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Research Paper

Design and Implementation of Wireless Sensors Network (WSN) Based Surveillance System at The Polytechnic, Ibadan.

Adejumobi, O.K.
Computer Engineering Department, The Polytechnic, Ibadan.
Kolastar32@gmail.com

ABSTRACT
Security is been defined as precautions taken against attacks, crimes, sabotage, espionage, etc. However, potential security threats within the institution due to daily increased number of crime such as stealing, students' hooliganism and flouting of gate pass rules prompted the execution of this Project titled, 'Design and Implementation of Wireless Sensors Network (WSN) Based Surveillance System at The Polytechnic, Ibadan. The Implementation of the surveillance system covered some selected areas (simply called, Nodes) on campus such as; the central administration building, the deputy Rector's building and, the walkways that are most prone to security threats. The project is divided into two (2) sections namely; the hardware (comprising of the motion detection, and the monitoring and recording units and the software sections. Whenever an intrusion is detected by the WSN, the microcontroller activates the cameras wirelessly. The cameras then capture the events going on at the time. The monitors connected to the digital video recorder (DVR) regularly displays all events taking place around the selected areas for proper surveillance. These events are also recorded to help detect crime and provide evidential materials for court proceedings if need be. There is also a router that transmits the captured events to mobile nodes.
This design and its implementation worked according to Specifications. It is simple, effective, easy to operate and maintain. However, it is recommended that more cameras be provided to capture more areas on campus. Alternative power supply should be provided in case of power interruption.
Keywords: Security Threats, Wireless Sensors Network (WSN), Mobile Nodes,
Cameras and Surveillance.

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Objectives of the Project

1. To carry out survey of the sites where the cameras, sensors etc are to be installed.
2. To help reduce the fear of crime.
3. To help detect crime and provide evidential materials for court proceedings.
4. To assist in the overall security management of the institution.
5. To enhance community safety by enabling a 24-hour monitoring of designated areas.
6. To provide a permanent record of activities from all connected cameras.
7. To provide a deterrent to crime and vandalism.
8. To enable clear identification of miscreants within the range of the cameras.
9. To provide independent viewing of any camera via mobile nodes.

I. INTRODUCTION

Security is the degree of protection against danger, damage, loss or any criminal activity. Nowadays many private and public organizations are setting up surveillance cameras such as the Closed Circuit Television (CCTV). Some parties seek to promote their benefits such as their use in criminal investigations and providing a feeling of safety to the public. The correct design and use of such systems is paramount to ensure a CCTV surveillance system meets the needs of the users, provides a safety and security for the wider law-abiding public and serves as a simple deterrent, especially for illegal entry or violent crimes.

II. RELATED WORK

According to [1], security has been defined as precautions taken to guard against crimes, attacks, sabotage, etc. The alarming crime rate in various homes and offices around the globe has necessitated the installation of surveillance security systems in most establishments. Surveillance is the systematic monitoring of the actions of people in a place [2].

In the work presented by [3], Passive Infrared Detector (PIRD) was used as one of the most common detectors found in household and small business environments. It does not emit infrared beam but passively accepts incoming infrared beam. This system can only be used to detect intrusion in an idle area with no motion. It cannot be used in busy areas where movement and activities are executed. Also, this system does not provide facial recognition of the intruders.

[4, 5] presented an overview of the use of CCTV systems as a problem oriented policing response to a crime problem. Automated surveillance systems are now core when it comes to effective infrastructures that enhance crime detection, prevention and the apprehension of criminals [6, 7]. CCTV systems have also become part of this infrastructure and are now very important and effective systems to implement in today's environments [8, 9]. [10], proposed a system that records human movement through face recognition in multiple camera systems. The custom convolutional neural network (CNN) model is tuned in such a way that it gets trained [11, 12] and extracts features that have a high potential of differentiability. This system is however dependent on CCTV camera conditions and light intensity. [13, 14] proposed an automatic surveillance system with facial detection, recognition, and face tracking. The proposed system consists of three main modules: MTCNN for face detection, VGGFace2 for facial recognition and identification, and D3S for face tracking. The system detects all faces found in the observation area and tracks when the face is not recognized in the database. The back-end method runs in a cloud platform that making mobile surveillance using an edge device, For future work, a surveillance system that can deal with masked face is recommended.

