Engineering and Technology Journal e-ISSN: 2456-3358

Volume 09 Issue 09 September-2024, Page No.- 5007-5011

DOI: 10.47191/etj/v9i09.04, I.F. – 8.227

Design and Implementation of a Reliable and Secure Wireless CCTV Camera Network for the Main Administration Building, Federal Polytechnic Offa

Frederick Ojiemhende Ehiagwina[1], Kamoru Oluwatoyin Kadiri[2], Surajudeen Adewale Yekeen[3], John Olusegun Azanubi[4], Khadijat Oladoyin Mustapha[5]

[1,2,3,4,5] Electrical/Electronic Engineering Department, School of Industrial Engineering, Federal Polytechnic Offa, Offa, Kwara State, Nigeria

ABSTRACT: This paper presents techniques for configuring, interfacing and networking of a wireless IP-based camera for real-time security surveillance systems for the main administration building of the Federal Polytechnic Offa, Kwara State. The real-time implementation techniques proposed for configuring, interfacing and networking the IP camera is through a vendor software. The live streaming video based on the proposed technique can be adapted for image detection, recognition and tracking for real time intelligent security surveillance systems design. The output of this proposed system outperformed other comparable methods.

KEYWORDS: CCTV, surveillance, Wireless cameras, campus security

INTRODUCTION

Wireless CCTV surveillance systems offer flexibility and mobility, they present challenges related to reliability, security, and effective coverage in various environments and applications. The existing wireless CCTV technology may encounter issues related to signal interference, limited transmission range, and vulnerability to cyber threats, thereby impacting the system's overall performance and integrity.

This paper is aimed at designing and implementing a reliable and secure wireless CCTV camera network for the main administration building, Federal Polytechnic Offa. This will be achieved through the survey of the main administrative building and camera selection, setting up of network infrastructure, installation of CCTV cameras and other devices, configuring surveillance software, testing and deployment.

In [1], Sassani, David, Li and Mehdipour introduced a prototype surveillance system rigged with several vital modules and mobility as an optional functionality. The developed system was anticipated to be achieved through integration of the ever-evolving mobile broadband with the current vastly available 4G LTE and 3G UMTS technology. The fact that this suggested idea was inexpensive and can be implemented using basic equipment and open domain resources means that anyone may take proactive security precautions for their home or place of business.

Sending high quality digital images through limited bandwidth needs several precautions and treatments, like which image to be sent, how the image will be sent and when. Without these precautions and treatments, in return it will result in energy inefficiency. Karna, Safira, and Madsu therefore focused on energy performance in [2] in order to create a high-quality electronic picture transmission schema for independent surveillance. The authors considered individual but consecutive images transmission rather than video transmission to limit the processing time and power. It also provided the algorithm in choosing images for transmission to reduce bandwidth usage and power consumption.

Otuu , in reference [3] suggested a potential application to election management in Nigeria. He noted that there have been upheavals in areas where elections have been conducted lately in Nigeria. The government of the day has done well in trying to computerize the electoral process by introducing BVAS in all polling units, but has failed to implement a non-human monitoring mechanism which could watch over electoral conducts and support result collation in all voting points without loopholes, intricacies and injuries to members of the voting communities. Wireless Close Circuit Television (CCTV) is an electronic monitoring system that combines network Software and hardware subsystems which are installed with Wireless channels and other monitoring mechanisms to cover and record activities in a particular domain. Data recorded in this device is immediately transmitted from the remote database in real-time, to a cloud-based central server where all happenings and events are stored for future retrieval and decision making. The author subsequently recommended that all polling units in Nigeria should have a Wireless CCTV system installed before the 2023 presidential election, irrespective of the cost, instead of the always compromised human monitors.

In [4], Sanjay Satam and El-Ocla proposed a smart and robust home security system. The system developed maked use of a relatively low cost but effective wireless sensor network that makes it an affordable security system to buy when compared to other expensive CCTV camera systems. This used the "Twilio" API to construct a computerised alarm system for residence safety and notify the host. One component of the detection system was a laser tripwire. Using a customised Raspberry Pi camera and a time of video recording that is stored in the Raspberry Pi's MySQL database, the system alerts the user to any potential theft or intrusion in their surroundings. The web server on the Pi, Apache2, is utilised to fulfil client requests from Android devices. Eventually, registered users will be able to control the application remotely by viewing the correspondingly collected photographs and videos.

MATERIALS AND METHOD

When installing a wireless Closed-Circuit Television (CCTV) system, a structured process is followed to ensure an effective and reliable surveillance setup. The basic block diagram is shown in Figure 1.

