# M.H Ali

Dept.of MCT, Faculty of Engineering International Islamic University Malaysia E-mail: hazratalidu07@yahoo.com

#### A.A.Shafie

Dept.of MCT, Faculty of Engineering International Islamic University Malaysia E-mail: aashafie@iiu.edu.my

#### Fadhlan Hafiz

Dept.of ECE, Faculty of Engineering International Islamic University Malaysia E-mail: fadhalan\_hafiz@yahoo.co.uk

#### Roslizar, M. Ali

Dept.of MCT, Faculty of Engineering International Islamic University Malaysia E-mail: roslizar@iiu.edu.my

#### Abstract

This research aims at developing an Advance Video Analysis System (AVAS) which can be used in wide range of video surveillance applications as well as to detect moving objects and human beings. The AVAS is able to detect and track interested objects along with human. It recognizes activities in an application environment, such as in a room, supermarket, car, or security checkpoint. Designing a real-time video analysis system is a complex task, as many factors including processing speed, system cost, accuracy, and robustness, need to be carefully balanced. This research has focused these factors at two levels, algorithm level and software level. Background elimination algorithm is proposed in this paper to enhance the performance of Smart Camera systems in changing background and varying lighting condition environment. Among the main features of this research some are, Event Id, Video Id, and Human Id which give detail information about the events, videos and other tracked objects. Finally, the software implementation of AVAS is applied to detect motion and then to trigger alarm for the security purposes. The system will trigger alarm once the motion is detected and when it exceeds the desire threshold value it will give warning to prevent any loss or mass destruction. Finally, we have given a number of recommendations that need to be addressed for the future growth of surveillance technologies and meeting the end-users' diversified and dynamic requirements.

Keywords: Object detection, Object classification, Smart surveillance, Video analysis, Occlusion.

# **1. Introduction**

Optical flow can be used to study a large variety of motions, moving observer and static objects, static observer and moving objects, or both moving [1]. The optical flow field is the velocity field that represents the three-dimensional motion of object points across a two-dimensional image [2]. A basic CCTV video surveillance system consists of a collection of video cameras, mounted in fixed positions, or on pan-tilt devices, and has coverage of a circumscribed area defined by the fields of views of the cameras. The video streams are transmitted to a central location, displayed on one or several video monitors and recorded. The person in charge observes the video to determine if there is ongoing activity that warrants a response [3].

Most of the camera networks deployed today are realized as closed-circuit television (CCTV) networks in which the video cam eras stream images over a high-bandwidth communication link to a set of TV monitors [4].For real-time analysis, this becomes an unreliable and error-prone task as it is well known that the hum an attention span drops rapidly within the first 10 to 30 minutes [5, 6].An operator will miss up to 95% of scene activity after approximately 22 minutes [6].The next generation of research in surveillance is addressing not only issues in detection and tracking but also issues of event detection and automatic system calibration [7]. By tracking objects and then using the trajectories, events of interest, for instance people entering a prohibited region or people entering through an exit only door, can be detected [8]. Kettnakcr and Zabih [9] present a method to track objects in an environment monitored by multiple non-overlapping cameras. Owens and Hunter present a method to detect unusual movements, which analyzes trajectories in a model-free fashion. A trajectory description vector is used as input to a self organizing feature map neural network, which is trained to recognize normal trajectories [10].

# 2. Hardware and Software Selection

Components	Description	Quantity
7. Outdoor Box Camera	1/3" Sony Super HAD, 380TVL / 0lx / 3.6mm / 22IR LEDs / 12VDC	3
8. Dome Camera	1/3" Sony Super HAD	1
9. DVR Card	4 Channel 3rd Party DVR Card	1
10. Cable	Lay coaxial cable	50 ft
11. DVR	DVR configuration	1
12. Workmanship	Workmanship	1
13. Main Server	High Speed CPU	1

## 2.1. Software Selection

The minimum software requirements for this project are:

- Windows Vista.
- Microsoft Visual Studio 2008
- SQL Server
- Task Manager (Testing Tool Server)

#### 2.2. Necessary Camera Parameters

The following parameters are very important to consider for selecting a camera. For any surveillance system these are the fundamental requirements.

