# VIDEO SURVEILLANCE

BTECH 450DT

End of Semester Report

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# Abstract

Since the first public video monitoring system was used in New York City, United Stated, 1969, video surveillance now has passed through 40 years' innovations and evolutions. Video surveillance systems now become the well-known products that used in almost every store, government departments, and corporations.

This report covers the research summary of BTECH project on the topic of video surveillances, includes the report of different kinds of technologies, the newest technology, and the fundamental elements used in the system. Also covers a brief description of an innovation on security related field that trying to combine two security systems together for better consumer experiences.

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# Introduction

## Company Background

Compucon New Zealand is part of an International Computer manufacturing group of companies founded in 1989 in Sydney. The NZ operation is registered as Modern Technology NZ Ltd and it was established in 1992 with an initial mission of serving the business communities in achieving productivity and competitiveness enhancements by supplying computer systems that are fit for purposes with the lowest cost of ownership. Then Compucon started to be involved in education as an educator in year 2000 by supervising 4 final year Bachelor of Technology students in the University of Auckland.

Computer New Zealand (CNZ) is a registered Solution System Integrator of Compucon Computers. CNZ is a total information system and solutions provider with skills and capabilities to implement information and automation systems for meeting clients' business objectives and increasing their productivity and competitiveness. CNZ expertise is focussed on 2 inter-related solutions for business customers: Information Systems and Video Surveillance Systems.[1]

CNZ started IP Video Surveillance consulting business in late 2008 after going through several years of research for an ideal approach. Video Surveillance has been the territory of the security industry and did not involve computers until about year 2002. At that time, camera images were analogue in nature and the images were converted into digital signals for processing in PC. In the few years following, the use of the Internet for communication has become more popular and the use of the Internet Protocol (IP) more prevalent. Why not give each camera an IP address so that it is accessible anywhere on Earth? This idea is valid, and the use of the standard Ethernet local area network for IP images has further propelled the development of technology in the same direction.

With years of experience of helping business customers set up information systems as an IT Consultant and Service Provider, CNZ has been asking if we could help customers set up video surveillance systems either as a standalone system or integrated to an existing IT network and what benefits we can give customers over and above the service of traditional security system installers.

[1] Company information is quoted from Compucon and CNZ website.

We spent one full year to search the answer and have found that IP technologies can provide a higher quality of surveillance service and a lower cost of ownership to customers than analogue technology based approach.[2]

## Project Theme

The theme of this project is about the transition of technology from analogue to digital and finally to end-to-end Internet Protocol for video surveillance and other forms of security systems globally and in New Zealand. The project is required to research about the progress of technology evolutions, current penetration rate of each in New Zealand, and works being done for expediting the migration of technology platform.

Technology developments have branched in 3 directions. One is the application of video analytics software to camera footage that will provide further values to business operations. Examples are the automatic recording of vehicle licence plate numbers for toll road charging and the automatic alarming to police of recognition of hands up video patterns in banks. The 2nd direction is the inclusion of access control, intruder alarm, and fire alarm systems etc in an IP based central control system. This will lead to an integrated security system in lieu of fragmented monitoring and security services. The 3rd direction is the transmission of video streams over the Internet and 3G media. This applies to surveillance in mobile conditions as well as for remote locations. [3]

## Project Objective & Goals

Smily Yu-Cheng Lin and I are the BTECH 450DT students of Auckland University which have been assigned to CNZ for training and research in year 2010. We work as a group on fundamental researches and then focus on different tasks.

The objective of the project is to assist students (e.g. Smily and I) to relate academic studies to real life development and deployment of technologies. Students will work as CNZ virtual staff members in establishing an infrastructure of engineering and information technology knowledge base. The infrastructure refers to a framework of content that will identify: (a) state

[2] History of IPVS is quoted from CNZ website, IP Video Surveillance section.
[3] Revised from TN Chan's handout, http://www.cnz.co.nz/content/view/62/37/

of the art of technology applications in New Zealand and (b) the procedures for handling system integration and implementation of projects.

There are generally two goals are expected to achieve for first semester. One is research on video surveillance implementation in term of technology and benefit for end user. The other one is deploy and test a video surveillance system then produce one end user documentation including user manual, issues and the issues solutions.

# Fundamental Research

"Surveillance is the monitoring of the behaviour, activities, or other changing information, usually of people and often in a surreptitious manner. It most usually refers to observation of individuals or groups by government organizations, but disease surveillance, for example, is monitoring the progress of a disease in a community."[4] Since surveillance systems especially video surveillance widely used in public places, there are manufacturers trying to produce a high strain capacity and quality system for severe situations. For example, the monitoring system used in Public Square for crime detection which must handle high range of sensitivity and suit for different temperatures and weathers. Products can be categorized into two groups nowadays based on different technology concepts:

Closed-Circle Television (CCTV, Figure 1), an analogue technology based surveillance system. Even it has been digitized in final step (e.g. digital recorder), it still has some unavoidable problems such as interference, signal attenuation and low resolution.