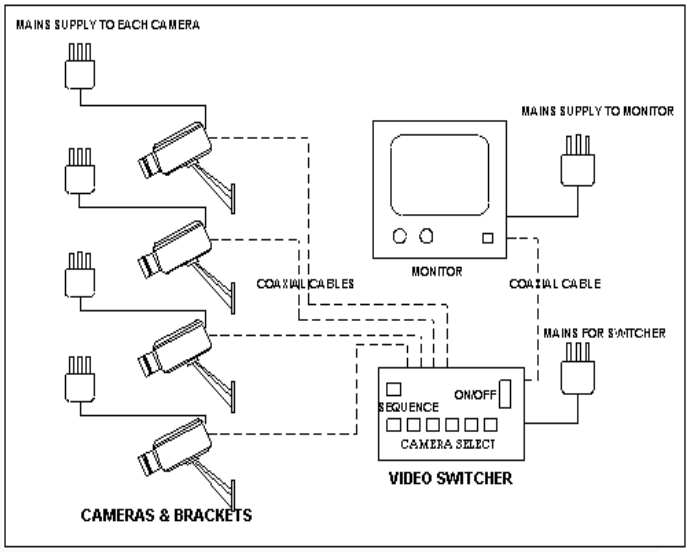

Figure 1: Block diagram of CCTV

The steps involved in the installation of a wireless CCTV system [5-6]:

1. Site Survey and Planning:

The installation site is surveyed to identify optimal camera positions, taking into account areas requiring surveillance coverage, potential obstructions, and strategic vantage points. We then analyze the wireless signal strength and potential sources of interference to determine the best locations for the wireless CCTV cameras.

2. Selecting CCTV Cameras:

A good selection is done to ensure that suitable wireless IP-based CCTV cameras appropriate for the surveillance needs are obtained, ensuring they have appropriate features such as motion detection, night vision, and weather resistance based on the installation environment.Some samples of existing CCTV cameras are shown in Figure 2.

(a)

(b)

Figure 2: Samples of existing cameras

3. Network Infrastructure Setup:

We need to establish a reliable wireless network infrastructure, including setting up wireless access points, routers, and switches to facilitate connectivity between the wireless CCTV cameras and the recording/storage devices.A commercially available wireless access point is shown in Figure 3.

Figure 3: Wireless access point

4. Power and Connectivity Testing:
The next stage is to verify wireless signal strength and network connection reliability at the selected camera positions to ensure consistent video transmission and coverage.

5. Installing CCTV Cameras:
The wireless CCTV cameras are mounted in the predetermined locations, ensuring secure attachment and proper angling for optimal coverage.This will be followed by setting up of camera orientations, viewing angles, and motion detection parameters according to the surveillance objectives. We establish a secure wireless connection between the IP cameras and the network infrastructure, ensuring smooth data transmission and availability.

6. Configuring Surveillance Software:
Install and configure the required surveillance software or Network Video Recorder (NVR) to manage the wireless CCTV system. Set up motion detection triggers, recording schedules, and remote access permissions.An example of a commercial NVR is shown in Figure 4.

Figure 4: Commercial NVR

RESULT
The system was deployed after a step by step installation of the wireless cameras. The signals from the cameras were fed to the NVR for onward display via the wireless radio system. The results obtained are shown in Figures 5-8.