 Table 2:
 Necessary Camera Parameter

Name	Symbol	Default Value
Focal Length	fc	1000 px
Number of Image	Ν	20
Camera Zenith	θc	90
Camera Azimuth	Фс	0

# **3.** Key Technologies, Applications of Smart Surveillance System **3.1.** Human Detection

In this mode, user can connect to all available cameras, and change the surveillance settings for each camera, such as motion detection, human detection, security settings and secured parameters.

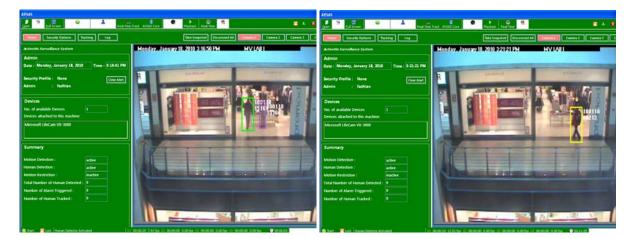


Figure 1: Shows the detected different person with different Id and blob color.

Fig.1 shows details of human detection using blob analysis. It gives an identical ID for each Human. From the figures it is clear that the system automatically can assign human id at any time for every single human. This mode also enables administrative control such as system lock, password management and profile selection. It summarizes all the running components and the result of each component such as number of motion detected, number of human detected, camera frames per second, and intruder detection. It also has full screen mode.

#### 3.2. Video and Event Analysis

	End Tae         Canadian           End Tae         Canadian           End Tae         Canadian           151140         01           151410         01           151410         01           151510         01           151510         01           151510         01           151510         01           151510         01           151510         01           151510         01           151520         01           151520         01           152000         01	ela Nane Fair Location C. MirSAS Wide C. MirSAS Wide	Status Status o. ractive o. ractive o. ractive o. ractive o. ractive o. ractive o. ractive o. ractive o. ractive o. ractive	Stand Bill Recent
Start Time           010         15.11.00           010         15.12.06           010         15.13.54           010         15.13.54           010         15.16.01           010         15.16.29           010         15.16.29           015         15.16.29           016         15.17.19           016         15.19.40           010         15.19.45           010         15.19.45           011         15.20.95	End Tane Can 1511-43 07 1512-51 07 1512-51 07 1514-57 07 1514-57 07 1519-07 1519-07 1519-07 1519-07 1519-07 1520-28 07	C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee	Status           0.         Inactive           0.         Inactive	. El Canas I El Canas I El Canas I
010         15.11.03           010         15.12.06           010         15.12.06           010         15.13.54           010         15.14.12           010         15.16.01           010         15.16.29           010         15.16.29           010         15.17.19           010         15.19.40           010         15.19.45           011         15.20.95	151148 01 151251 01 151251 01 151420 01 151457 01 151513 01 151715 01 151805 01 151924 01 152028 01	C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee C WARASWee	Anactive	
010         151206           010         151354           010         151412           010         151601           010         151601           010         151629           010         151719           011         151240           010         151249           011         151240           012         151945           013         152055	15.12.51 01 15.14.10 01 15.14.57 01 15.15.13 01 15.17.15 01 15.19.05 01 15.19.24 01 15.20.28 01	C W/MAS/Wdec C W/MAS/Wdec C W/MAS/Wdec C W/MAS/Wdec C W/MAS/Wdec C W/MAS/Wdec C W/MAS/Wdec	o. Fuctive o. Factive o. Factive o. Factive o. Factive o. Factive o. Factive	
010         151354           010         151412           010         151601           010         151629           010         151719           010         151945           010         151945           010         151945	151410         01           151457         01           151513         01           151735         01           151805         01           151924         01           152028         01	C WISAS Webe C WISAS Webe C WISAS Webe C WISAS Webe C WISAS Webe C WISAS Webe C WISAS Webe	0. inactive 0. inactive 0. inactive 0. inactive 0. inactive 0. inactive	
010         1514.12           010         1515.01           010         1516.29           010         1517.19           010         1518.40           010         1519.45           010         1519.45	15:14:52 01 15:15:13 01 15:17:15 01 15:18:05 01 15:19:24 01 15:20:28 01	C W/SASWide C W/SASWide C W/SASWide C W/SASWide C W/SASWide C W/SASWide	o. inactive o. inactive o. inactive o. inactive o. inactive	
010         15.15.01           010         15.16.29           010         15.17.19           010         15.18.40           010         15.19.45           010         15.29.55	151513 01 151715 01 151805 01 151924 01 152029 01	C W/SASWide C W/SASWide C W/SASWide C W/SASWide C W/SASWide	o. nactive o. nactive o. nactive o. nactive	
010         151629           010         151719           010         151840           010         151945           010         152055	151215 01 151805 01 151924 01 152029 01	C W/SASWideo C W/SASWideo C W/SASWideo C W/SASWideo C W/SASWideo	o inactive o inactive o inactive	
010 151719 010 151840 010 151945 010 152055	1518-05 01 1519-24 01 1520-29 01	C W/SASWideo C W/SASWideo C W/SASWideo	o inactive o, inactive	
010 151940 010 151945 010 152055	1519.24 01 1520.28 01	C WVSAS Wideo C WVSAS Wideo	o, nacive	
010 151945 010 152055	1520.29 01	C VAVSAS Wideo		
010 15.20.55			o mactive	
	15.21.09 01			
000 15/21/10		C:W/SASWideo	o inactive	
	15:21:54 01	C-WirSASWideo	o., inactive	
	No of Makara: 0	Ned Materia	Red Have a Ned Have Decide	Nod Mators