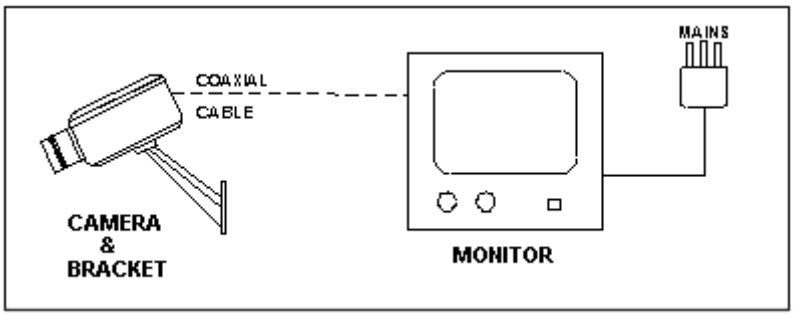


Figure 1 A Basic Line Powered CCTV System

Internet Protocol Video Surveillance (IPVS, Figure 2), based on digital technology and IP network. Digital cameras and high efficient transmission lead IPVS to an upper class member of surveillance family.

[4] Wikipedia, "Surveillance." Available: http://en.wikipedia.org/wiki/Surveillance

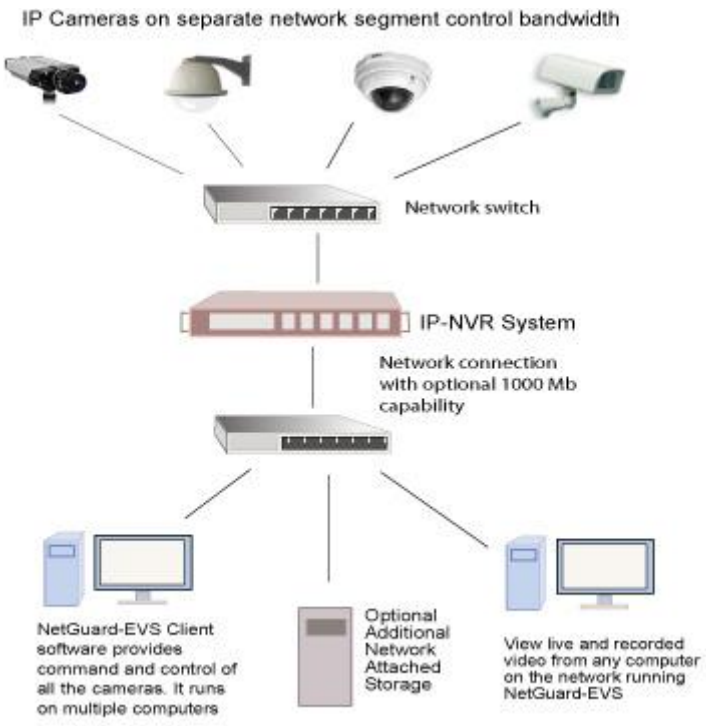


Figure 2 Basic IPVS System Diagram

# Different between IPVS and CCTV

### *What is CCTV*

"Closed Circuit Television (CCTV, Figure 1) is a television transmission system in which live or pre-recorded signals are sent over a closed loop to a finite and predetermined group of receivers, either via coaxial cable or as scrambled radio waves that are unscrambled at the point of reception."[5] In security system, CCTV is a traditional solution for monitoring issues. The necessary parts to get CCTV works are analogue cameras, monitor and a Digital Video Recorder (DVR). An analogue camera captures video and the analogue signal transmits over a coaxial cable. At the receiver end either a video switcher or a multiplexer has been used to process multi-video signals and then signal has been digitalized and recorded by DVR.

### *What is IPVS*

IP video surveillance, also known as IPVS (Figure 2) normally includes two parts: IP cameras and Network Video Recorders (NVRs). The camera used in IPVS system could be a standard IP camera, and NVR could be simply understood as a standard network connected PC plus recording and viewing functions. IPVS is a newer technique to solve issues about monitoring and the basic idea of IPVS is: digital cameras capture moving pictures; each camera transmits these videos over internet to the recorder and monitor digitally; recorder records videos automatically and monitor displays the video, or does some other tasks by user's requirements.

### *Technologies in IPVS and CCTV*

As mentioned above, both of IPVS and CCTV will record video signals to storage as digital format at the final state. However, the processes of how camera footages transmit to a viewer/recorder are completely different, because of different input devices are used and different implementations. CCTV uses analogue cameras which are the cameras commonly used in the past and now. They are easy to build and use – cameras just produce analogue signals to transmission medium. Technology of analogue camera and its related technologies such as analogue-transmitting technology have been almost fully developed today and most of related issues have been solved. Therefore we now have a variety of designs of cameras and recorders in the market with higher compatibility, lower cost. However, analogue system still has a few disadvantages that would cause some significant problems. Signal attenuation and interference are the most important issues.

[5] Anna McCarthy, "CLOSED CIRCUIT TELEVISION." Available: http://www.museum.tv/eotvsection.php?entrycode=closedcircui

If the signal transmitted over a long distance or there are some devices close to or plug into the medium try to interfere it, the receiver would receive a weak signal or totally lost it. The other unavoidable problem is resolution – both of cameras and transmission specifications follow the OLF NTSC/PAl standards, which correspond to 0.4 megapixels at 4CIF.[6] The resolution is not clear enough to make a detailed surveillance (e.g. face capturing) and it is impossible to process additional tasks such as high precision video analytics. To overcome the shortcomings and disadvantages of analogue camera, IP camera is a good substitution. IP camera is used in IPVS and it is simply a combination of one chip and camera. IP camera stream live video via packets across an IP based network or internet digitally. The fundamental idea of how does IP camera work is capturing, compression, encryption then shifts video via packets to internet (more details on IP camera will be discussed on "IP Camera and Analogue Camera" section). Interference and attenuation would not happen anymore because:

1. Recognition capability of digital signal attenuation is much better than analogue signal attenuation and interference is hard due to the features of digital technology.
2. It uses IP network – significant information are encapsulated by TCP packet; TCP's error detection can reduce packet loss quite well.

