A Novel Design and Implementation of a Real-time Wireless Video and Audio Transmission Device

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Abstract: A wireless communication system consolidated with real-time video transmission and half duplex voice communication features is implemented in this project. The system disseminates live video with synchronized audio both via wired and wireless means. LAN, Wi-Fi and GSM network are the modes of communication employed in transmission of video and audio data. Video decoding, processing and altogether transcoding the captured video for transmission is executed by Raspberry Pi. Pi camera is incorporated with the Raspberry Pi to serve the purpose of capturing video and still images. The audio transmission system is designed utilizing the module SA828. Security is ensured by automatically generated random and undisclosed IP address. The system is drafted ensuring portability, ease of operation, reliability and cost optimization. Some specific applications of this project include remote monitoring and military tactical surveillance operations

Key-Words: - Wireless, Wi-Fi, GSM, Raspberry Pi, SA828, Transcoding

1 Introduction

Wireless communications is the most expeditious growing segment of the communications industry. It has caught the consideration of the media and the creative ability of general society. Cellular systems have encountered exponential development in the course of the most recent decade and there are as of now around more than two billion clients across the world. Remote video and audio transmission systems via wireless network have turn into a standout amongst the most mainstream correspondence frameworks in this current era of cutting edge inventions. Wireless networks were first developed before the industrial age. Smoke signals, flares, flashing mirrors etc. transmitted information over line-of-sight distances. Marconi carried out the first radio transmission from the Isle of Wight to a tugboat 18 miles away, and with this demonstration the era of wireless radio communication begun in 1895. In 1990's remote data access via wireless means (email, _le transfer, web browsing) at a speed of ap15proximately 20 kbps was demonstrated and launched commercially. But the services were swept away by the remote information exchanging capabilities of cellular phones and wireless local area networks (WLANs). IEEE 802.11 standards are followed in the current wireless LANs. Transmission data rate of wired ethernet is many times higher than wireless LANs. But despite of providing glow data rate wireless LANs are becoming a more popular method in modern applications because of ease of installation and portability [1]. The IEEE802.11standard states that any digital information can be carried by a signal and can be transmitted over the 2.4 GHz ISM band. Most of the protocols used today in wireless networks were defined after 1997 [2].

There are numerous applications of video over wireless networks such as: mobile video streaming, video calls, remote health care in rural places, wireless video surveillance, video communication for security personals (police, military) and many more. News or regalement video clips streaming on demand on mobile and other hand-held devices is now widely popular. For surveillance 30 purposes if wireless connectivity is provided, camera installation becomes easier and much cheaper. A WLAN network can connect various devices of a normal household for easy control over the devices that we regularly use. Most importantly in high risk operations or in rescue operation real time audio-visual communication is very crucial which needs to be provided via wireless transmission method.

Wireless video transmission can be implemented by different networks. Elements of today's wireless video networks generally are: wireless LANs, WiMAX, Cellular, especially LTE, Ad hoc and mesh networks [3]. Wireless video transmission networks have numerous topologies. Transcoding of the internet's multimedia content for universal or personal access can be done through different methods. The system of transforming multimedia, in this case video and audio raw data, from the original encoded configuration into a second alternative format is known as transcoding. Transcoding enables any transceiver device to transform multimedia in a suitable form so that transceiver machines via human can access that multimedia content. Transcoding also increases the perceived speed of access to that content by reducing its quality a little bit. It enables video accessible over slow internet links. So transcoding the recorded video is necessary also for real-time video transmission [4]. At the receiving end a wide range of mobile and fixed clients may try to access with different internet speed. Adaptation to this kind of bandwidth heterogeneity, client heterogeneity, is also necessary. Utilization of a transcoding proxy resolves this problem. It transforms the server's contents to an acceptable form to the diverse clients connected to the internet via diverse access link [5]. Different protocols are maintained in order to stream video over wireless means: stored video streaming, real-time video streaming, broadcast video streaming and multi-cast video streaming. Our constructed device works under the real-time video streaming (two-way video) protocol. The video that we need to transmit have a certain structure, not all bits are equal in a video signal. Also video signal transmission faces different constraints such as delay and buffering. Although we receive video signals in instruments or man-made machines, humans are the final receiver of the transmitted video signal. So the signal transmitted must be comprehensible to the human brain. From source of video signal to network, from the transmitted signal via Wi-Fi to receiver optimization can happen at every point in the network [6].

Wireless radio networks cannot provide the requirement of steady information flow of data needed to stream a video. But a Wi-Fi network via WLAN can provide a much stable flow of information and delivery of packets reliably. Multipath fading and shadowing might increase due to the variability in link capacities and transmission error rate. To reduce this problems video coding for reliable transport and wireless resource allocation must be considered [7]. The transmission rate of the transmitted video should be compromised accordingly as the wireless link varies. Switching between multiple bit streams with different rates [8] or bit stream truncation [9] can be implemented to achieve video rate adaptation. The streamed video then can be received on a designated URL or can be encoded to stream via public URL websites.

The transcoded video can be encoded into different coding format. H.264 is an advanced video compression format standardized for video compression. Video compression is the process of converting the video data into a format which is more compatible for transmission [10]. H.264 has been applied in most popular applications such as media players for computer, smart phones, television and internet streaming. Encoder and decoder are the two main parts of the H.264/AVC [11]. Peer to peer is also known as p2p. The p2p network is a distributed network architecture where all the nodes in a network are altogether the clients and the servers. The p2p network enables sharing of computer resources and services by direct exchange between them. This system is light and low-cost. In addition, p2p network's address is not fixed and can disappear after the work is finished [12]. A voice or audio input recorder can be used to record real-time live video data with sound and transmit it accordingly.