Figure 2: Video and Event details of the surveillance system.

Fig.2 gives detail information about video and event for advance analysis. All events and videos are saved into the hard disk and their locations are saved into the event and video database. This database keeps track of any event detected by the surveillance systems and linked the events to corresponding videos as in Fig. 4. This will enable the user to easily s open the video automatically and this feature can manage large volume of videos and reduces laborious work of searching tasks for single piece of video from terabytes of data.

#### **3.3. Human Database**

Fig.3 shows the database for human tracking. We can track human for the latest date or for all the dates whose videos are stored in the system. As from the figure it is visible that there is an option for image. Once we click on the image we will see the clear picture by adjusting the image size.

It becomes easy to track the exact human from the image. It saves time and gives better solution. This also shows the human id which gives another option to search the human using this id.

	luman Vid		ed Search Video Analysis			Close	00:25:19		
🤶 Huma	n Database	View Today	×						
Human ID	Event ID	Date	Time Image	White Pixel	Mean	STD DEV	Median	H.0	
0011815111501	1001181511001	1/18/2010	15:11:15	659	158.2344632768	123.7402229151	255	0	
0011815111503	1001181511003	1/18/2010	15:11:15	408	161.5527950310	122.8684546601	255	18	
0011815111502	1001181511002	1/18/2010	15:11:15	771	154.0791536050	124.6988315648	255	0	
0011815111904	1001181511006	1/18/2010	15:11:19	300	105.0824175824	125.5137522287	0	12	
0011815112105	1001181511007	1/18/2010	15:11:21	286	124.0306122448	127.4527887046	0	0	
0011815112206	1001181511008	1/18/2010	15:11:22	845	159.6111111111	123.3901395704	255	0	
0011815113707	1001181511009	1/18/2010	15:11:37	299	154.9695121951	124.5057263733	255	0	
0011815114608	1001181511010	1/18/2010	15:11:46	344	122.8571428571	127.4154381444	0	0	
0011815121501	1001181512001	1/18/2010	15:12:15	456	104.1935483870	125.3517423621	0	97	
