

# A Review of Securing Home Using Video Surveillance

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**Abstract:** Home security has been a concern of worldwide. The need of security systems is considered as one of the important aspects of our modern life, people are using such systems to be aware about anything could be happen in their places like their houses when they are away, these system also let them feel more secure and that is what the people really need. As the technology is emerging, abundant home based security systems have been developed and implemented to keep their welfare safe. Video surveillance is an important area of computer vision research, its applications including both outdoor and indoor automated surveillance systems Home security system is an essential mean of protecting our home from illegal invasion. A conventional home security system consists of a Closed Circuit Television, CCTV and burglar alarm which can be replaced by computer based systems with the capability of smarter detection and alert system. In the context of smart home environments, the In-House Video Surveillance systems have as main goal to control the safety and the security of materials and of people living in a domestic environment. This paper provides an overview of various methods and techniques that address the problems of representation, recognition and learning of events, actions and activities of inhabitants from a demotic environment.

**Keywords:** Home Security, Video surveillance, Motion detection, Security approaches, Communication methodology.

## 1. Introduction

Security is one of the biggest issues in today's world. The current home-security service system in market included preventing thieves from intruding, monitoring and control system, fire control etc. Even though all of them were comprehensive, yet there still were some defects among them such as the consumers must construct cooperative relationship with security supplier, and this condition resulted in high expenditure for service quality as well as much difficulty in maintain and discriminating of responsibility. The existing system can be broadly categorized into;

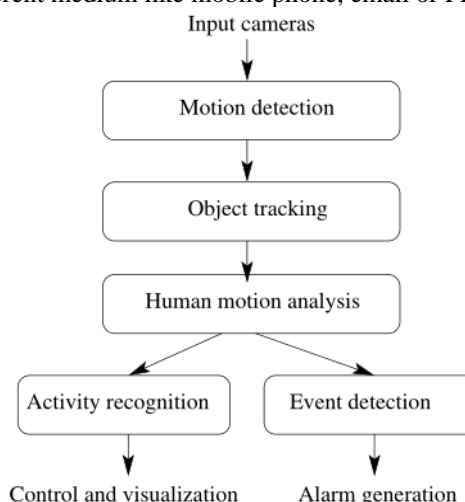
1. Microcontroller circuit based
2. Microprocessor based

Video surveillance in smart home environments, attempts to detect, recognize and track persons from image sequences, and more importantly to understand and recognize their actions and activities. Video surveillance systems in smart home environments can be classified as: (a) centralized systems, where human activity analysis is performed on a centralized server, and (b) distributed systems, where analysis is performed on a distributed cameras network. In general, an in-house video surveillance system includes, as presented in Figure 1, the following modules: (a) motion detection, (b) object tracking, and (c) human motion analysis.

Computer vision based solutions have the potential for very discriminating detection and very low false alarms. The bottom line is that applied computer vision has the potential for the greatest return on investment (ROI), both short-term and long-term. The research in the field of vision surveillance meets with the research in several smart home

techniques, especially in two important demotic aspects: home health, and home security.

An indoor surveillance system attempts to detect and recognize objects of interest from video obtained by one or more cameras along, eventually by fusion information obtained from cameras and other sensors installed in the monitored area. The output of video surveillance aims in determining decision on the object detected. The action can range from raising an alarm as in conventional security systems to sending automated short messages on owners cell phone and automatic e mails with pictures from house to the house owner. There is surely a need for a system which can act as a surveillance for our offices and home and which is easy to use, which can run on a PC, which can be accessed via different medium like mobile phone, email or PDA.