Figure 5: Full view of the surveillance locations

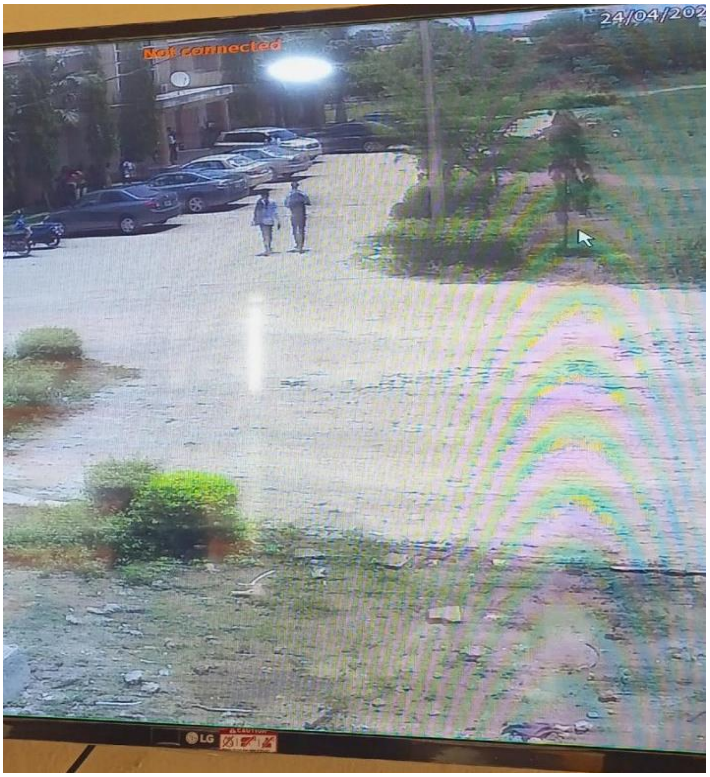

Figure 6: View of the Bursary unit entrance area

Figure 7: Front view of the main administrative building - parking lot

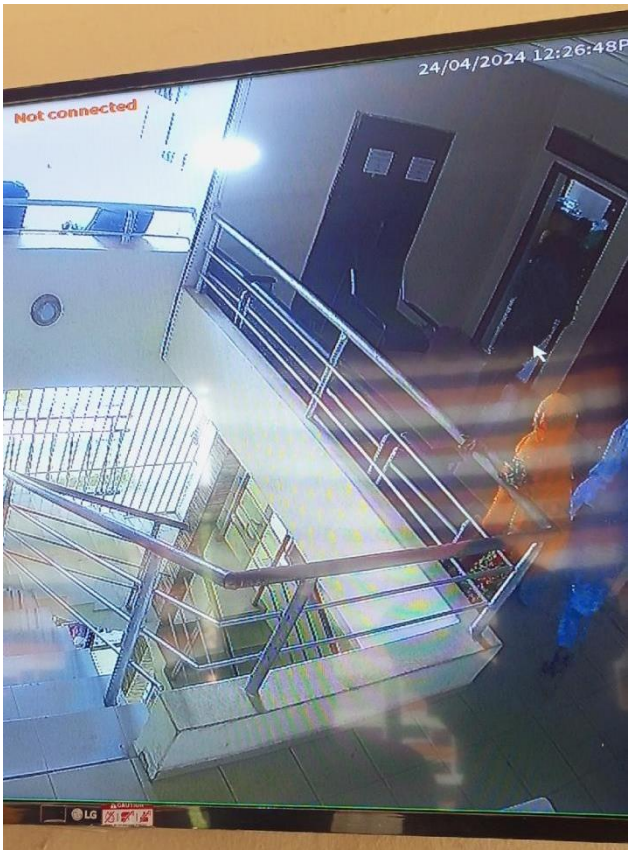

Figure 8: View of the stairway of the main administrative building

The monitor can display 16 camera channels. Of these, eight channels were utilised to show strategic locations within the main administrative building. Figures 5-8 showed different sections of the main administrative building covered by the project.

The video feed was based on H.265, which is a high efficiency video coding (HEVC). It is a video compression standard developed within the MPEG-H initiative to succeed the widely adopted Advanced Video Coding (AVC, H.264, or MPEG-4 Part 10). HEVC improves upon AVC by achieving 25% to 50% better data compression at equivalent video quality, or by significantly enhancing video quality at identical bit rates. It supports resolutions up to 8192×4320, encompassing 8K UHD. Unlike AVC, which primarily supports 8-bit color depth, HEVC's Main 10 profile delivers higher fidelity and is widely supported by hardware implementations. In contrast to AVC's use of integer discrete cosine transform (DCT) limited to 4×4 and 8×8 block sizes, HEVC incorporates both integer DCT and discrete sine transform (DST) across block sizes ranging from 4×4 to 32×32. The High Efficiency Image Format (HEIF) is derived from HEVC technology, further extending its capabilities in multimedia compression and storage.

CONCLUSIONS

This article highlights the development of a wireless CCTV surveillance system for the administrative building in Federal Polytechnic Offa. The materials needed were mentioned. The system was tested with satisfactory results.

The design and implementation of a reliable and secure wireless CCTV camera network for the main administration building at Federal Polytechnic Offa has been successfully completed. The proposed system ensures the seamless transmission of video feeds from multiple cameras to a central monitoring station, providing real-time surveillance and enhanced security for the institution.

The system's reliability is ensured through the use of a robust wireless network infrastructure, which includes the deployment of multiple access points and the implementation of Quality of Service (QoS) policies to prioritize video traffic. This ensures that video feeds are transmitted without interruptions or significant delays, even in high-traffic areas.

The security of the system is enhanced through the use of advanced encryption techniques, secure authentication protocols, and access control mechanisms. These measures prevent unauthorized access to the system and ensure that only authorized personnel can view or record video feeds.

The system's performance was evaluated through a series of tests, which included video quality assessments, network latency measurements, and security vulnerability assessments. The results of these tests indicate that the system meets the required standards for reliability and security.

The implementation of this system has several benefits for Federal Polytechnic Offa, including enhanced security, improved surveillance capabilities, and increased efficiency in monitoring and managing the institution's facilities. The system also provides a scalable platform for future expansion and upgrades, ensuring that the institution's security needs can be met as they evolve.

In conclusion, the design and implementation of a reliable and secure wireless CCTV camera network for the main administration building at Federal Polytechnic Offa has been successfully completed. The system provides a robust and secure platform for real-time surveillance and monitoring, ensuring the safety and security of the institution's facilities and personnel.

ACKNOWLEDGMENT

This work was funded by Tertiary Education Trust Fund (TETFUND), Nigeria under the Institution Based Research (IBR) Grant Batch 13 RP disbursement. We also acknowledge the Research and Innovation Unit of the Federal Polytechnic Offa, Kwara State, Nigeria.

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