Surveillance systems not only record activities but also act as a prevention tool. The proposed approach is an innovative technology in the smart home concept explained by Wei [15]. Surveillance systems must have the capability to perform automatic detection, recognition, tracking, and behaviour analysis [16, 17].

[18, 19] proposed a CNN-based face mask classifier. However, it still deals with the front view image, which is not the natural condition in the surveillance system. Jain developed CamAspect, an intelligent surveillance system that employs Deep SORT tracker and FaceNet to detect, track, and recognize a person however, further improvement is recommended [20].

III. METHODOLOGY

The following criteria were considered in the design:

i. Understanding of the aim of the research.
ii. Installation locations of sensors, cameras and monitors.
iii. Understanding the environments where cameras and monitors will be installed.
iv. Selecting sensors, cameras, drives, signal routing, monitors, and switches.
v. Selecting recording methods.

The project is divided into two (2) sections namely; the hardware (comprising of the motion detection, and the monitoring and recording units - see Figures 1 and 2) and the software sections. The sites of the project are the school's Central Administration building area, the main gate, the deputy Rector's building and the walk ways that constitute security threats.

1. Hardware Section

The main aim of the surveillance system is to prevent crime actions. This application is generally referred to as "crime prevention cameras". This aims not only to create a psychological effect to act as a deterrent to crime, such as theft and molestation, but also to help identify criminals after crimes are perpetrated by reviewing recorded images resulting from the installation of a CCTV system. According to the site survey in the case study location, outdoor cameras were chosen. Hikvision camera was chosen because of its HD video output, easy installation and its ability to adjust in three (3) axes.

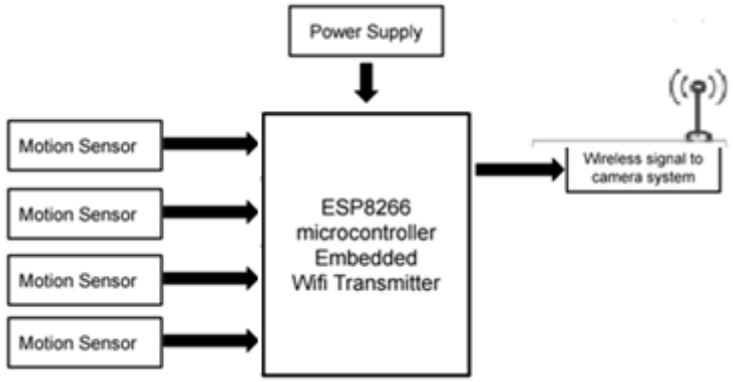

Figure 1: Architecture of the WSN - based Surveillance System (Motion Detection).