**Figure 1:** Traditional processing in in-house surveillance

## 2. Requirements of HSS

A security system isn't very reliable unless it is able to monitor your home for potential threats and then alert someone when it detects such threats. Monitoring services generally provide professional security systems as part of their service contracts. These services will watch over your home 24 hours a day, and will send police, fire and rescue personnel if an alarm is triggered. If you have cellular or internet monitoring as part of your security system, you can get instant notifications of any activity detected in your home. As stated in [4] a home security system must satisfy these requirements ideally. The requirements were classified as functional requirements and non-functional requirements which are as follows:

### 2.1 Functional Requirements

- The system should be a distributed system.
- The system should be able to capture video.
- The system should be able to detect motion from the captured video.
- The system should be able to take snapshots of the moving objects/intruder.
- The system should be able to send SMS in real time to notify the stakeholder (person interested in the security of the premises).
- The system should be able to generate automated emails for notifications.
- The system should be able to handle more than one client at the same time (Multi-tasking/Multi-threading).
- The system should be able to transfer the snapshots to distributed location for permanent storage, so this could provide accessibility to stakeholder to see them from remote location.
- The system should also provide web-based front end for users to register and download software.
- The system should be able to restrict unauthorized access.
- The system should have GUI at the client side of the system for users to interact with the system.

### 2.2) Non Functional Requirements:

- The system should be robust.
- The system should be user friendly
- It should be operating system independent.

The above requirements can be deeply analyzed under the focus of following parameters [14] that can be applied to any type of security system.

(E1) Cost: The cost of the hardware and software that is used to implement system

(E2) Friendliness: The ease with which the user could interact with the system to locate an object of interest

(E3) Range: The monitored area that can be covered by the system is range.

(E4) Calibration: The amount of work needed from when the cameras are physically mounted, until the system is fully operational.

(E5) System Complexity: The sophistication of the entire systems hardware.

(E6) Software Complexity: The ability of the systems

software to adapt to changes in the monitored scene and possible camera failures.

(E7) Robustness: The system's ability to deal with changes in physical factors

(E8) Scalability: The ease with which cameras could be added or removed from the system.

(E9) Lifetime: The duration of time for which the system could perform consistently.

(E10) Real-time: systems ability to respond to queries about an objects location at any time and return the result without the user noticing a delay.

(E11) Reliability: The ability of systems software to consistently provide correct results to the user.

(E12) Self-Starting: If a system was disrupted by a total system failure (such as that in a power outage), the system could restart itself without human intervention.

(E13) Synthesis: The ability of a system to create an virtual environment from all cameras.

(E14) Alternative Power: The ability of the system to run (if only for finite period of time) without electricity from the general power grid.

**Table 1:** Relative importance of elements

	User	Engineer	Software Developer	MD/Provider	Average
E1	10	8	7	2	6.75
E2	10	8	8	10	9.00
E3	10	10	5	8	8.25
E4	5	10	1	5	5.25
E5	7	10	6	8	7.75
E6	4	9	10	7	7.50
E7	10	10	10	10	10.00
E8	10	10	10	10	10.00
E9	10	9	7	10	9.00
E10	10	9	9	10	9.50
E11	10	10	10	10	10.00
E12	10	10	10	10	10.00
E13	6	9	10	10	8.75
E14	10	10	5	10	8.75

## 3. Approaches of HSS

The efforts of detection of intruders in done using microcontroller based systems. Yanbo Zhao and Zhaohui Ye [13] had designed and implemented a low cost, low power consumption, and GSM/GPRS (Global System for Mobile Communication/General Packet Radio Service) based wireless home security system is dealt with . The system is a wireless home network which contains a GSM/GPRS gateway and three kinds of wireless security sensor nodes that are door security nodes, infrared security nodes and fire alarm nodes. The nodes are easy installing. The system can response rapidly to alarm incidents and has a friendly user interface including a LCD (Liquid Crystal Display) and a capacitive sensor keyboard. The wireless communication protocol between the gateway and the nodes is made suitable for other home appliances. The system represent that GSM/GPRS is more convenient and reliable than internet. The system has the shortcomings like need of two processor architecture, Simple sensor based system with no use of cameras for intruder detection, inability to identify residents, manual setting is to be done with keyboard, use of microprocessor at every sensor and alarm is ON and SMS is send in all the situations