Each element in IP surveillance system works as a single network device and most of them (cameras) have an IEEE 802.3af standard POE (power over Ethernet), which means it can get power from network cable if the switch supports POE. IP camera can be either wired or wireless with encryption, so wiring, re-wiring and operating would be simple and cheap. Another advantage of IP system is higher definition – most of IP cameras' resolution is higher than 1.3MP. The higher the resolution of the camera, the more detailed coverage of large areas, thus video analytics could be completed precisely. The disadvantages of IP system are high cost of camera and high cost of transmission. Compare to analogue camera, there are additional technologies build into IP camera, so the price will be higher. For the higher camera resolution, a higher bandwidth is required. This would be a huge cost in the past, but today both network hardware and resources is not quite expansive. We can also relieve this problem by allocating specific network segments.

[6] Nahshon Roberts, "IP Network Camera vs Analog Camera." Available: http://ezinearticles.com/?IP-Network-Camera-vs-Analog-Camera&id=1131118

### *More Functions*

Both of IPVS and CCTV can achieve the basic requirements of video surveillance. Due to the limitations of hardware and older technology used in CCTV, the functions of pure analogue CCTV system have been restricted to very basic ones: monitoring by human and store monitored video. Other advanced functions such as evidence of vandalism, motion detection are hard to achieve because of the lower video resolution. However, these advanced functions can be achieved by IPVS and digitized CCTV easily. We can have an accurate automatic detection by improving algorithm of video analytic software and/or improving the resolution of camera, so unmanned surveillance is achievable with IPVS and CCTV with DVR. For example, IPVS can simply record the typical actions of crime and if detected images are matched with these actions, alarm will be turned on. As mentioned early, remote control and access is another important function that can be only achieved by IPVS[7]. An authorized user can view captured videos or even change the setting of camera at any time any place if the user has an internet connection or a mobile 3g connection. The functions of IPVS could be unlimited, we can keep develop new software by provided SDK to satisfy user's requirements.

[7] Some high-end CCTV DVRs also allow remote control but it requires IP network connection, however remote view cameras separately are not supported.

# IP Camera and Analogue Camera

Camera refers to a device that records images, is the one of the key components of vision system which has been produced and innovated by many manufacturers and research institutions nowadays. There are millions of cameras have been produced in the market and generally they have been categorized by two groups: Digital and Analogue. This paper will discuss the cameras used in video surveillance system – IP camera & analogue camera, and compare their difference by analyzing a few typical camera models. The content of paper is separated by optical analysis and technical analysis.

Following camera models will be discussed:

- IP Cameras:
  - ACTI ACM7411 [outdoor]
  - UDM IPCM903A [outdoor]
- Analogue Cameras:
  - UDM IR916F [indoor]

### *Optical Analysis*

The principle of work of both kinds cameras are same – light pass through the lens then project onto an electronic image sensor, the sensor coverts the captured image into electronic signal. An ADC (analogue-to-digital converter) is needed to convert the signal to digital for IP camera. So the quality of image is affected by the lens and sensor directly. To expand on it, quality and size of lens, focal length, type of sensors and sensitivities are all the important factors to capture a quality image.

Focal length stands for the distance between lens and sensor. It determines how far the object can be captured. All of selected models of IP cameras which have been list in introduction have a variable focal length: 3.3~12 mm, and IPCM903A has an option of 2.9~10mm. The focal length is about the angle of view it provides, “A short lens with less mm (18 for example) provides a very wide angle of view. Lenses with less millimetres provide a wide overview photo.”[8] A focal length is variable means that we can setup the camera with the best image definition or we can adjust the how far can be monitored without change camera’s physical location (e.g. Zoom in and zoom out).


Figure 3 View of 15 mm focal length and 50 mm length

For surveillance system cameras, a large angle of views means more area could be monitored, and a closer view means we clearly can capture the object, for example, we could have more time to capture a person’s face while he/she walking around the camera with large angle views. There is no information about IR916F’s focal length, but according the principle of monitoring purpose cameras the focal length should not be too large.

Sensor is used for capture images and produce signals. There are two types sensors have been widely used, CCD (Charge-coupled device) and CMOS (Complementary metal–oxide–semiconductor). “In a CCD sensor, every pixel's charge is transferred through a very limited number of output nodes (often just one) to be converted to voltage, buffered, and sent off-chip as an analogue signal.”[9] In a CMOS sensor, conversion of charge to voltage is performed individually for each pixel, and the sensor often includes amplification, noise-correction before outputs digital bits by ADC. “CCDs use a special manufacturing process to create the ability to transport charge across the chip without distortion. This process leads to very high-quality

[8] Focal Length, Available: http://www.focallength.info/
[9] DALSA , “CCD vs. CMOS.” Avaialble: http://www.dalsa.com/corp/markets/ccd_vs_cmos.aspx

sensors in terms of fidelity and light sensitivity."[10] Normally, digital cameras (IP cameras) more likely to use CMOS sensors and analogue cameras use CCD. It seems that CCD has higher quality, but due to the limited 'output nodes' as mentioned above, there is a bottleneck for the process of charge-voltage conversion. The conversion in CMOS is completed separately, so CMOS can process huge amount of information quality, to output high quality image. For example, ACM7411 and IPCM903A use CMOS sensors so they can capture a 1.3M Mega-pixel image (1280 x 1024 pixels). IR916F uses a CCD sensor, even the sensor could capture a very high quality image, but it is still unmatchable to IP cameras because of the low efficiency of sensor. However, CMOS is not perfect and CCD is not trashy. CMOS has some disadvantages such as higher noise and lower sensitive than CCD. For example, ACM7411's sensitivity is 0.05lux, ~1.0 for IPCM903A and IR916F (the one with CCD) is zero with infrared. As image shows below, lower Lux refers to darker background light. So IP cameras are disadvantaged in the night, and may be unable to work. For user who wants to monitor ground at night with poor light source, an analogue camera or a CCD IP camera would be considered.

