# Setrix
# Wireless Video Monitoring Solution

**June 2002**

## Remote Vision

The proliferation of the Internet has opened the door to new and affordable "remote vision" applications. The personal "web-cam", which is a networked camera with an embedded web server, allows people to watch live scenes remotely using a PC and an Internet connection. Anyone, with very little training, can set up the web cam and run the system in a few hours. The communication bandwidth, network traffic, and the video compression technology determine how fast the scene can be "streamed"[1] over the packet-switching network. The web-cam demonstrates the technology and it is fun to have — but its usefulness is hardly convincing.

On the other hand, traditional video surveillance vendors have been enhancing their professional product lines by using digital technology to compress and store the video in mass storage. The recorded content can then be accessed via the Internet by either file download or sometimes video streaming. The focus of surveillance products is on the complete recording of the monitored scene and offline viewing. Usually these products don't have the capability to view the live scene remotely. Furthermore, searching for an unusual event in voluminous recording media can be tedious.

The web-cam devices and the traditional surveillance products lack many important usability features that users would prefer for monitoring and security applications. First of all, users would like to be notified immediately an event occurs, rather than having to constantly view the remote scene, even though nothing is happening. Secondly, they would like to be informed and be able to interact with the remote vision device quickly, anywhere, anytime, rather than having to rely on a fixed PC with an Internet connection. A notebook PC with a wireless connection is a clumsy solution since the setup can be time consuming. Users should be able to use a client device that is as easy and convenient as a cellular phone. Thirdly, the remote camera device should be able to record video events of interest autonomously so that users can access them at any time. Fourthly, users should be able to set up a "Personal Remote Vision System" in a few minutes — both the server side (camera) and the client side (mobile viewing devices). And last but not least, the cost of ownership of the system should be affordable for the end user, especially the wireless bandwidth cost.

Setrix has developed a complete video monitoring solution with the aim of offering an easy-to-install and easy-to-use system based on existing wireless network infrastructures. The core of the system is a smart video recording server device that continuously analyzes the video, detects unusual events, and records the corresponding video locally. When an unusual event occurs, an alarm message with relevant but compact information is sent to the selected recipients via a GSM SMS, circuit-switched data or GPRS service. The recipient can then access the past event log of the server device and decide whether to request further information such as the alarm-triggering image or the recorded alarm video on the client device, or to ignore the alarm completely. A user can also watch the live remote video if desired. All responses to client requests, such as video streaming, occur simultaneously with the continuous video capture-analysis-detect-record cycle in the server device. This deliver-while-record functionality is similar to the playback-while-record function of the modern digital video recorder, such as TiVo™ systems for TV programs[2]. The

[1] Streaming of the media – video or audio – means the content travels in a continuous stream of packets of data. The user's computer can play the media as it is received rather than waiting for the entire file to be downloaded.

[2] See the TiVo™ patent: "Multimedia time warping system", US Patent 6,233,389.

difference is that in this case, the media playback is not to a local monitor, but to a remote client device.

In this white paper, we will describe in detail the system structure, technology, and applications.

## System Structure

There are three basic components of the system: the camera server, the viewing client, and the network infrastructure, as shown in Figure 1. The camera server is a Setrix S37xx[3] product, complete with a vision sensor, a RISC CPU with media storage and a wireless GSM module or wired/wireless LAN modules (e.g., 802.11b). The GSM module is a Siemens TC-35 (circuit-switched data, SMS) or MC-35 (GPRS) dual-band data module that supports GSM900 and GSM 1800 networks. The camera server can connect to the internet or landline network (POTS, ISDN) using the services provided by the GSM network operator. The viewing client can be a fixed PC with Internet connection, a PDA with a GSM network connection, or a GSM cellular phone. The straightforward system structure doesn't require any intermediate server or gateway to host this application. The camera server device communicates directly with the GSM-equipped client device via the GSM network operator.

