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Video Surveillance
using IP cameras

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Abstract

This dissertation aims to describe the research work done on the integration of video surveillance systems. The word vigilância comes from the Latin term "vigilia" and has that definition as a period over which the person is intentionally awakens with devotion to observe an event. Video systems for this purpose, although they have appeared in the mid-twentieth century, just at the end of that century and early twenty-first century, began to gain importance and reach a maturity so they can be used in virtually all areas, including in our homes. But with the great demand for these solutions, we found an endless number of solutions and diversification rather large. Something that results in a process quite time consuming and sometimes complicated as regards the integration of technologies from different manufacturers.

In order to achieve this objective, the integration of video surveillance systems, began to conduct a market study to select the video cameras more "common" with a reasonable value for money, and try to find a solution from there.

After a study of already implemented solution Eye Net, it was found the possibility to develop some features and wider the application with respect to environments and systems for display. So, in this way the application becomes more ambitious in its purpose.

In order to evaluate the performance of the upgraded application, it was uploaded to a server, getting on-line for testing and demonstrations. Finally are discussed themes that can be developed in future projects, or future developments.

- Keywords

Cameras, video surveillance, security, integration, CCTV, HTML, PHP, ActiveX.

Resumo

Esta dissertação tem como objectivo descrever o trabalho de investigação efectuado sobre a integração de sistemas de vídeo vigilância. A palavra vigilância vem do termo latim 'vigilia' que tem como definição um período sobre o qual a pessoa está intencionalmente desperta com a intenção de observar um evento. Os sistemas de vídeo para este efeito embora tenham aparecido em meados do século XX, apenas no final e início do século XXI, começaram a ganhar importância e a atingir uma maturidade para poderem ser usados praticamente em todas as áreas, incluindo em nossas casas. Mas com a grande procura destas soluções, encontrou-se um infindável número de soluções e uma diversificação bastante grande. Algo que resulta num processo bastante moroso e por vezes complicado no que toca à integração de tecnologias de diferentes fabricantes.

Com o intuito de alcançar este objectivo, a integração de sistemas de vídeo vigilância, começou-se por efectuar um estudo de mercado para seleccionar as câmaras de vídeo mais 'comuns', com uma relação qualidade/preço boa, e tentar encontrar uma solução a partir desta base.

Após um estudo da já implementada solução Eye-Net, verificou-se que era possível desenvolver algumas funcionalidades e torná-la mais abrangente no que toca a ambientes e sistemas de visualização para que a aplicação se torne mais ambiciosa no seu propósito.

De modo a avaliar o desempenho da aplicação desenvolvida, esta foi transferida para um servidor, ficando online para testes e demonstrações. Por fim são abordadas temáticas que podem ser desenvolvidas em futuros projectos, ou em desenvolvimentos da mesma.

- Palavras-Chave

Câmaras de vídeo, vigilância, vídeo vigilância, segurança, integração, CCTV, HTML, PHP, ActiveX.

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List of Codes

List of Acronyms

ASP   Active Server Pages

AVC   Advanced Video Coding

CBR   Constant Bit Rate

CCTV   Closed Circuit TeleVision

CGI   Common Gateway Interface

CSS   Cascading Style Sheet

DVD   Digital Video Disc

DVR   Digital Video Recorder

FPS   Frames Per Ssecond

FTP   File Transfer Protocol

HTML   HyperText Markup Language

ISO   International Organization for Standardization

ITU-T   International Telecommunication Union- Telecommunication

JVM   Java Virtual Machine

MJPEG   Motion Joint Picture Expert Group

MPEG   Motion Picture Expert Group

MSSQL   MicroSsoft SQL

OS   Operating System

PC   Personal Computer

PCI   Peripheral Component Interface

PCM   Pulse Code Modulation

PHP   Hypertext Preprocessor

PTZ   Pan Tilt Zoom

SQL   Strutured Query Language

TCP   Transmission Control Protocol

URL   Uniform Resource Locator

VCEG   Video Coding Experts Group

VCR   **V**ideo **C**assette **R**ecorder

WWW   **W**orld **W**ide **W**eb

Introduction

Security has become a more and more important issue in our life. Everything that surrounds us is concerned about this topic, and the search of security devices like video cameras is increasing day by day. If we look around it is possible to observe that video surveillance exists in airports, banks, offices, streets and even in our homes [Col00]. Video surveillance appeared around 1940 in Germany to monitor the rockets launch and it used radio transmission to transmit back to base the video images [Dor54]. And as some other systems video surveillance as improved the technology and became more famous around the eighties with the analogue CCTV (Closed Circuit Television) system. In this system the signal of the cameras is transmitted to a specific place. Normally is a human operator watching the video from the cameras in a monitor, and the signal is recorded in magnetic tapes.

Now we live in an era that everything is changing from analogue to digital. Video surveillance is not an exception. The analogue technology has already started changing to digital era, and to the new generations of cameras, the IP cameras. With these kind of cameras it is possible to connect to any kind of IP network, including the internet. They allow the visualization and recording from any place in the world. This technology brings much more flexibility in video content processing and video transmission. When we speak about digital we are talking about an endless number of features that we can apply on the received data, for example: Snapshots, face recognition, object tracking, audio, etc [Col00].

These was a promising market to all video cameras manufacturers, and all of them started developing new features, new models according to their vision and ideas. They developed also software to monitor and apply all of those features. This seems correct as an enterprise view, but when it goes to a customer view it changes the picture. A customer that buys today one

video camera from one brand and tomorrow buys another video camera from another brand will not have the software inter-operability. This means that or he will have to work with two different kind of software individually, or he will have to buy third party software that gathers the functionalities of both cameras. But maybe this third party of software will not work in a different operating system. And is exactly here that comes Eye-Net to fill this gap. Eye-Net offers the basic functionalities of a certain number of video cameras in different browsers, in different operating systems.

1.1   Motivation and Objectives

Why study video surveillance technologies? And, what is the motivation to read this dissertation?

These two questions are answered throughout this document, but here are some topics that help us to answer these questions. More and more is needed to guarantee the stability and the safety of the people. Prevention and surveillance are the most effective way of protection. The actual tendency says that the most chosen method, by his effectiveness, is the video surveillance. And, due the improvements that video surveillance had been in last decade, it is possible to find these systems in highways, banks and even in our home.

Eye-Net is intended to make an application that supports multi video surveillance cameras with the basic features like live video, and also some extra features like PTZ, snapshot, ability to listen the environment sound, and ability to record the video. And as the user will be not always in the same place is also intended to make that application accessible by different places and by different means. To accomplish these purposes and to make the application, there will be used programming languages like PHP, HTML and JavaScript. It will be stored in a Web Server, with the intention of being accessible worldwide by a computer or any other device connected to Internet.

By all these, the purposes of this work is to offer to the user the comfort and the safety that wherever he will go, wherever device he will have, it would be possible to monitor the things he cares by an effective, efficient, simple and easy way at the distance of one click.

1.2   Application scenarios

There are a wide variety of possible applications for video surveillance. Nowadays these systems are explored in commercial, military, personal and academic fields, which make this

amount of applications even more wide and diverse. Some of these applications that can be used in enterprises, offices, highways, army are:

- Surveillance of an area or building;

- Movement detection;

- Face recognition;

- Object tracking;

- Crime preventing;

- Marketing;

- Improve customer relations;

- Remote telepresence;

- Traffic regulation;

- Performance monitoring;

- Construction progress monitoring;

- Compliance monitoring.

1.3   Dissertation structure

After the introduction, chapter two presents, in a summarized form, the technologies and system that are related with the subject of this dissertation, namely: analogue video surveillance, digital video surveillance and hybrid video surveillance.

In chapter three are shown the support technologies for web applications where there are described the programming languages used in the application and also the usual protocols and media formats in these type of applications.

Chapter four starts with a brief introduction to the video equipment used in the application and also the features able for each one and the price as well. In second part of the chapter it is described the available strategies that video cameras use for streaming. Those strategies are analysed and compared to choose which one fits better to the purposes of the application.

Chapter five is all about the application. In the first part there are described the analysis made to the already implemented solution of the Eye-Net summarizing the conclusions at the

end of this part. In second part of the chapter it is shown the upgrades that were made describing what was enhanced and how those changes were made.

Finally, in chapter six, some conclusions about the project are taken and some ideas for future work are proposed.

State of the art

Video surveillance crossed a long path, since it was born, until nowadays. Many technologic ideas were thought to this kind of systems. Some ideas were tested and developed and others were putted out. Basically all of these ideas and thoughts can lay in two methods. Even that the application was built to work in one of the methods (digital), this chapter was conceived with the intention to gather the present methods to perform video surveillance. It will be presented the methods, simple diagrams, advantages and disadvantages of each one and also in which things the costumer should think before buy a video surveillance system.

The structure of a video security system can be supported basically by two methods [Kru06]. In first place is possible to put the classic Closed Circuit TeleVision (CCTV), the analogue way, where all elements, cameras, monitors, recorders will be analogue. This type of installation has many possibilities and it is used for a long time already. Therefore, there is a big variety of manufacturers, products and installations available.

In second place we can opt for a video surveillance system based in digital technology and IP networks. This is a type of structure that is taking a huge success nowadays because the characteristics of compatibility, scalability, economy and other advantages that will be explained in next chapter.

It is also possible to do another type of installation but it is not a new type because it is a mixture of the installations referred above. So to a circuit that is analogue but we add some IP elements to gather the good things of each one, is called a hybrid surveillance system.

2.1 Analogue system

Traditionally analogue CCTV is composed by a camera with video outputs connected to a proper wire of this kind of installation and visualized in one or more screens putted on a static way which the only purpose is represent the images collected from the video camera.

For the better handling of analogue video cameras, it is possible to use multiplexers where video cameras are connected. In this device it is possible to show many video cameras in one screen, and/or program the sequence that they will be showed and also program some more features. For instance when a alarm is triggered, it is possible to put the video camera to be shown in a specific monitor and program their movement.

In some cases, these multiplexers have inputs/outputs of alarms that allow the generation and handling of events in a limited way. For example when an alarm is enabled, like a smoke sensor, show always a determinate video camera in the monitors and issue an acoustic signal. Another example is by a movement detection sensor that, when movement is detected, activate a signal like turning on a light in that area.

As we can imagine in the present days almost every video security system have also the feature to record the signal provided by video cameras. This has the aim of record every important event and also minimizes the necessity of human surveillance in the monitors. Normally the images are recorded in a VCR (Video Cassette Recorder) [Cab09]. In some cases the record device can be a digital device such as a DVD or hard drives but the classification of "analogue" still the same.

In the equipments of this type of systems it is possible also to find some signal controllers, video cameras positioning controllers, speakers/microphones to exchange audio with the monitored area. Each one of these services have a specific cable associated, for example, audio have a specific cable that is used only for audio and nothing else.

Basically an analogue CCTV system without any feature like audio, or video camera detection have the follow design:
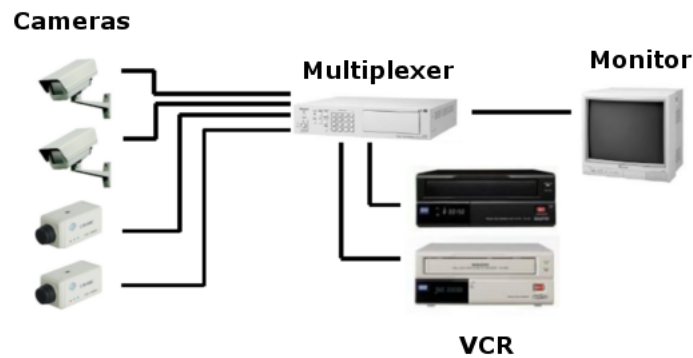
Figure 2.1: *Analogue system diagram.*

2.2 Digital system

In this technology the approach has changed: the wires are not specific for an installation, it is not required dedicated monitors for this service and the control operations are made by software, and not by hardware avoiding, in this way, the use of multiplexers or video matrices. The actual technology allows connecting the video cameras directly in the data networks that will communicate with computers that are present in almost all offices and enterprises. The video and audio are transmitted from any camera to any computer and to any place in the world since that computer have access to the Internet. To see the images from the camera over internet there are three ways:

- Through a website. In this case the camera will do streaming to a web page. User has to access this web page to see the streaming;

- Through a FTP. The camera will do the streaming to a FTP server. User will have to access this FTP server and choose the file to see;

- Directly connect Through IP. User has to know the IP address of the camera and put it on the browser to get in;

With this type of technology there is not so much constrains in the elements of the service. Each element can have others functionalities and they can be reused for another type of functionalities at the same time.