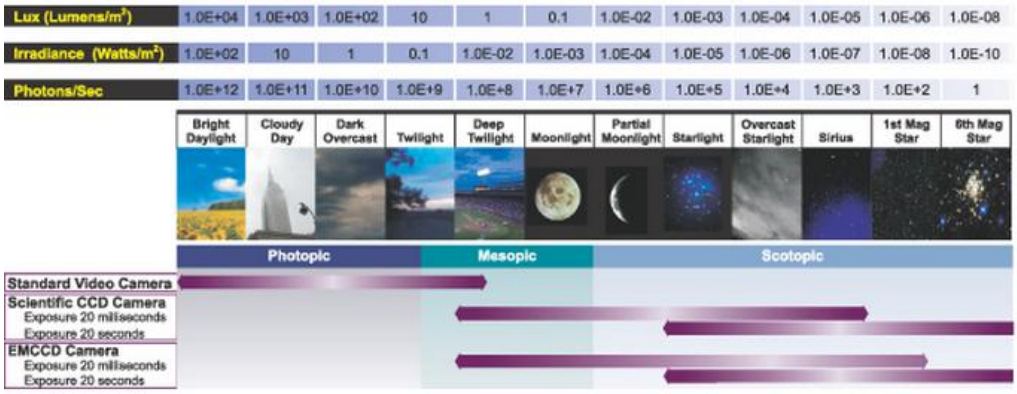


Figure 4 Darker background – lower lux

## *Technical Analysis*

Basic functions of both IP camera and analogue camera are same. Analogue camera has a longer history and IP camera is based on modern technologies, so IP camera has some additional features than analogue camera. From the structure of cameras, as mentioned above, IP cameras often use CMOS sensor and analogue use CCD. IP camera requires lesser power than analogue camera. For example, analogues camera IR916F requires 12V DC power supply but IP camera ACM7411 and IPCM903A supply POE (power over Ethernet). Which means user must connect a power cable to the camera if user wants to use the analogue camera and user can simply connect the IP camera to a POE supplied network to get the camera run. Normally IP

[10] Massimo Mancuso, ST Journal of System Research, vol 2, number 2 December 2001, "An Introduction to the Digital Still Camera Technology."

cameras are more flexible, ACM7411 allows 360 degrees angel adjustment on panning and rotating, 180 degrees on tilting. IR916F only allows 20 degrees tilting adjustment. IP camera is also allows user to control its facing area remotely by sending instructions, but analogue camera is hard to achieve this. To be more competitive and satisfy market requirement, many cameras have additional features such as weatherproof casing with IP66 standard, vandal proof supports for outdoor cameras. However, due to internal circle design and physical features, IP cameras are usually bigger than analogue cameras.

### Image qualities and transmissions

IP camera has a higher quality images but no advantages on jerkiness (moving pictures). IP cameras for example, ACM7411 has three specifications for resolutions: SXGA (1280*1024), HD720 (1280*720) and VGA (640*480). It can achieve 30 fps (frames per second) with VGA resolution, only 8 fps with SXGA. This would cause either an unclear videos or a faltering video. Compare to analogue camera, analogue camera follows NTSC specification has a 60 refresh rate (~30 fps), and PAL has a 50 refresh rate (~25fps), which is similar to the highest fps of IP camera. But the resolution is restricted by technologies – 510*492 for NTSC and 500*582 for PAL. So even the CCD sensor could produce a quality image, but considering the limitation of technologies, the cost of hardware, the communication specifications etc. analogue camera can only capture a smooth but unclear video.

Higher quality image causes a higher cost on transmissions. IP camera uses compression to handle this problem. IP camera IPCM903A uses video encoder H.264, MPEG4 and M-JPEG to compress the footage. H.264/MPEG-4 is a video compression standard and it has a low quality drop rate, which means any device has decoder can view the almost original videos. Analogue camera use analogue signals, it sends out signals pass through the medium to the receiver. There is no compression before/ during transmissions because of lower image quality and the image quality on the receiver end is not guaranteed.