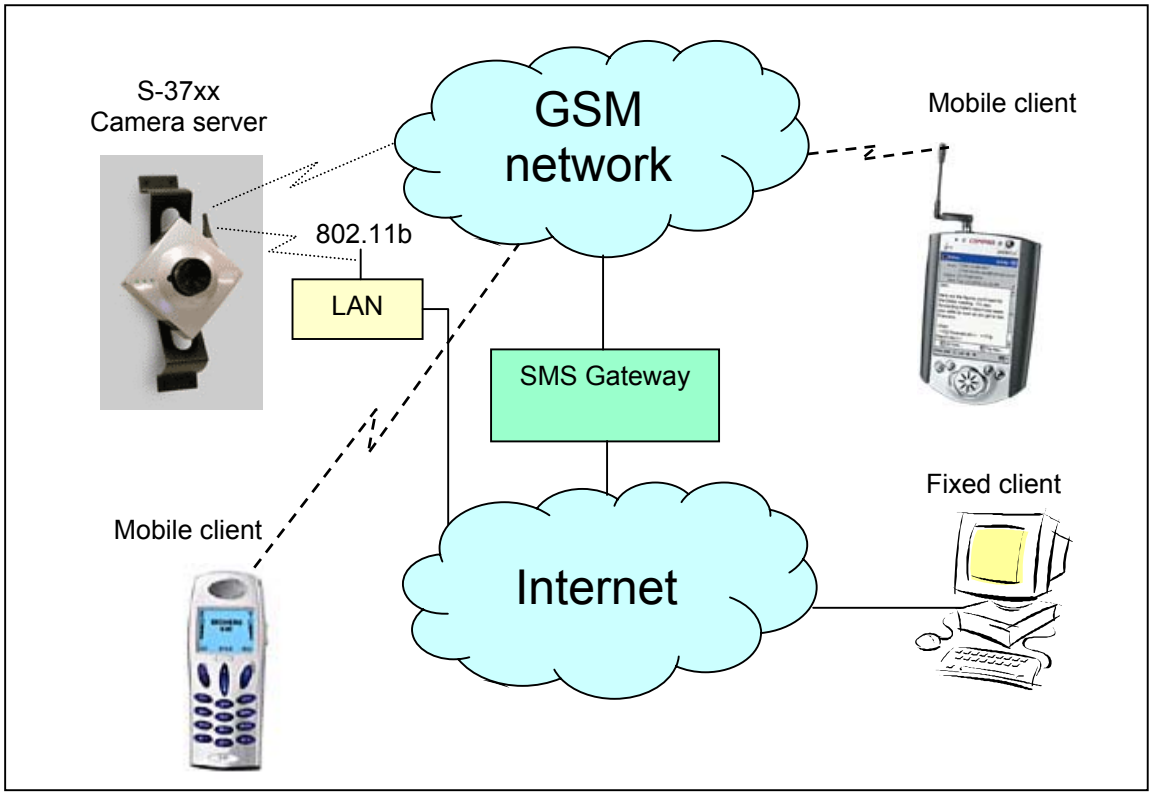


Figure 1 The mobile client and fixed client can access the event and video data stored in the camera server via a GSM network or internet.

Technically, the client device makes a CSD (Circuit-Switched Data) call and establishes a PPP (Point-to-Point Protocol) with the camera server. The two sides can then communicate using

[3] Currently there are three S37xx products for the video monitoring application: S3700, S3721 and S3721x. Please contact Setrix for details.

TCP/IP. Since this is a circuit-switch connection, only one client can talk to the camera server at a time. If the GPRS service is used (with a MC-35 module), then the connection is open all the time and multiple clients can access the camera server simultaneously. This simple solution is most appropriate for users who need only a "personal" remote video system to monitor a few places such as private homes, business offices, or private warehouses. For a business enterprise with camera server devices installed on a wider scale, an SMS gateway between the GSM network and the Internet may be more suitable. The SMS gateway can perform management functions for all installed camera servers and cache data from the camera servers. Setrix already has project experience of running an SMS gateway.