In a video surveillance security system are included video cameras that work in day light, night light, interior cameras, exterior cameras, with infra-red, with illumination, with audio,

digital outputs, etc. One of the biggest advantages of a digital system is that most of these options are configurable in real time by the user of the service and can be enabled remotely.

Among the distinct cameras and the image to present to the operator, there is a huge variety of possibilities depending on the architecture of the building and the client's desire. Like the analogue systems there are cameras with moving systems, signal controllers, recorders, microphones and speakers, etc. All these equipments can be controlled by software and, as been explained above there is no specific wires to connect them, just a simple IP technology as Ethernet, optic fiber or Wi-Fi.

The recorded images are stored in a DVR (Digital Video Recorder) [Dam04]. Normally these devices are supported by hard disks or any other type of digital discs like DVD.

A digital system although has the same approach, the operation method is completely distinct from a analogue system, increasing the possibilities and simplifying the installation and the equipments needed.

A basic diagram of a digital installation can be observed in the figure 2.2
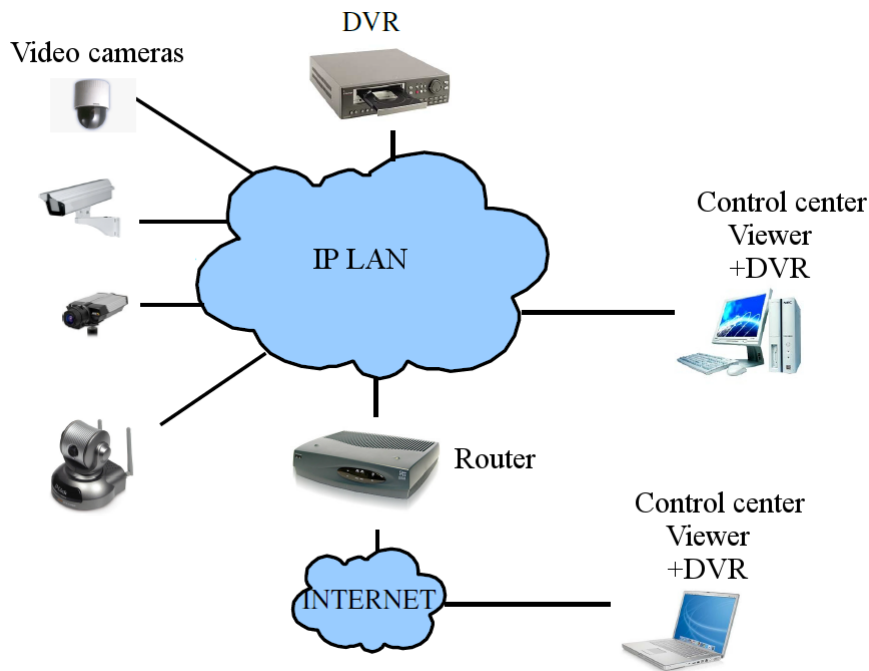
Figure 2.2: *Digital system diagram .*

2.3   Hybrid system

In some occasions it is desirable to have a hybrid system where all elements are analogue except the control center that will be a PC. This can be due to many factors:

- The need to reuse material and installations already existent like cameras and wires;

- Simplicity in the installation: analogue cameras that simply transmit their signal to a pc or to the control center;

- A simple maintenance since it is a dedicated network (analogue system network), there won't happen traffic overloads and it will be not necessary high specialized personal;

- Small areas where where a complex system is not necessary;

- It is possible to access images through internet, because the control center is a computer. But is not possible to change some configurations, or listen audio. These configurations will need additional wires;

- It is possible the recording and image processing in the store device and it is possible also to define areas where ta change in the image will trigger an alarm;

- It is always possible possible to add more elements but it will be subject to the availability of the resources on the computer (inputs on the PCI card);

These types of installations are made through PCI cards normally called DVR that make the video capture. These cards have some pins were the analogue cameras will be connected. These features offered by this kind of system is subjected to the software of the card like quality of the video, format of the video, access through web, etc.

The diagram of this kind of installation is showed in the figure 2.3

Figure 2.3: *Hybrid system diagram .*

2.4   Advantages and Disadvantages

After reading about analogue and digital technologies, it is possible to observe that both technologies have advantages and disadvantages. So, in this chapter, there will be shown those

advantages and disadvantages of each system.

2.4.1 Analogue system

2.4.1.1 Advantages

- Relatively cheap set-up;

- Mature technology;

- Simple to use;

- Built as a modular way;

- Easy to replace/add components because its modularity;

2.4.1.2 Disadvantages

- The features offered are relatively static and simple. Adding new features is a complicated task and more wires and more components are needed;

- The search for stored information (magnetic tapes) takes a lot of time;

- Tape replacement when recording consumes time and human resources, and the information can be lost during the process;

- Degradation of the quality of video, because the tapes will be reused. It is also needed space for the recorded tapes.

- The movement detection is not possible.

2.4.2 Digital

2.4.2.1 Advantages

- The system recordings can be seen and duplicated without loss or degradation;

- Easy to find the recorded information;

- Digital video can be stored in many supports (e.g. DVD, hard disks).

- The recorded information can be encrypted as a security measure.

- The quality of video can be changed depending on the system requirements at a moment.

- Real time and remote modification of some features by software.

2.4.2.2 Disadvantages

- For a short time, the digital installation can be more expensive than analogue.

2.5 So which one to choose?

After enumerating the advantages and disadvantages of each system it is normal to ask which one is the best system, or if we should install a completely analogue/digital system or a hybrid. And, as always, the answer is: it depends! It depends on the necessities and on the service that is pretended for the installation. After describing the different technologies it is easy to understand why nowadays everything is becoming digital. It offers a big variety of possibilities and features. In summary the main characteristics that people choose in a full digital system are:

- Flexibility. Practically it is possible to put cameras everywhere. There are no limitations. It is possible, to connect the cameras to a network by an Ethernet wire or by Wi-Fi;

- Scalability. A network video system can be expanded to enlarge the capacity. The scalability of this technology is a practical solution for hundreds of cameras and the same solution for enterprises that have few cameras;

- Economy. Digital technology is much more economic because there is no need of a dedicated computer for cameras working. To watch the images from the cameras any computer connected to the network is able to do it, so it is not needed also any dedicated monitor or screen. Also, it is not needed the special dedicated coaxial cables to transmit the signal. It is possible to transmit this signal by an existent IP network;

- Remote access. It is possible to access live images at any moment and in any place with any computer. The images can be stored in remote locations for safety reasons and use internet as a medium of transportation.

- Future ready. Digital cameras have the most modern technology, so all investment that is made now will report many benefits in the future;

- Store devices. For storing the images, the hard disk of a computer have many more advantages than a magnetic tape. Its life is longer, can be configurable and due to his fidelity, making backups is not usual;

- Versatility. Digital cameras have a big variety of features and possibilities that can be applied in different situations and in different areas;

3

Support technologies for web applications

Technology is a term that involves the scientific and technical knowledge and the tools, processes and materials created and / or used from this knowledge. They are the support or/and the base of web applications and choosing the appropriated technologies for an specific module can determine aspects such as efficiency, costs and the services offered to the user. The technologies discussed in this chapter are directly related to the Eye-Net.

In this chapter it will be discussed the technologies used to develop a web application. It will be presented themes such as programming languages, database management system, web server, development platform, protocols and video formats. All these points will be introduced with general description and, as well as why was choose those technologies.

3.1   Programming languages

Programming language is a standard method to communicate instructions to a computer. It is a set of instructions, syntactic and semantic, to define a program in a computer. Since this project is highly based on machines, it is normal to program these ones to run and offer to the user what is pretended with the least actions possible.

In this section it will be briefly described the main programming languages that were used to build the application.

3.1.1 HTML

Connectivity has a huge impact in our daily lives. Millions of people have access to internet and it is estimated that 4 billion web pages are available in World Wide Web [Com06]. This connectivity allows people to communicate with others around the world, gather information to make informed decisions and many more [Whi03]. Without HTML (HyperText Markup Language) and its associated technologies the web could not exist. With HTML, creating web pages can be really simple. HTML can't be considered a programming language but a formatting language, which allows the creation of web pages through a list of commands designated by tags. Normally the learning of this language is quite fast because is very intuitive and although there are a lot of tags, only few of them are used normally.

3.1.2 PHP

"PHP: Hypertext Preprocessor", originally Personal Home Page, is an open source language and it was launched in 1995 by Rasmus Lerdorf. It is a server side language and practically is possible to do everything, since it generates dynamic web pages, send and receive cookies to connect to a database [Hud06]. PHP code is embedded in a HTML page and it has a tag to start and another to end the block of PHP code. In this way the server knows which part of PHP code should execute. This interaction between PHP and HTML is what gives all purpose to this language. The ability of PHP to generate HTML is fundamental and the ability to process the forms that are sent by HTML with data, is what gives the dynamism to the web pages [Pow10].

The main characteristic of this language and why it became so famous on the web programming is also because it is open source. It means that is free and it is very easy to find, on internet, a block of code to perform a desirable action [Ull03].

The concurrent of this language is ASP (Active Server Pages), which performs same things as PHP but have a big con. It is licensed by Microsoft, which means that it is paid, it only runs in Microsoft platforms and only connects to Microsoft databases (MSSQL).

3.1.3 Javascript

JavaScript is widely used in the creation of web pages. It was created at Sun Microsystems with the intention of creating a method of manipulating the web page without having to refresh or jump to another web page [TN09]. It allows enhancing the browsing experience, but it has several annoyances associated with this technology. Image roll-overs and pop up messages are

some of the annoyances, and some security issues on early implementations lead people to not use or limit this technology on their browsers [EG05].

JavaScript is loaded by the browser when the HTML is loaded and it allows animations, forms validation and enhancements to run. This technology run on client side, so this type of security model is very easily bypassed. Usually there is confusion between JavaScript, Java applets and Java. These technologies were created by Sun Microsystems with a similar name, but everything else is not related in any way.

3.1.4   CSS

CSS (Cascading Style Sheet) is a language that allows the customization of a web page through rules definition in the HTML tags. The HTML was never intended to contain tags for formatting a document. To solve this problem styles were added in the version HTML 3.2. But it was only in the version of HTML 4.0 that all formatting could be removed from HTML code and stored in a separated file [IP10]. With the use of this language, there are some advantages that can be listed:

- Control the layout of all web page through a single document

- Is fast to maintain and edit the layout

- Fast loading time

3.2   Database management system

Database management is a set of software, intended to manage all the storage and data manipulation of the system, doing the interface of the application level with the database. In the early models, information was stored through files management systems. In these models it was necessary a physical connection to access them, and big problems appeared when many applications wanted to access the same file. In the actual models this problem was successfully solved changing the physical connections into logical connections. The actions that can be made in a database management system are:

- Creation, definition and edition of the structure of the database

- Creation, definition and edition of tables

- Creation, definition and edition of attributes from tables

- Creation, definition and edition of data

- Data control operations

- Attribution or suppression access to a user or a group of users

In the following section it is possible to see more detailed information of the database management system used in this project.

3.2.1 MySQL

It was named MySQL by the co-founder Michael Widenius and the meaning of the name comes from two sources. My is from the co-founder daughter and SQL represents Structured Query Language [MyS11]. This database management system is widely used in the Web, and is very common to find services for hosting Web pages compatible with MySQL. This system offers many resources and have the main characteristics:

- SQL instructions

- Requires low processing

- High compatibility with programming languages such as PHP, Java, Python, etc.

- Secure connectivity

The choice of this database management system was due to many factors. It could be factors like high compatibility with the host server, the high speed of the data requested or the low processing requirements, but the main factor was the previous knowledge about this system gained through academic works.

3.3 Development platform

Choose a platform to develop the applications is the first step to program in a specific programming language or even start to build applications. In this section it will be briefly introduced the platform that was used in this project and it will be discussed why this option was made.

3.3.1 RapidPHP

Rapid PHP is a PHP editor which extends through the essential and the basic environment of a common PHP editor. It is possible to create and edit not only PHP, but also codes in HTML, XHTML, CSS and JavaScript with integrated tools to validate, reuse, navigation and code formatting.

The chapter of the resources in the Rapid PHP is very wide. Syntax analysis, code auto fill, tips, project management, possibility to open and save files through FTP are only some of the most important resources. It is a good choice, not only for small, but also for big projects. The choice for this editor was because the familiarity with him, which came along with the academic use.

