Configuration, Interfacing, and Networking of Wireless IP-Based Camera for Real-Time Security Surveillance Systems Design.

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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 camera using the Wanscam vendor software, *2).* accessing the IP camera via Firefox® web browser, and *3).* accessing the IP camera via MATLAB/Simulink®.

The paper also demonstrates the interfacing and networking of the IP-based camera with multiple computers using an Ethernet switch. 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.

(Keywords: closed-circuit television (CCTV), internet protocol (IP), security surveillance, wireless networking)

INTRODUCTION

Traditionally, the surveillance monitoring system is done in larger rooms/areas and accomplished by a great deal of manpower. But nowadays, monitoring surveillance system can be done through online networks. This type of monitoring is less time-consuming and can reduce the manpower involved. Moreover, it gives the user the flexibility to monitor their properties wherever they want as long as they have the internet network.

Security is an aspect of life which cannot be neglected. Governments and individuals desire to know the conditions of their highly valued properties every second, despite the fact that these properties may be located in different places across the globe.

Surveillance is the monitoring of behavior, activities, or other changing information, usually of people, for the purpose of influencing, managing, directing, or protecting them (Lyon, 2007). 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 equipment 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 (ACLU, 2009).

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 (Van Eck, 1985).

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 court of law. It is also expensive to have human operators monitoring real-time camera footage around 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 (Shah. et al., 2007).

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 (Lipton, 2005).

OVERVIEW AND DESCRIPTION OF THE WIRELESS WANSCAM IP-BASED CAMERA

Overview of IP-Based Camera: Characteristics and Specifications for Implementation

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 (Axis, 2013). 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 .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 (Joseph, 2004).

Camera Image Compression

IP cameras use either MJPEG (Motion Joint Photographic Experts 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.

MPEG 4 is primarily designed for video streaming from 4,800 bps to 4 Mbps and has higher quality compression than MJPEG. For the purposes of video surveillance, MPEG 4 would be the ideal choice, but it is costly to implement and can be very difficult to decode images from the stream. In this project, a Wanscam IP camera is used to capture the image.

The Wanscam IP Camera

The Wanscam AJ Series IP Camera products are designed and equipped for local and remote network video surveillance system, including wired IP bullet camera, wireless IP bullet camera, IP IR dome camera, IP IR waterproof camera, IP Pan/Tilt/Zoom Camera etc. It adopts high performance chip to ensure high quality media processor which processes audio and video collection, compression and transmission. Standard M-JPEG compression format ensures clear and streaming video performance. It enables users to view live video via IE6.0, IE7.0, IE8.0, Firefox, Google browser or other standard browser.

Wanscam AJ series IP Camera products are applicable for big, medium-sized and small enterprises, chain store, factory, home and all kinds of spots where remote network video transmission and control supposed to be installed, they are easy to be installed and operated.

The Wanscam AJ Series Wireless IP-Based Camera's Specifications

It adopts high Performance, strong function media processor 32-Bit RSIC (reduced instruction set computer); It has high sensor CMOS resolution; it adopts optimized MJPEG video compression algorithm, realize high-definition images transmission in narrow bandwidth; maximum support of up to 15 users viewing at the same time, no limit for users if using forwarder; several server functions; built in web server, convenient for users to use standard browse to realize the real-time monitoring and setting administration; support WIFI:802.11 b/g/n wireless networking; support remote system update; support DDNS analysis, support LAN & Internet (ADSL,Cable Modem); support variety of network protocol: TCP/IP, UDP, SMTP, PPPoE, dynamic DNS, DNS Client, SNTP, BOOTP, DHCP, FTP, SNMP, WIFI/802. 11b/g; parts of modes products support for one/two way audio, talkback; support motion detection alarm function (area and sensitivity configurable); support image snapshot; Abnormal automatic recovery function, auto reconnection available when network; support for interruption occurred streaming video; dynamic alarm functions with alarm time-schedule reconfigurable facilities.

REAL-TIME IMPLEMENTATION OF THE IP-BASED WIRELESS CAMERA

Overview of the Real-Time Implementation

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 Wanscam vendor software, *2).* using web browser, and *3).* using MATLAB (The MathWorks, 2012a).

Accessing the IP-Based Camera Using the Wanscam Software

The software is installed through the Wanscam 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 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 shown in Figure 1.