0011815121802	1001181512002	1/18/2010	15:12:18	625	155.3362573099	124.4242451412	255	0	
0011815121803	1001181512003	1/18/2010	15:12:18	834	168.7857142857	120.6305922886	255	0	
0011815122404	1001181512004	1/18/2010	15:12:24	837	158.1	123.7735432150	255	0	
0011815122405	1001181512005	1/18/2010	15:12:24	405	140.3192934782	126.8539148576	255	0	
0011815124806	1001181512006	1/18/2010	15:12:48	331	131.8828125	127.4246481438	255	0	
0011815142301	1001181514001	1/18/2010	15:14:23	408	161.5527950310	122.8684546601	255	18	
0011815142402	1001181514002	1/18/2010	15:14:24	635	157.8216374269	123.8420296335	255	0	
0011815142403	1001181514003	1/18/2010	15:14:24	837	169.3928571428	120.4210883541	255	0	
0011815143004	1001181514004	1/18/2010	15:14:30	851	160.744444444	123.0896295939	255	0	
0011815143005	1001181514005	1/18/2010	15:14:30	410	139.0292553191	126.9776605225	255	0	
0011815145106	1001181514006	1/18/2010	15:14:52	390	125.5681818181	127.4853641737	0	0	
0011815163801	1001181516002	1/18/2010	15:16:38	468	102.9680759275	125.1176834076	0	103	_
0011815164102	1001181516006	1/18/2010	15:16:41	632	157.0760233918	124.0222110765	255	0	

Figure 3: Shows stored human databases.

# 3.4. Event Data Analysis

This data model represents the events that occur within a space that may be monitored by one or more cameras.

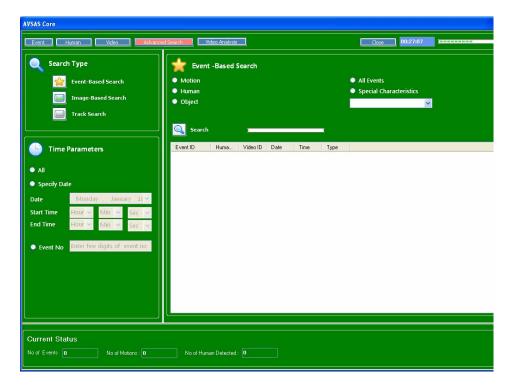


Figure 4: Details of Event based advanced search mode.

Bellow is given few key points of the Event Data:

- Event: An event is defined as an interval of time.
- Start Time: Time at which the event starts.
- Event ID: This is a unique number which identifies a specific event. We can see in our software the Event Id.
- Video Id: We can search an object also using Video ID.
- Date/Time: From the figure 11, we can see that with the Even and Video Id we can also get the event date and exact time for the desired search.

#### 3.5. Image Based Search

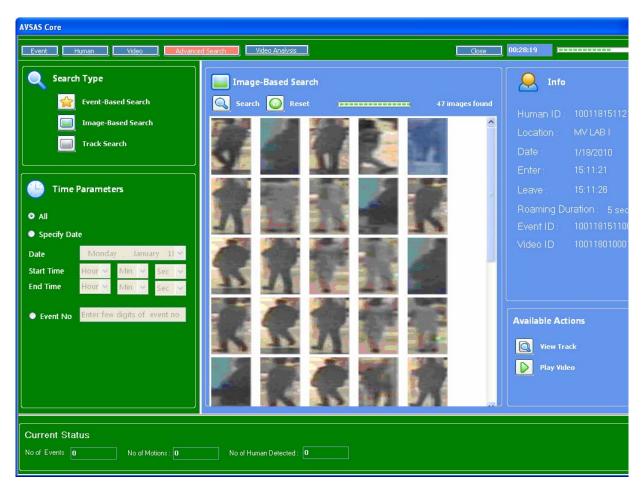


Figure 5: Details of the Image based advanced search mode.