If it is necessary to monitor several places in one location, the camera server can be expanded to multiple slave cameras and one camera master (or camera gateway). The difference between the slave and master is that only the camera master has the GSM module. The communication between the master and slave cameras can be established using the wired Ethernet, the power-line communication, or the wireless 801.11b network. The power-line network is convenient for a home environment where the wire installation is difficult. Each slave camera device performs the video capture-analysis-detect-record function locally. The camera gateway obtains the data from the camera slaves when the user makes a request associated with the slave cameras. The system is scalable in the sense that slave cameras can be added incrementally without interrupting the existing system operation.

Instead of installing multiple cameras at one location as discussed above, another alternative is to mount the camera server on a mobile platform (robot). The camera server then controls the motion of the mobile robot. Because S37xx is a compact and lightweight device and consumes very little power, a small battery-powered mobile robot[4] can direct the camera server to any position or any viewing direction to perform the monitoring task. No wire is required. A remote user can even control the robot movement while the live video is being viewed.

## Smart Video Recording

One of the key technologies Setrix has developed in the camera server is the ability to record unusual events and corresponding video by using image analysis technology. When the camera is viewing a stationary scene any motion of the objects within the field of view is detected, tracked and analyzed. The image analysis software can adapt to a slowly changing illumination of the environment. Based on the characteristics of the object movement, the system can determine what alarming events should be recorded and what alarming events should be notified to recipients immediately. For example, an intruder, but not a moving pet in the house, can trigger an alarm. The camera server can be programmed to recognize different kinds of unusual situations. Because of the built-in image analysis capability, the system does not record when nothing is happening. This conserves storage space in the camera server and eliminates the need for the user to search for events of interest, because they can be predefined instead.

The system is designed in such a way that the recorded information can be accessed at different levels. For example, users can first obtain a list of past events and a brief textual description. They can then access the alarming image shot of a suspicious event. If the situation warrants further investigation, the full video can be displayed. Each level allows more valuable data to be accessed that in turn raises the cost of the wireless payload transfer. With this system the user gets only the information needed, anytime, anywhere, and without delay.

[4] See www.cs.cmu.edu/~pprk

The camera server can monitor a scene 24 hours a day and 7 days a week. However, due to the limited storage capacity in the camera server, the historic data will be cyclically overwritten. Instead of simply erasing the entire event data, the server condenses the information in various levels of data granularity. For example, when the data of the oldest event has to be replaced, the first step is to erase all the video frames except for one alarming image shot. If more storage space is needed, the alarming image itself is removed. However, the time history of the moving object representation (only location and size) is retained in the event database. With a single image and the time history of moving object representation, a simulated alarming event video can still be created.

Figure 2 shows a block diagram of the processing in the S37xx camera server. The dashed arrow from the "image analysis" to "encoder" indicates the recording of the images/video, which only occurs for alarmed events.