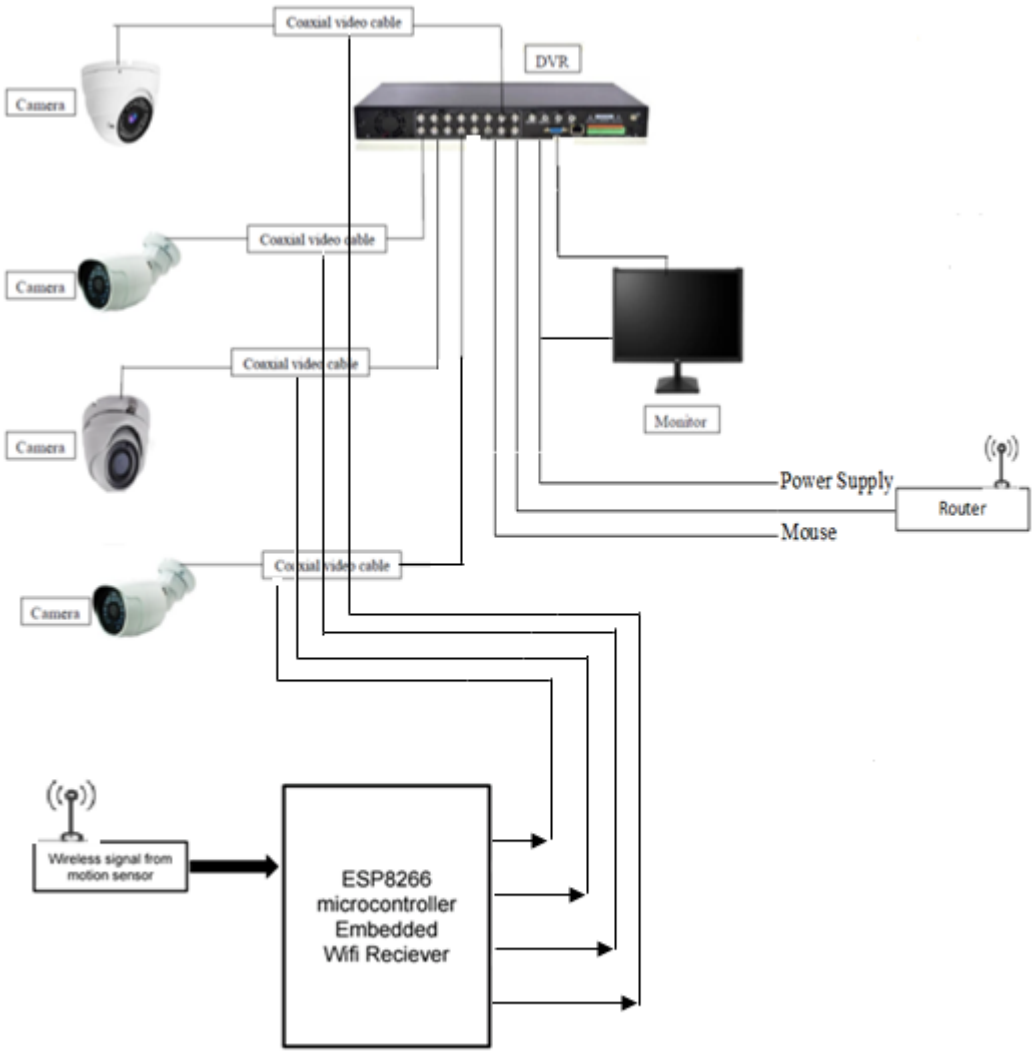

Figure 2: Architecture of the WSN - based Surveillance System (Monitoring).

Recording Days (*Dr*) and Time (*Tr*).

The recording time depends on many variables, and can be calculated by the following equation;

$$Dr = \frac{HDD}{F*C*N} \quad \text{(s)}\ldots\ldots\ldots\ldots\text{..equation 1.}$$

Where: Dr is the recording days.

HDD is the hard disk capacity (b)

F is the frame rate per second
N is the number of cameras in the system
C is the picture capacity (b)
In this project, nodes with 4-channel NVR with a 2Tb in-built hard drive and 4 cameras (8MP) were setup to capture 8192 frames/sec. In this case the recording days (24 hours/7 days) can be calculated with the equation 1.

$$Dr = \frac{2048GB*1024^2*8}{8192*3600*24*4}\ days = 6\ days.$$

Tr (Recording hours) = $6 * 24\ hours = n144\ hours$.

2. Software Section

The Algorithm used to develop the program for the SWSN – based Surveillance system is as follows:

1. Start
2. Configurations;
3. Cameras are OFF.
4. Check if there is intrusion via WSN;

If Yes;

- WSN sends signals to the Microcontroller that activates the Transmitter.
- Also, Transmitter sends signals to the camera system.
- DVR records captured events on the hard disk and displays events on Monitors.
- Router sends Signals to Mobile Nodes (cell phones).

5. If No;
- Go to 3;

6. End.

IV. INSTALLATION

Installation of Cameras, DVR, Routers and other Accessories.