### Functionalities and software

Most of IP cameras have audio input/output; the chips inside the cameras will compress the audio into video stream or separately compressed to keep high quality. This function is not often covered by analogue camera. Also, all of programmable functions are unachievable for analogue cameras because of the design and hardware used in camera. IP camera is network ready, it uses standard network cable 10/100 Base-T and supports all protocols higher than IP (internet protocol) such as TCP, DHCP, 3GPP... These protocols can be used to build a centre control video surveillance system with remote control

and lots functions such as video analytics. User can simply accesses/controls the system/camera by web browser. In theory, user can program infinite many functions with supported SDK/API (software development kit/ application programming interface). For example, both of ACM7411 and IPCM903A have a built-in password protection, user can use the provided API to build an additional protection system to force administrator to change password regularly. Anyway, all of software-level functions are based on the chips, so a powerful chip is important for IP camera.[11]

| System Integration | |
|---|---|
| Application Programming Interface | Open API for software integration<br>SDK |
| **Viewing System** | |
| OS | Windows® 2000, XP, Vista |
| Browser | IE 6.0 or latter / Firefox 2.0 or later / Safari |
| Cell Phone | With 3GPP player |
| Video Player | VLC, Quick Time, Real Player |
| **Software** | |
| Search & Installation | IPWizard-2 |
| Easy DDNS | DIPS™ |
| Bundled NVR Program | SecuGuard 64CH Basic |
| Optional NVR Program | SecuGuard 64CH Pro. |

Figure 5 Screenshot of AVIPCM 903A's function list (partial)

[11] Resources used in this section: ACTi, IP Surveillance 2008 buyer's guide

# About the Recorder

Recorder is a necessary part of a complete video surveillance system. In modern system, it records all camera footages which have captured by the surveillance cameras in digital format for security and evidence purposes. Recorder could be categorized into two types by different technologies used in the system, Digital Video Recorder (DVR) used in CCTV and Network Video Recorder (NVR) for IPVS. This paper will discuss these two recorders separately and some related data transmission issues.

To make a better explanation, following recorders will be used as examples:

- DVR: UDM AV-A7208
- NVR: HORUS

### *Digital Video Recorder*

A DVR used in the video surveillance system is a device that records video in a digital format to a disk drive or some other memory medium devices including the features of displaying, searching and some other manufacturer build-in functions. Generally there are two types of DVR in the market, standard PC based DVR and DVR box. The idea of PC based DVR is turning a personal computers running an operation system into DVR by specified video recording software and hardware such as multi-channels video card. The implementation of DVR box is similar to the PC based DVR, it is also build by one or more processors, motherboard chips, video card and hard disks. The only difference is manufacturers build them into a closed box and hard-coded the specified functions for user due to some profit-making issues. DVR box is widely used in the surveillance system because it is smaller and more stable than PC based system.

For typical specifications, a DVR usually could handle 8 cameras with 30 fps per camera, 640*480 resolutions for NTSC specification and 25 fps per camera, 640*512 resolutions for PAL specification. It has split display mode which means the DVR allows view multiple cameras on a VGA or higher screen. The operation usually done by a mouse or/and a keyboard, or an IR remote controller. The user also can operate it over network if the DVR support network protocols.

Functions of DVR are normally build-in by manufactures. For example, AV-7208 allows user to save 4096 events for motion detections. There is an adjustable sensitivity and if action is matched with saved events, the alarm

will on. AV-7208 also allows user remote viewing. User could connect the DVR to network and remote access it with a high speed internet.

To record the images, a typical DVR uses a maximum 300:1 compression rate to compress the videos. The compression is completed by software algorithm and in accord with H.264 standard. Analogue signals firstly come into the video card, and then chips on the video card will process these signals and output digital data to the processor via data bus. Processor completed the compression and then save the data into hard disk. For most of DVRs, the recording quality is adjustable. For example, AV-7208 could achieve total 120fps (e.g. 15fps per camera) recording and it has an adjustable rate from 1 to 5. User could choose poor video quality but minimal hard disk required or the highest quality, lowest compression and of course it would take huge disk spaces. If a DVR has a 160 Gig Bites hard drive, the average record time is about 2 weeks (with medium compression rate) and the record time could up to several months if it has a 1T disk. For data security reasons, a scheduled back up is necessary. User can copy the video data into a USB-external hard disk or use some build-in functions to backup. For example, AV-7208 has a JPEG capture function. It can capture the video in a scheduled time and save into JPEG format. So user could back up the data by copy these images into a USB flash drive if video records are not very important or user want to save disk spaces. Data search is also important to DVR. DVR usually allows user searches data by file, event, frame, time or date and gives up to 60 times faster playback. A fast, clear, accurate search and play back is based on a good designed algorithm and good hardware. Some low end DVRs that have lower power requirement use ARM CPUs and this would cause a slow search speed due to powerless of processor. The other factor of search speed is type of hard disk. SATA 7200 rpm hard disk is much faster than IDE 7200rpm or 5400rpm.

### *Network Video Recorder*

NVR is an internet protocol based device that sits on the network to record and access live video streams from IP cameras. NVR is a newer generation of DVR and it uses digital technology from receiving signals to recording videos. NVR refers two definitions: the NVR software or the complete video recording solution including PCs and pre-installed software. NVR software is the application that can run on a standard OS such as Windows and Mac OS to view, control, manage, store, retrieve videos or complete some other advanced functions. The complete solution usually refers to a ready-to-use PC based product with pre-installed, pre-tested and pre- configured NVR software.

Let us have a look a particular example of NVR. A NVR named HORUS is an intelligent video analysis NVR which runs on Windows-based systems. It has a few built-in motion detections, alarm events and customable events are also supported. For example, it has detection on Focal loss, missing object, camera tampering, signal loss etc. It is designed for enterprise, and it can handle up to 64 IP cameras. The software allows user has a multiple channel display mode up to 64 images displayed on the save screen and also allows user to control PTZ cameras by just clicking the control panel. It has programmable video and audio recording function can produce a high quality, H.264/MPEG4 compressed video. The resolution of recorded video up to Mega-Pixel and frame rate is up to 30fps. An adjustable and programmable event recording function could process a 10 seconds pre-alarm recording and record up to one hour after alarm.