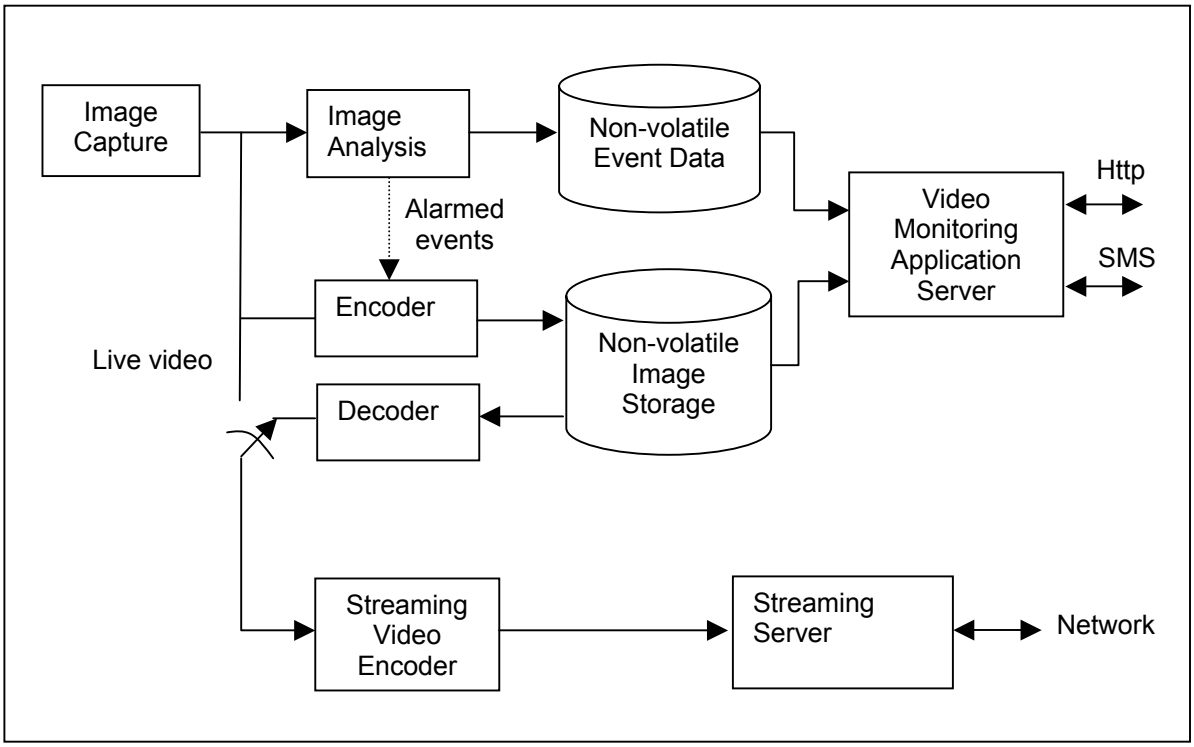


Figure 2 The processing in the S37xx camera server

Instead of erasing the old event data stored on the camera server, the system can be configured to archive a portion of the event data to a PC with larger storage capacity during a few predefined hours during the day. During this off-the-air period, requests from clients are suspended. However, the monitoring task is still continued. For circuit-switched data service, the upload data rate from the camera server to the network is limited at 9600 bps. Therefore one off-the-air hour can archive about 1 Mbytes of data if GSM circuit-switched data service is used. Because the cost of wireless bandwidth usage may be based on the data volume transferred, this archiving alternative must be weighted against the cost.

With the current implementation using an S37xx as a camera server, the system is capable of monitoring a scene and recording the video at about 4-5 frames per second. The local storage media inside the S37xx can be a compact flash (CF) card or an IBM microdrive, with a storage capacity from 16MB to 1GB (6GB soon). With a 256MB CF card, the camera server can store 1.5 hours of alarmed event data and alarmed color video. If alarm events only occur 10% of the time, then the camera server can store event data with full video of the past 10 hours and the event data with a single alarmed image of the past 7 days, without the need for remote archiving.

## Video Compression and Streaming

The video compression and video streaming in the camera server is performed completely by the software for which various standard techniques such as MPEG4, H263 or MPEG1 are available. For media transport, standard streaming protocols such as RTP/RTSP or HTTP streaming are used. By using standard protocols, a wide selection of mobile client devices, such as Compaq's iPAQ or Casio's Cassiopeia can be used to access the information from the camera server using a GSM network. Figure 3 shows a frame of the surveillance video captured and processed by S3700. The moving object that triggers the alarm is highlighted in yellow color. There is also another smaller moving object (in blue) in the upper right region. (In this simple example, the system is configured to set an alarm for any moving object larger than a certain size. There are more sophisticated alarm definitions implemented in S37xx.) The video is compressed using the MPEG4 compression standard, with a constant bit rate of 9000 bits per second. The data is streamed over the network to a client device.

Figure 3 A single frame of the surveillance video. The region highlighted in yellow is the moving object that triggers the alarm.

## Applications

Because all applications in the S37xx camera server are implemented in software, it is easy to tailor the system for the special requirements of applications. In general, the system is capable of all traditional video-monitoring applications, such as

- Residential house monitoring
- Warehouse monitoring

- People counting in retail stores
- Monitoring of remote facilities, such as power stations and railroads
- Border surveillance
- Monitoring of high crime areas
- Parking lot or parking garage monitoring for safety or space management

The system is easy to deploy because it uses the existing wireless network infrastructure. This is especially useful for countries where the landline network infrastructure is not well established.

In the following, we describe a warehouse-monitoring scenario.