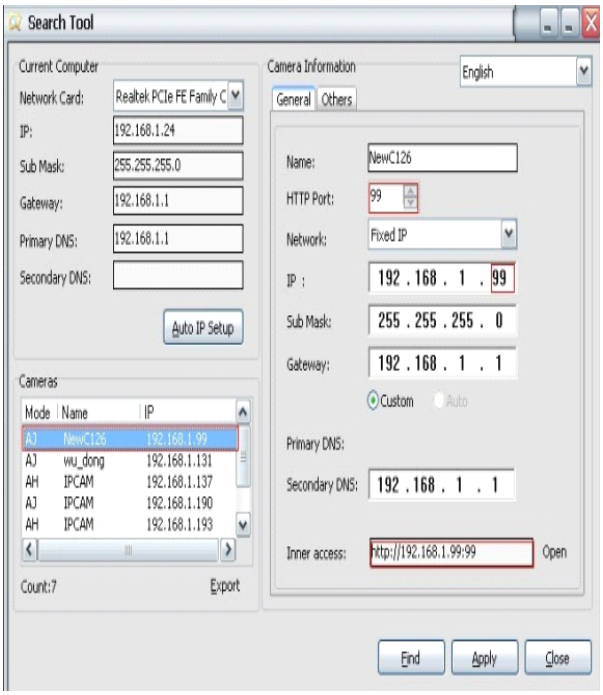

Figure 1: Configuring and networking of the IP camera using the Wanscam vendor software.

The software searches for the Wanscam 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 2.

Accessing the IP Camera via the Firefox® 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 3 pops up.

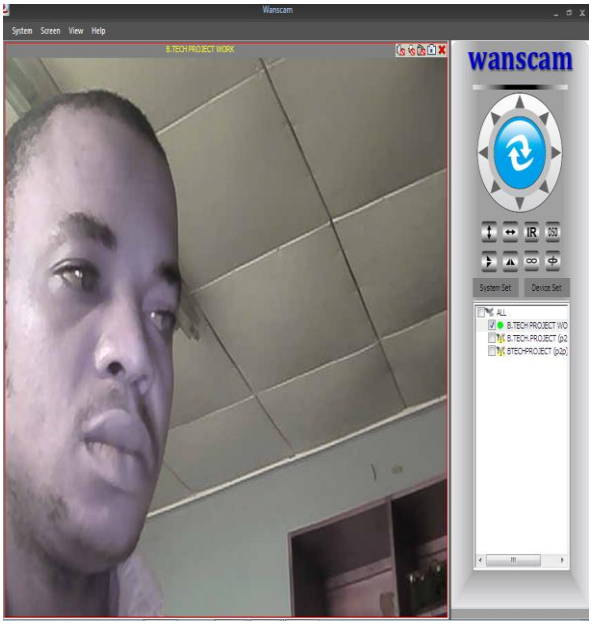

Figure 2: The captured image using the Wanscam vendor's software interface.

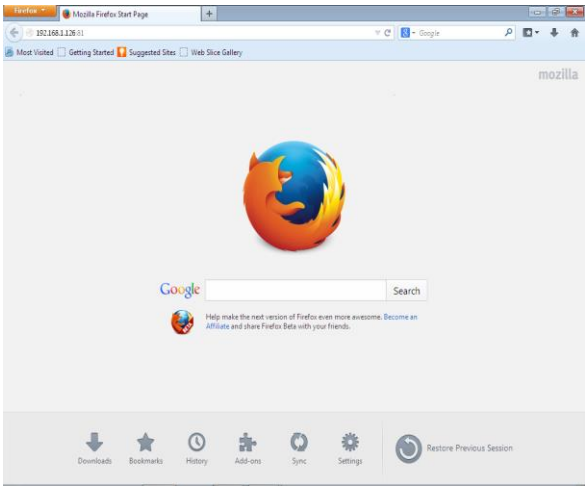

Figure 3: Stage 1 of the interfacing the Wansacm IP camera with the Firefox® web browser.

After inputing 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. 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.

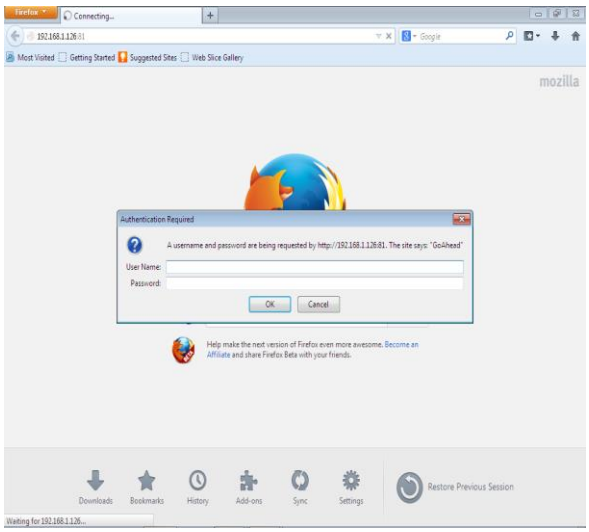

Figure 4: Stage 2 of the interfacing the Wansacm IP camera with the Firefox® web browser.