There are three types of voice over wireless communication system: simplex, half duplex and full duplex. This research will weigh on the half-duplex communication system as we want to implement our research to the surveillance and real-time security personnel communication purposes. In a half-duplex system, the data can be transmitted in both directions on a signal carrier, but not at the same time. When one end transmits other end receives. The communication between transmitter and receiver is usually done by wireless radio networks. The loss of signals and instability is present, but the noise cancellation systems and filters provided can deliver the audio signal quite reliably. Also strong security can be provided via encoding the transmitting signal. Channel bandwidth selection is one of the most important features as it characterizes the transmission of the signal and also provides additional security to the system [13]. A voice-over wireless communication framework requires two transceivers for direct live communication between two persons. Transmitted signal frequency must match the antenna frequency of the receiver. This kind of system actualizes PTT (push to talk) system. When a voice signal is received, the system converts the signal into a radio signal which is a part of the electromagnetic

spectrum, so they travel at the speed of light to all the radios that are within range and on the same channel. Modern half duplex systems work on dozens of possible channels or frequency bands, so in order to communicate with the other transceivers frequency band have to be same. Not all frequency bands can be used as government imposes restriction over certain frequency band. The FRS and GMRS frequencies (public transmission) are mainly used for developing communication systems for civilians, but with government permission (GMRS license) we can go on and use other frequency bands [14].

2 Relevant works:

A considerable body of research has been done in the field of implementing the transmission of video over wireless medium till date. Very few embedded systems have been developed concerning real-time video transmission. Serenar et al. designed a wireless telemedicine system in which broadband multimedia information of patients health (video, audio and still images) is transmitted wireless via satellites [15]. The proposed system utilizes emergency medical helicopters, which take an important role in providing medical assistance where ground ambulances cannot reach the scene fast enough. Use of satellite communications and highly sophisticated equipments makes this design costly and inefficient for the hospitals in the developing countries.

Dash et al. proposed an embedded device which is able to stream or transmit voice in real-time over Wi-Fi (IEEE 802.11) [16]. This system uses Raspberry Pi board and a USB microphone to capture and process audio signals. The processed audio data is transmitted over Wi-Fi with an acceptable audio quality. SSH (secured Shell) is used, which is a cryptographic network protocol for secure data communication protocol between transmitting and receiving nodes. The proposed arrangement cannot offer synchronization of audio files between Raspberry Pi and PC and thus real-time voice transmission has a certain lag time.

A video surveillance system based on 3G wireless mobile Internet access is suggested by Liwei et al. Both wired Ethernet and wireless 3G access of internet realization of the system is implemented in this project [17]. Chauhan et al. in their embedded system transmitted real-time video over internet using embedded web server and raspberry Pi B+ board on the TCP/IP based network [18]. The video was captured using MJPG streamer algorithm to convert streaming data into different frame and these frames are transmitted to a web server over Wi-Fi. Security protocols are totally ignored in both of the subsystems. Moreover, the quality of the video transmitted is not specified.

Kumar et al. presented a network video surveillance system using ARM9 board support package (BSP) [19]. The device captures video, share the video among networked systems and also alters the controlling person with short message service alarm. The arrangement is supported by embedded RT Linux and works in a real-time environment. Zhou et al. also structured a similar embedded system based on S3C2440 processor [20]. Video4Linux is used to get the camera video data, which is transferred to web server, and finally the data is displayed on client browser. This system provides anti-theft protocols with SMS to control alarm equipment. But both modules must be connected to networked receptors with CCTV camera for video surveillance. Wireless surveillance via Wi-Fi, WiMAX or 3G networks is not included in these embedded projects.

Chitte el al. created an embedded system for video transmission which transmits video within a room sensing source of the voice [21]. Location of the speaker is 155 tracked in this video conferencing system which makes controlling of the video camera easier in a conference room. The streamed data is directly sent to a designated laptop/pc. Gora presented a method of video and photo recording of any moving object using Raspberry PI and motion sensors [22]. The system is triggered by the motion sensors and collects visual data from a specific area. The data are recorded and can be extracted. Surveillance operations and real time communications are not possible using these systems. The manuscript of Wu et al. addresses the design and implementation of a practical home security system (PHSS) using mobile phones through GPRS communication protocol [23]. The embedded surveillance server triggers the integrated camera to capture a still image when IR sensors detect any disturbance. The RISC based controller sends the image to user's phone where a java applet is required to be installed. Vigneswari et al. suggested a wireless security system using GSM [24]. The paper presents the idea of monitoring a particular place in a remote area using Pi camera and Raspberry Pi module. IR sensors detect any interrupt occurring in that area and send the information to Raspberry PI which triggers the camera to capture an image. The system only captures the photo of the perpetrator and sends it by wireless means.

Yang et al. introduced a micro embedded wireless video transmission system based on Wi-Fi using

ARM&DSP dual-core processor module [25]. The system communication is based on C/S structure. Wi-Fi communication module receives the transmitted processed signal (RTP format) and transmits it. RTP video data is received and decompressed by PC. Users can monitor the acquired videos and send controller signals with interface software. Even though this system is very reliable; high complexity, use of costly processors and modules and lack of security are the main drawbacks of this system. Soliman et al. in his paper concentrated on the transmission of video streaming over wide switched LAN [26]. A simulated study of surveillance video network in a WLAN is presented. For studying the performance and quality of the video stream H.264 and MPEG-2 codecs are used to transmit video over two different protocols: 185 HTTP and UDP. Our research work provides a compact embedded system which can transmit video by several wireless means with 720p resolution and also provides real time half duplex voice communication. It devotes scant attention to secure transmission by implementing proxy server system for video transmission and discrete channel selection system for audio transmission. In particular, research for providing secure wireless communication is lacking in most of the embedded systems. Our research seeks to fulfill this requirement by implementing a secure and reliable real-time wireless communication module.

3 System construction

The proposed real-time wireless communication system can be divided in three different segments:

i) Video and audio transmission and reception segment

ii)Half-duplex voice transmission and reception segment and

iii)Power supply segment

3.1 Video Segment

Fig.1 presents the complete video and audio transmission and reception module and the block diagram is shown in fig.2.