John See and Sze-Wei Lee [14] propose an integrated dual-level vision-based home security system, which consists of two subsystems – a face recognition module and a motion detection module. The primary face recognition module functions as a user authentication device. On an event of a failure in the primary system, the secondary motion detection module acts as a reliable backup to detect human-related motions within certain locations inside the home. Novel algorithms have been proposed for both subsystems. Several experiments and field tests conducted have shown good performance and feasible implementation in both subsystems. The Vision-based security system having the advantage of easy to set up, inexpensive and non-obtrusive. The system poses the advantages like - unobtrusive and user-friendly vision based system, User authentication and intruder tracking from distance, No need of human intervention, No need of human contact with sensors and Setup being easy and inexpensive. The system also has the cons like - requirement two processors for operations, One camera only monitors door/entrance, System based on human motion detection, heavy computations for Fuzzy rule based classification scheme and system alerts only security alarm

The efforts of Young-Keun Choi et al [18]] recommend a new algorithm to detect the intruder in room. The basic idea of the proposed method is to estimate the variation of features of the room acoustic transfer function (RTF). Several simulations and actually tests show that the proposed method provides good performance for intruder detection. The system has the disadvantages like highly sensitive to Room transfer function, requirement of speaker and microphones, more power consumption and system alerts only via alarm.

Recent progress in wireless technologies has led to the renovation in building automation which makes it possible to upgrade the existing building without destroying the original interior decorations. Jun Hou et.al proposed an intelligent home security system based on Zigbee [12] which can monitor the important positions inside a home through a surveillance camera. The home state SMS and image Multimedia Message Service (MMS) can be sent to mobile phones. Zigbee modules are used to connect the system motherboard with temperature and gas sensors, forming a Wireless Sensor Network (WSN). But this system requires an expensive and high end system mother board for controlling and managing the WSN. Vivek Nainwal et.al proposed a system which explores WSN for remote surveillance [5]. Sensors are used to detect the presence of objects in the surveillance area and the information is collected over time to extract the event of interest. The information gathered by the surveillance camera i.e. video or still images could be used for further analysis and detection of the intruding object. But the proposed system uses the traditional sensor alarm method for user notification and does utilizing advanced alerting techniques like call making.

Advantages of computer based approach:

- High stability: Run continuously for more than 300 days.
- High operation of file storage: The file name and its path express time and location information.

- Minimum necessary storage: Simple picture selection software has been adapted. The software saves a picture only when the difference between two consecutive pictures exceeds the threshold.
- Automatic delete: Folders that are older than the save period set by the owner are automatically deleted.
- Compatibility with many types of cameras: The software can operate in the VFW mode (PC cameras and USB video adapters) and the FTP mode (network cameras).
- Simultaneous operation: The software can operate several cameras connected to a PC.

## 4. Motion Recognition

### 4.1. Motion Detection

Motion detection methods attempt to locate connected regions of pixels that represent the moving objects within the scene. Conventional approaches for motion detection methods use background subtraction, temporal differencing and optical flow. As the name indicates background subtraction consists in subtraction of a background or reference model from the current image followed by a labeling process. Recent background subtraction algorithms focused on adapting to varying illumination conditions, geometry reconfiguration of background structure, and repetitive motion from clutter. Among others may include methods such as: (a) background subtraction methods for modeling a multiple modal background distribution [9], which use a Gaussian-based approach for real-time applications, (b) statistical background modeling [10], where an edge segment-based statistical background modeling is used, and (c) universal background subtraction algorithm for video sequences [6], which stores a set of values taken in the past in the same location or in the neighborhood. In temporal differencing the subtraction of two or more consecutive frames followed by thresholding is applied. The optical flow approach uses the velocity field that warps one image into another image.

