# Internet Cooperative Surveillance System Design and Implement

**童曉儒 施富荃 謝伯俊 仇力衛 王怡方 吳筱鈴 謝嘉謙 蔡宜錚**

**國立屏東科技大學 資訊管理系**

**{ srtong, b9256048, b9256049, b9256019, b9256012, b9256016, b9256030, b9256001} @mail.npust.edu.tw**

## 摘要

「屏東某大學訊：小偷趁四下無人入侵宿舍行竊，原以為能順利得逞，但進去不到三分鐘，四、五位同學破門而入，迅速將小偷制服。灰頭土臉的小偷納悶著：怎麼會被發現?」。隨著社會治安日益惡化，人們對保全系統的迫切需求因應而生，然而在現行的保全系統運作模式中，多採由保全公司經營管理或建立警民連線的方式進行，一方面系統建置費用昂貴，另一方面警力支援往往緩不濟急，成效與普及率不彰。

有鑑於此，本系統 i-COPS (Internet cooperative surveillance system)，利用網際網路與行動通訊的普及性與便利性，提出一套「多人互助式監控聯防」的新保全模式。本系統運用網路攝影機結合影像辨識系統，於使用者端建立一個主監控畫面，用來判斷是否有人入侵，並透過無線網路技術運用手持式裝置傳送警訊至使用者手中，使用者並可在任何時間、地點連線察看監控情形，除了使用者可自行監控之外，本系統並建立聯防機制，集結好友構成一套組織綿密的互助聯防網路，達到守望相助的目的。基本上目前寬頻網路ADSL已相當普及，加上家家戶戶幾乎都有電腦，只要加購一台低價位網路攝影機搭配使用即可。本系統可直接與現有的電腦、網路與通訊設備結合，且透過成員互助的方式，大大降低了硬體設備投資成本與營運人力耗費，提供了一套「成本低、親和性強、信賴度高」的保全方案。

**關鍵詞**：監控聯防

## Abstract

Facing with the high criminal rate, nowadays the demand for a reliable and pervasive security surveillance system to guard our daily life becomes more urgent than ever. General approaches taken today are either authorizing some private security service company to perform security surveillance or establishing an alarm warning system between civilian houses and police offices. However, these approaches usually incur high system establishment/operational cost and heavy human labor. They are difficult to be widely deployed to support a large number of households at a low cost.

In this project, we propose and implement a novel economic and high-availability surveillance system, termed, i-COPS (Internet cooperative surveillance system). I-COPS intends to build up a network service platform to allow a group of Internet users to participate surveillance in a cooperative way. Group members can share information of their local sites with each other by defining alarm events, and rules and ways of notifying warning messages. The system is made up by low-cost off-shelve components commercially available today, such as web-cam, PCs, PDA, cellular phone and broadband Internet. This offers a pervasive, cost-effective and highly reliable solution to the security surveillance.

**Keywords**：Cooperative surveillance

## 1. System Overview

### 1.1 Background

With the advents of broadband wired/wireless communications, multimedia processing and handheld mobile devices technologies, we are being engaged with pervasive accessibility of Internet and many evolving multimedia information services. Particularly, in facing with today's high criminal rate, the security surveillance is one of these services, which becomes even more important and urgently needed then ever. Traditional approaches used to be taken follow a customer-to-business model, where either some private security service company is hired to take in charge of security surveillance affairs or an auto-alarming system is built up in civilian houses, perhaps equipped with a telephone line to inform police offices about the occurrence of any dangerous event. However, these approaches usually incur high system establishment/operational cost and require dedicated human resources 24-hours-a-day and 7-days-a-week. Such high-cost investment makes them impractical to be deployed in a large number of small-unit households.

