

Implementation of Closed-circuit Television (CCTV) Using Wireless Internet Protocol (IP) Camera

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Abstract

This paper presents three techniques for configuring, interfacing and networking of a wireless IP-based camera for real-time security surveillance systems design. The three different real-time implementation techniques proposed for configuring, interfacing and networking the IP camera are: 1). accessing the IP-based camera using the WANS CAM or XXCAM vendor software, 2). accessing the IP-based camera via Firefox® web browser, and 3). accessing the IP camera via MATLAB with SIMULINK on an internet ready system. The live streaming video based on the proposed techniques can be adapted for image detection, recognition and tracking for real-time intelligent security surveillance systems design. The paper also carried out a thorough comparative analysis of the three methods of achieving video streaming resulting from the output of the IP-based cameras. The analysis shows that the WANS CAM or XXCAM software displays the best video animations from the IP-based cameras when compared with the performance of the other methods.

Keywords: Closed-circuit television, Internet protocol, Security surveillance, IP-based cameras, Wireless networking, animations

1.0 Introduction

Traditionally, the surveillance monitoring system is done in the larger room and by a mount of manpower. But nowadays, monitoring surveillance system can be done through online network. This type of monitoring is less time consuming and can reduce the manpower. Moreover, it gives the user flexibility to monitor their properties wherever they want as long as they have the internet network. Security of lives and properties is an aspect of life which cannot be toyed with. Governments and individuals desire to know the conditions of their highly valued properties every second of life despite the fact that these properties are located in different places across the globe. Surveillance is the monitoring of the behaviour, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them as described by [1]. Alternatively, surveillance can be the observation of individuals or groups by government organizations but can also relate to disease surveillance, which monitors the progress of a disease in a community while not directly observing individuals.

This work is concerned with the configuring, interfacing and networking of IP-based camera for real-time security surveillance systems design. The word surveillance may be applied to observation from a distance by means of electronic equipments such as CCTV cameras and IP camera, or interception of electronically transmitted information such as Internet traffic and/or phone calls. It may also refer to simple, relatively no- or low-technology methods such as human intelligence agents and postal interception. Surveillance is very useful to governments and law enforcement to maintain social control, recognize and monitor threats, and prevent/investigate criminal activity. With the advent of programs such as the Total Information Awareness program and “ADVISE” technologies such as high speed surveillance computers and biometrics software, and laws such as the Communications Assistance for Law Enforcement Act, governments now possess an unprecedented ability to monitor the activities of their subjects quoted by [2].

There are different types of surveillance methods available in the world today, example of which are; Computer surveillance, telephones, social network analysis, biometric surveillance, aerial surveillance, data mining and profiling, corporate surveillance, human operatives, satellite imagery, identification and credentials, global positioning system, mobile phones and surveillance camera illustrated by [3].

However, video surveillance systems have since the 1970s consisted of National Television System Committee (NTSC) or Phase Alternating Line (PAL) analogue cameras connected over a coaxial cable network to VHS tape recorders or digital video recorders (DVRs) in a monitoring station. Such surveillance systems are often comprised of black and white, poor quality analogue videos with little or no signal processing, recorded on the same cassette. Most of the recorded images are of insufficient quality to hold as evidence in a law court. It is also expensive to have human operators monitoring real-time camera footage all round the clock. The effectiveness and response of the operator is largely dependent on his/her vigilance rather than the technological capabilities of the surveillance system as expressed by [4].

Events and activities can be missed, should the concentration level of the operator drop; attention levels drop significantly after 15 minutes of inactivity in the scene. The advent of high resolution digital IP surveillance cameras, connected via the internet to a remote security monitoring station, enables a new approach that draws

attention to events identified in the camera scene. IP-based cameras coupled with the introduction of video content analysis or video analytics promise to extend the reach of video beyond security in a local area into a wide area surveillance system. Such automation and wider coverage will significantly reduce the drudgery workload on law enforcement agencies, thus making it possible for them to concentrate on the thing they do best: responding to suspicious events compiled by [5].

The alarming crime rate in various homes and offices around the globe has necessitated the installation of surveillance security systems in most establishments. The security threats ranging from armed robbery, kidnapping and recently bomb blasts has kept the entire regions on their toes to the extent that no one can be sure of his/her security in the next moment. Surveillance is the systematic investigation or monitoring of the actions or communications of one or more persons in a place as explained by [1]. Surveillance security systems monitor the activities that go on in areas of the establishment with the use of surveillance cameras. The cameras may be stationary or it may rotate in different directions to achieve more coverage of activities in an area. Such rotation of cameras is achieved with the use of DC motors or stepper motors. Section 2.0 of this paper briefly discussed the concept of wireless CCTV surveillance system and principle of installation and operation. The methodology employed from the configuration to measurement approach was explained in section 3.0. Section 4.0 narrates the wireless IP camera results obtained. Finally, the conclusions were enumerated in section 5.0.