In fig.5 it has shown the image based search result. It shows the color and the shape clearly. Also can be recognized either human or not. We can search the image in a specific date, time or using event id.

#### 3.6. Tracking

## 3.6.1 Real Time-Tracking

This shows the real-time motion tracking for the real –time video surveillance system. This plot a motion path according to the camera placement Show in details where the moving objects pass through. Different colors indicate different person or object in the graph.

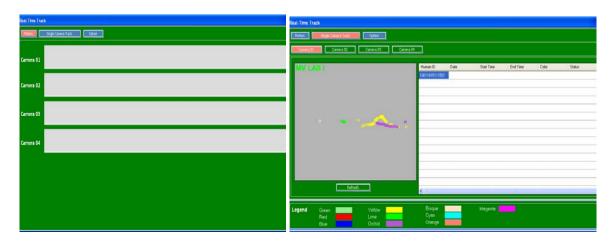


Figure 6: Real-time motion tracking for single camera.

#### 3.6.2. Advance Tracking

Figure 7: Advanced human/motion tracking mode.

AVSAS Core		AYSAS
Evert Human Webo WirAddAnset Search Mills Video Anahass	00:03:36	gen <sup>16</sup> Ful Soven <sup>10</sup> Assistant avSASCove <sup>10</sup> Playbash Real-Time <sup>10</sup> <sup>10</sup> <sup>10</sup> <sup>10</sup> <sup>10</sup> <sup>10</sup> <sup>10</sup> <sup>10</sup>
Enter Human ID Avdede Hamel D C Refreek Soarch Vew Track Database	Info Image Snapshot Location: Unavailable Date: Unavailable Enter: Unavailable Leave: Unavailable Reaming Duration: Unavailable	Texturby Options     Texturby Options     Texturby Options     Conversit     Convers
	Event ID :: Unavailable Video ID Unavailable Shirt: Unavailable Troulaer: Unavailable Hair: Unavailable Hair: Unavailable Exgend © ExdPoint © BookPoint © Rowa Point	Marine Marine Marine Color States Marine Color States MV LAB Harris Color States 100(01114/00) Dee Stat Tee End Tee Color States 100(01114/00)
Current Status No of Evens (0) No of Homan Detailed (0)		

Fig.7 gives the tracking result in using different color. Starting point is indicated by green color while route and end points are indicated by the blue and red colors respectively. From the path we can easily track the motion of human/moving object successfully.

## 4. Discussion

Our developed software works very efficiently with the real time video surveillance system. The software is a great tool to classify and track the movement of any object under the camera focus area. The software has details display mode like time, place, human or non-human, how many object, trajectory path of the moving object, video retrieve using search index, playing past videos from the hard drive and so on. The details of those features have been discussed in details in the previous.