The Video transmission and reception segment is further divided into three segments:

- Video capturing segment
- Audio capturing segment
- Video and audio transmission segment

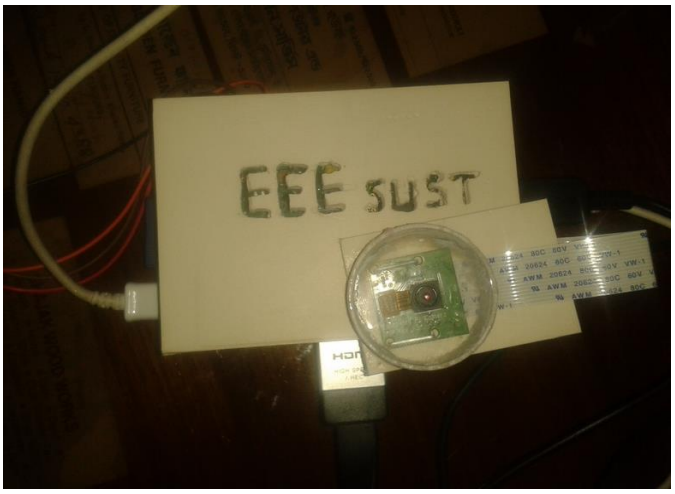

Fig.1:Real-time Video and Audio Transmission Device

3.1.1 Video capturing segment

Video capturing is performed by external command and still image capturing is performed by the integrated camera. Raspberry Pi B is used as the processor of this segment. Some individual code is written in python coding language to control some different functions. These programs are stored in the PI's memory segment. These control programs are executable in the raspberry pi Operating System (OS). Then a master program is also written which integratesand executes all those individual programs via instruction provided in GPIO pins of raspberry pi. For video files encoding a MJPG streamer algorithm has to be installed. The MJPG-streamer transforms the jpg frames from a single input plug-in to multiple outputs plug-in. This algorithm enables the frames captured by camera to stream over an IP-based network to any viewers with the correct IP address with the TCPMP player. Also the H.264Encoder is used which carries out prediction, transform and encoding processes to produce a compressed H.264bitstream. When the raspberry Pi boots, it will automatically run the program that is in rc.local which is a part of the command file of raspberry pi. In order to have a command or program run when the Pi boots, program has to be added in this file. So the video capturing and streaming program executes automatically when the raspberry Pi starts and executes commands according to the external inputs provided. The complete process of video encoding and decoding using the H.264 encoder is shown in fig. 3.

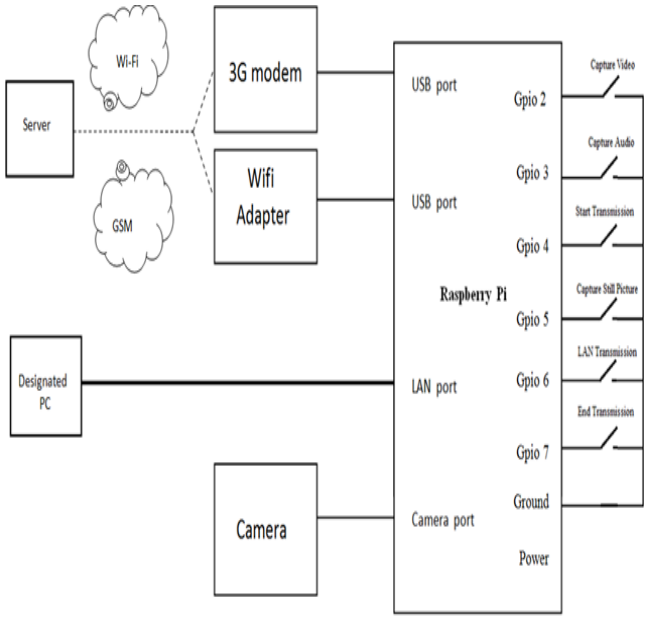

Fig. 2 Block Diagram of Video Transmission Segment

3.1.2 Audio Capturing Segment

Raspberry pi does not have any supported audio input port, so it was quite difficult to record live audio and synchronizing the audio in our device. To record audio in the raspberry pi, a sound card was introduced. The recorded sound can be streamed or can be stored in either a USB flash drive or a micro SD memory card. The software libsox is installed in the operating system of raspberry pi. This application is specialized for recording, processing and playback sounds. Libsox library is encoded to mp3 format to ensure good quality playback. The existing installed sound card software in raspberry pi is terminated as it can create contradiction with the external sound card. Then the external sound card is set up using modprobe. Modprobe is a Linux program which adds a loadable kernel module (LKM) to the linux kernel or removes a loadable kernel module from kernel. Kernel is a computer program which governs I/O requests from software and turned them into data processing commands for the CPU and other electronic component attached to the device. A loadable kernel module is an object file which can be utilized to include codes in order to extend the current kernel. The device manager of kernel is known as Udev. Udev uses mod probe to load drivers for automatically detected hardware. Snd-bcm module is loaded before audio processing. The kernel was updated in order to avoid any unwanted error protocols whilst installing Snd-bcm. When the sound module is loaded ALSA (Advance Linux Sound Architecture) is installed to provide audio and MIDI functionality to the Linux system. It has systematic support for all types of audio interfaces.

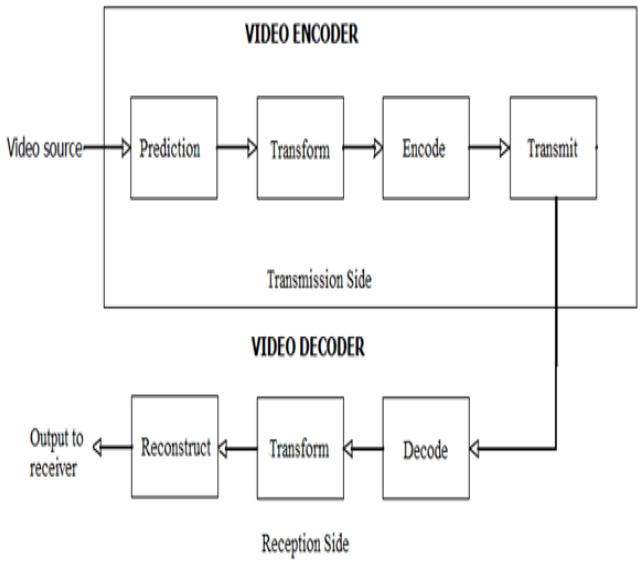

Fig.3: H.264 video encoding and decoding

Amixer permits command line control of the mixer of the ALSA soundcard driver. Using amixer the output sound can be forced to the analog output of raspberry pi. The recording level of the sound card is set by alsamixer. The recording time was set in manual mode. Two push buttons are introduced to initiate and terminate recording. A record command Initiates recording. The recorded audio data was configured to stream automatically. The audio is piped from microphone into an ssh communication to the designated computer by using plighw command prompt. Fig. 4 represents the complete audio capturing and transmission process.