Therefore, the purpose of this project is to propose a novel scalable, economic and high-availability surveillance system, termed, i-COPS (Internet cooperative surveillance system). Basically, i-COPS provides a network service platform to allow a group of users to establish a pervasive security surveillance network over the Internet in a cooperative way. Users register to the network service are able to get protection from each other. They can define alarm events and when, how and whom the events are notified to. For example, a user may set up the system to activate his/her regular alarm from 9:00am to 5:00pm during weekdays. Or he/she can activate or inactivate the alarm from a cellular phone or remote

PC to change the regular settings. He/she can log into the home PC to watch the live video captured from a web-cam in the house from any remote PC or NB? at any time. He/she may also form an alliance with some friends and authorize them to perform some monitoring tasks. If a movement is detected during the secured period, an instant warning message (maybe along with a short video clip) will be sent to all alliance members right away for them to take necessary rescue action. If he/she is currently away from any Internet access, the instant message will be sent to his/her cellular phone instead. In this way, we construct a pervasive and self-sustaining security surveillance network system.

## 1.2 Design Objectives

I-COPS aims at building up a low-cost high-availability security surveillance network system. Specifically, the system achieves the following design objectives.

- **Video-based Internet surveillance**

  We take Internet as our transmission backbone. Its pervasive deployment saves the high cost of infrastructure laying and increases the system accessibility. The system consists of a collection of security agents (SA). Each SA captures a live-video stream from a web-camera. The video can be recorded in a local PC or transmitted to other remote sites for real-time monitoring. SA employs some image recognition software to detect the dangerous events and issue alarm warnings to users. When an event is detected, an instant warning message will be sent to the user's residing PC, and the video transmission to that PC will be activated at the same time for the user to view the live video. If he/she is away from the Internet, the instant message will be forwarded to him/her through the cellular phone system.

- **Flexible policy control**

  A user can access SA from any remote PC via a Web-based interface to perform monitoring and alarm setting. He/she can define alarm events and processing policy, such as when the alarm should be activated, what and how the warning message is distributed and whom should be notified.

- **Civilian alliance**

  A group of people can ally together. If any dangerous event is detected, the system will also distribute the warning message and activate live-video streaming to those group members who are currently on line. Then the members can check and discuss the situation with each other and take prompt response by calling police for backup.

- **High reliability and scalability**

  Since the instance warning message will be distributed to a group of people, the chance of missing the event is quite rare. Also a live video stream helps people to realize the real situation, identify the intruder and discern false alarms. Additionally, in order to scale up the performance and prevent the system from single-point-failure, we take a distributed system design that the system load-balance and error-recovery is accomplished by employing multiple data-bases servers.

- **Cost-effectiveness**

  The system is implemented by taking off-shelve components which are available in today's low-end commercial market, such as web-cam, PC, PDA, cellular phone and broadband Internet (ADSL). These components are also available in most households today. Therefore, our system creates new add-on value, which provides an affordable solution to the security surveillance problem for a large number of small-unit households.

## 1.3 Principles of Operation

Operational description of the system is illustrated in Fig.1.

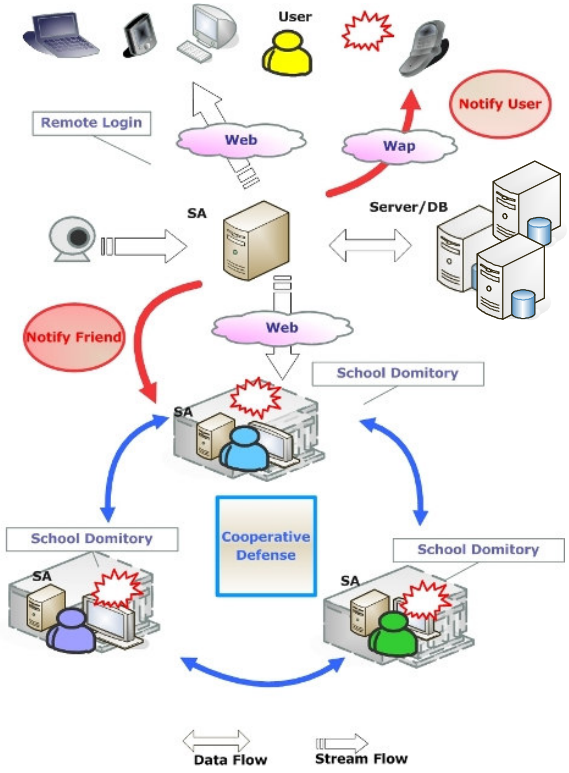


**Fig.1 Cooperative Surveillance Overview**

A security agent (SA) is installed in each site. When it is activated, it will register to one of the backend database servers according to a predefined