# 4.1. Tracking Database

Figure 8: Details Surveillance Mode

ivsas			AVSAS Care					
gen Bal Street Halon Detector An Read Time Track Av	rsas cive Plentest Citible	<b>2</b> * <b>8</b>	Cont. Conner. Contes. MANAGEMENT	BRANKS ANALYSING		(and the second	MORAL21	
Security Cyclams Ricking Log	Docornert At	Canes] Canes] Canes] Co	Enter Human ID 10011215121000 👻 😈 Refiesh 🔍	icarch	Track	Detabese		
ActiveVia Surveillance System			And a second back highly second s	Ten Track Galabase	Today		10	
Admin			MV LAB I		Hutuen ID	Date	Stat Time	EndTime
Date : Monday, January 18, 2010 Time : 3:46:40 PM						1/20/2010	1511.42	1511.46
and the second			100 C		10012015114302		1511.43	15.11.48
Security Profile : None Ciral Alert			•		10012015114403		1511.44	1511.46
Admin : fadhlan					10012015115004		151150	1512-03
					10012015115005		151150	151210
Devices					10012015121206	1/20/2010	151212	151218
No. of available Devices 1					10012015124001	1/20/2010	151240	1513.00
Desices attached to this machine:					10012015130402	1/20/2010	151304	151208
And and the set of the					10012015130623	1/20/2010	151206	151315
Microsoft LifeCam VX-3000					10012015130904	1/20/2010	1513.09	151312
					10012015475001	1/20/2010	15.47.50	154813
		2			10012015481482	1/20/2010	15.4814	15.48.20
Summary					10012015481603	1/25/2010	154816	15.48.25
					10012015481904	1/20/2010	15 48 19	15.48.22
Motion Detection : inactive								
Human Defection : active								
Motion Redriction : Inactive								
Total Number of Human Detected : 0								
Number of Alarm Triggered : 0								
Number of Human Tracked : 0					<			
			Current Status No of Event II II No of Human II II II					
Start - ELoci Szreillarce Hode	0.00 fps == 00.00.00 0.00 fps == 00.00.00 0.00 fps ==	00:00:00 0.00 fps. 0 00:05:53						

Fig.8 gives detail information for surveillance options and tracking for the moving human being or object.

## 4.2. Human/Motion Racking using Color

Fig.9 tells us the details features of advanced search. We can track human using the color of shirt, trouser and hair. Also height of the moving object can be used to track the human, car, animals by the developed software. This gives more precise and accurate searching results for the surveillance system in the practical applications.

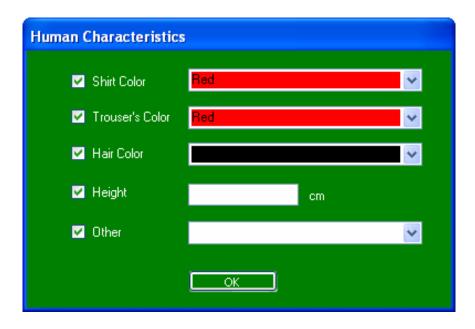


Figure 9: Human search using color code.

#### 4.3. Playback Mode

Playback mode as in Fig.10 can carry out several video analysis such as video searching according to time constraints, video searching according to video IDs or locations. It has playback feature from normal surveillance system such as play, pause, stop, fast forward, and rewind with adjustable magnitude. The user can open up to maximum 4 video at a time where each video window have the same time stamp but corresponds to different camera locations.

AVSAS Core		15A5 1 5 2 0 1 4	e Track AVSAS Core Surveilance Real-Time	<b>2</b> 4 <b>2</b>
Event Human Video Advanced Search Middle Andrea	Core 00056-48	gen Full Scheen Motion Detector Real-Time	e Track AVSAS Core Surveillance Real-Time	• * •
Enter Video ID		Playback Mode	PlayBack 0.0 fps tabPage2	
Available Video ID		Search	1	3
Available video id		Pick a Date Monday , January 18, 2010 📝		
Events related to this video		Pick a Date Monday , January 18, 2010		
		Specify Time Hour 💌 Min 👻 Sec 💌 🔍		
		· · · · · · · · · · · · · · · · · · ·		
		Control		
		Open Manually Snap Picture Disconnect All		
		🖾 Camera 1 🖾 Camera 2 🖾 Camera 3 🖾 Camera 4	00:00:00 / 00:00:00	00:00:00 /
			2	4
		•		
		D D D C C + Multiplier 10 👻		
Date: Unavailable				
Start Time : Unavailable End Time : Unavailable				
Dutation: Unavailable Location: Unavailable	🕞 🕕 😥 🚳 🔲 x Multipler 🛽			
		Video Summary		
Current Status		Date :		
No of Events 0 No of Motions : 0 No of Human Detected : 0		Start Time : End Time :		
		Start ELock Automatic Playback 0:	00:00:00 0.00 fps 02 00:00:00 0.00 fps 03 00:00:00 0.00 fps 04	00:00:00 0.00 fps 200:05:16

Figure 10: Displays stored video and playback mode.