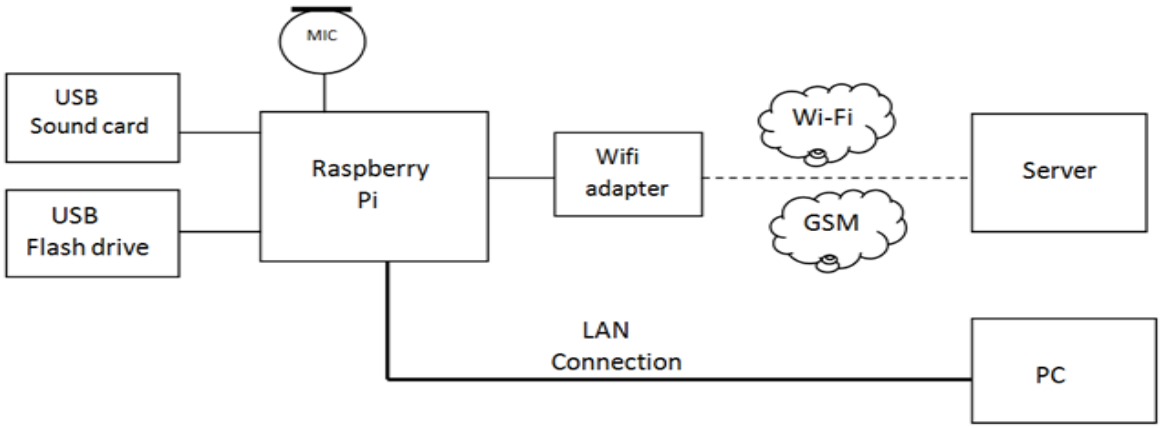

Fig.4: Block diagram of audio capturing and transmission process

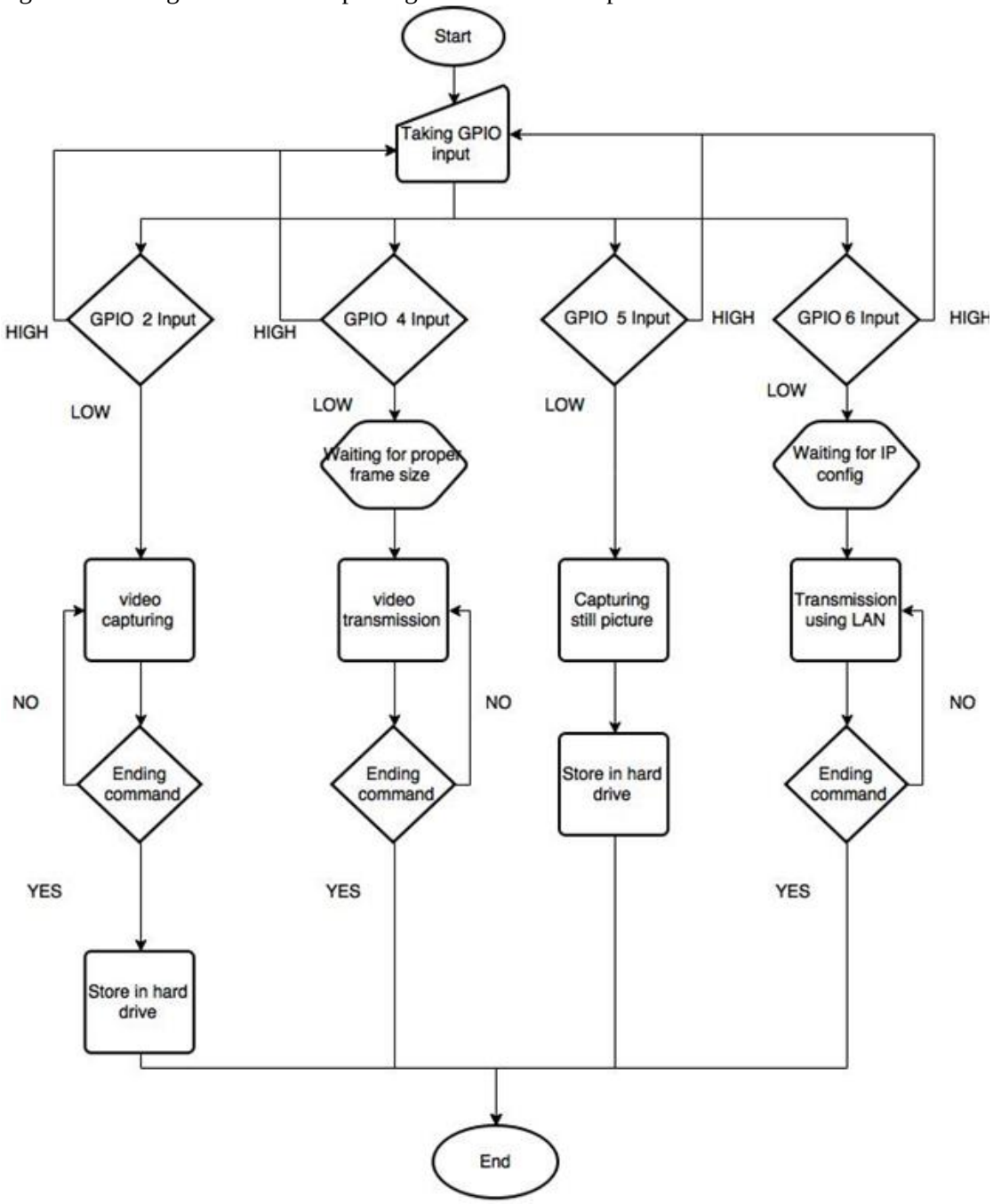

Fig.5: Workflow diagram of video segment

3.1.3 Video and Audio Transmission Segment

The proposed framework utilizes the modes of communication to transmit recorded live video feed with synchronized audio. Wired transmission is performed using a LAN connection to some designated PCs. Wi-Fi and GSM networks are utilized to transfer data through the wireless medium. The complete workflow diagram of transferring video data is shown in fig. 5.

3.1.3.1 Transmission via Wi-Fi and GSM Network.

To transmit the converted video frames to a designated IP address, a Wi-Fi dongle is used. Raspberry Pi only supports certain models of Wi-Fi dongle. We used the TP-LINK TL-WN725N ver-2.0 because this model is low cost, reliable and widely available.