Mr. Davis is the owner of a small business. He has three warehouses at three sites in New Jersey, USA. Because of his business, he needs to travel a lot. However, he would like to know, whether in the office or on the road, what is going on in his warehouses. Having learned about Setrix's solution, he bought three camera server masters and six camera slaves. In each warehouse, he installed one camera master and two camera slaves at suitable locations and plugged the units to the power outlet. All three cameras communicate via the power-line network and no extra wire is required. In one warehouse, he added a slave camera on a mobile platform in order to monitor several places cyclically. The mobile camera has a wireless 802.11b module that communicates with the master camera server. He purchased a GSM service contract for each master camera. Since Mr. Davis already has a wireless GSM-enabled PDA, he is able to access the camera server using the PDA after completing the simple setup procedure.

Mr. Davis wants the system to inform him whenever any of the docking doors in the truck loading/unloading area are opened or closed. He also wants the system to record, but not inform him, of all people entering or leaving the front door. At the end of the day, if desired, he can get a summary of people counts over time or even see the images of the people. During off-duty hours, he wants all cameras to monitor for intruders or unusual events and to inform him immediately. All these requests are programmed by Mr. Davis who sets the appropriate parameters using a GUI. The programming of the mobile camera slave in one of the warehouses takes a little longer since Mr. Davis needs to train and orient the mobile camera on the various monitoring locations.

After the installation, the system runs as planned by Mr. Davis. Whenever the docking door in one of the warehouse is opened, he receives an SMS message. Sometimes he chooses to attend to the event later and sometimes he immediately views the streaming video on his PDA. On one occasion, Mr. Davis received an alarm during the night from the warehouse with the mobile camera. After viewing the video of the alarmed event, he decided to change the angle of the camera that was recording the event, so he redirected the mobile camera while viewing the live video in order to get a close-up view. It turned out that in one corner of the warehouse some smoke was starting to build up. So he called the fire department immediately.

The application scenario described above could be taken from real life. The technology and the products are available today!

## Delivering Useful and Affordable Remote Vision Professionally

Setrix's video monitoring solutions focus on three points: (1) usefulness, (2) affordability and (3) reliability. The system delivers the appropriate amount of monitoring information to the user as soon as the event occurs, no matter where the user is located. The user can decide what amount

of data (image or video) to view, when (now or later) and how (mobile or fixed connection). The solution is based on a wireless network infrastructure, which means it is affordable and easy to set up and use. Ease of deployment is the key differentiation of Setrix's product from conventional video surveillance products. Just aim the camera, connect the power and the system is on. The system is designed to run 24 x 7 non-stop. It can recover autonomously from power-loss without user intervention. Unlike the web-cam that is fun to have, Setrix's solution is meant for serious applications, for consumers or business enterprises. A technical specification of the S3700-based Smart Video Recorder is in the Appendix.

For further information or a demonstration, please contact

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## Appendix

### Technical Specification of the S3700-based Smart Video Recorder

| | |
|---|---|
| Frames per Second | Live video streaming depends on type of network connection and image quality. For event recording, the frame rate is 5 frames per second. |
| Indoor/Outdoor | Indoor or Outdoor. Outdoor use requires a weather-proof housing. |
| Max video resolution | 320x240 pixels for color model. 640x480 pixels for black/white model |
| Image sensor | 1/3” CMOS sensor, 0.3 Mpixels |
| Lens type | Any C/CS mount lens, fixed or varifocal lens with manual iris. |
| Lens changeable | Yes |
| Minimum illumination | 2.5 lux @ f1.4 for color model, 0.5 lux @ f1.4 for black/white model (3000K) |
| Motion event detection & recording | Yes. |
| Motion event & Alarm definition | Programmable |
| Local storage | Compact flash memory card (16MB to 1GB) |
| Alarm notification | Yes. Via GSM network. |
| Communication | (1) Point-to-Point Protocol via RS232<br>(2) LAN via Compact flash Ethernet card (Ethernet or 802.11b)<br>(3) WAN via built-in GSM data modem |
| Event & video database archiving | Yes. Uploadable to an Setrix Internet-Ready Gateway server (SIRGS). |