Fig.10 also describes the advance playback option in the developed system. We can play the video back as forward, backward, slow or fast from the stored video database.

#### 4.4. Movement Search

In fig11.it is shown that if anything has a motion under the surveillance area then immediately the system stored the motion by assigning the identical id to the moving object/human.

VSAS Core			AVSAS Core			
	Alteretitett	Com 101921 NEEDOCCOULD	Event Human Video.	Titles Analysis	Close 00.02:33	
Search Type Search Type Corol-Based Search Dauge-Based Search Track Search	Verent -Based Search     O Motion     Homune     Object     Giget	Al Forents     Spread Characteristics     Se     239 averts	Enter Human ID 100101511226 V (5) Refresh ( WV LAB	Search Teev Track Database	Infe         Image           Human ID :         10011815112206         Image           Location :         MVLAB1         Date :         1/18/2010           Date :         1/18/2010         Enter:         15.11.22	ge Snaps
Time Parameters      A      Specify Date      Date      The Specify Date      Surface      A       Constraint      Constr	Earlier         Marcin         Marcin         Call         The Coll         The	4 4 5 6 6 7 7 7 7 7 7 7 7 7 7 7 7 7			Leave : 15:11.28 Rotming Duration : 4 seconds Event ID : 1001/8/15/1008 Video ID : 1001/8/15/1008 Video ID : 1001/8/15/1008 Trouser : Unevalable Hair : Unevalable Legend End Point O Storing Point O Storing Point O Storing Point	1
Current Status	No of Human Datected : 0		Current Status No of Events 0 No of Molecus	No of Human Delected : 0		

Figure 11: Shows the motion search option and image based tracking

#### **4.4.1. Object Detection**

This software can detect moving objects in a video sequence generated by a static camera.

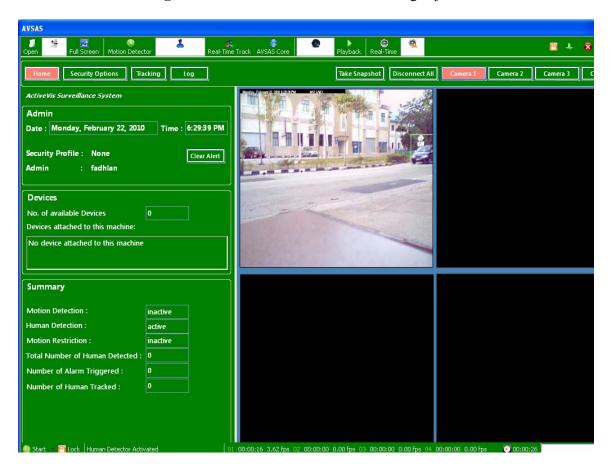


Figure 12: Shows a detected car as a moving object.

Fig.12 shows a moving car, detected by the system which serves as a means of advance surveillance application for highly secured purposes. The detection techniques are invariant to changes in natural lighting, reasonable changes in the weather, distraction movements and camera shake. Several algorithms are available in this software including adaptive background subtraction with healing which assumes a stationary background and treats all changes in the scene as objects of interest and salient motion detection [10] which assumes that a scene will have many different types of motion, of which some types are of interest from a surveillance perspective.

#### 4.4.2 Object Tracking

This software can track the shape and position of multiple objects as they move around a space that is monitored by a static camera.

# 4.4.3. Object Classification

This software uses various properties of an object including shape, size and movement to assign a class label to the objects. Our system fulfills the following criteria for advance search:

- i. Search by *Time* retrieves all events that occurred during a specified time interval.
- ii. Search by Object Presence retrieves the last specified number of events from a live system.
- iii. Search by *Object Size* retrieves events where the maximum object size matches the specified range specified in the programming part.
- iv. Search by *Object Speed* retrieves all objects moving within a specified velocity range as the user desired for their own verification purposes.
- v. Search by Object Color retrieves all objects within a specified color range.
- vi. Search by Object Location retrieves all objects within a specified area in a camera.
- vii. Search by Activity Duration retrieves all events with time durations within the specified range.
- viii. Joint Search combines one or more of the above criteria as specified by the user.