precedence and starts its surveillance function. A user can remote log into a SA through a web-based interface (using PC or PDA). The SA then performs the authentication by checking his/her identity with the database server. The database server responses the SA with the user's privileges. After successful login, he/she can modify the surveillance policy or start to view the live video captured from a web-cam. He/she also becomes an on-line member of an alliance group. If a movement event is detected by a web-cam, SA will take necessary actions according to alarm thresholds. If the alarm indicates a low thread, only a low-thread event will be recorded for logging purpose. If the alarm indicates a high thread, SA will log a high-thread event, start the video recording function and issue a warning message to notify other on-line users under the same alliance. This message may be sent through either Internet or the GSM system. The on-line members can choose to watch the live video to check the situation, wherever they are capable, and take necessary defensive actions.

## 2. System

### 2.1 System Architecture

Basically, the system architecture can be divided into two major parts. The first part corresponds to the SA, which consists of five subsystems: user interface, collate, video/image control, cooperative defense and video database subsystems. The second part corresponds to the backend database server, which consists of two databases: friend list and personal information databases. Their relationships are illustrated in Fig.2 and functionalities are described as follows.

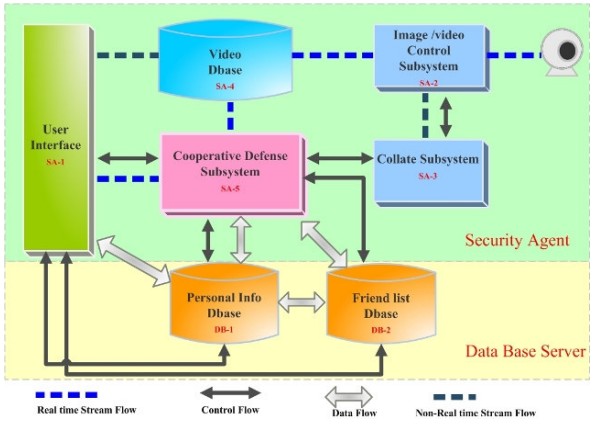


**Fig.2 System Architecture**.

**(1) User Interface Subsystem (SA-1)**

This subsystem provides a web-based interface for a manager or user to log into the system. A manger can create alliance and user accounts and define surveillance policies for different user categories. A user needs to pass the authentication process to log in SA. The related information is stored in the personal information database and friend list database.

**(2) Image/Video Control Subsystem (SA-2)**

This subsystem provides three image/video control functions:

- Image capture/motion detection: Images are periodically captured from web-cam and stored in PC.
- Live video recording: This function records the live video captured from the web-cam. It is turned on when a high-thread alarm is triggered.
- Live video streaming: This function transmits the video stream to user PC directly.

**(3) Collate Subsystem (SA-3)**

This subsystem performs the detection of object movement by applying some motion detection algorithm on the stored images. It also control the access to the live video based on user's privileges by checking the personal information database.

**(4) Video Database (SA-4)**

This is a local database where videos and images are actually stored.

**(5) Cooperative Defense Subsystem (SA-5)**

This subsystem is the core for performing the cooperative defense for the alliance. Major functions are listed as follows.

- Warning notification and monitoring control: When a dangerous event is detected, the subsystem checks the friend list database to distribute the warning message to those on-line members. Monitoring right is then opened to allow some of them to access the live video.
- Messaging: This function allows members to exchange text-based messages.
- Event logging: This function records the event-related information, such as the event type, event content, the event time, the action taken, the persons who took the events.

