at any moment the number of people present in different areas or enclosures must be known. This way the authorities can properly act in case of fire or any other reason approaches that requires the complete evacuation of the building. People counter systems are intended to ensure that organization involved in the hospitality and leisure industries is capable to comply with modern fire regulations. (Gardel et al, 2007)

Having gone through all the associated problems and requirements of video surveillance system and the concept of computer vision, it is clear that the solution for various problems aforementioned is an automated, advanced and efficient computer scene analyzer integrated with video surveillance system. Thus, this will serve to greatly increase the effectiveness and performance of visual surveillance system, reduce the human operators' workload and the need for human capital, manage the surveillance data efficiently, and more importantly overcome human visual limitations thus producing tighter security.