2.0 Concept of Wireless CCTV Surveillance System

There are many existing devices in market such as CCTV Cameras, IP camera, Infrared Sensor, Laser Sensor etc.

CCTV: Implementation of CCTV cameras is very costly and has drawbacks since it require constant monitoring of every activity which is not as ease. Continuous manual visualization hampers the productivity and time. Criminals can penetrate into the CCTV system, thereby facilitating criminal acts in [6], [7] & [8].

IP camera: Implementation of IP cameras is also very costly and not feasible. This system cause major problems as it becomes open to hackers via internet (i.e. false bomb threats could call in hoaxers while watching the cameras). This is a big shortcoming in this present world of hackers.

Infrared Sensor and Laser Sensor: These devices are quite economic in comparison to above devices however they have some drawbacks too. These devices are difficult to install and rarely available. One of the major disadvantages of infrared sensors is the size required to provide good resolution to the signal as described by [9].

Overview of IP Video Surveillance System

IP- Surveillance refers to a security system that present a user the ability to monitor and record video/audio over an Internet protocol –based computer network such as local area network or the internet. IP – surveillance also known as video or IP CCTV uses the IP network technology as the backbone for transporting information.

As a result of digital nature and method of video distribution, IP-based surveillance systems introduce a host of advanced functionalities that enhance greater control and management of lives and record video data thereby making them highly suitable for security surveillance applications. Some of this includes remote accessibility, high image quality easy and future proof integration, scalability, flexibility, cost effectiveness, event management and intelligent video [2].

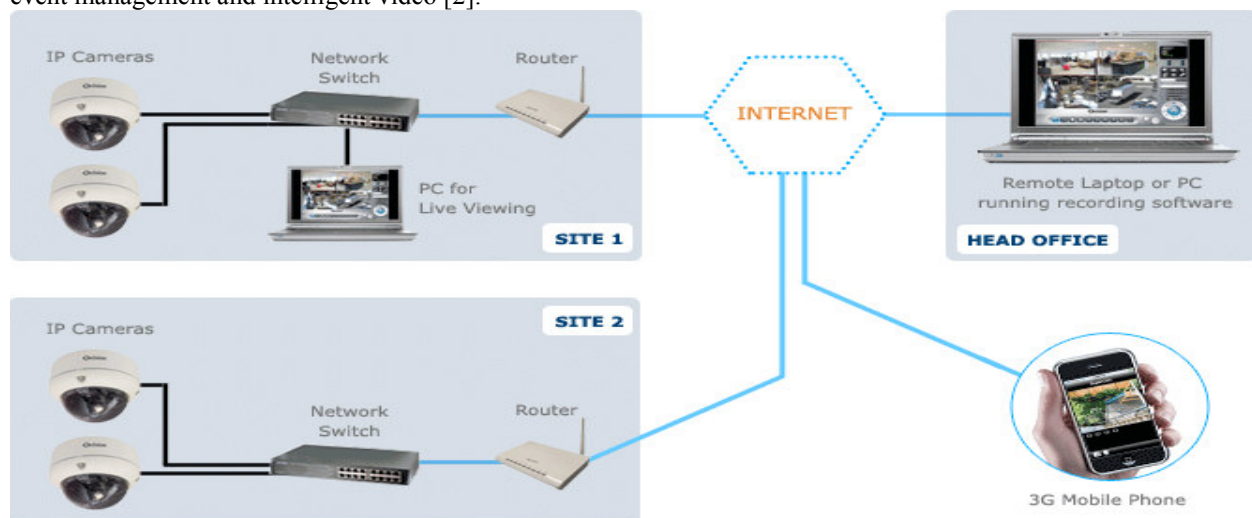


Figure 1: The IP Video Surveillance System

IP-based cameras are future of surveillance systems. Although this technology has being available for over decade, it has gained widespread attention in the last few years leading to the developments in the megapixel IP. Table 1 presents a summary of the benefits of using IP-based system over traditional analogue system described in [7].

Table 1: Comparative Analysis of IP-based CCTV and Analogue type

Standard Feature	IP CCTV	Analogue
Greater flexibility	They do not require local recording as they can transmit their images across LAN, WAN and internet to central location.	This system is designed to record security cameras locally only.
Better performance and reliability	IP CCTV system convert all images to data and has no theoretical limit to resolution, providing the relevant bandwidth to transmit the image exists	They are on PAL analogue technology thus limiting the amount of quality images a single analogue camera can supply and reducing the area it can view.
Easier system installation	Run over existing IP networks thus causing less disruption, reduction in installation time and minimize unsightly cables especially in the case of PoE IP cameras which are powered via the network cables.	They have their own proprietary cabling. Each camera has to wired back to the DVR or monitor and also has to connect to a power source.
Better value	With installation and setup requires little time, IP can work out to be far more economical than traditionally analogue solutions.	They are an excellent value of money. However, IP camera represents an investment into a futures technology whereas analogue CCTV systems are based on old technology.
Better system integration	They communicate using IP, allowing them to integrate and co-exist on the same network/cablings as other IP based systems such as access control and IP phone system.	Designed to be close circuit systems, hence they do not integrate easily with access control, intruder alarm or other system found in the building.