TP link adapter has been installed using LAN. When the GPIO pin gets instruction for video transmission, the system will fix the resolution of the video to be transmitted. If we want to change the resolution of the video, internal coding has to be altered. When the LED in the dongle starts blinking it indicates transmission of video has begun. Transmitting through the wireless medium requires a designated IP address. The workflow diagram of video transmission via different methods is given in Fig. 6.

The raspberry pi camera captures high resolution video and if this video data is transmitted using a 2G network, increased amount of buffer time is needed. To remove this predicament, the third generation of mobile technology, also known as 3G network is used. 3G modem enables Raspberry pi to be connected to a high speed WCDMA and HSPA cellular network. In this surveillance system the modem enables the device to be connected to HSPA network. We used HSPA network for its lower latency time compared to WCDMA, where latency is a time interlude between the stimulation and acknowledgement. HSPA has large packet scheduling which is not present in WCDMA. HSPA is a coalescence of two mobile telephony protocols, HSDPA and HSUPA, which stretch and improves the execution of existing 3G mobile telecommunication networks employing the WCDMA protocols. Among these two technologies our wireless transmission system utilizes WCDMA for the downlink and HSPA for the uplink to render increased data transfer speed. HSPA uses higher order modulation, 16QAM is used in the downlink to enable high data transfer rate. Using shared channel increases the efficiency of transmission, link adaptation maximizes the channel usage.

For utilizing the 3G modem WvDial is used. WvDial is a utility that helps make a modem based internet connection in Linux operating system. WvDial is a point to point protocol dealer. PPP is a data link protocol, which is used to inaugurate a direct connection between two nodes. It allocates connection authentication, encryption in the transmission and compression. WvDial dials a modem and starts PPPD so that it can be connected to the internet. Then it utilizes the Wv streams library. WvDialconf detects the connected modem, it also detects the maximum baud rate and a good initialization string generates or updates WvDial configuration in accordance with this information. Login name and password of the desired network must be added in the WvDialconf to connect the device. To make the process simple a 3G SIM (Subscriber Identification Module) is used in a Wi-Fi router to create Wi-Fi network. The router is portable and rechargeable which can provide backup for around 7hours. The created Wi-Fi is utilized by the system through Wi-Fi Adapter and with this connection the system begins to transmit video data. For streaming, FFmpeg software is used in raspberry pi.

FFmpeg is software that constructs libraries and programs for handling multimedia data. It includes an audio, video codec library, a computer program for encoding and decoding both audio and video signals, an audio, video mix/demux library, FFmpeg command line programs for transcoding the multimedia files. The system uses codec library of FFmpeg, which is a combination of several computer programs with the capability of encoding and decoding digital data streams. The library is used for decoding the capturing video before streaming. For high quality video stream up to 720p resolution some buffer time is needed. The built-in FFmpeg of Raspberry Pi is removed and a new FFmpeg codec is installed because the built-in distributed package does not compile with H.264 support. After installing the software, configuration of the username and the codec quality is performed. The width and height of the video are set up by a python code. The frame rate is also increased to cap at a minimum of 25 FPS. Then the url and password of any selected website are introduced in the code and finally the system is ready for online live streaming. It is to be reminded that user must have proper authority over the selected website.

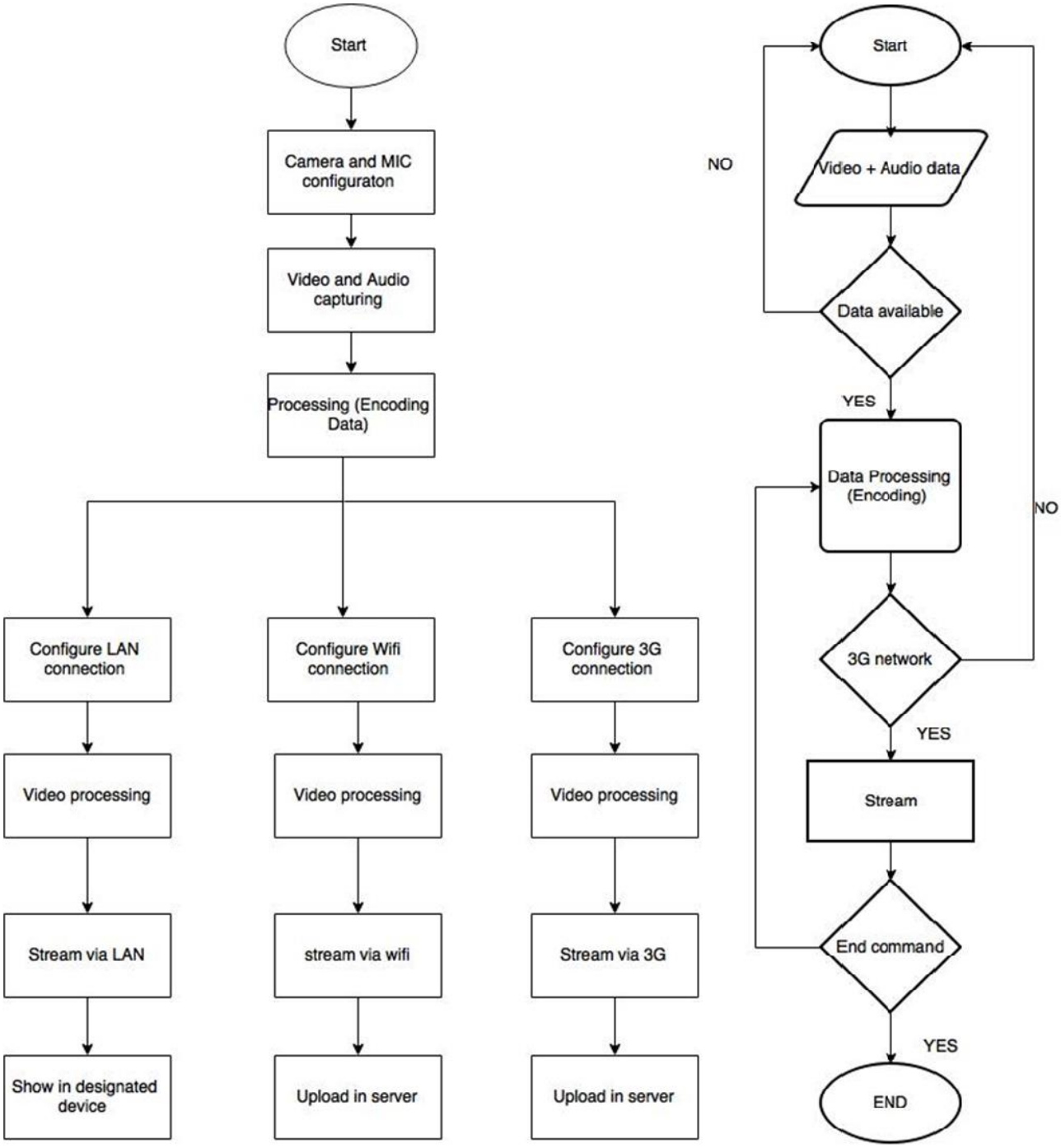

Fig.6: Transmission via different methods flow chart (left) and GSM (3G) transmission flow chart (right)