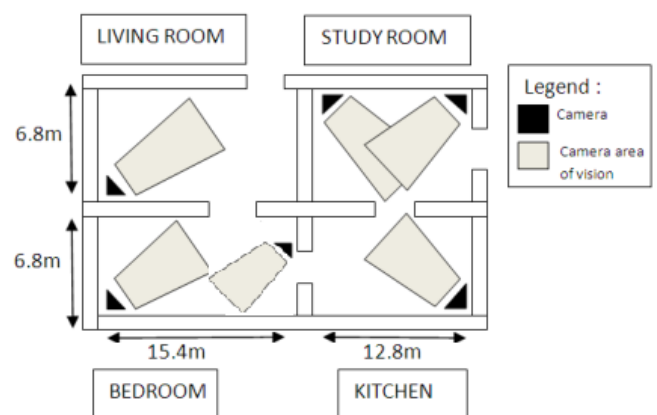


Figure 2: An example of camera placement

**Table 2:** Comparison between methods

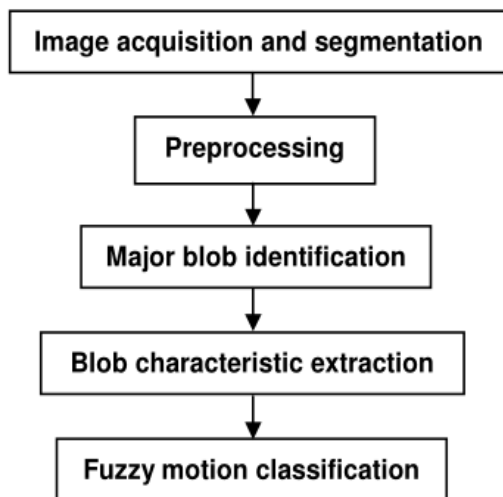
Method	Merits	Demerits
Background subtraction	Simple	extremely sensitive to changes in light
Temporal differencing	robust to dynamic changes of the environment	poor results in case of moving objects
Optical flow based	detect independently moving objects even in the presence of camera motion	computationally complex and very sensitive to noise cannot be applied to video streams in real time without using specialized hardware

**4.2 Object Tracking**

The object tracking module is responsible for detecting and tracking of moving objects by using information from the motion detection module, object locations being subsequently transformed into 3D coordinates. There are several approaches to classify object tracking methods. According to [17], object tracking can be classified into (i) region-based tracking, (ii) active contour-based tracking, (iii) feature-based tracking, and (iv) model-based tracking.

**4.3 Motion Analysis:**

After the of motion detection step, human actions can be viewed as a series of detected motions. In [15] an action taxonomy is defined, based on the degree of abstraction: (a) basic motion recognition, or action primitives, which represent the atomic entities out of which actions are built, (b) a set of different or repetitive action primitives that make up an action, and (c) activities, which represent complex sequence of actions performed by several humans who could be interacting with each other in a constrained manner.



**Human motion detection algorithm flow**

**Figure 3:** Steps in motion recognition

**5. Decisions**

In this part of the module of any home security system, involvement of humans is significant. The systems are designed only for identification of object, motion and can be made to operate in variable lighting conditions but the major part of identifying the object still needs human intelligence. In system proposed in [13] working on two cameras need the

human intervention to identify the unknown but the system represent that GSM/GPRS is more convenient and reliable than internet. In another low cost alternative [8] the elders can also see the stranger at the door and make a conversation with them. In addition to informing the police, the system also activates an emergency alarm to alert the neighbors. Even this system requires a person for taking decision and it is clearly mentioned in the paper that the person should be good in health for operating the system. In some system like [13] [3], the home user is made aware using SMS. The GSM/GPRS modem can be an external device or a PC card. External GSM modem is connected to a computer via serial cable or USB. The GSM/GPRS modem requires a SIM card to operate and is configured using AT commands. The compatibility with receiving mobile phone is very important. This mode is very fast, efficient and can be operated from command line which is very helpful in integrating into new developed system.

**Table 3:** AT Commands

AT+CMGS	To send a text message
AT+CMGR	To read a text message
AT+CMGD	To delete a text message

Further the other alternative to short message is to send email with details of detection and notify about the mail via SMS. This particular method is a very good way of communicating the information as the detailed images consider the scenario inside the house and less text in message will transmit the message fast.

**6. Conclusion**

In this paper, we have presented an overview of the current approaches on vision surveillance techniques for secured home environments. In this review, we have summarized the methodologies used in several stages of an in- house video surveillance system: motion detection, object tracking, and human activity recognition. There is still research to be done into robustly tracking the wide variety of possible objects that one camera may see, and into methods that would allow multiple cameras to share the information that they gather amongst themselves. From the analysis it is clear that a computer based system can be a better alternative to microcontroller based systems. Further a visual feedback will also be preferred over a short message.

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