3.4 Server

Web servers are computers that deliver web pages. These computers have their own specific software also called web server. Each web server has an IP address, and when it is requested that IP the web server will deliver a web page to the browser.

The performance of a site is highly dependent of the efficiency of this web server because of the latency and the time to load the requested web page. So, in this section it will be discussed the software, and also some characteristics, of the web server that was used in this project.

3.4.1 Apache

Apache server is among all the most used due to the main characteristics [Sha09]. Highly configurable, flexible, can be executed in different platforms, it is in constant development to include the latest protocols, open source and doesn't possess limited or restrict licenses are some of those characteristics. It is composed by modules and different modules offer different characteristics improving the server functionality. It is open source, and this means that it have a huge support from the community. Some of the features that lead to the most used server are listed below:

- It supports scripts cgi using languages like PHP, shell script, ASP, etc

- It supports access authorization where can be specified restrict access to an address or path in the server

- Content negotiation, allowing the exhibition of the web page in the idiom of the client browser

- Virtual hosting support

- IP virtual hosting

- Proxy FTP and HTTP support

The concurrent of Apache is the Microsoft server, the Microsoft IIS (Internet Information Server), that is also a good choice for web applications. The choice of the use of the Apache server on this project was based on cost and in the platforms supported. About the cost, because it is a Microsoft product, it will have costs associated to the use. About platforms supported, and again because it is a Microsoft product, it only run in platforms of this enterprise, given a limited field of operations.

3.5 Protocols and formats

From the architecture of a video surveillance system is possible to observe that it will be a server-client application. The servers will be the video equipments, the client will be the machine where the user will watch the information provided from cameras. In this way it is very important to define the distribution of the data. This distribution can be made by many ways but it is settled in two basic items, the protocol and the format. The protocol specifies how data will be transmitted and its distribution structure. The data format will specify the media format to be distributed.

So, this chapter will focus in those two main items. In the first part it will be presented information related with different protocols while, in the second part, is related with the formats and to finalize it will be discussed which of the protocols and formats will fulfil the application purposes.

3.5.1 Protocols

A protocol is a convention or a standard which enables a connection, communication, data transfer between two systems. It can be understood as a set of rules that control the syntax, semantics and synchronization of the communication. It is essential in video surveillance since it is mandatory that information has to be transferred between the video equipment and the user.

It is very difficult to generalize a protocol because it changes in its purpose and sophistic-ation, but the major of them specifies some properties like characteristics of the connection, how to start and end the message, detection of corrupted messages and many other character-istics. In this section it will be described some of the most important protocols related to the application.

3.5.1.1 TCP/IP

TCP/IP is a set of protocols. The acronym TCP/IP means " Transmission Control Pro-tocol/Internet Protocol ". It comes from the names of the protocols and the set of protocols TCP and the protocol IP. TCP/IP represents all of the communication rules for the internet and it is based in the notion of IP [Bra89]. This means that to address a message to a specific system, this machine have to take an IP address. The TCP/IP protocol was initially created with military purposes, and it is designed to accomplish a certain amount of criteria that are:

- To divide messages in packets

- To use an address system (IP address)

- To route the data through the network

- Error detection in the data transmission

The knowledge of the set of protocols TCP/IP is not essential for a simple user, in the same way that a spectator doesn't need to know how television works, but to administrate or to give some support in a TCP/IP network, this knowledge is fundamental.
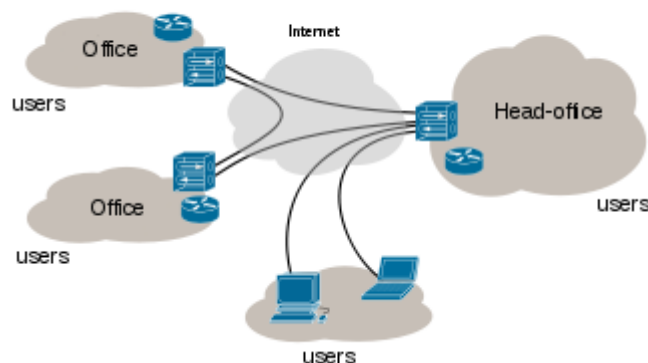

Figure 3.1: *Computer networks.*

3.5.1.2 HTTP

HTTP (HyperText Transfer Protocol) is a protocol that is used in each World Wide Web transaction. It was created by Wide Web Consortium and Internet Engineering Task Force. It is a protocol oriented to transactions and follows the scheme of client-server. The client sends the request, normally through a web browser, and this request is made by an URL (Uniform Resource Locator) that, as the name suggests, locates the resources that are trying to get. These resources can be files, database consults, program executions, etc. HTTP is a protocol without state and this means that it not saves any information about the previous connections. The need of stored information from one connection to another, lead the arising of new solutions like cookies or sessions variables. With this technology it is possible to the server system save information in the client machine. This is very helpful because allows to the user to not be always writing his information. He writes only once and than the information will be stored in the session. When the server needs them he will just read them from there becoming the transactions faster and more efficient.

3.5.1.3 HTTPS

HTTPS (HyperText Transfer Protocol Secure) is the combination of HTTP (above described) with SSL (Secure Sockets Layer). The purpose of this combination is to offer to the user a safety connection for the data transferred. To accomplish this purpose it is used in HTTP an encrypted connection where all data transferred will be encrypted and it is impossible to decipher. Unlike a normal HTTP connection when someone is between the client and the server, it could access to privileged information; in HTTPS this leak of information would be no problematic because the data will be encrypted.

To implement these protocols are needed certificates that will be exchanged in server-client to establish a secure connection. Normally these certificates are paid. This is one of the reasons because not all websites have HTTPS, but only the websites that really need like banks or any web page that have personal data transactions.

3.5.2 Video formats

Selecting the proper imaging technology will be one of the most important decisions on the application. How data will be coded will reflect in many components like image quality, network bandwidth, storage management, etc.

So in the first part of this section it will be briefly introduced the main formats used in

video surveillance systems. In the second part it will be analysed the formats, introducing some advantages and disadvantages of each one. It will be discussed also which ones were used on this application.

3.5.2.1 MJPEG

MJPEG was developed for multimedia PC applications and it is widely used in mobile devices with video capture like digital video cameras. Although the bit rate is lower when compared with modern formats, it is bigger than formats that use inter frame movement compensation like MPEG-1, because MJPEG uses intra-frame compensation. Intra frame is the compensation that is made in the frame, and inter frame is the compensation used between the frame sequence.

Although the good characteristics of MJPEG, this has been replaced by newer formats like MPEG-4 [OnS06]. The reason of this replacement is because when it is compared the quality of a MJPEG file with a similar file size MPEG, the quality on the MJPEG is lower than the other format. Another reason is about the audio. In MJPEG the audio was PCM which have lower quality and very few compression.

Some of the advantages and the disadvantages can be observed in the following items [OnS06]:

Advantages:

- Image quality

- Resiliency (fast image stream recovery in the event of packet loss)

- Interoperability (industry standard compression/decompression available on all PCs)

- Decompression on the PC is better (more video streams on PC)

- Large Number of Supported Cameras

- Lower Latency

- Graceful degradation (reduced bandwidth does not reduce image quality)

- Constant image quality (quality remains constant regardless of image complexity)

- Can display and record up to 30 FPS

Disadvantages:

- High bandwidth usage (at frame rates above 10 FPS)

- High storage requirements (at frame rates above 10 FPS)

- No support for synchronized sound

3.5.2.2 MPEG-4

MPEG-4 is a standard format widely used in video surveillance. When is used MPEG-4, normally is referred to MPEG-4 Part 2, also known as MPEG-4 Visual. It is a licensed standard, so who wants to work with this format have to pay the license. MPEG-4 works in applications with low bandwidth and applications that demands high quality images, unlimited capture velocity and practically unlimited bandwidth [OnS06]. To a better understanding of the advantages and disadvantages, they will be following summarized:

Advantages:

- Higher compression Rates (above 10 FPS)

- Can Maintain Constant bit rate (CBR)

- Good Streaming Protocol (designed for real-time viewing)

- Can Sync Audio and Video (for live and recorded streams)

- Can display and record up to 30 FPS

Disadvantages:

- Image quality is less than MJPEG

- Bandwidth does not perform as advertised

- Low robustness (can lose video if bandwidth drops)

- Higher latency (delayed live viewing)

- Less Resilient (packet loss causes lost video)

- CBR Mode Issues (image quality suffers with network congestion or movement in scenes)

- Licensing restrictions (may need to pay for viewers)

3.5.2.3 H.264

H.264 also known as MPEG-4 Part 10 or AVC (Advanced Video Coding) is a new codec standard which can achieve high quality video in relatively low bit-rates. It was created by ITU-T Video Coding Experts Group (VCEG) in partnership with ISO/IEC MPEG. The aim of these groups were to offer similar video quality in half the size of formats like MPEG-2, DivX and MPEG-4. So it can be called of a successor of these formats. Another point in favour of this format is the ability to be compatible with low and high bit-rates and also be compatible with high and low resolutions [IT12]. Advantages and disadvantages are showed in the following items:

Advantages:

- Higher compression Rates (above 10 FPS)

- Lower storage requirements (at 10 FPS or higher)

- Can Maintain Constant bit rate (CBR)

- Good Streaming Protocol (designed for real-time viewing)

- Can Sync Audio and Video (for live and recorded streams)

- Can display and record up to 30 FPS

Disadvantages:

- Storage issues with many cameras (fragmentation)

- Decompression on the PC is quite high (fewer video streams)

- Low robustness (can lose video if bandwidth drops)

- Higher latency (delayed live viewing and sluggish PTZ control)

3.6 Video formats conclusions

It was already said that choosing the correct format will be reflected in many factors. The main items that the format is directly connected are:

- Image quality

- Minimum and maximum frames

- Storage requirements

- Minimum resolution available bandwidth

- Average latency

- Budget

The various formats were described, but to choose the one that fits better to the purpose of this application, it should be analysed the benefits and handicaps of each format to be able to reach a conclusion. So, after reviewing all and comparing the advantages and disadvantages is possible to take some conclusions:

- With the appearance of H.264, MPEG4 popularity has diminished dramatically.

- If it is required to synchronize audio and video, then H.264 is the clear choice.

- For the most security surveillance and remote monitoring applications MJPEG compression technology is the best choice.

So, after review all these characteristics it is possible to organize the system in two parts according to formats. The first will be used when audio is needed and, the other, when the audio is not needed. The format that will be used when audio is needed it is the H.264, due to the characteristics for transporting audio. When live video is needed the used format will be MJPEG because it will make the system more simpler and efficient without using too many resources.

4

Video cameras and strategy for streaming

Only in Great Britain, it is estimated that there are over five million CCTV cameras in private and public hands [Joh07]. This fact is made by a wide range of organizations and for an increasing number of purposes. Beyond this achievement, it is an extensive list of video equipment with many strategies to perform the desirable services.

This chapter will present in the first part the video cameras used in the application while, in the second part it will be discussed the main strategies that video cameras are using to perform the streaming.

4.1 Equipments

Video surveillance started long years ago, and many products were developed. As told before, this project will lay in a digital system so digital equipments will be used. Digital cameras can be connected directly to a network without the need of a computer. So, the main focus of this section will be the video cameras and, as this application is based on a digital method, this section will focus on IP video cameras.

In the first part of this section it will be described some considerations about the equipments used in video surveillance. In the second part it will be briefly described the video equipments that were used along this project. Finally in the third part, it will be shown the features of each equipment.

4.1.1   Considerations

Before starting the development of any project an accurate survey of the available equipments is needed on the market and its characteristics to specify the application. Nowadays there are a great offer of IP cameras. It is possible to find IP cameras from 0.3 Mega pixels till 21 Mega pixels, with or without zoom, resistant to weather conditions or not and many other characteristics. Only specifying the video equipment that will be used, is possible to define the purpose of the application. Some of the considerations that were made in order to choose the video equipment were:

- What cameras should be used (including considerations regarding fixed or pan, tilt, image quality, zoom and day/night operation cameras)?

- It is needed cameras with great angle of vision?

- It is needed any special adjustment like been exposed to bright lights or other variable lighting to have only a minimal impact?

- It is needed to be weather resistant (including excessive heat and cold)?

- How many cameras are needed to cover an area (bearing in mind that this will be critical on the performance of the system)?

- Will the cameras be wireless or operate on an cable platform?

- How often will they be cleaned and require maintenance?

- What requirements are there for installation (including excavation)?

- What fixtures, trees and lighting will need to be modified / improved to enable the cameras to work effectively?