Figure 6 Screenshot of NVR software

The software uses current PC's hard disk, so the storage limitation is adjustable by user. User can simply adds additional hard disk into the PC to extend the storage size, map network drive on windows or connect the NVR to a network attached storage. Last two methods are remote access - they have heavily used network, so a 1G or higher capability network switch is preferred. However, the most of traffic managements for remote accesses have done by operation system, so it would not have significant pacts on the current network if there are not many cameras connected.

The search and playback function is powerful and intelligent. The NVR provides normal searches like search by date, time, file name etc. and also provide a powerful smart search. Smart Search helps user to investigate for changes or actions in recorded videos automatically. The smart search includes Focal Loss Detection, Missing Object Detection etc. For recorded or searched video, user can play them with adjustable speed from 1x to 6x simultaneously on multiple channels or user can export it to external storage devices for backup purpose.

To ensure the efficiency of the NVR, it usually has a high requirement on PC hardware. For a 64 channels NVR, it requires a high end PC with a quad core CPU and a GeForce 8800 graphic card to get a better experience. It is also requires gigabit LAN connection. All of the components of IPVS system connect to network, and the network may be also used by office's PCs, printers etc. So IP address-based and package type based QoS (Quality of Service) is a low cost solution to make sure that there is no delay for important, high priority level message transmission.

# Review and Analysis on current research

### *Motion Detection Algorithm*

Motion detection is a necessary function for recorders. It helps people to reduce their searching time, save more disk spaces and other benefits such as integrate into automatic responder/alarm for unmanned monitoring.

For secure purpose, the recorder is required to keep at least 10 seconds video recording before an action. Technically, there are always 300 frames saved in memory. (Assumes there is only one camera operating at 30fps) Processer keep disposes and adds new frames to memory follows First-in first-out rule if there is no motion being detected.

The actual implementation of motion detection algorithm used in the recorder is unable to present here due to commercial confidentiality, however we will discuss the concept by using a C# library[12] (licensed under GPLv3[13]).

The basic concept of the algorithm is comparison. Firstly we set a value called sensitive level, say it is 30. Then compare current frame and the previous one, if the difference between two frames is bigger than 30%, then there is a change. The reason of setting sensitive level to 30 instead of 3 is image noises. Image noises always happen and they are unavoidable, so we must raise the 'change range' to ignore the noise. Therefore, we can either leave the algorithm inaccuracy or calculate a value that can give us best sensitive.

The concept gives us a problem: If there is a slow motion, the sensitive value is high, it is undetectable. With original design, solve this problem is difficult. We can apply a filter to the image to filter out the noise but it also filter out the small differences. Therefore we import another object for comparison – background frame. The background means the initial frame of current stream. The outside environment is always changing. Therefore, we make an optimization that change background to somewhere if there is a change. Figure 7.1 and 7.2 shows more details on how three frame changes.

[12] Andrew Kirillov, "Motion Detection Algorithms." Available: http://www.codeproject.com/KB/audio-video/Motion_Detection.aspx
[13] GNU General Public License version 3 (GPLv3), Available: http://www.opensource.org/licenses/gpl-3.0.html