The most important aspect of installing a WSN-based surveillance system is choosing the right spots for cameras, DVR etc to maximize camera coverage. Figure 3 showed some of the installed camera at the central administration building area. Figures 4, 5 and 7 showed the installed cameras at the deputy Rector's office while Figure 6 showed one of the cameras installed at the main gate. Figure 8 showed the configuration of DVR network at the main gate.

Figure 3: Camera Installed at the Central Administration Building Area.

Figure 4: Installed Camera at the Deputy Rector's Office.

Figure 5: Installed Camera at the Deputy Rector's Office Walkway

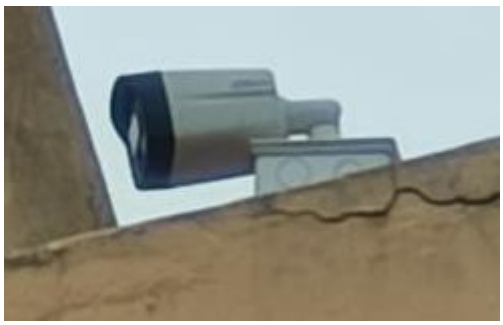

Figure 6: Installed Camera at tha Main Gate.

Figure 7: Installed Camera at the Deputy Rector's Office.

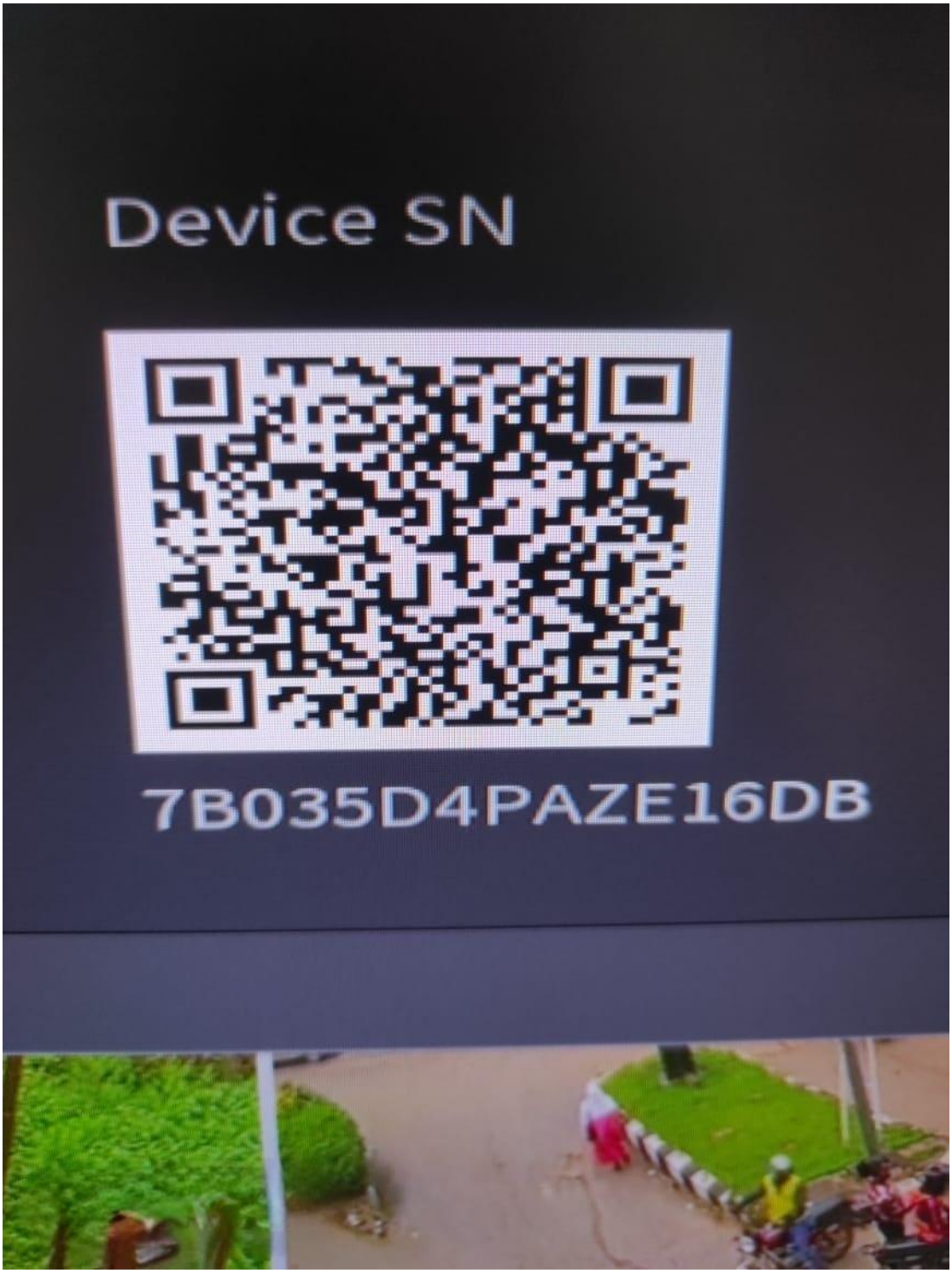

Figure 8: Configuration of DVR Network **At the Main Gate.**

V. RESULTS AND DISCUSSION

(i) Results

After the implementation of the WSN-based surveillance system and other accessories it was tested to ascertain its effectiveness. Figures 9, 10 and 11 showed some of the pictures captured at the main gate, central admin area and the deputy Rector's office area respectively.

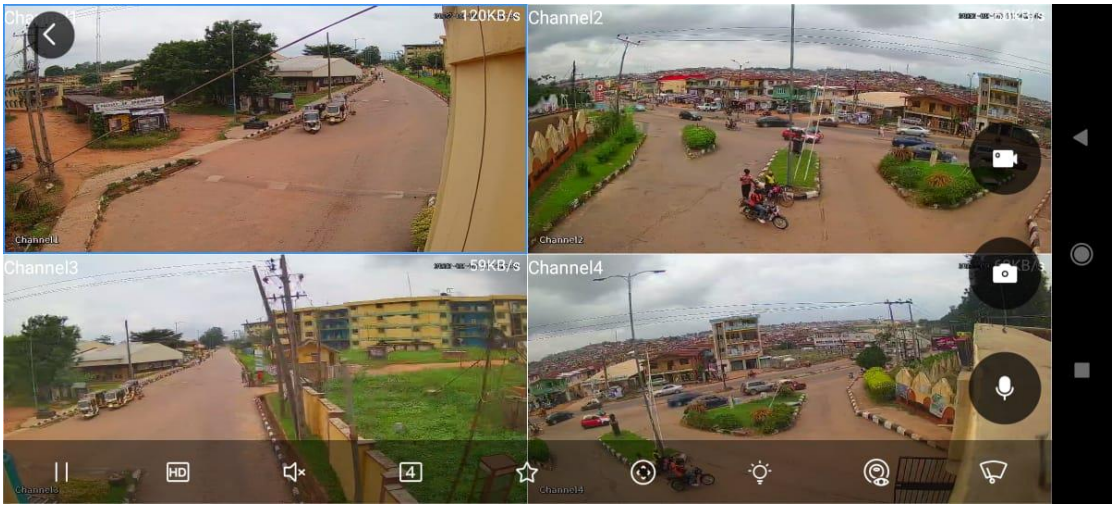

Figure 9: Captured Pictures at the Main Gate

Figure 10: Footage of the Installed Cameras at the Central Admin Area.