- And the last but maybe the most important, the price.

So, after all that has been said above, it was needed to adjust these project purpose to the considerations. This project can be applied in all range of fields, but the main target will be the domestic and small enterprises with lower complexity. In this area there will be not needed a great image quality because the network capability will be not so great. For instance, a 5 Mega pixels (Mpx) camera in a live view can introduce on the network, in average, 25Mb in each second. So a clear point is about network bandwidth. A good relation between quality

and and network bandwidth consumed should me maintained. It will not need extra fixtures. Less fixtures will lead to a less complexity and this is one goal of the project: basic features, just the basic ones used in day life. And, as any other product in the market, the costumer always want the best at the lowest price possible. After all these, it is possible to summarize the main considerations of this project:

- Basic features;

- No need of extra fixtures;

- No need for great image quality;

- Indoor video cameras;

- Lowest price possible;

These characteristics will be a starting point in the search of the equipments. In the next section it will be described the used equipments, even different in some aspects, they are all based in the considerations written above.

4.1.2   Used Equipments

As it was told, in the previous section, there is an extensive list of video cameras but with the considerations made it is possible to define a short variety of video cameras that will fill the purposes of the Eye-Net.

In this section will be presented the used video equipments. It is composed by three video cameras. A general description about them and about the manufacturer will be made, as well as, an available services comparison in the end of the section.

4.1.2.1   Foscam

Foscam is a new company that officially started in December, 2007 [Fos10]. Due to the quality/price relation and due to the reliability of the products, this brand has conquered his position on the market. The model FI8908W that is used on this project was launched and patented in June of 2008 [Fos10]. This model has also a big list of features that will be shown and compared in the next section. Bellow it is possible to see an image of the model Foscam FI8908W.

It is possible to purchase this camera through many vendors. It was checked on Amazon, (www.amazon.com), and the price can be seen below.

Figure 4.1: *Foscam FI8908W used in the application.*

Prices(21/08/2012):

New from: 78.99$

Used from: 52$

4.1.2.2 Fitivision

Fitivision is the youngest brand from the three described. It appeared in 2009. The main focus of this enterprise is the research and development. They provide solutions and products for the leading companies of the area. It has two main factories. One is in Taiwan and the other is in the North of China [Fit10]. The next picture show the camera that was used by Fitivision brand.

Figure 4.2: *Fitivision ics 130A used in the application.*

It was not possible to find it on Amazon, neither on another similar websites. The price that was given to that camera when bought was around 120$

4.1.2.3 Axis

Axis communications AB is a Swedish manufacturer of network cameras for physical security and video surveillance. It was founded in 1984, so it is one of the companies with more presence (if not the most) in the market with its own products. But it was only in 1996 that axis introduced the first camera: the Axis 200. In this model, the Axis 207W, Axis presented (in the year 2005), the smallest network camera to incorporate MPEG-4 image compression [Axi09]. It has a huge list of features that will be described and compared in the next chapter. In the figure below it is possible to see a picture of Axis 207W.

Figure 4.3: *Axis 207W used in the application.*

Nowadays it is still possible to buy this video camera. The store that was consulted to check the price was Amazon and the prices for a new and for a used one can be seen below:

Prices(21/08/2012):

New from: 449$

Used from: 250$

4.1.3 Features description

In this section it will be shown a table with the main characteristics of the video cameras. The main characteristics that we will check are:

- Price: the cost price for a new model;

- Megapixels: how many mega pixels have the model;

- Ethernet: if it has an Ethernet jack to connect;

- WiFi: if it has the WiFi technology integrated;

- Snapshot: if it is able to take a snapshot;

- Record: if it is able to record video;

- PTZ: if it is possible to move the camera remotely;

- Digital IO: if it is possible to switch On/Off an external device;

- Speakers: if it has integrated speakers;

- Microphone: if it has an integrated microphone;

- Night vision: if it is possible to see during night light;

- Video: if it performs the streaming of live video;

In the table 4.1 are shown the characteristics of the video cameras.

	Foscam Fi8908W	*Axis 207W*	*Fitivision ICS 30A*
Price	78.99$	449$	120$
Video	Yes	Yes	Yes
Night vision	Yes	No	Yes
WiFi	Yes	Yes	No
Movement	Yes	No	No
Digital IO	Yes	Yes	No
Microphone	Yes	Yes	Yes
Speakers	Yes	No	No
Snapshot	Yes	Yes	Yes
Ethernet	Yes	Yes	Yes
Record	Yes	Yes	Yes
Megapixels	0.3	0.3	0.3

Table 4.1: *Video cameras characteristics*

Through the table 4.1 it is possible to observe the video characteristics. One main aspect that the costumer is taking in account is the price of the video equipment and which characteristics is possible to perform with such video camera. From the table 4.1 and the tests made in the application, the choices tend to fall in one camera, the Foscam model. It has all characteristics above discriminated and has a incredible price making a excellent choice due to the good quality - cost relation.

4.2 Strategies for streaming

Streaming is a way of distribute media information in a network through packets that are received and presented to an end user while being delivered by a provider. This scheme is essential in video surveillance, being the video camera the provider and the person that will be watching the end user. Normally, in streaming there is no storage of the content, it is just temporary stored in the cache, and it is displayed when it is received by the user. To fill this purpose, many protocols and file formats were created for a faster and efficient transmission of the files to be seen. These protocols and formats can be found in chapter 3.5.

The different platforms and different needs lead the video surveillance industry to create different technologies to make video streaming and, to choose the best one, it only depends on its purpose. In this section will be presented the main technologies to make video surveillance. It will be made a comparison between them where it will be shown which services each one can offer. Finally it will be discussed the reasons to choose the technologies for this project.

4.2.1 Server push mode

Server push is a technology adopted for almost all browsers excluding Internet Explorer®. This technology describes a network communication where the request for an operation is started by the server [euk12]. Normally in this case, a client subscribes to an information channel and when new data is available the server sends the information to the client. Many applications work like this. Examples of applications that use this technology are many, like for instance: on-line chat, email, auctions, betting and many others.

In the case of this project it will be used HTTP server push mode, because it will be an on-line service through a browser. To implement this mechanism we need a web server. Video cameras used in this project have it, and a web browser, one that we choose, that can be Mozilla Firefox®, Google Chrome®, Netscape®. The mechanisms that the web servers use

in the camera is through a CGI script. And when we subscribe that script, normally the web server does not terminate the connection and it will be always sending the video to the client that, in this case, it will be the web browser.

4.2.2   ActiveX

ActiveX was presented in 1996 as a release of Microsoft. And by its definition is a software component of Microsoft Windows [Mic08]. With it, is possible to create interactions and mini programs running on the browser. To write these programs it is used Visual Basic script or Visual C. So by this definition it is possible to say that these components will work only in Windows operating systems. Nowadays this technology no longer exist, it was replaced for .Net also from Microsoft.

For this project it will be used ActiveX components in Internet Explorer®. One good thing of the ActiveX is that is language independent. It is possible to write a web page in any language and also include this component on it. When navigating on an ActiveX web page the user will be prompted to install the component. It is up to the user install it or not.

An analogy can be made with Java applets. Both are mini programs that improve the user relation with the browser, but Java applet will not run with privileges for doing anything that could damage your computer, while ActiveX can do practically everything without informing the user. It is recommended to install ActiveX only when you trust the web page that you are visiting.

4.2.3   Java applets

Java is an object-oriented programming language created by Sun Microsystems, Inc ® in 1994 and released in 1995. This language derives from C and C++ and is a general purpose, concurrent, class based and object oriented language that is specifically designed to have as few implementation dependencies as possible. The idea of this language is Write Once Run Anywhere (WORA). This means that, once the program is compiled to an environment it does not need to be compiled for another. It is, at this moment, one (if not the most) popular programming language. It was estimated that in 2012 it had 10 millions of users.

Java applets were introduced in the first version of the Java language in 1995. Java applet is a short application which is written using the Java programming language. It had a huge success because of the simplicity of include them in a HTML page and also because of the security. To include it in a page is pretty the same as including an image, but just using

the HTML tag applet [Boe09]. About security, they have built-in security measures. In this way it is impossible to an application take administrator privileges, preventing, in this way, to read/write or access to resources from the local machine.

To understand how Java applet run in a HTML page is very easy. Basically it is transferred to the local system and executed by the browsers Java Virtual Machine (JVM). Normally the only action to take by the user is to click on the applet to run the application, but in some cases it is possible to start automatically.

The content of these programs is very wide and is spread in many areas like video displays, calculators, animations and many more. In the video surveillance, Java applets didn't get so much success because of the security policy. To get access to the resources of the computer and have some privileges is possible but it is complicated. Bellow is possible to enumerate some of the advantages and disadvantages of this technology.

Java Applets advantages

- Applets run in multi platform (Windows, Linux, Mac OS)

- Applets run in the browser, so the user does not need to trust the code, so it can work without security approval

- Applets run practically in all browsers

- Applets stay in cache in most web browsers, so it will be quick to load when visiting again the web page

- Only have full access of the machine if user allows

Java Applets disadvantages

- Java plug-in is needed to run applet

- Java applet requires JVM so first time it takes significant start-up time to start JVM

- If applet is not already cached in the machine or is the first time to visit the web page that contains the applet, it will be downloaded from internet and will take some time

- Compared with HTML, it is not so graphically attractive

4.2.4   Services offered in each strategy

Each strategy has its advantages and disadvantages. In table 4.2 it is possible to identify the services that are allowed in each strategy. It is also possible to identify that ActiveX allows all services but has the disadvantage that it has to be installed in the machine and has also some safety risks.

In other hand, the server push mode, allows only the basic services but doesn't have to be installed, doesn't have safety risks and it is possible to access from any operating system and any browser.

Java applets offers several services but is independent of the platform and independent of the browser. This advantage makes this kind of technology easy to implement on the system. Bellow, it can be observed a table with the description of the different services in the different technologies.

	ActiveX	*Server push mode*	*Java Applet*
Live video	Yes	Yes	Yes
Snapshot	Yes	Yes	Yes
Listen	Yes	No	Yes
Digital IO	Yes	Yes	Yes
Speak	Yes	No	No
Movement	Yes	Yes	No
Record	Yes	No	No

Table 4.2: *Allowed services in the different techniques*

4.2.5   Technologies used and reasons

After the research phase, about these kind of applications and about surveillance video cameras it became obvious that we need to split the application in two parts. One part should be for systems that have Windows OS and running IE (Internet Explorer). The second one can be applied for all the others operating systems and browsers. Most of the manufacturers only offer full services in Internet Explorer. It is much easier and less complicated for them

to make an application that will be controlled by a browser, than to make an interactive " no installation needed " application.

The option for this project was to use Windows OS and running Internet Explorer with ActiveX technology. It was chosen this technology because it allows all services that are pretended to offer to the user. It have some disadvantages, like the ones explained in the section above, but it is up to the user to decide if is worth to run those safety risks. The other technology that was chosen was the server push mode. This technology will complement the ActiveX on the Internet Explorer. Server push mode will be available in all other browsers than IE. This will allow user to access basic services, like was shown in table 4.2, without the need to install anything. Also with the implementation of this technology, the user is able to access to the application through a smart phone with an internet connection, because the source code is 100% HTML.

Java Applets will be not used, although it would be easy to make its implementation. Some issues were found, provoking the not inclusion on this project. Those issues were:

- It is not a standard for video surveillance so not all manufacturers have this. (in this project only Axis have it)

- Some smart phones doesn't support Java, so it will not allow to access to the service.

- Demands to load the applet each time that user will access, and if it is not in cache can take sometime to download it.

So, in conclusion to fill the purposes of the application, ActiveX will be used in Internet Explorer and server push mode will be used in the rest of the browsers and platforms.

5

Eye-Net

Video surveillance systems had been highly developed in the last decade, passing through many improvements along its history. Nowadays, since that improvements had been made and a certain number of features have been reached, it is time to take and deliver them to the customer in a fast, safe, efficient and comfortable way.

Eye-Net is one of those applications. It takes advantage of the characteristics of IP video cameras, and through an interactive interface based on technologies and programming languages, presented on this dissertation, offers to the customer a ideal solution for surveillance. It allows a customer to have a high number of video cameras associated to his account, enabling a remote access to them.

This chapter is divided in two parts. In the first part it will be presented the application that was already implemented and it was the support and the base of the developed services, describing their components and how they work. In the second part it will be described the upgrades that were made in the Eye-Net, and how they where implemented on the application.