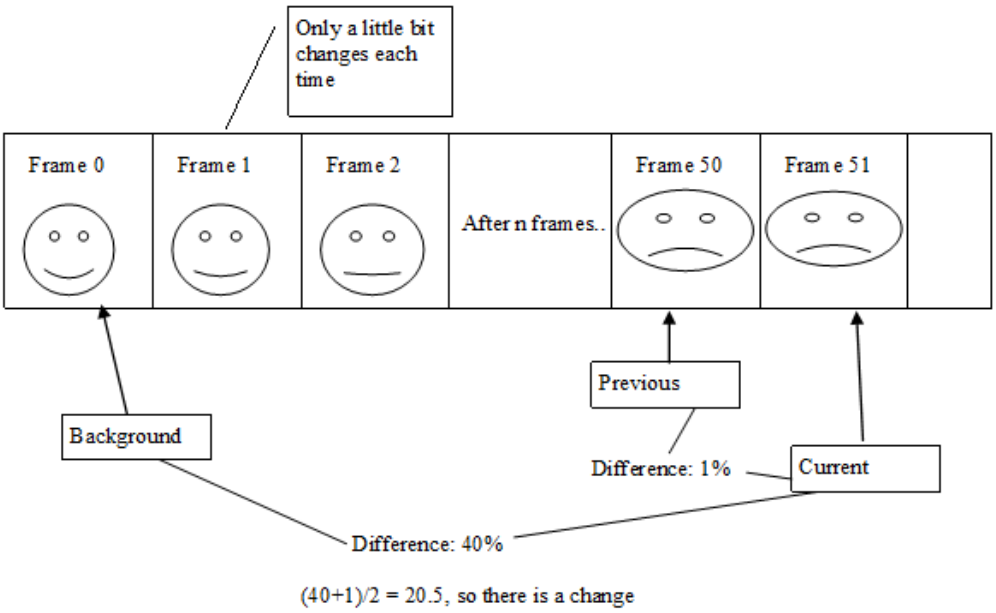


Figure 7 There is a change

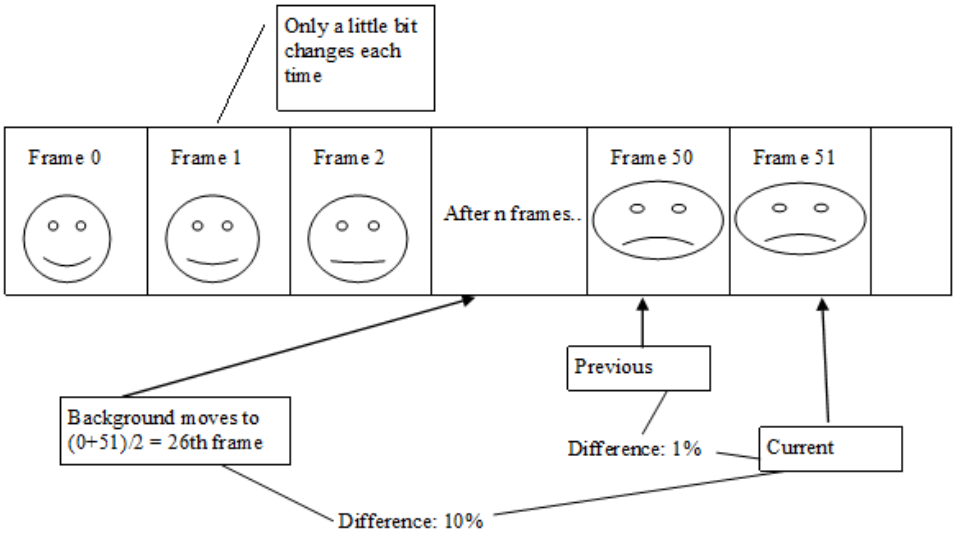


Figure 8 Background move to middle

### *Innovation on surveillance camera system*

Scientists at the University of California in Los Angeles (UCLA) have developed a prototype surveillance camera and computer system to analyze the camera images and deliver a text feed describing what the camera is seeing.[14] The whole system bases on a database of over two million images containing identified objects in over 500 classifications. After each image taken, an image parser analyses the image and removes the background and identifies the shapes. Then searching the database and find out the analogous image and then assigns the meanings to the shape. The process completed automatically and, one of the developers Zhu said that transcribing the shapes into natural language "is not too hard" once the image is parsed.

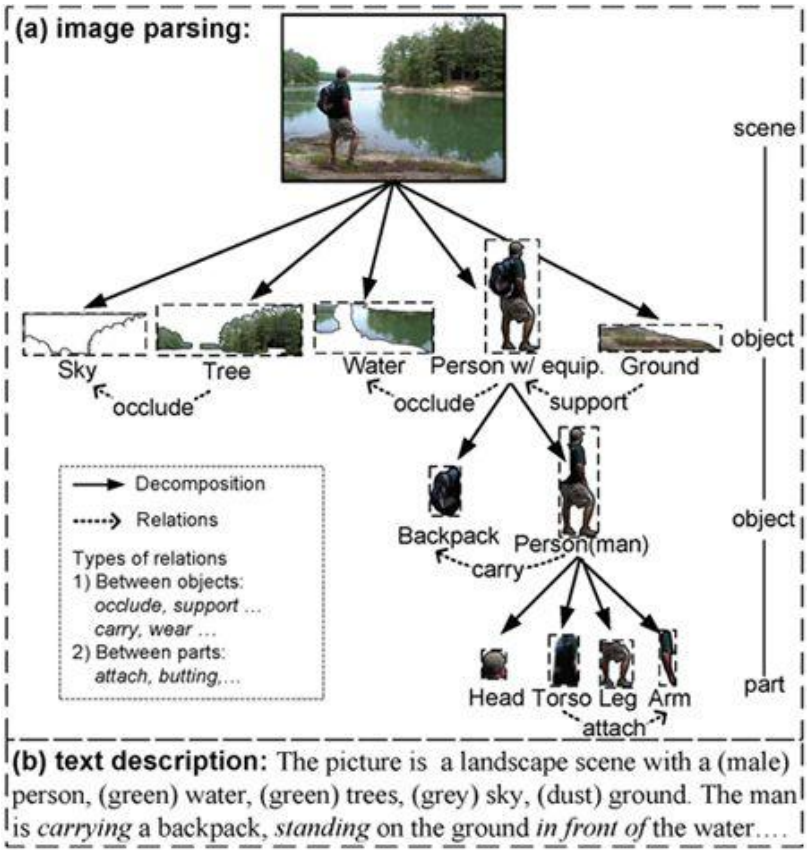


Figure 9 Example[15]

The system now is only a prototype and not advanced enough to recognize a large number of images instantly. However, in the future, if this system can be integrate in to commercial video surveillance system, it will significantly improve the searching speed of recorded videos and change the way of monitoring.

[14] Edwards Lin, "New surveillance camera system provides text feed." Available: http://www.physorg.com/news194765743.html

[15] Image source: http://www.physorg.com/news194765743.html

# Future Task - Digital Input / Output

## Task description

Add Digital Input and Output to the system. Digital Input can be the state of a window (open or closed). When the window is open, it will trigger recording of video by a camera and sending out an alert message. If a camera detected a motion, it can trigger a Digital Output such as to start a siren.