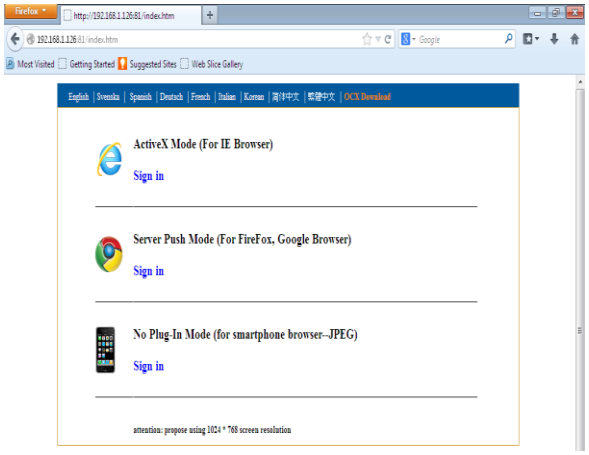

Figure 5: Stage 3 of the interfacing the Wansacm IP camera with the Firefox® web browser.

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®. And in achieving 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.

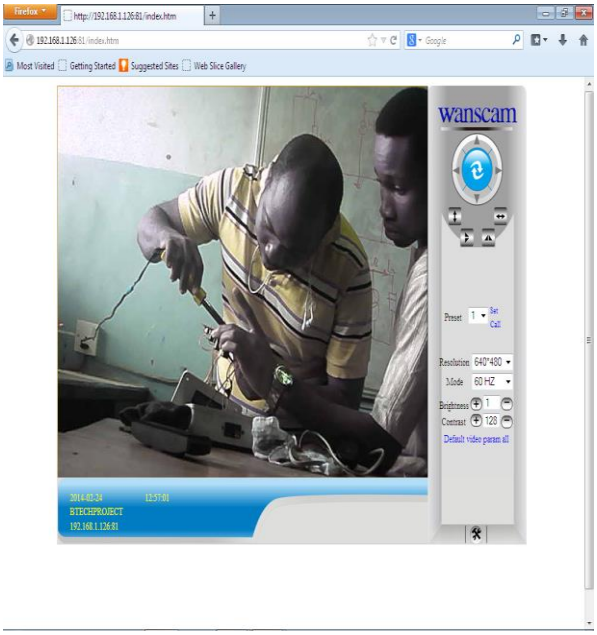

Figure 6: The captured image by Firefox® web browser via the Wanscam vendor's software.

The MATLAB Implementation Platform

MATLAB (MATrix LABoratory) (The MathWorks, 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 Fortran. 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, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems (Gilat, 2004).

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 (imread method)
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 (imread method)

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 11.

The IP address is entered as shown in the Figure 8. Once the page shown in Figure 8 pops up and the Enter key is pressed on the keyboard, then the page shown in Figure 9 pops up. The Username is supplied and page shown in Figure 10 is pops up. Note that the page shown in Figure 10 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.

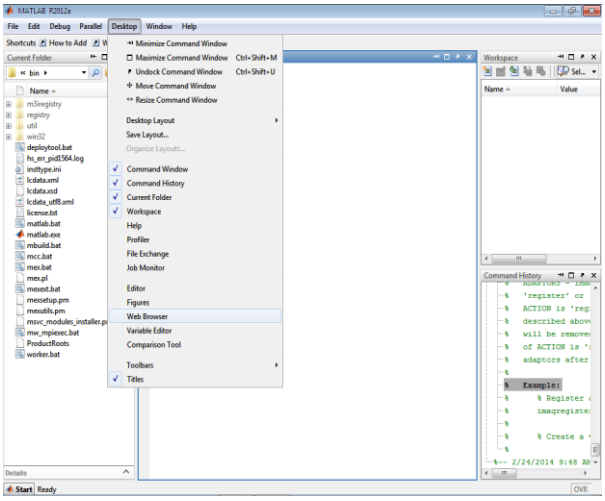

Figure 7: Stage 1 of MATLAB interfacing with IP camera.

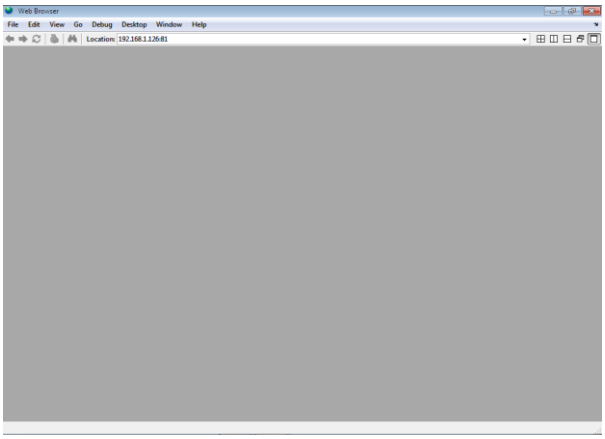

Figure 8: Stage 2 of MATLAB interfacing with IP camera.