5.1   Application analysis

It was said already that Eye-Net was a application for video surveillance, that allows users to a certain number of services regardless where it will be. The figure 5.1 is illustrating the Eye-Net concept.
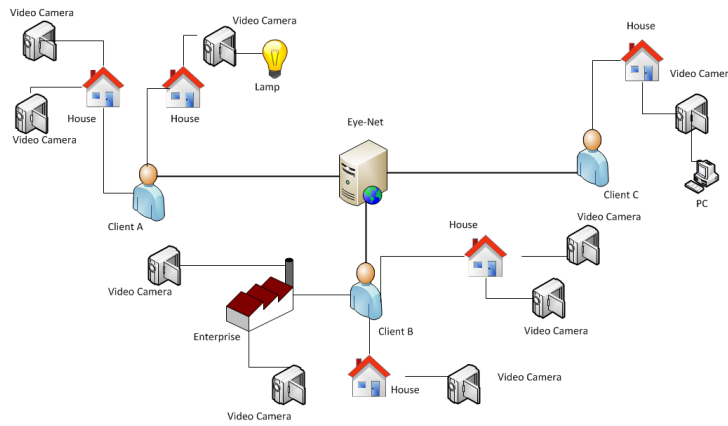
Figure 5.1: *Eye-Net diagram scheme.*

To organize all information from the system it was needed to create a model that would be organized according to the major needs of the system. In this way, the requests for information will be more simple, efficient and fast. In the figure 5.2 is possible to observe how data was organized in the database and how it is connected with each other.
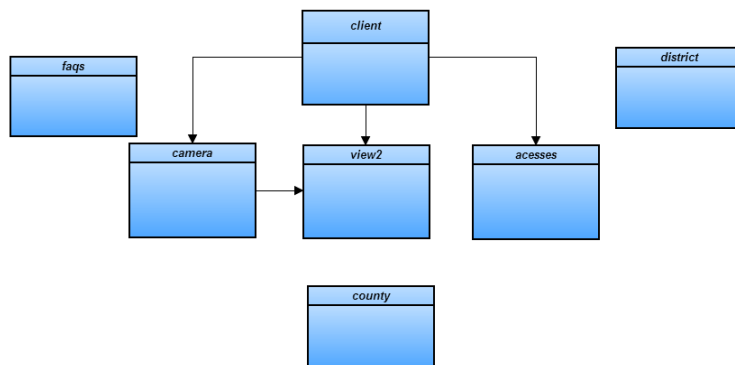

Figure 5.2: *Database conceptual model.*

To fulfil the purpose of the project this application is divided in two parts. A part, denominated as Front Office, that will present to the customer all possible options related with video cameras and, the Back Office, that will be used by the administrator to manage the customers, cameras, systems, etc.

5.1.1 Back Office

Back office was created with the intention to be the area where it is possible to administrate the system. According with the different areas, this part of the system has 5 sections which can be consulted.

With this structure it is possible to navigate easier and faster through the desirable information. In the next sections it will be briefly described each one of those sections.

5.1.1.1 Home

This section will be the first one to appear when the user will log in the system. Here, the user can find useful information to navigate faster, finding what he is looking for.
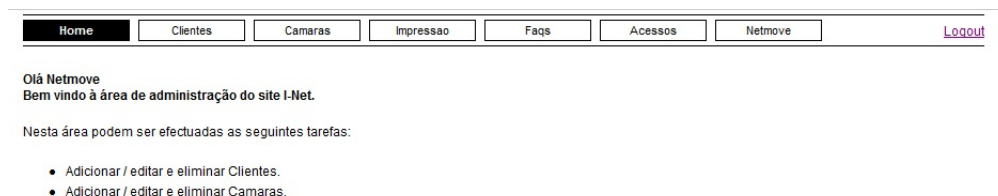

Figure 5.3: *Home web page.*

5.1.1.2 Clients

The name of this section is very intuitive. It is responsible for the management of all data related to the client. Some of the information that can be seen here are: Name, Address, Phone, Number of cameras, account data, etc. In the figure 5.4 it is possible to observe a screenshot of this section.
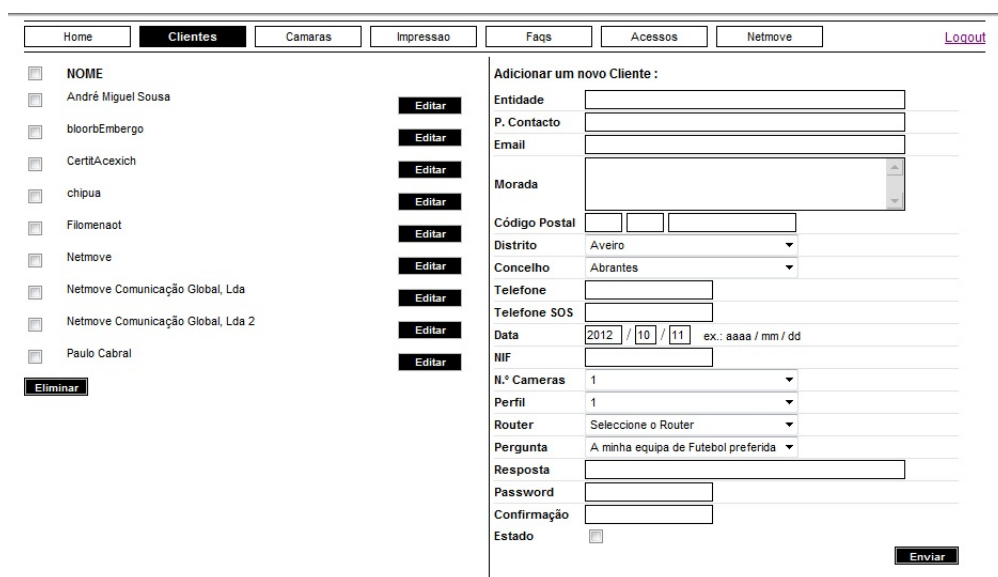

Figure 5.4: *Clients web page.*

5.1.1.3 Cameras

Here it will be displayed the information related to the clients cameras. It is possible to add, remove or edit those settings. Information shown in the figure 5.5 can be found in the cameras section.

Figure 5.5: *Cameras web page.*

5.1.1.4 FAQS

FAQS (Frequently Asked QuentionS) is essential in an application where clients are involved. This is a quick and easy way for a customer to see their questions answered. In this page it is possible to add more questions and answers, that will stay on-line to consult when a user have some similar problem. In figure 5.6 it is possible to observe the structure of the FAQS page.
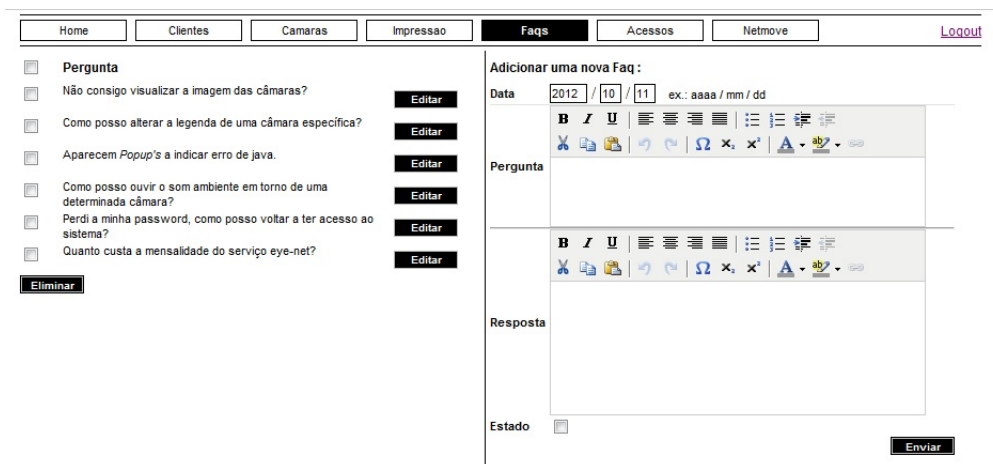

Figure 5.6: *FAQS web page.*

5.1.1.5 Impression

To provide an efficient answer to a new trouble sometimes it is needed some additional information. This section is intended for that. Here is possible to find information like type of connection, video cameras position, etc. In the figure 5.7 it is possible to observe the content of this section.
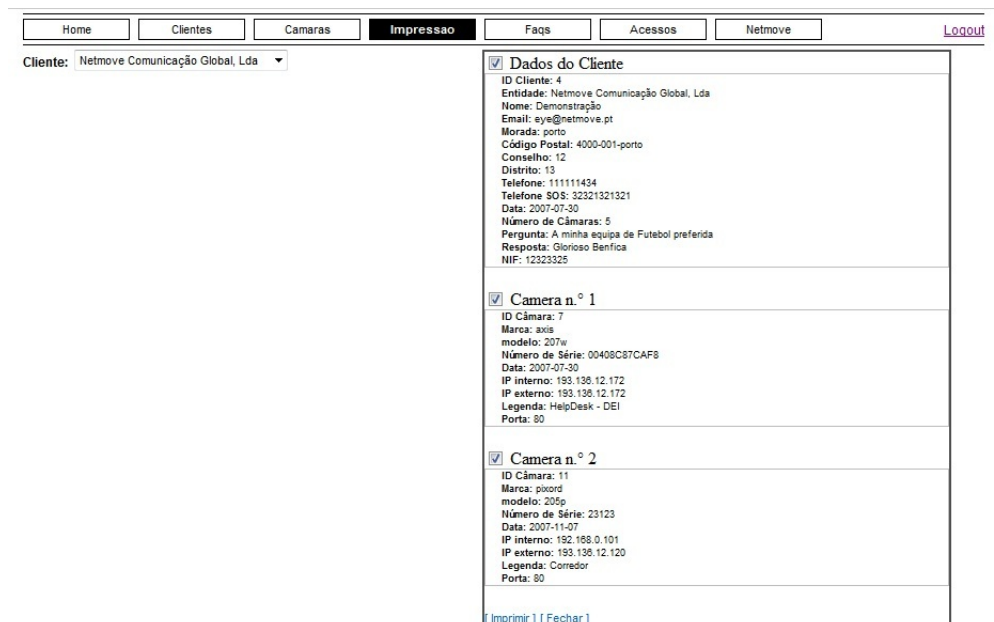

Figure 5.7: *Impression web page.*

5.1.2 Front Office

As it was told before, front office will be the application front-end for the customer. Here, he will have access to the services offered by the application. The Eye-Net is accessible through www.i-net.tv. Once open this web page, it shows the general content that is accessible to everyone. This public information is about the enterprise and about the application. It is also possible to find the contacts, register, recover the password and access the help in case of any problem.

Once the user logs on, the range of options will increase. When authenticated, the user can view the live video from their video cameras and edit his information such as: personal data and password to log on. A diagram describing the possible services is shown in the figure 5.8.

From figure 5.8 it is possible to observe also that from live view the user can switch from different views. Each view have different options and different modes of video cameras visualization. There are 3 types of visualization:
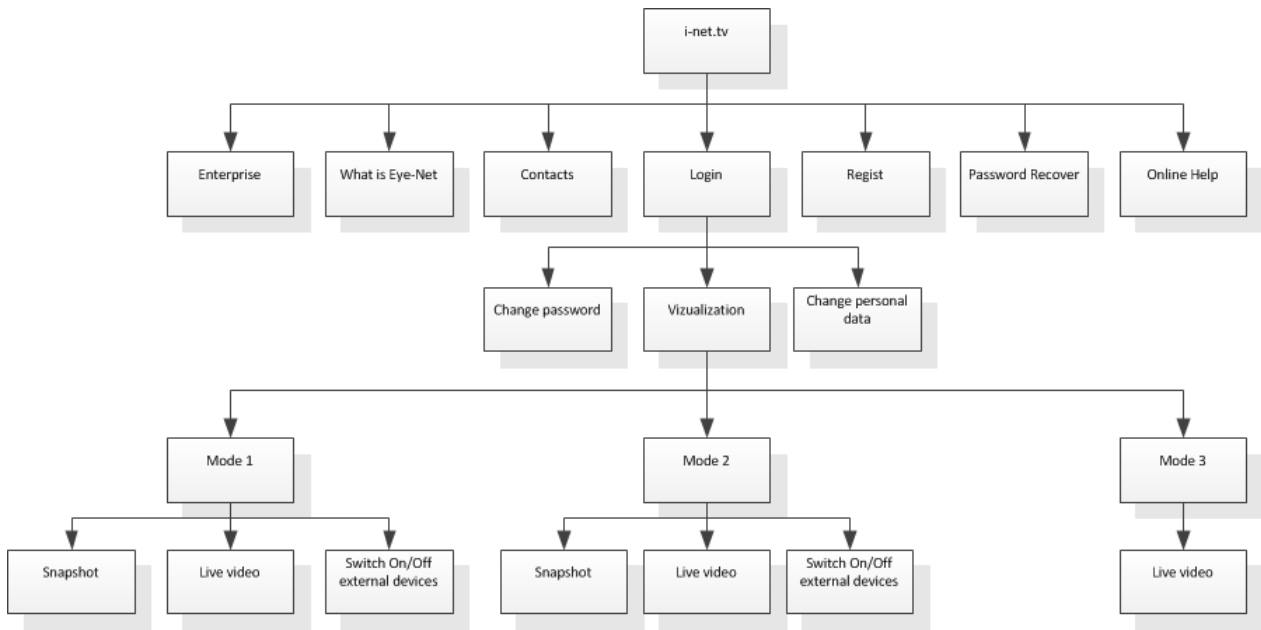
Figure 5.8: *Application map.*

5.1.2.1 Mode 1

This mode can be seen as Single camera mode. It allows to the user to watch with more detail the image provided from the video camera. The image is displayed with a resolution of 640x480px. It is possible to take snapshots (if the camera has this feature), and allows to a fast switching video camera with a drop down menu on the bottom of the image.