## Conceptual Design

The basic of how electrical device communicates each other is sending signals within a circle. We can either use analogue waves (with ADC) as a representation of alarm status (for analogue alarm) or use data packet transfer via IP network for alarm controlling and messaging (for IP alarm only). Therefore, there are two conceptual designs:

1. Conventional alarm with output function

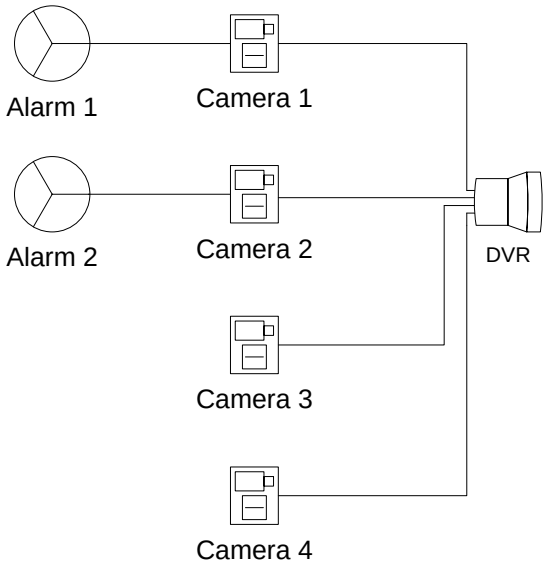


Figure 10 Alarms in CCTV system

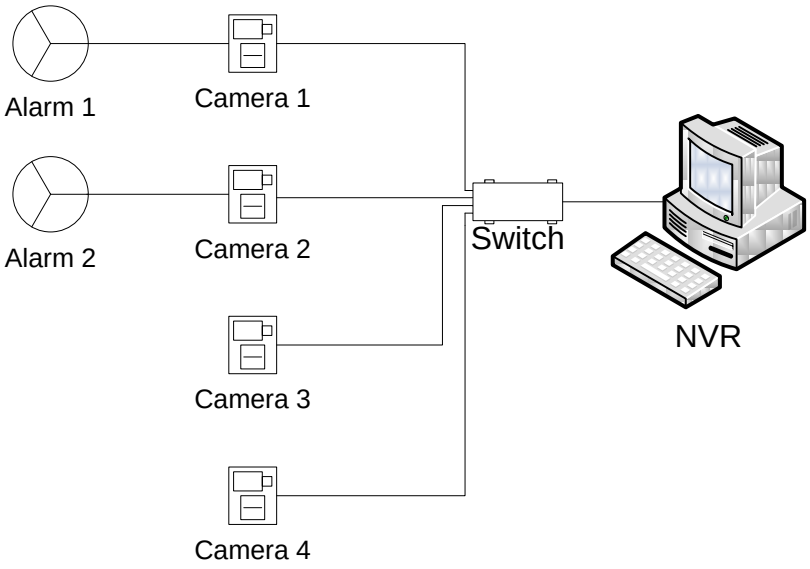


Figure 11 Alarms in IPVS system

As two diagrams show above, the connection between conventional alarms and recorder requires a bridge, because most recorders do not support other adapters than BNC/RJ45 originally. The recorder treats camera and alarm as one entity but two different signals. For example, if alarm 1 on, camera 1 will receive signal 'A1', and then immediately forwards to recorder. Recorder receives 'A1' and then produces an action (e.g. record video footages of camera1, 2).

2. IP alarm

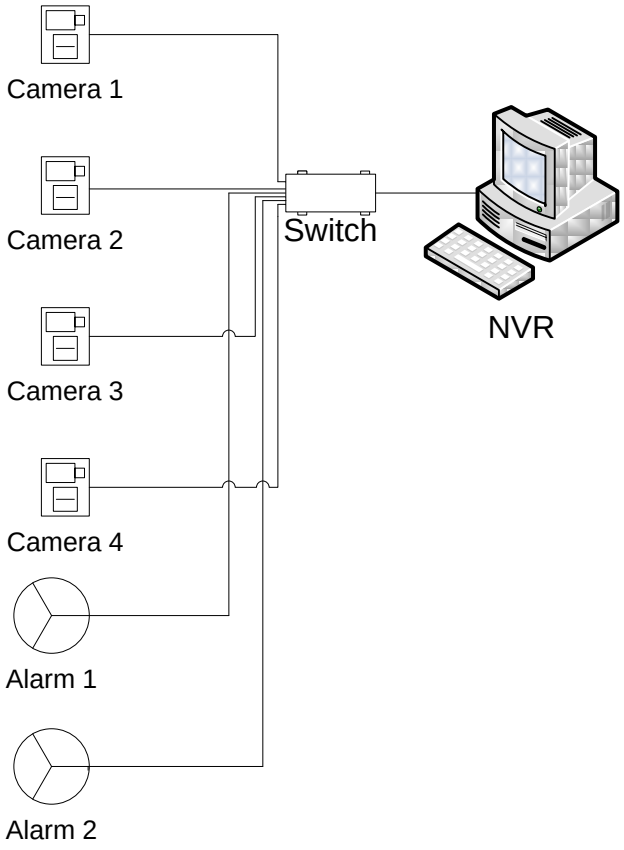


Figure 12 IP Alarms in IPVS system

The connection of IP alarms is much easier than conventional alarms. Both cameras and alarms regarded as standard network device. They use TCP packets for controlling message. Following data should be included: Alarm's IP address, NVR's address, current state, controlling message.

# Conclusion

During the first half of the project, I have completed the tasks that outlined in the latest project plan – research on CCTV & IPVS and its base elements. Review on my research result, elements with digital technology and IP network features enabled have more advertences than others. Digitization and moving to IP network is an unstoppable trend for both consumer and service provider.