The surveillance operation by Internet Protocol (IP) camera is by streaming and live video streaming refers to sending video and audio signal captured by an IP camera in real time over the internet. Today, live video streaming technologies are widely used in broadcasting, connecting friends and relatives in online chat, online face to face business transaction, selling products and services, online teaching, showing online movie and finally streaming of live video is used in surveillance which is the purpose of this project.

IP Cameras or network cameras were first introduced by Axis in 1996 by [3]. They developed an open source programming language called VAPIX which utilized an embedded Linux operating system within the cameras. IP cameras transmit video using open internet protocols and standards (mainly HTTP) for recording or monitoring. The camera has a built in web server. This means it can operate as a standalone product, accessed by its IP address and therefore does not require the host computer/workstation to function. This provides an economical method to monitor an area from a remote location.

These cameras use the HTTP protocol to issue and receive instructions or data to or from an external network source (i.e. to view a motion JPEG stream from the camera: <http://192.168.1.126:81> (or a similar address) can be accessed through a standard http connection in code). The live video stream from the camera is obtained using the standard HTTP via the URLs with the following <http://192.168.1.126:81>. Various arguments can also be passed to the camera web server as long as the TCP/IP connection exists.

Network Bandwidth

IP cameras typically generate between 0.2 Mbps and 2 Mbps of traffic on a network. This figure varies with size, frame rate and image compression used. A typical 100 Mbps office network can have a number of cameras attached, without effecting standard traffic. A larger number of cameras may require their own surveillance networks as explained by [3].

Camera Image Compression

IP cameras use either MJPEG (Motion Joint Photographic Expert Group) or MPEG 4 (Moving Pictures Expert Group) compression techniques for image transmission. MJPEG saves each frame as a JPEG whereas MPEG only retains information about the differences between the captured frames. MJPEG is a JPEG based compression codec. It is the current top choice for video surveillance as it is inexpensive to implement and simple to decode, requiring a few modifications on top of existing JPEG compression systems. It does however require a large amount of bandwidth on a network, as much as a full T1 link for full motion video.

Principle of Operation of IP Cameras

Network cameras are widely described as a combination of a camera and computer into the same unit.

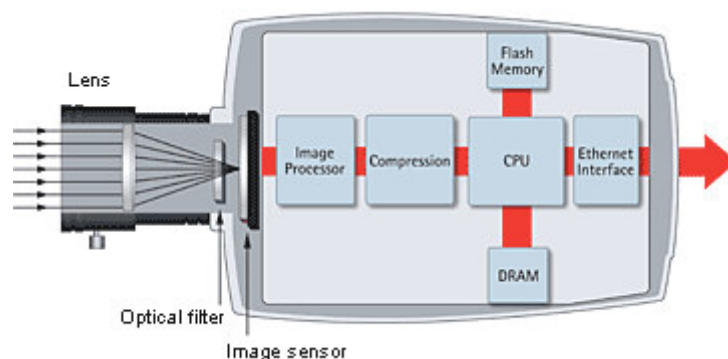


Figure 2: Building Blocks of an IP-based Camera

The network camera usually has its own IP address with which it accesses the network directly just like any other network device. Everything needed for viewing images over the network is built into the unit. It also has in built software for a Web server, FTP server, FTP client and e - -mail client. Other features include alarm input and relay output functions. More advanced network cameras can also be equipped with many other value added options such as motion detection and an analog video output. The lens of the network camera captures the image represented as light of different wavelengths and passes the image through the optical filter. The function of the optical filter is to ensure that infrared light is removed so that the necessary colors are displayed. The image sensor further converts the image, which is composed of light information, into electrical signals. These signals from the image sensor are then converted from analog to digital format making them now in a format that can be compressed and transferred over networks as illustrated by [10].

3.0 Methodology

To access the IP camera for live video streaming or for real-time video transfer, either wirelessly or using hard wire connection, also, either for local area network connection (LAN) or for wide area network connection (WAN), there are ways through which this can be achieved. In this chapter, the software involved in interfacing the IP camera with the computer at the monitoring end and the stages of installation of each of the software till a live video is streamed or transferred are discussed. Below is the list of the ways to interface the IP camera:

- 1). using WANS CAM or XXCAM vendor software,
- 2). using Mozilla fire-fox web browser and
- 3). using MATLAB (The MathWorks, 2012a) with SIMULINK

Using WANS CAM or XXCAM Vendor Software

Accessing the IP-Based Camera using the WANS CAM Software is as follows:

The software is installed through the WANS CAM or XXCAM accompanied CD. When the CD is inserted into the host computer, the following options are itemized: Mobile view software, computer IE view via Ocx Setup.msi and the Search tool.exe. From the above options, Ocx Setup.msi is selected, clicked and run leading to the installation of the software. Thereafter, the camera powered before connecting the IP camera host computer via a CAT5E cable with the RJ45 connector at both tips of the straight cable. Then, the Search too.exe is double clicked and run, this will search for the IP of the connected IP camera and this page is loaded as figure 3 below.