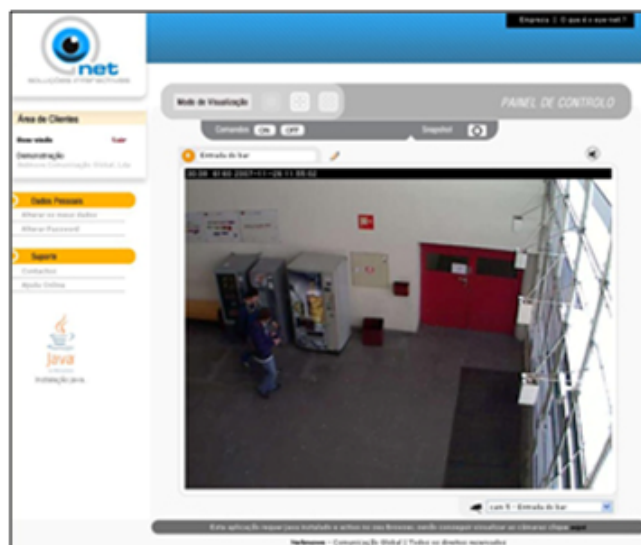In the figure 5.9 is illustrated this mode of visualization.

Figure 5.9: *Visualization Mode 1.*

5.1.2.2 Mode 2

In this mode it is possible to observe simultaneously a maximum of 4 video cameras. They will be displayed as two cameras by two cameras and the image resolution will be 320x240px of each one. These 4 video cameras can be changed and it will be stored in the database for the next time to access to this visualization mode. The user will have the same disposition. It is possible to take a snapshot and, to switch to single we simply have to click on the number of the camera.

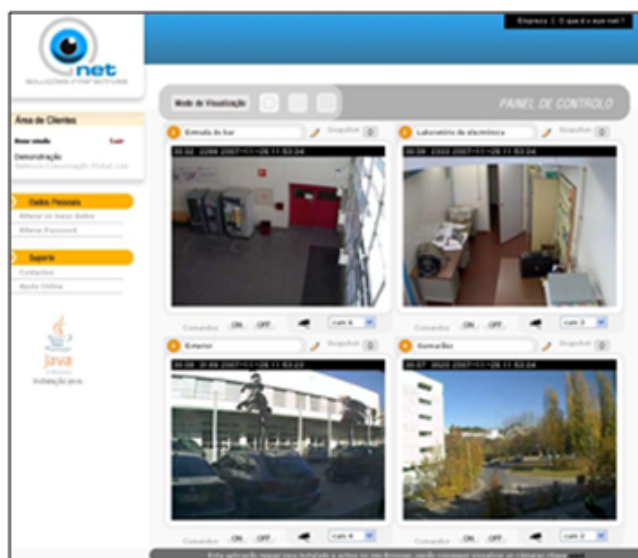The figure 5.10 shows this mode of visualization

Figure 5.10: *Visualization Mode 2.*

5.1.2.3 Mode 3

This mode can be seen as a Multi camera mode, where user can see the image of all video cameras. The resolution of these images are 160x120px and the user doesn't have permissions to do other actions than watch the live video. To switch to mode 1 on each camera we only need to click on the number of that video camera.

In the figure 5.11 is presented this mode of visualization

5.1.3 Embedding video image in the web pages

Video is the most important part of the application and the way that it will be displayed to the user will affect all the system. In Eye-Net, the video embedding in the HTML will be done through Java applets. Chapter 4 described how this technology works, the advantages
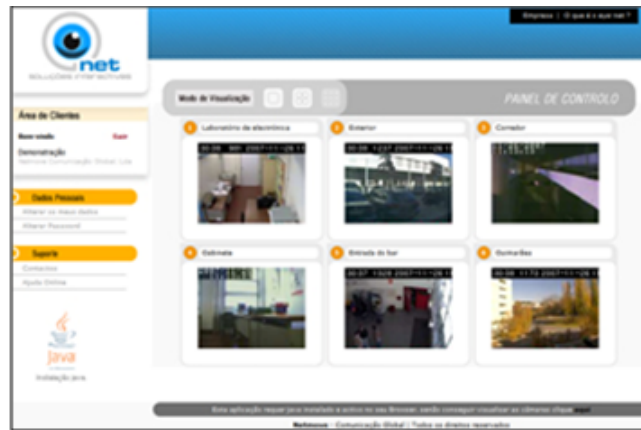
Figure 5.11: *Visualization Mode 3.*

and disadvantages, so it will not be repeated again in this section. Following it is possible to observe the code that allows the embedding of the Java applet in the HTML code and the many parameters that are needed to configure it.

```
1  <SCRIPT LANGUAGE="JavaScript">
2  var BaseURL = ip + porta + "/";
3  var Width = "largura";
4  var Height = "altura";
5  var File = "axis-cgi/mjpg/video.cgi?resolution="+Width+"x"+Height+ "&
       compression=40&color=1";
6  var output = "";
7  var AppletDir = BaseURL + "java/ama";
8  var VideoPath = "axis-cgi/mjpg/video.cgi?resolution=";
9  var restOfPath = "&compression=40&color=1&clock=1&date=1&text=1";
10 var VideoURL = BaseURL + VideoPath;
11 output  = '<APPLET  archive="ama.jar" codeBase="';
12 output += AppletDir + '"';
13 output += ' code="ama.MediaApplet" height=';
14 output += Height;
15 output += ' width=';
16 output += Width;
17 output += '>';
18 output += '<PARAM NAME="code" VALUE="ama.MediaApplet">';
19 output += '<PARAM NAME="archive" VALUE="ama.jar">';
20 output += '<PARAM NAME="codebase" VALUE="';
21 output += AppletDir + '">';
22 output += '<PARAM NAME="ama_cgi-path" VALUE="axis-cgi">';
```

```
23  output += '<PARAM NAME="cache_option" VALUE="No">';
24  output += '<PARAM NAME="cache_archive" VALUE="ama.jar">';
25  output += '<PARAM NAME="cache_version" VALUE="0.92.1.0">';
26  output += '<PARAM NAME="ama_plugins" VALUE="">';
27  output += '<PARAM NAME="type" VALUE="application/x-java-applet;version=1.4">'
        ;
28  output += '<PARAM NAME="ama_url" VALUE="';
29  output += VideoURL;
30  output += Width + 'x' + Height;
31  output += restOfPath +'">';
32  output += '</APPLET>'
33  document.write(output);
34  </SCRIPT>
```

Code 5.1: *Java Applet code*

5.1.4 Conclusions

In this phase, Eye-Net reached a stable level where it starts to be desirable in video surveillance world. It offers to the user a simple remote way to watch the live video of the video cameras and to perform actions such as snapshot or switching on external devices. Although it gathers the basic features to most of the users, to be commercialized there are some points that are needed to discuss and if possible to develop them, making the application more attractive to the clients.

One thing that attracts potential clients are the services that the application will offer. At this step, Eye-Net offers remote live video visualization with any computer connected to the internet, offers snapshot and the control of a switch of on external devices. Compared with other similar applications, Eye-Net is quite limited on this area. Nowadays, services like environment audio and record, are considered basic services and it is a priority to include them in Eye-Net.

Another topic that is relevant on the area of video surveillance is the mobility. With the integration of the Java Applets in the HTML web pages, already discussed in chapter 4, Eye-Net allows the users to watch the live video in any platform and any browser but these brings some disadvantages to the application. Some devices doesn't run Java (Smart phones), so it will be impossible to use the application. Java applet have to be loaded, that takes time and makes the application slower. Another issue about Java Applets is that it is made by the video camera brand for that specific model and it will not work on other video cameras. The issue

here is that not all video cameras have this Java applet. This aspect will limit the choice of the cameras to integrate on the application.

Another important issue for the client is also the power of choice among different products and not feeling that they are fixed or locked to a specific product. In this version of Eye-Net the choice of video cameras is reduced. So it is important to increase the variety of supported video cameras offered to the client. In few words, to improve this application it is needed to add more services, add mobility and enlarge the number of the supported cameras.

5.2   Upgrading the application

Normally the term upgrade refers to the replacement of a product with a newer version of the same product. The changes that will be described in this section are an improvement to the already implemented application. These changes consist in adding more services, changing the strategy for video cameras making streaming and also there were added two more video equipments to the compatible list. Because Eye-Net is based on two different technologies, to Internet Explorer and to not Internet Explorer, the explanation of how they were implemented is also divided in two parts. Along this section it is described which and how these enhancements were implemented and how to proceed in case of adding a new video equipment.

5.2.1   Checking the browser

Eye-Net consists in offering services through web browsers, but when the services offered are dependent from the browser, finding the type of the browser that the user is running is fundamental. To implement this browser verification it is used a script written in PHP language. It will verify the current browser, if it is the Internet Explorer it will return true, if not it will return false. The code where it is implemented this solution can be observed in the code 5.2.

```
1    function ae_detect_ie(){
2                    if (isset($_SERVER['HTTP_USER_AGENT']) &&
3                    (strpos($_SERVER['HTTP_USER_AGENT'], 'MSIE') !== false))
4                        return true;
5                    else
6                        return false;
7                        }
```

Code 5.2: *Check which browser the user is using*

5.2.2   Implementing strategies for streaming and services for Internet Explorer

To do streaming in Internet Explorer, like was told in chapter 4, it is used the ActiveX strategy. This technology is an application offered by the video camera and allows to the users the possibility to access to all services. To understand how it is possible to integrate this application in the Eye-Net, it is necessary first to understand in what it consists and how it works. When the access to the video camera is made through Internet Explorer for the first time it is asked to user to install the ActiveX like is shown in figure 5.12
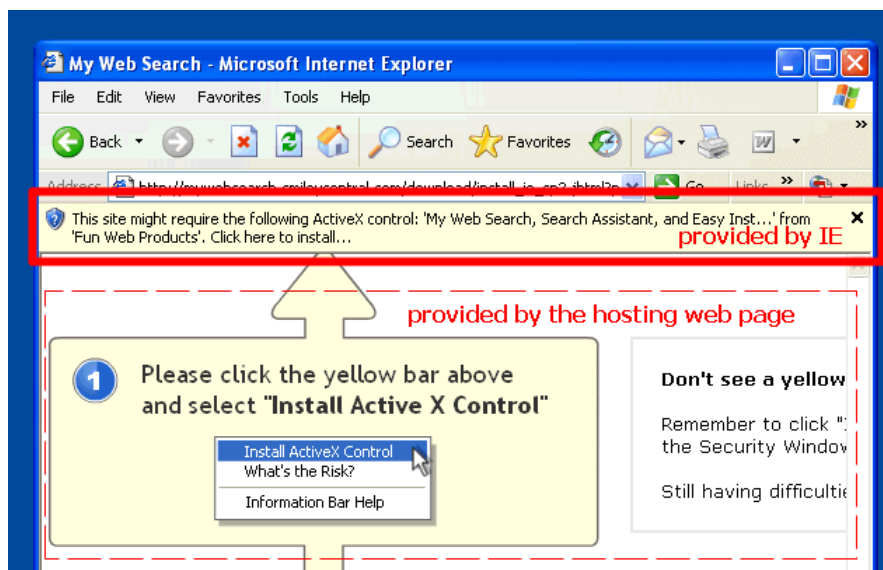

Figure 5.12: *Permission to instal ActiveX.*

After the installation of this resource it is not needed to install it again (on that computer), and it will be loaded when it will be requested. This ActiveX can be seen as an object that has inside it the options to the services. To access the services of the ActiveX resource it may vary from the video cameras. In Foscam, it is needed to be authenticated to access to any service from ActiveX. This account has to be specified on the video camera. In Axis or Fitivision this is not required. In figure 5.13 it is possible to observe a flow chart describing the steps to do before accessing a service.