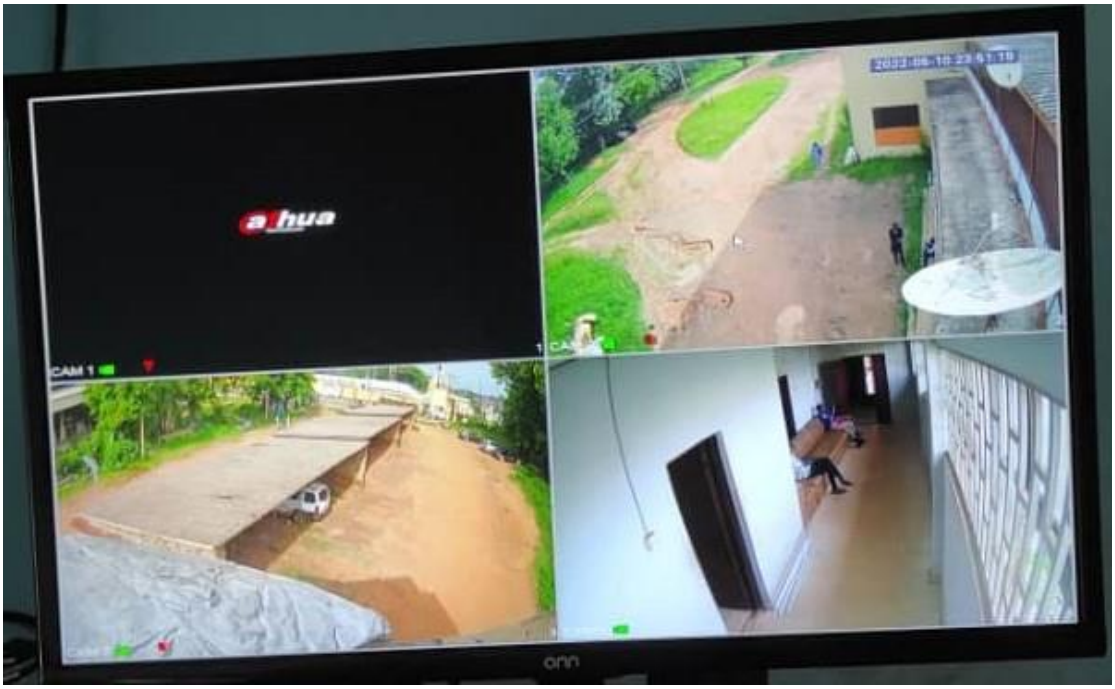

Figure 11: Footage of the Installed Cameras at the Deputy Rector's Office Area.

(ii) Discussion

Whenever there is any intrusion, the WSN detects it and activates the cameras while the cameras capture the events going on at the time. The monitors connected to the digital video recorder (DVR) regularly displays all events taking place around the selected areas for proper surveillance. These events are also recorded to help detect crime and provide evidential materials for court proceedings if need be. There is also a router that transmits the captured events to mobile nodes. Figures 9, 10 and 11 showed some of the pictures captured at the main gate, central admin area and the deputy Rector's office area respectively. The implemented surveillance system worked effectively and according to design specifications because of the following features of the components used especially, the 5 MP, 8 MP cameras and the supported DVR used.

VI. CONCLUSION AND RECOMMENDATIONS

Conclusion

The effectiveness of this project, WSN-based surveillance system has been evaluated in terms of its impact on crime. Doubtlessly, project is one of the most cost-effective ways to ensure that lives and properties are safe. It is implemented at the Polytechnic, Ibadan, Oyo state to ensure safety of lives and properties on campus. This design and its implementation worked according to Specifications. It is simple, effective, easy to operate and maintain. In conclusion, it should be noted that the CCTV system is good for potential crimes and the crimes already committed because the system has a storage unit that keeps tracks of events.

Recommendations

Since the importance of the WSN-based surveillance system cannot be over emphasized, it is recommended that more cameras be installed to cover more areas. Also, rotatory cameras should be used to replace the fixed cameras used, to enhance the effectiveness of the surveillance system.

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REFERENCES

[1]. Christine Ammer (2015): "Security". The American Heritage Dictionary of Idioms. APA (American Psychological Association): Dictionary.com website: http://dictionary.reference.com/browse/security.
[2]. Franck, L. (2001): "Encryption and Cryptosystems in Electronic Surveillance: A Survey of the Technology Assessment Issues". Peggy Becker. Vol. 1, pp 99-106.
[3]. Walker, M. (2008): "Electronic Security Systems", University Press, Cambridge UK. Pp 66-75.
[4]. Ratcliffe, J. (2015): "Video Surveillance of Public Places". Proceeding of the POP Conference.
[5]. Goold, B.J. (2004): "CCTV and Policing: Public Area Surveillance and Police Practices in Britain". Oxford University Press, Oxford.