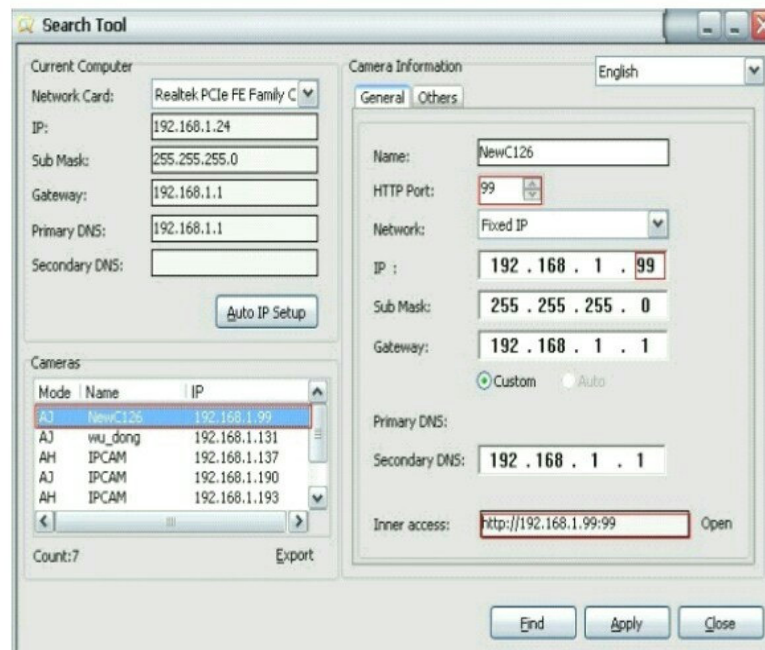


Figure 3: The configuration of the IP address menu on the network

The software searches for the WANSCAM or XXCAM camera IP address automatically over a LAN. In Figure 1, the following actions takes place: 1). Current Computer indicates the Computer's IP Address information, 2). Camera information indicates the IP camera's IP Address information, and 3). If found that the camera's "Subnet Mask", "Gateway", "DNS Server" is not as same with the current computer's. Then, there is a need to change either the camera's IP address or the host computer IP address, because the IP addresses of the IP camera and the computer must be on the same network. It is important to ensure that the "Subnet Mask", "Gateway", "DNS Server" are the same as the router's or as the current computer's.

Configuration of the Network

Once the camera's IP address' Subnet Mask, Gateway, DNS Server are not the same as the computer or router, one needs to configure the camera's Network parameters manually. The IP camera can be connected directly to the computer and it can at the same time be connected to the Router or switch and from any of this to the computer i.e. IP camera Router/switch Computer.

- 1). *IP address*: The IP address assigned is filled in and it is important to ensure that it is in the same subnet as the Gateway, and the subnet should be the same as the computer or router (i.e. the first three sections are the same) .
- 2). *Subnet Mask*: The default subnet mask of the equipment is: 255.255.255.0. One can find the Subnet Mask from the host computer or router.
- 3). *Gateway*: It is important to ensure that it is in the same subnet with computer's IP address. Here gateway is the LAN IP of the router.
- 4). *Primary DNS*: IP address of IPS network provider. One can also set it as the same as the Gateway.
- 5). *Http Port*: LAN port assigned for the equipment, default is 99. One can change the port number to any of this: 81, 98, 211, 9999, etc.

Double clicking on the IP address of the camera in the Figure 1 above will load a page displaying the live streaming video shown in Figure 4.

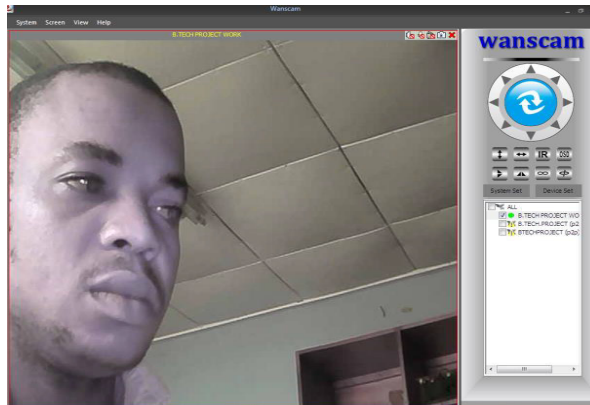


Figure 4: The captured image using the XXCAM vendor's software interface.