**(6) Personal Information Database (DB-1)**

This database is for storing member's personal profile, including basic account information, privileges, current IP address and other event log. It also performs query operation upon receiving SA's request. Multiple database servers operate at the same time. They periodically exchange updates to maintain the content consistency. SA is assigned with a DB server to

perform query operation according to a priority precedence randomly generated when it was first started. That is, if a DB server goes down, SA will switch to the next successor. In this way, we achieve the system redundancy and load balancing.

### (7) Friend List Database (DB-2)

This database is for storing the member name list of the alliance and tracking the on-line status of them. When some event detected, the warning message will be distributed according to this name list.|

## 3.System Operation Interface

### 3.1 Server Interface

Server interface consist of four parts (Refer to Fig.3):

【Main】Show information about server and user. User can connect to database.

【OnLine】Show information about user.

【DB】Provide test of database connection, and user can appoint database IP address.

【SYSTEM】Show information about system.

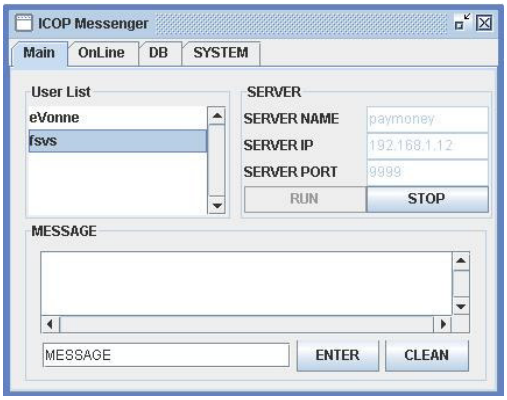


**Fig.3 Server Interface**

### 3.2 Client Interface

Server interface consist of two parts (Refer to Fig.4):


**Fig.4 Client Interface**

Main Tool：

【File】logout、open/close sound.

【Friend】Add/Delete friend.

【Function】photo, video, set up surveillance.

【Help】To resolve any confusion about operation.

Second Tool：

【FRIEND】To show the online and outline friend name list.

【WABCAM】Watches own video recording .

【SET】Set up video file locate site.

【MONITOR】Set up surveillance on/off time.

【DELETE】You can delete any of friend list.

## 4. Comparison

According to Implement result, we arrange comparison table as compared with other surveillance system. Like table 4-1.4-2.4-3.

**Table.1 Comparison**

| Type / Options | i-Cops | Watchdog | Traditional |
|---|---|---|---|
| Costs | Low | Medium | High |
| Recording | V | V | V |
| Motion Detection | V | V | |
| Multi-user Surveillance | V | V | |
| Remote Watch | V | V | |
| Remote Set up | V | V | |
| Send e-Mail/phone Message | V | V | |
| Surveillance Reservation | V | V | |
| Internet Surveillance | V | | |
| Instant Message | V | | |
| Cooperative Surveillance | V | | |

(Refer to https://www.webcamsoft.com/tw/tw-index.html)

## 5. Conclusion and Future Work

Along with Internet and wireless communication

equipment being in vogue, people are learning how to use the modern technology to enjoy its convenience. The integration of webcam and cooperative defense subsystem brings up a new application which enriches the usage of multimedia information and wireless motion instant message. The proposed i-COPS (Internet cooperative surveillance system) provides a user-friendly interface to allow users to remotely access the security surveillance in anywhere at anytime. Basically, our system can achieve the following objectives:

1. Active warning distribution.
2. Auto-detection of intruders.
3. Integration of cellular phone and Internet.
4. Remote surveillance.
5. Cooperative Defense.
6. Cost-effective and high-reliable service.

With the increasing mobile communication bandwidth, in the future, we may consider of bringing the live-video into 3G cellular phone. Also we may consider of adding some locating mechanism (like GPS) to be aware of the present location of users and available communication mechanisms to help the system to correctly distribute warning messages.

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