5.2.2.1   New services, Record and Audio

The new services such as record and audio are two of the major upgrades in the Eye-Net. In this section it will be discussed their characteristics and how they work.
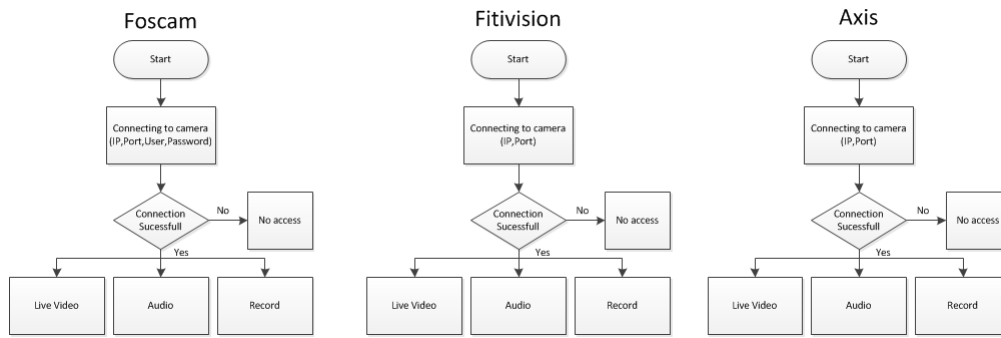
Figure 5.13: *ActiveX services flow chart.*

Record

With this service the user can save images from the video camera in a specific moment.

To store the recorded digital video from video cameras can be used NVR's or PC's with their disk. In Eye-Net the file recorded it will be stored in the equipment where the user will be accessing the application.

To perform the recording action it is simple as a click in the control panel. In this panel there is a button with the record logo and, when clicked it starts recording the live video from the video camera. When it is pretended to stop the recording is just go to the same button and click on it. The buttons can be seen in the figure 5.14.

Figure 5.14: *Record and stop record buttons.*

Once the user clicks on the recording button, this button will change to stop, advertising the user that the recording is happening. After user clicks stop, the button will change to first state and it is ready to start a new recording.

When the user clicks to begin recording, it will be created a file with the images from the video camera. It will be completed only when there is no more disk space or when it is stopped the recording. This file can be found on the machine where the recording was done, in the C: drive, in a folder named Eye-Net - Recordings. The name of the file will be the date and time that the recording has started followed by the extension avi.

As it has announced in chapter 3, different media formats lead to different file sizes. The

media format that will be used in Eye-Net is the H.264. Although the media format is important for the size of the recorded file, aspects such as image resolution and quantity of frames per second have a crucial role as well. The recordings in Eye-Net will have the resolution of 640x480px and a quantity of 30 frames each second giving a good quality and image fluidity. The bit rate generated with these definitions is between 1024kbps and 2048kbps.

Coding this service although it looks very complicated it is simple and easy. Once the ActiveX is installed on the machine, to start record it is just accessing to a function on that object. This code can be seen in the code 5.3.

```
1 if (IPCam1.RecordStatus == 0)
2 {
3   var ret = IPCam1.StartRecord2();
4 }
5 else
6 {
7     IPCam1.StopRecord();
8 }
```

Code 5.3: *Code to record from Foscam video camera*

The code showed above is just an example. Some other functions are supported by the ActiveX object to the same purpose. Finding those functions is described in section 5.2.2.3.

Audio

This service brings the possibility to the user to listen the environment sound of the video camera. At the similarity with the record service, the activeX component is fundamental when it is needed to access the computer resources. Listening the sound works in the same way of the recording service but only does not generate any file. It has a button that once clicked it will start transmitting the sound and when clicked again it will stop that transmission. These buttons can be seen in the figure 5.15.

Figure 5.15: *Record and stop record buttons.*

Coding this service is simple and very similar to the recording service above described. When user clicks on the sound button, it is checked if the user is already listening or not. If listening, it will be accessed a function in the ActiveX object and the sound transmission will stop. If the user was not listening the transmission of the sound will start. That code can be observed in the code 5.4.

```
1  if (IPCam1.AudioStatus == 0)
2      {
3        IPCam1.PlayAudio();
4      }
5  else
6      {
7        IPCam1.StopAudio();
8  }
```

Code 5.4: *Code to listen the environment sound from Foscam video camera*

The quality of the sound listened is not the ideal one but it can be very useful in some situations. In some video cameras there is the possibility to add an external microphone and, with this improvement the sound quality will improve as well.

5.2.2.2 Embed ActiveX in HTML pages

Similarly to what is done with Java applet, embedding ActiveX is also easy. It uses the HTML object tag. Inside this tag it will be the class ID of the object, the path to install it, if it is not installed already (this path is from the video camera), and the size of it. An example of that complete code can be observed on the code 5.5.

```
1  <object classid="CLSID:8ED1093F-319E-48ec-A9F2-971236F0CC21"
2    codebase="http://192.168.1.30:80/UltraCamX.cab#version=1,0,52,18"
         width="640" height="480" align="middle" id="ucx"
3    title="ActiveX Streaming Client">
4  </object>
```

Code 5.5: *Code to embedded ActiveX on HTML page*

With this code it is possible to load the application from computer or download it from the camera to computer. But to the purposes of Eye-Net, this code is not enough because are

needed interactions with the object in order to realize the services.

It is in this part that JavaScript comes. It will be the responsible for those interactions and it will make the bridge between the web page and the ActiveX resource on the computer. A code exemplifying that connection is shown in the code 5.6.

```
1 <script LANGUAGE="javascript">
2 function Conect(){
3   IPCam1.MonitorConnect("192.168.1.1", "80", "username", "password");
4       }
5 function IPCam1_OnMonitorConnectResult(result,pri){
6   IPCam1.PlayVideo();
7      IPCam1.OSD = 2;
8 }
9 </script>
```

Code 5.6: *Example of Javascript code interacting with ActiveX*

The code described in the code 5.6 is an example of how to authenticate in the Foscam video camera in order to watch the live video or perform any other action that requires ActiveX.

5.2.2.3   New video camera. How to find the ActiveX code and services available

The objective of Eye-Net is to be a dynamic service and not a static one. So, it should be available to receive new video cameras to integrate them in order to expand the range of products. From the previous analysis of ActiveX, it was possible to trace a common line - HTML loads the ActiveX and then Javascript will do the bridge to communicate with it.

Although this process is simple, to find the correct ActiveX code and the services available on it can be a big problem. There are 3 ways to discover that issue.

The first one that should be checked is if the manufacturer offers this kind of information in any manual, book, on-line help or even in the video camera guide. From the experience of this project it is possible to conclude that this will not happen. In those 3 video cameras it was not possible to find any manual or information explaining the process.

The second one is to analyse, line by line, the code provided by the video camera. All video cameras bring an integrated software, and when accessed by the IP device, it is possible to access the services. This way can be a really hard way. Sometimes to discover a part of code that we are trying to find is needed to check thousands of lines of HTML code.

The third way is through MS Visual. This program enables to use the object, the video camera ActiveX, showing which services that object allows. This process can be very helpful because it is possible to discover services that are not in the software provided by the video camera.

To follow this third way, it is needed some requirements. Like was told, this option needs MS Visual, that has to be installed on the machine (there is a free version on Microsoft web page), and the other requirement that is needed to fulfil before start this process is to be sure that the ActiveX of the video camera is installed on the computer. This last requirement can be fulfilled by accessing the software of the video camera and install it from there.

The steps of this process are explained, with more detail, in the paragraphs and figures bellow .

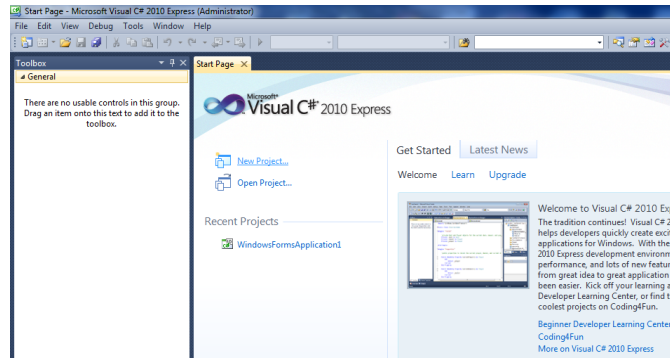- Step 1 - Open MS Visual and select new project

Figure 5.16: *Working with ActiveX in MS Visual step 1.*

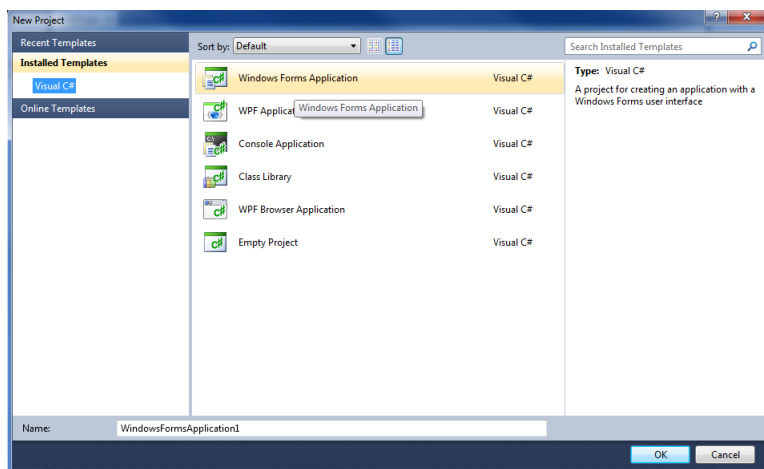- Step 2 - From new project choose Windows Forms Application

Figure 5.17: *Working with ActiveX in MS Visual step 2.*

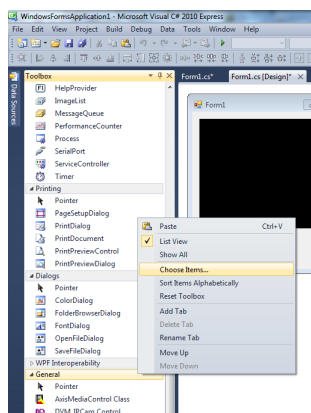- Step 3 - On the toolbox go to General section and right click on it. Select the option "Choose Items".