Accessing the IP Camera via the Mozilla Fire-fox® Web Browser

To access the camera by Firefox web browser directly, the camera's IP address and the http number is typed in the address bar of the Firefox and enter key is pressed. In this study, the camera's IP address is configured as 192.168.1.126:99 and the enter key is pressed, and the web page shown in Figure 5 pops up.

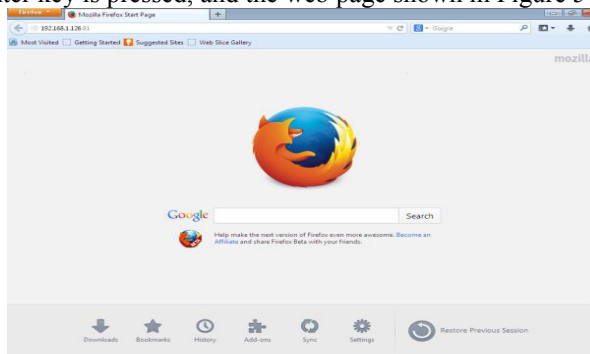


Figure 5: Stage 1 of the interfacing the IP camera with the Mozilla Fire-fox® web browser.

After inputting the IP address as shown above, the enter key is pressed and the page below is pop-up and the Username "admin" is entered while the Password is left blank and then ok is clicked, then the resulting page shown in Figure 3 pops up. During the first time login, the camera will need ActiveX prompt, this is either done by downloading the OCX (or run in CD) and install first, then, Run Add-on is chosen, it is refreshed and login into ActiveX Mode(For Firefox Browser) is selected and it is Signed In and the page in Figure 6 below pops up.

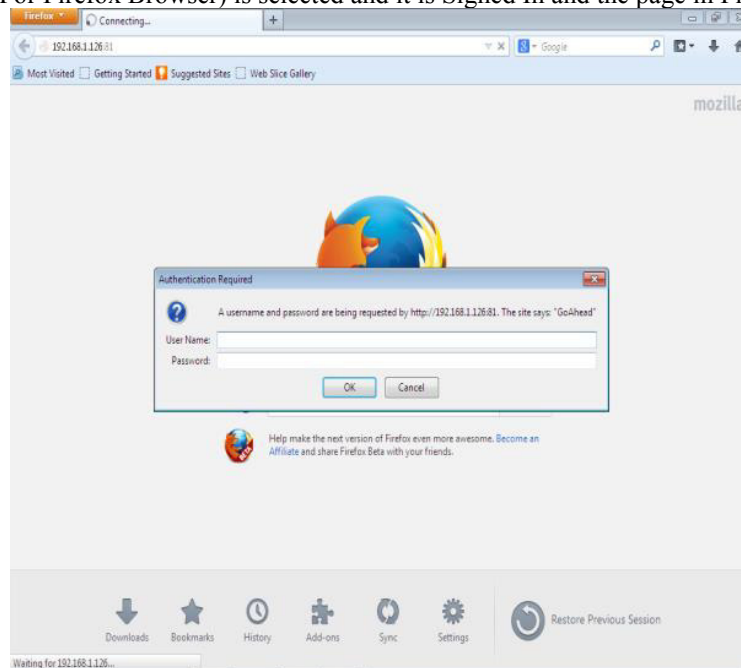


Figure 6: Stage 2 of the interfacing the IP-based camera with the Mozilla Fire-fox® web browser

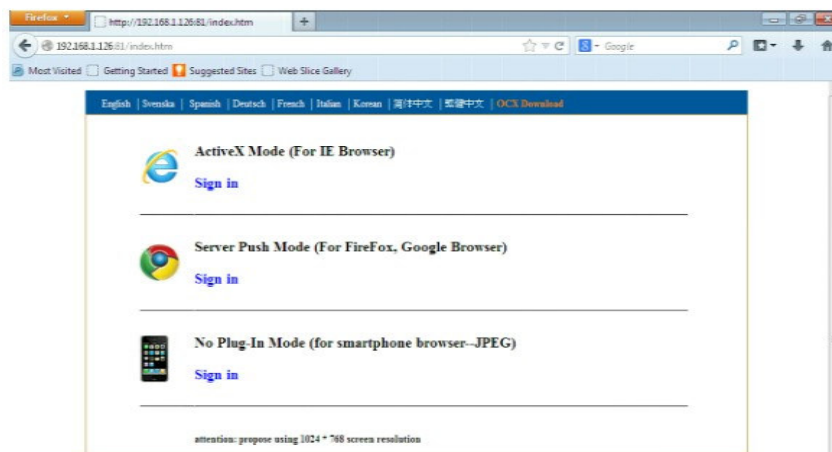


Figure 7: Stage 3 of the interfacing the IP camera with the Mozilla Fire-fox® web browser