3.1.3.2 Transmission via LAN.

The device has an option to transmit the video using LAN (Local Area Network). Basically raspberry pi captured the video in H.264 format which is not supported by all the software. For this reason, VLC player is needed to be set up in both transmitter and receiver section. Here the transmitter will be the raspberry pi and the receiver will be a PC. To set up LAN Connection the network needs to be configured for both the transmitter raspberry pi and the receiving PC. The network can use static or dynamic IP address, but for remote login static IP address is preferable. In the network interface menu, the eth0 corresponds to the raspberry pi Ethernet port. The network type, address, netmask and gateway are also configured to connect the device to the network. To stream the video over LAN raspvid and cvlc command is used. A predefined resolution for high speed internet connection is set in the device. Finally, the captured video is piped to cvlc

where it is transcoded. The video data streams utilizing http access protocol using the video format H.264. Watching the real time video from receiver end requires configuring the proper http address in the open network stream in vlc player.

3.1.4. Hardware

Raspberry Pi Camera Module:

This is a 5MP camera module that is capable of 1080p video and still image and can be easily integrated into Raspberry Pi directly with CSI (Camera Serial Interface). Its dimension is 25 x 20 x 9 mm. This module is used for capturing videos and still images.

Wi-Fi Adapter:

Our developed device transmits the video live on internet via Wi-Fi network. We used TP-LINK TL-WN725N ver-2.0 to connect the device with Wi-Fi network. TL-WN725N enables 150 mbps data connection to the network. The adapter is connected via the USB 2.0 port of the Pi module. This adapter supports WMM which is standard for better streaming of real-time data such as Video, Music, and Video Chat.

Micro SD card:

A micro SD card is used for loading the OS of raspberry pi for processing and controlling the whole process. Raspberry pi Operating systems (Raspbian & RaspBMC) are installed in this single 8GB memory card.

3.2. Half-duplex Voice Transmission and Reception Segment

This unit consists of SA828, microphone, speaker, microcontroller and seven segment displays. Audio amplification, filtering, frequency band and channel selection are done through SA828. For RF transmission and receiving purpose 2dB antenna is connected with SA828 for transmission distance up to 2Km (although we could transmit audio signal at a distance of 800 meters effectively) range though RF frequency band. Microphone and speaker are directly connected with

SA828 as well as a microcontroller unit for controlling functionality of SA828. Microcontroller sets up control parameters of SA828. The object of setting up parameters through microcontroller and for displaying parameters, logic buttons and numerical display unit are interfaced with the microcontroller though which selection of channel and transmitting and receiving frequency canbe set up and visualized. System components are listed below. The complete module is shown in fig. 7.

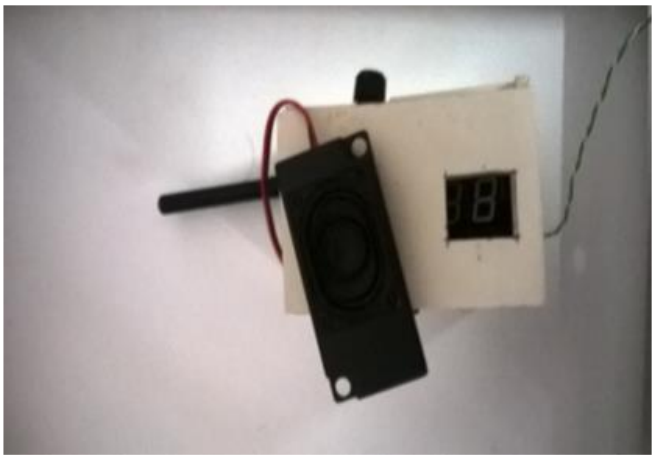

Fig.7: Half Duplex Voice Transmission and Reception Module

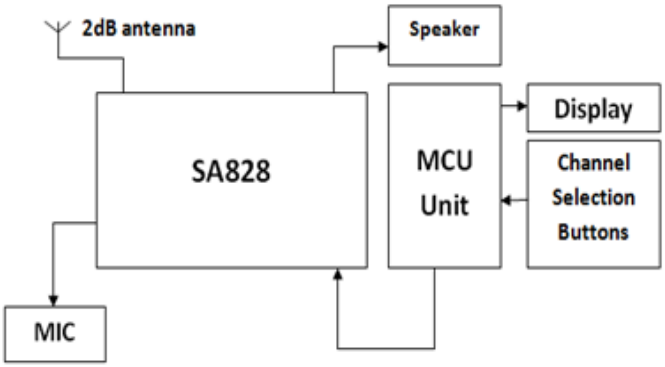

Fig.8: Half Duplex Voice Transmission and Reception Block Diagram

3.2.1. Hardware

SA828:

SA828 is an all in one audio transmission module for transmitting audio signal through RF frequency band. Module incorporates audio filter, audio amplifier, RF amplifier and transmitting and receiving unit. Microphone and speaker and connected with SA828 for audio capturing and audio output. Input audio signal from microphone first filtered then modulated with RF signal and transferred to RF power amplifier. Output of the RF amplifier is fed to transmission antenna. In receiving mode, signal received from antenna goes to RF amplifier and amplified signal is demodulated and power amplified by SA828. Amplified audio signal is than fed to connected speaker as output.

Microcontroller:

In this proposed design ATmega8 microcontroller is used for controlling and setting parameters of

SA828 and displaying channel information on numeric display unit. Channel selection process is completed through parallel communication with SA828, sending BCD codes for selecting channel and frequency. Logic buttons are interfaced with the microcontroller for manualcontrol over transmission and reception of signal channel and frequency. Numerical display unit is also interfaced with the microcontroller for displaying channel info to user.