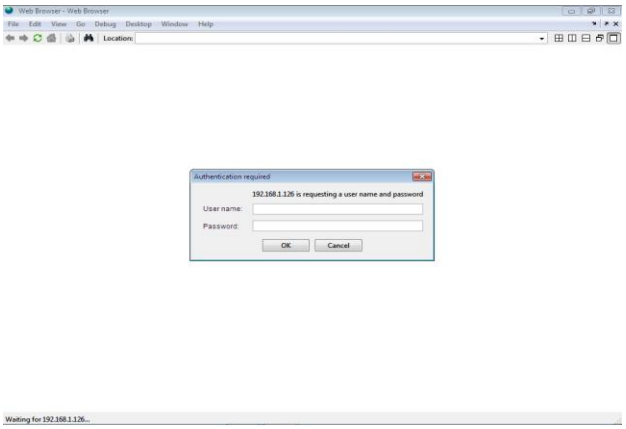

Figure 9: Stage 1 of MATLAB interfacing with IP camera.

Figure 10: Stage 4 showing the web server of the IP camera when interfaced with MATLAB.

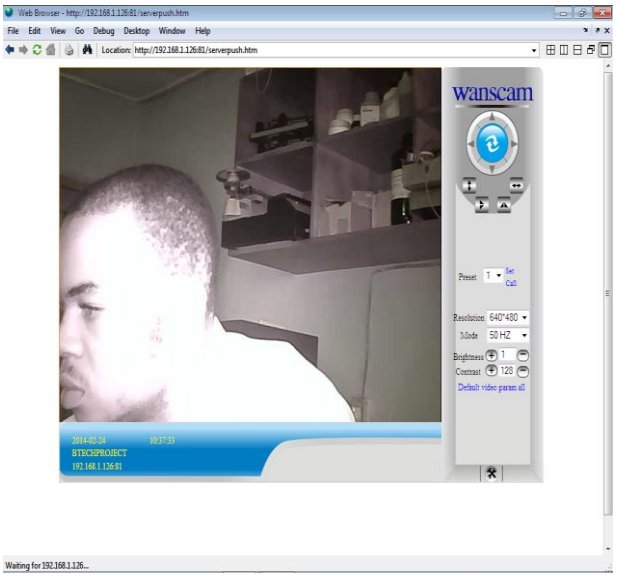

Figure 11: The captured image by MATLAB from the wireless Wanscam IP camera.

Accessing The IP-Based Camera Over A Network With Multiple Computers Using 100MB/s Ethernet Switch

Using any of the aforementioned software, either the software from the vendor, web browser or the MATLAB, the software is installed first in each of the computers with the same procedure as other ways explained above. Each of the computers is connected to the switch using CAT5E cables with RJ45 connector at the tips of the cables. The switch is then connected to IP camera using the same cable and connector, as shown in the Figure 12.

Each of the computers can access the camera either simultaneously or separately. The IP addresses of the involving computers must be on the same network for to communicate over LAN.

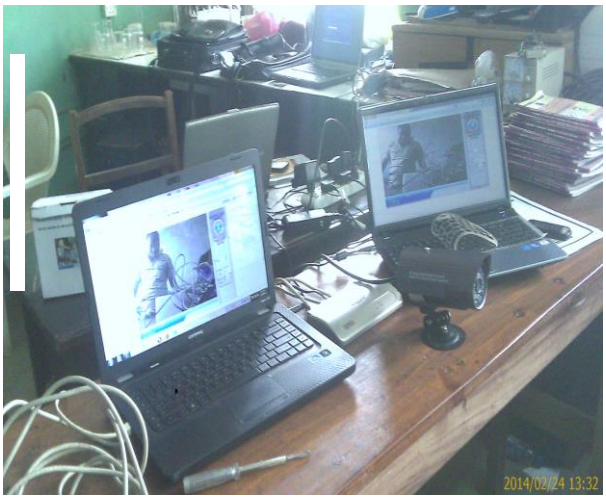

Figure 12: Connection and accessing the IP-Based Camera through 100MB/s Ethernet Switch.

CONCLUSION

Real-time capturing and viewing streaming video from an IP-based camera on the host computer has been proposed and implemented using three different methods, namely: *1)* using the software from the vendor, *2)* using the web browser, and *3)* using MATLAB/Simulink.

As a future direction, work has started on techniques to capture streaming video using MATLAB/Simulink® image acquisition and signal processing toolboxes 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.

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SUGGESTED CITATION

Akpan, V.A. and R.A.O. Osakwe. 2014. "Configuration, Interfacing, and Networking of an IP-Based Wireless Camera for Real-Time Security Surveillance Systems Design". *Pacific Journal of Science and Technology*. 15(2): 115-123.