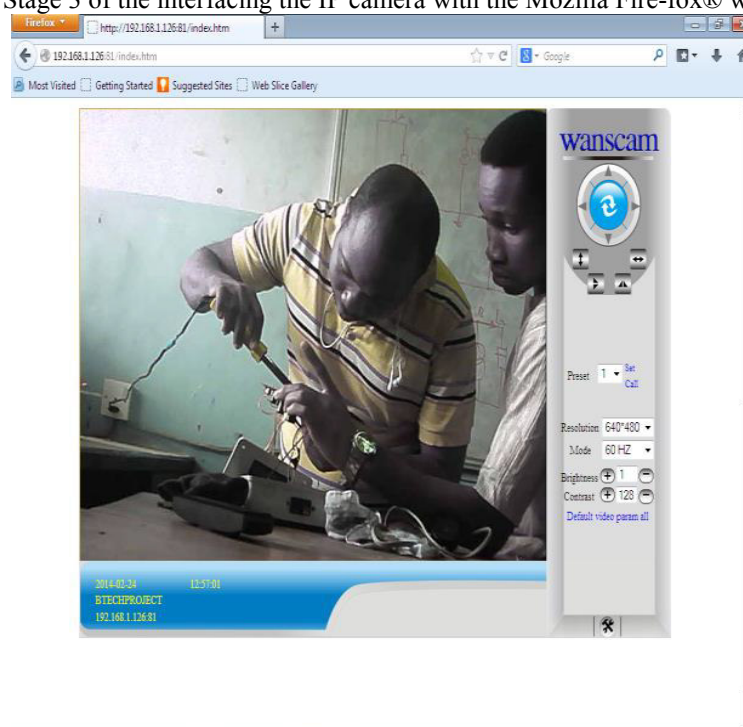


Figure 8: The captured image by Mozilla Fire-fox® web browser

The MATLAB with SIMULINK Implementation Platform

MATLAB popularly known as MATrix LABoratory (i.e. the MathWorks version 2012b) is a numerical computing environment and fourth-generation programming language developed by The MathWorks. MATLAB/Simulink® allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java, and Fortran77 programming language. Although, MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine which allows access to symbolic computing capabilities. An additional package called Simulink adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems [3].

In 2004, MATLAB had around one million users across industry and academia. MATLAB users come from various backgrounds of engineering, science, and economics. MATLAB is widely used in academic and research institutions as well as industrial enterprises. It was first adopted by researchers and practitioners in control engineering, Little's specialty, but quickly spread to many other domains. It is now also used in education, in particular the teaching of linear algebra and numerical analysis, and is popular amongst scientists involved in image processing and this consequently makes it suitable for this project. Setting aside the software from the vendor in accessing the IP camera and using MATLAB to access it for live video either wired (LAN) or wirelessly (WAN) involves series of processes and stages.

Networking MATLAB with the IP Camera using Hard-Wired Connection

This is when the live video from IP camera is streamed directly to MATLAB interface on a laptop when they are at a short range of distance from each other. This can be achieved in two ways, namely:

1). Using MATLAB web browser

In this method, the IP camera is registered in the image acquisition tool box of MATLAB by creating an adaptor kit for the IP camera.

2). Using MATLAB web browser

In this second method, the IP addresses of the IP camera and the host computer are ensured to be on the same network. If, however, this is done, then MATLAB will be made to run on the laptop that will receive the live video. On the MATLAB default desktop layout, at top of this page, desktop is clicked, then it is scrolled down to web browser option, the sequential stages and processes from the starts till the live-video is streamed are shown in Figure 7 through Figure 12. One of the main objectives of this work is to set aside all the aforementioned software used in accessing or interfacing the IP camera with the laptop except with MATLAB/SIMULINK®. In order to achieve this, MATLAB as a powerful computer programming language is used to access and interface the IP camera with the host computer. The processes and the stages involved are explained below.

The IP address for the camera is entered as shown in the Figure 3. As soon as the page shown in Figure 9 pops up, and the Enter key is pressed on the keyboard, then the page shown on Figure 10 will pops up. The Username is supplied and page shown in Figure 11 is pops up. Note that the page shown in Figure 12 is the inbuilt web server which is one of the inbuilt characteristics of the IP camera. The desired web browser is signed in but in the case of this study, we only signed in with Firefox.