Display:
As mainly numerical data is needed to be displayed and also keeping small size, portability and low power consumption in mind only seven segment numerical display is used in this proposed design. For batter management of I/Os of microcontroller two seven segment displays are multiplexed together. Fig. 8 represents the block diagram of Half-duplex Voice Transmission and Reception Segment.

3.1.5. Wi-Fi Adapter
Our developed device transmits the video live on internet via Wi-Fi network. We used TP-LINK TL-WN725N ver-2.0 is to connect the device with Wi-Fi network. TL-WN725N enables 150 mbps data connection to network. The adapter is connected via the USB 2.0 port of the Pi module. This adapter supports WMM which is standard for better streaming of real-time data such as Video, Music, and Video Chat.

3.3. Power Supply Segment
Raspberry pi B is used as the control unit of the whole real-time video and audio unit. The board takes fixed 5V dc as input. This 5V goes straight to HDMI and output USB ports. The Pi board provides a polarity protection diode, a voltage clamp, and a self-resetting fuse. It recommends the 5V dc, 700-1500mA current supply. Power consumption of Raspberry pi B model is 5V, 400-700mA (3.5W) while no device is connected to it. Requirement varies depending on how busy it is and what devices are connected to it. The USB devices and Ethernet connection will take extra power. For audio transmission SA828 IC is used which recommends voltage in the range of 3.5-5.5V dc and Tx current of500 mA (500 mW -1W).
A USB rechargeable power bank is used for supply power to the whole system. This makes the whole system portable and compact. Nonstop power supply without interruption is provided to the framework with Power Bank Adata Choice PC500 whose output is 5000mAh. So the power supply will serve the device for around 5 hours. Electrical overcurrent and temperature protection makes this power source very reliable plus alarm mechanisms of the supply triggers when the power bank reaches 100 percent load or 10 percent at discharge.

4 Research Contributions
There is a perceptible lack of research to provide adequate security in embedded wireless communication systems. Our research seeks to fulfill this deficiency of security by implementing a secure real-time wireless communication module. Hu et al. in his paper reviewed attacks on ad hoc wireless networks and also discussed about recent security approaches and protocols for establishing secure wireless network routing [27]. Security problems are combated by providing variable IP address and password protected stream site for the live video transmission system. The half-duplex audio transmission utilizes 14 different channels for transmission and reception which provides sufficient concealment of transmission data from public hands. Considering the perspective of remote monitoring and military surveillance application requirements, one of the most crucial design consideration of this wireless video and audio transmission system is its compact and small design. The entire system can be attached or mounted onto portable items for remote monitoring and surveillance. Also a small rechargeable power supply unit can provide the entire power required by the device, making this system a complete stand-alone system. This device is a very lightweight device weighing approximately only 500grams.
In spite of the device being less costly and very compact, quality of video and audio transmitted are not sacrificed. The device can stream video of minimum720p quality via wired and wireless means and the received audio is pretty clear with a minimum amount of noise. The demodulation in high codec quality of video data and sampling audio data over the rate of 44 kHz ensures better quality. Low speed internet or Wi-Fi connection can reduce the quality of the video to be transmitted. Dixit et al. presented an e-surveillance robot for video monitoring and living body detection, where quality of the video was not discussed [28]. Also the video monitoring system that they implemented does440 not support audio feed with video. Our device supports real-time synchronized audio with real-time video feed.
Most of the wireless surveillance modules available require skilled and trained manpower to operate because of their complex design. Chen at el. presented a broad and complicated video

surveillance system with many low cost sensors and few cameras [29]. Complicated operation of sensors and cameras in his device demands trained manpower. Considering the lack of training facilities in developing countries like Bangladesh, we designed our system less intimidating and user friendly. Few button pushing operation and easy maintenance protocols make the device very easy to operate for unskilled operators. Options to capture video and still pictures and to store it on a removable disk are also provided in this device.

The system is very versatile because it provides three different methods of video transmission. Encoded video can be transmitted via a LAN wire or using Wi-Fi and 3G mobile networks. The User is given the flexibility to choose the transmission medium according to availability by configuring the device using raspberry Pi. This design criterion is crucial for the surveillance application in developing countries where not all modes of internet connectivity are available everywhere.

The socioeconomic condition of the developing countries like Bangladesh is taken into consideration whilst designing this device. Many of the wireless video/audio communication gadgets exist commercially, utilize the satellite communication system prompting broad expense. Our internet network based device is approachable to regular people as the whole device only costs nearly16000 BDT (approximately $206 and e187).

Conclusion:

An embedded system which includes real time video transmission with synchronized audio employing wired and wireless network is developed. In addition, a half-duplex voice communication scheme is amalgamated with the video communication for a total audio-visual systematization. Image capturing and video recording are the additional features that are employed in the framework. Confidentiality of the communication method is safeguarded by arbitrary and anonymous IP address only acknowledged by users on the transmitting and receiving ends. Convenient and user friendly interface, lightweight and compact design, nonchalance maintenance and commendable security makes this device amenable for remote monitoring and high risk surveillance applications.

References:

[1] Wu Dajun. Keng Pang, Yu Rongshan, Feng Pan, Zhu Ce, "Wireless video communication on embedded system," *Signal Processing, 2002 6th International Conference* , vol.2, no., pp.1377,1380 vol.2, 26-30 Aug. 2002.mdoi: 10.1109/ ICOSP. 2002.1180048.

[2] Qian Liu, Zixuan Zou, Chang Wen Chen, "A deadline-aware virtual contention free EDCA scheme for H.264 video over IEEE 802.11e wireless networks," *Circuits and Systems (ISCAS), 2011 IEEE International Symposium* , vol., no., pp.625,628,15-18May2011
doi: 10.1109/ISCAS.2011.5937643.

[3] M. Budagavi, J.D. Gibson, "Multiframe video coding for improved performance over wireless channels," *Image Processing, IEEE Transaction* , vol.10, no.2, pp.252,265, Feb 2001,doi: 10.1109/83.902290.

[4] R. Mohan, J. R. Smith, Chung-Sheng Li, "Adapting multimedia Internet content for universal access*" , Multimedia IEEE Transactions* ,vol.1, no.1, pp.104,114, Mar 1999,doi: 10.1109 /6046.748175.