Figure 5.18: *Working with ActiveX in MS Visual step 3.*

- Step 4 - Go to COM Components tab, on the top of the window, and select the correct ActiveX object.
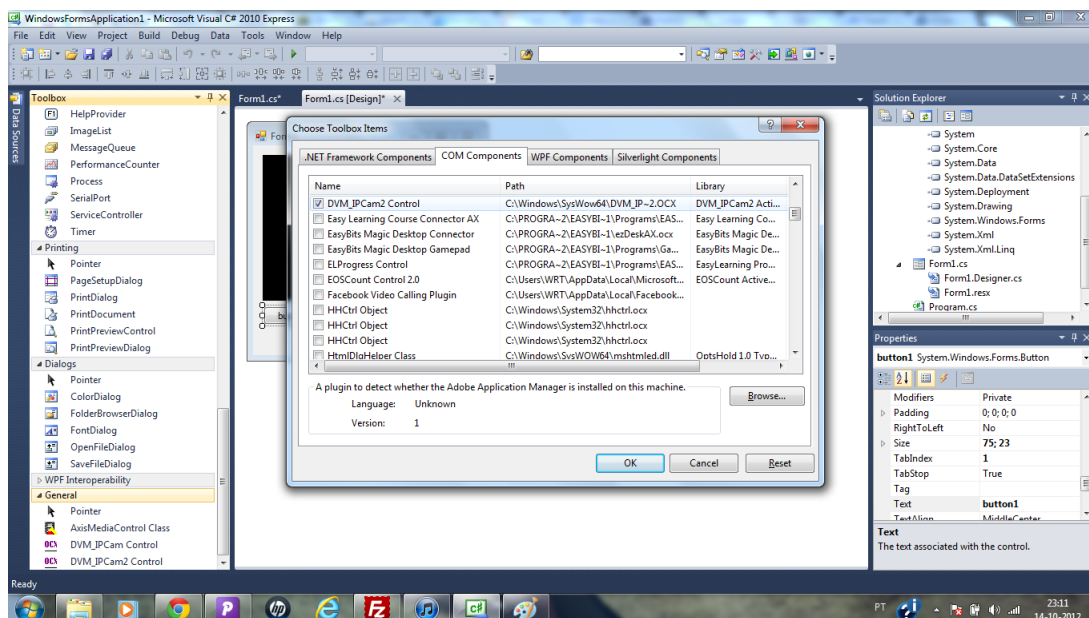

Figure 5.19: *Working with ActiveX in MS Visual step 4.*

- Step 5 - In the code tab, write the name of the ActiveX object followed by dot and it will appear all options related with the ActiveX content.
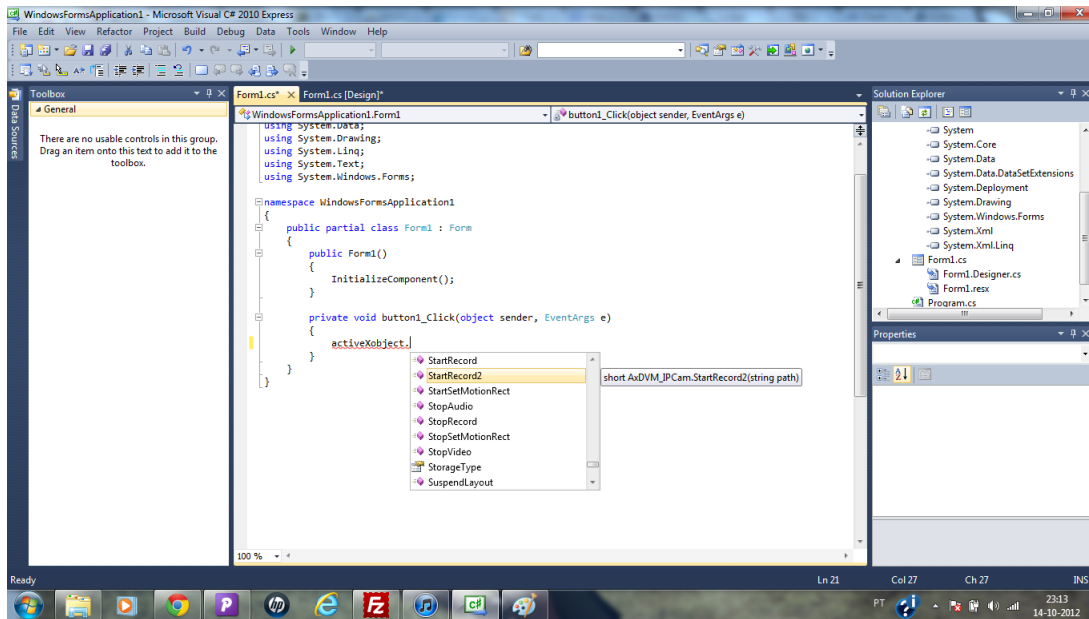
Figure 5.20: *Working with ActiveX in MS Visual step 5.*

All the steps presented above a way to find the functions available in the ActiveX object. With this information is also possible to build an MS Visual application and perform live video from the video cameras and other services, but one of the requirements of the Eye-Net was to not need any installation. It is a on-line tool so the process of how to build these type of applications will be not discussed in this document.

5.2.3 Implementing the strategies for streaming and services for not Internet Explorer

The area of not Internet Explorer includes a wide range of browsers and platforms. These systems, as was told in chapter 4, will run the Server Push Mode technology. This brings many advantages but also some limitations on the application. It is not needed any installation, but also doesn't offer to the user services like, audio or recording, that requires the use of the device resources such as speakers and file management.

Doesn't have to install anything is a major advantage. In this way the code is 100% HTML compatible and can be used in all browsers and platforms that support HTML and Server push mode. In the most used browsers category only Internet Explorer doesn't allow. This advantage also allows using the services in other devices than computers, such as tablets or Smart Phones.

5.2.3.1 Embed Server push mode in HTML pages

There is no installation needed so everything will work online. This interaction, between the video camera and the user, is done through URL which contains the IP address of the video camera, the parameters with the values associated for the request and also the authentication details of the user. An example of an URL for this kind of service can be seen in the code 5.7.

```
1
2 $endereco =  "http://192.168.1.2/videostream.cgi?user=username&pwd=password
3
4
5 echo '<img src="'.$endereco.'" width="640" height="480" style="border-color:
      #0099FF;border: 1px solid #0099FF" /> <br />';
```

Code 5.7: *Code to embed Server push mode on HTML page*

The code above illustrated is an example of the live video service in the Foscam video camera, where the user can watch the live video in any platform and any browser other than Internet Explorer

In the figure 5.21 it is possible to observe the flow chart of the strategy that is used on the different video cameras.
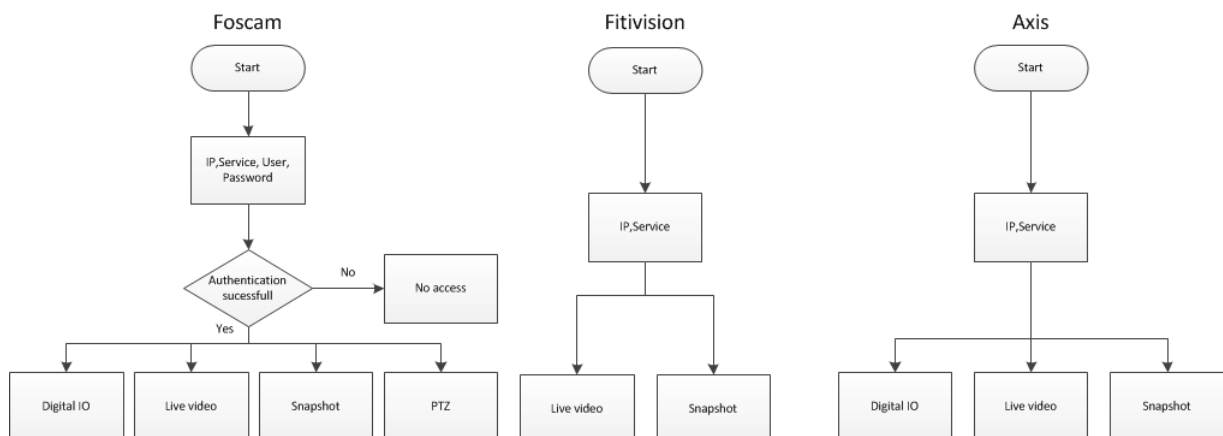

Figure 5.21: *Not ActiveX services flow chart.*

As it is possible to observe, different manufacturers have different strategies to offer services to the user. In these services only Foscam video camera requires the authentication to perform the services.

5.2.3.2   New video camera. How to find the Server push mode code and services available

Similarly to what is done with ActiveX, there are some ways to find the appropriate code to embed in HTML. In this project to find and build the correct code in this technology proved to be simple and easy. Unlike ActiveX, there is a lot of information about Server push mode either by the manufacturer or either by a simple search in a search engine.

A fact that is in favour of this technology is simplicity that have on its working. To use any service of this technology a single line of code is needed and there is no need to use the Javascript or any other language.

Another way to discover the HTML codes is also to analyse the source code of the software provided by the video camera. This can be very hard if we don't know exactly what to look for but extremely fast to find and to understand if there is an idea of it.

5.2.4   Displaying content

With the many improvements made in the application it was needed also to think in how to show the correct information to the user. This can look simple but all system is based on this principle. To know when is correct to show and apply the definitions of one video camera instead of another is fundamental.

This application offers a service and this service is related with different video cameras. Different video cameras will offer different services. Since Eye-Net supports three different video cameras, there will be three different profiles according to the specific video camera.

Displaying the content by the profiles allows the user to benefit of an efficient and specific content to that video camera that he is using in the moment. With each profile it is possible to display the correct video on the page and also it is possible to load the specific control panel. So when the video camera is changed, the control panel and the settings will change also.

Like was told, this strategy is based on the different video cameras brands, so it makes perfect sense to make this decision of defining the correct profile when the data have been retrieved from the database and is being processed. A general flow chart to illustrate this process can be seen in figure 5.22.

To implement it on the application it was used the "if then else" statements from the PHP language. The condition to verify if was true or not, was to compare the data requested to the database with the brands of the video cameras. In the code 5.8 can be observed a portion of the code that performs this action in the not Internet Explorer browsers.
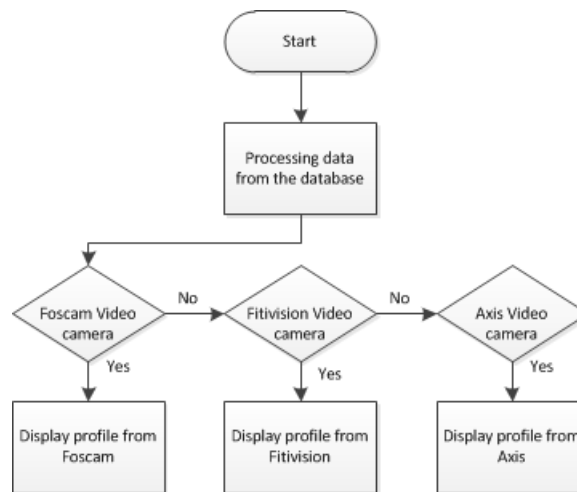
Figure 5.22: *Defining profiles.*

```
1   if($row[3] == "Foscam")
2           $endereco =  "http://".$row[2]."/videostream.cgi?user=".$row[4]."
                &pwd=".$row[5];
```

Code 5.8: *Choosing the correct profile*

Summary

In this point all the all the upgrades were shown and discussed. It is possible to say that after this upgrade the Eye-Net application is more wide on its purpose and more attractive to the costumers.

The major problems with this upgrade was the requirement of the Eye-Net to work on any platform and any browser. Since there was not any general solution, it was needed to search specific solutions for different browsers and different platforms and try to integrate them on Eye-Net without the user have to manually choose any technology to perform the basic services.

The results can be seen on-line on the application web site, www.i-net.tv.

6

Conclusions

In today's society there is an increase use of video surveillance over the world. There is a lack of knowledge about video surveillance especially on the used equipment. Everyday these systems are taking a more vital role in today society. Security systems have a huge impact to the society welfare. A few years ago they were only used for industrial and commercial buildings but, now it is common to find them within our own homes.

In this dissertation a study on video security systems was carried out. Special attention was given to the technology, equipment, services and protocols and media formats.

It was analysed the Eye-Net, which is an application that was already been implemented. Eye-Net was able to view live video and use other services from video cameras like snapshot and switch ON/OFF external devices. After made a detailed study of the current state of implementation, it were surveyed possible improvements that have led to new developments that were integrated in the application.

To validate, test and use the implemented solution the application was uploaded to a web server, where it was possible to test the desirable services. In this way, it does not matter where the user is and what device has, he can access to the Eye-Net since he has an internet.

6.1   Achieved Results

The research carried out on the application and the upgrade made on it has gone into further depth in chapter five. The application shows potential to be used in any kind of environment and offers new features to the user. Comparing the previous implemented application with the new solution it is possible to conclude:

- The new solution brings more variety of video equipments. The previous solution only had the support of one type of video camera. New solution allows for integration of new video cameras.

- The new solution has more features. The previous solution enabled live video, snapshot and the ability to switch external devices ON or OFF. The new solution provides these features plus three more which are recording, PTZ and audio.

- The new solution is now compatible with different devices and can be used in different systems. The previous solution was reliant on Java technology and it could only run on devices which used Java. The new solution is now not dependent on any other software. Providing that there is an internet connection it is possible to use the features on the device. These devices can be anything from a smart phone to a personal computer.

From the conclusions presented above it is possible to say that the objectives which were set out in the beginning have been achieved. The Eye-Net is a new solution which is capable of being commercialised and implemented into any home or building which requires video surveillance.

6.2   Future work

The objectives which were set out in the beginning were met although Eye-Net is not a static application. There are some areas which can be developed and built on in order for customers to enjoy more the product. Here are some suggestions for further research:

- Integration of new video cameras. The integration of video cameras will provide the customer with a wide range of choices of new cameras available.

- Implementation of new services. As the above point mentioned, customers want a lot of features within one application. Especially features which the customer will use and ones which are useful to them. Such features recommended are: motion detection and alarm triggering.

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