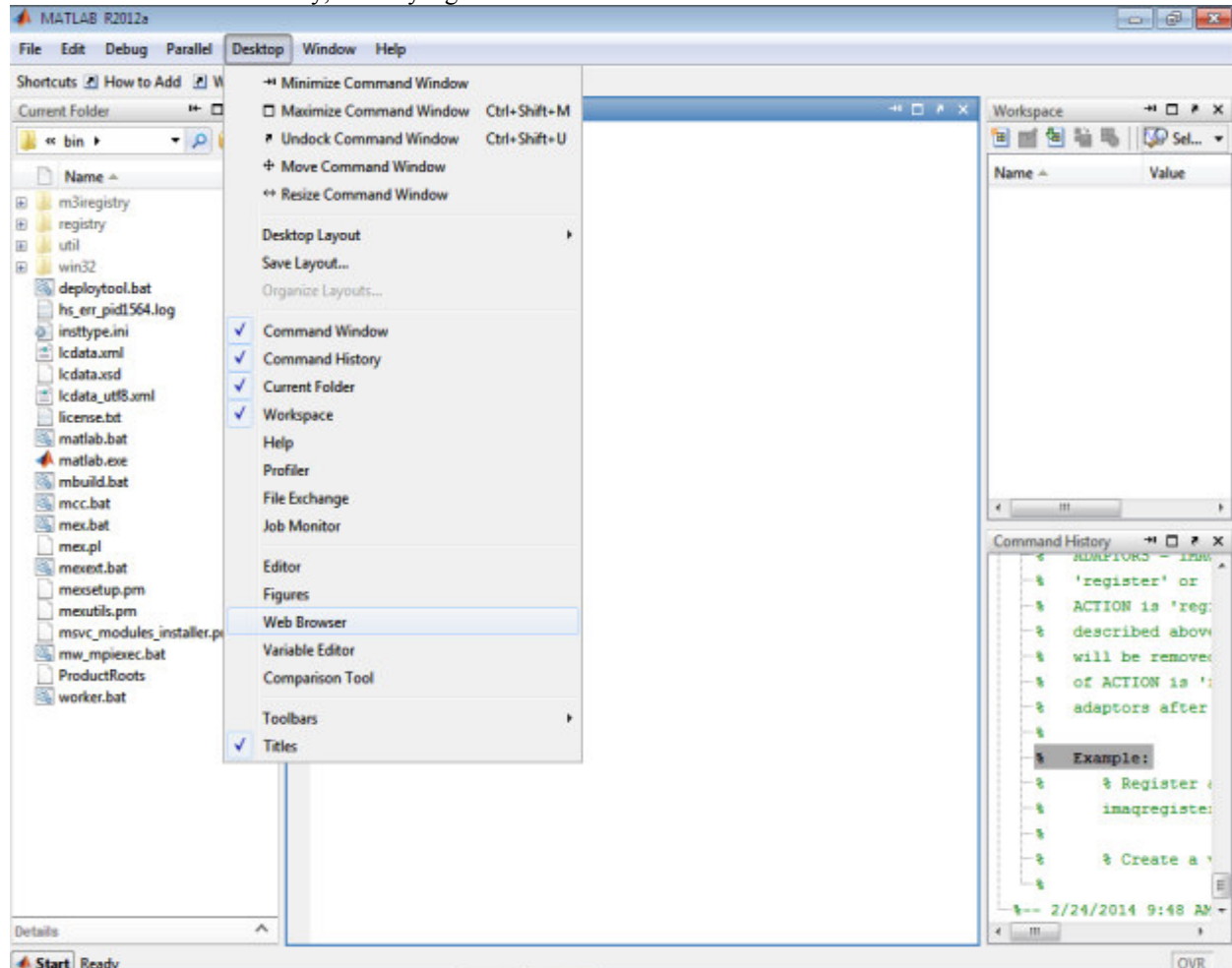


Figure 9: The MATLAB setup software platform

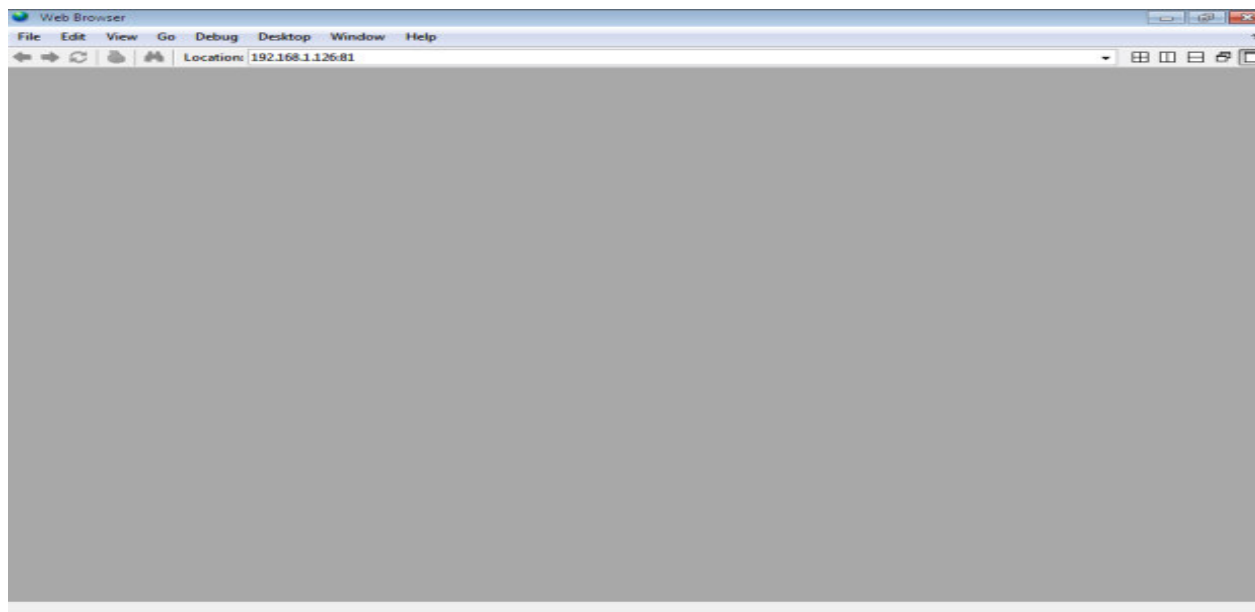


Figure 10: The MATLAB graphical worksheet

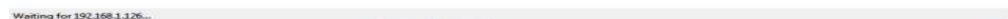


Figure 11: The SIMULINK interfacing sheet with the MATLAB

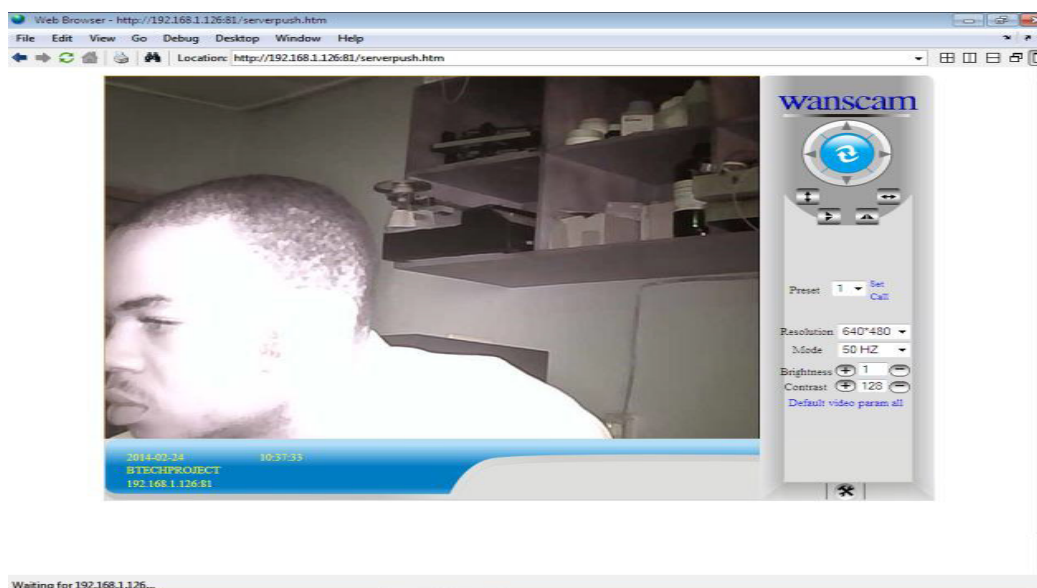


Figure 12: The image captured through the MATLAB software

4.0 Results and Discussion

Comparing the three outlined way for achieving the implementation of CCTV camera using wireless IP camera using the results obtained using the WANSCAM or XXCAM vendor software, MATLAB & SIMULINK software and Mozilla fire-fox web browser, it is observed that the video quality and video resolution of the three methods implemented is superb as compared to using the analogue technique of poor video quality. The process of connection using the three methods is much easier as compared to the analog which has been in existence for a long time. Greater flexibility has made the three outlined methods to be more useful over the analogue. In addition, the video streaming animations from the WANSCAM or XXCAM software produced a very outstanding display when compared with the other two methods implemented and discussed.

5.0 Conclusion

Real-time capturing and viewing streaming video from an IP-based camera on the host computer has been proposed and implemented using two different methods, namely: 1) using the WANSCAM or XXCAM software from the vendor and 2) using the Mozilla fire-fox web browser.

As a future direction, work has started on techniques to capture streaming video using web browser with a view for the design and implementation of online detection and recognition of multiple targeted images in real time for intelligent security surveillance systems design and deployment.

Video surveillance has become a foremost global strategic tool for fighting the war against terrorism, preventing crimes, protecting corporate assets and enhancing public safety. Since they serve the needs of military, government, utilities, corporate, medical, retail, hospitality, transportation and education, no individual can claim not to be affected by this trend. Despite the challenges to its widespread deployment in some regions, the future is very bright for this technology. This paper work and the processes outlined in it will therefore be useful for both local and international security agencies. It will as well be useful for industries watching over equipments and workers for security purposes, it will also be useful for individual to watch over his/her property, it will as well be useful in the banking sector.

6.0 References

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