[5] I. Ahmad, Xiaohui Wei, Yu Sun, Ya-Qin Zhang, "Video transcoding: an overview of various techniques and research issues," *Multimedia, IEEE Transactions*, vol.7, no.5, pp.793,804, Oct. 2005
doi: 10.1109/TMM.2005.854472.

[6] Joe Yuen, Kam-Yiu Lam, E. Chan, "A fair and adaptive scheduling protocol for video stream transmission in mobile environment," *Multimedia and Expo, 2002. ICME '02. Proceedings. 2002 IEEE International Conference, vol.1*, no., pp.409, 412, vol.1, 2002 doi:10.1109/ ICME. 2002.1035805.

[7] Xiaoqing Zhu and Bernd Girod, "*VIDEO STREAMING OVER WIRELESS NETWORKS*", Information Systems Laboratory, Stanford University Stanford, CA 94305, USA, Aug. 2005.

[8] T. Ozcelebi, M.R. Civanlar, and A.M. Tekalp, "Minimum delay content adaptive video streaming over variable bitrate channels with a novel stream switching solution", *Proc. IEEE International Conference on Image Processing*, (ICIP'05),vol. 1, pp. 209.212, 2005.

[9] F. Yang, Q. Zhang, W. Zhu, and Y.-Q. Zhang, "Bit allocation for scalable video streaming over mobile wireless internet," *Proc. Twenty-third Annual Joint Conference of the IEEE Computer and Communications Societies (INFOCOM'04)*,Hong Kong, China, vol. 3, pp. 2142 . 2151, Mar. 2003.

[10] A. Vetro, T. Wiegand, G. J. Sullivan, "Overview of the Stereo and Multiview Video Coding Extensions of the H.264/MPEG-4 AVC Standard (2011).doi:10.1109/JPROC.2010.2098830.

[11] N. Saito, K. Kitagawa, "Overview of Peer-to-Peer Universal Computing Consortium (PUCC): Background, Current Status and Future Plan (2007)".doi:10.1109/CCNC.2007.159.

[12] J. Sen, "Peer-to-peer networks (2012)". doi:10.1109/NCETACS.2012.6203284

[13] Lewis, C. William. "Portable audio communication transceiver device." U.S. Patent No. 3,916,312. 28 Oct. 1975.

[14] I. Vasugi, M. Ramakrishnan, I. Arivazhagi, "Half-duplex bandwidth allocation with stations in wireless networks," *Information and Comm. Technologies (WICT), 2011 World Congress*, vol., no., pp.1368-1373, 11-14,Dec.2011, doi:10.1109 /WICT. 2011. 6141448.

[15] Serener Ali and C. Kavalcioglu. "Wireless telemedicine system in emergency medicine helicopter," *WSEAS International Conference. Proceedings. Mathematics and Computers in Science and Engineering*, World Scientific and Engineering Academy and Society, 2009.

[16] Rajeeb Lochan Dash, Mrs. A. RuhanBevi," Real-time Transmission of Voice over 802.11 Wireless Networks Using Raspberry Pi", *International Journal of Engineering Development and Research*, Volume 2: Issue 1, 2014.

[17]Wang Liwei, Yan Shi, Xu Yiqiu, "A wireless video surveillance system based on 3G network," *Environmental Science and Information Application Technology (ESIAT), 2010 International Conference on* ,vol.2, pp.592,595, 17-18 July 2010, doi:10.1109.

[18] Mahima F. Chauhan, Gharge Anuradha P, "Real Time Video Surveillance System Based on Embedded Web Server Raspberry Pi B+ Board", *National conference on recent research in engineering and technology (NCRRET) International Journal of advance engineering and research development (IJAERD)*, 2014.

[19] M. Kumar, D. SARMA, C. Sridevi, A. Pravin, "ARM9 Based Real Time Embedded Network Video Capture and SMS Alerting System." *International Journal of Research in Computer and Communication technology*, IJRCCT, Vol 1, Issue 7, December 2012.

[20] Duanchun Zhou, Guangxing Tan, "Network video capture and short message service alarm system design based on embedded Linux," *Natural Computation (ICNC), 2010 Sixth International Conference on* , vol.7, no., pp.3605,3608, 10-12 Aug. 2010

[21] P. P. Chitte, R. R. Shinde, S. V. Thosar,," Smart Automated Conference Room System", *International Journal of Emerging Technology and Advanced E*[9] *ngineering*, Volume 5, Issue 3, pp. 591-595, March 2015.

[22] Gora Oguz, "A Novel Video/Photo Recorder Using an Online Motion Sensor-Triggered Embedded System." *Innovative Systems Design and Engineering 6.4*, pp.44-51, 2015.

[23] Wu. Bing-Fei, Hsin-Yuan Peng, and Chao-Jung Chen. "A practical home security system via mobile phones." *WSEAS Transactions on Communications* 5.6: 1061-1066, 2006.

[24] P. Vigneswari, V. Indhu, R. R. Narmatha, A. Sathinisha, J. M. Subashini, "Automated Security System using Surveillance, " *International Journal of Current Engineering and Technology*, Volume 5, No. 2, pp. 882-884, April 2015.

[25]Yong-ming Yang, Xue-jun Chen, Wei He, Yu-xing Mao, "A Micro Wireless Video Transmission System", *Advances in Swarm Intelligence*, Volume 6729, Springer Berlin Heidelberg, pp 441-448, 2011.

[26] H. Soliman, Hassan, Hazem M. El-Bakry, and Mona Reda, "Real-time transmission of video streaming over computer networks", *Proceedings of the 11th WSEAS International Conference on Recent Researches in Communications, Electronics, Signal Processing and Automatic Control, Cambridge, UK*. 2012.

[27] H. Yih Chun, A. Perrig, "A survey of secure wireless ad hoc routing", 2004.
560 doi:10.1109/MSP.2004.1.

[28] D. S. K. Dixit, M. S. B. Dhayagonde, "Design and Implementation of e-Surveillance Robot for Video Monitoring and Living Body Detection", *International Journal of Scientific and Research Publications, 4(4).*

[29] W. T. Chen, P. Y. Chen, W. S. Lee, C. F. Huang, "Design and Implementation of a Real Time Video Surveillance System with Wireless
Sensor Networks , 2008.
doi:10.1109/VETECS.2008.57