# 5. Key Challenges in Surveillance System

Three important key challenges for Smart Camera:

# 5.1. The Multi-scale Challenge

This is one of the biggest challenges of a smart camera. Multi-scale techniques open up a whole new area of research, including camera control, processing video from moving object, resource allocation, and task-based camera management in addition to challenges in performance modeling and evaluation.

# 5.2. The Contextual Event Detection Challenge

This challenge is mostly on using knowledge of time and deployment conditions to improve video analysis, using geometric models of the environment and other object and activity models to interpret events, and using learning techniques to improve system performance and detect unusual events.

# 5.3. The large System Deployment Challenge

It has several challenges include minimizing the cost of wiring, meeting the need for low-power hardware for battery-operated camera installations, meeting the need for automatic calibration of cameras and automatic fault detection, and developing system management tools.

# 6. Conclusion

We have presented our developed software for the surveillance and security purposes. Also we have introduced a smart video surveillance system, which relates the computer vision algorithms for surveillance system. All these methods are linked with the surveillance system. From the practical point of view we found the developed software is more effective compare to the traditional surveillance system as well as it has a detail "Display Mode" which helps us to track the moving object in an easier way.

# 7. Recommendations for Future Works

There are few recommendations for further research:

- (i) High resolution camera should be used where clear images are necessary.
- (ii) For dark place and at night, day/night camera best suits for surveillance purposes.
- (iii) Wireless camera can be used to reduce wiring and maintenance cost.

# References

- [1] A.A.Shafie, M.H.Ali, Fadhlan Hafiz, "Classification of Optical Flow Patterns for Motion Detection." The 7th International Conference on Robotics, Vision, Signal Processing, & Power Applications (RoViSP 2009)18-19 December 2009. P1028. Awana Porto Malai Hotel, Penang, Malaysia.
- [2] A.A.Shafie, Fadhlan Hafiz, **M.H.Ali**, "Motion Detection Techniques Using Optical flow". International Conference on Computer, Electrical, and Systems Science, and Engineering, Vol-56, pp-559, Singapore, August 26-28, 2009.
- [3] C. P. Diehl, "Toward Efficient Collaborative Classification For Distributed Video Surveillance," PhD thesis, Carnegie Mellon University, 2000.
- [4] M. Valera and S. Velastin, "Intelligent distributed surveillance systems: a review," IEE Proceedings Vision, Image, and Signal Processing, vol. 152, no. 2, pp. 192-204, Apr. 2005.
- [5] N. Custance and G. Leach, "Image surveillance systems: some novel design features," in Crime Countermeasures, Proceedings of the IEEE 1990 International Carnahan Conference on Security Technology, Oct. 1990, pp. 73-77.
- [6] C. Steffen and D. Cogswell, "A user's guide to digital video," Aventura Technologies, User's Guide, 2006.
- [7] VACE: Video Analysis and Content Exploitation [Online]. http://www.icarda.org/InfoExploit/vace/
- [8] S. Velipasalar, L. M. Brown and A. Hampapur. "Specifying, interpreting and detecting highlevel, spatio-temporal, composite events in single and multi-camera systems," *International Workshop on Semantic Learning Applications in Multimedia (SLAM) in conjunction with IEEE CVPR*. New York, NY, June 17-22, 2006.
- [9] V. Kettnaker and B. Zabih, "Bayesian multi-camera surveillance," *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition* (CVPR), pp. 253-259, 1999.
- [10] J. Owens and A. Hunter, "Application of the self-organizing map to trajectory classification." *Third IEEE International Workshop on Visual Surveillance*, pp. 77-83, July 2000.