[6]. Norris, C. and McCahill, M. (2006):" CCTV Beyond Penal Modernism". Brit. J. Criminol., Vol, 46. Pp 97-118.
[7]. Ansong, K.K. and Ofori-Dwumfuo, G.O. (2015): "The use of CCTV in Crime Combating in a Ghanaian University". Research Journal of Applied S ciences, Engineering and Technology. Maxwell Scientific Publication Corp. Pp 1196-1209.
[8]. Farrington, D.P., Gill, M., Waples, S. and Argomaniz, J. (2007): "The Effects of Closed-Circuit Television on Crime, Meta-Analysis of an English National Quasi-Experimental Multi-Site Evaluation". J. Exp. Criminol. Vol.3. Pp 21-38.
[9]. Williams, D. (2008): "Effective CCTV and the Challenge of Constructing Legitimate Suspicion Using Remote Visual Images. J. Invest. Psychol. Offender Profiling, 4(2): 97-107.
[10]. Kokadwar, I., Kukarni, A., Limbhore, V., Khare, S. and Chandurkar, S. (2020): " Camera Based Smart Surveillance System". International Journal of Computer Applications (0975 – 8887) Volume 175 – No.17, PP 20-23.
[11]. Chauhan, R., Ghanshala, K. K. and Joshi, R. C. (2018): "Convolutional Neural Network (CNN) for Image Detection and Recognition". First International Conference on Secure Cyber Computing and Communication (ICSCCC), Jalandhar, India, pp. 278-282.
[12]. Jmour, N., Zayen, S. and Abdelkrim, A. (2018): "Convolutional Neural Networks for Image Classification". International Conference on Advanced Systems and Electric Technologies (IC_ASET), Hammamet, pp. 397-402.
[13]. Haryadi, E. A., Jati, G., Husodo,A.Y. and Jatmiko, W. (2021): "Low-Cost Camera-Based Smart Surveillance System for Detecting, Recognizing, and Tracking Masked Human Face". iJIM – Vol. 15, No. 23, pp 104-119.
[14]. I. S. Areni, A. Waridi, C. Yohannes, A. Lawi, and A. Bustamin, "IoT-Based of Automatic Electrical Appliance for Smart Home," International Journal of Interactive Mobile Technologies (iJIM), vol. 14, no. 18, pp. 204–212, 2020. https://doi.org/10.3991/iji
[15]. N. T. Wei, A. S. Baharudin, L. A. Hussein, and M. F. Hilmi, "Factors Affecting User's Intention to Adopt Smart Home in Malaysia," International Journal of Interactive Mobile Technologies (iJIM), vol. 13, no. 12, pp. 39–54, 2019. https://doi.org/10.3991/ijim.v13i12.11083
[16]. S. Kakarla, P. Gangula, M. S. Rahul, C. S. C. Singh, and T. H. Sarma, "Smart Attendance Management System Based on Face Recognition Using CNN," in IEEE-HYDCON, 2020, pp. 1–5. https://doi.org/10.1109/HYDCON48903.2020.9242847
[17]. L. Rai and Z. Wang, "Software Development Framework for Real-Time Face Detection and Recognition in Mobile Devices," International Journal of Interactive Mobile Technologies (iJIM), vol. 14, no. 4, pp. 103–120, 2020. https://doi.org/10.3991/ijim.v14i04.12077
[18]. G. T. S. Draughon, "Implementation of a Computer Vision Framework for Tracking and Visualizing Face Mask Usage in Urban Environments," in IEEE International Smart Cities Conference (ISC2), 2020. https://doi.org/10.1109/ISC251055.2020.9239012
[19]. A. Negi, "Face Mask Detection Classifier and Model Pruning with Keras-Surgeon," in IEEE International Conference on Recent Advances and Innovations in Engineering—ICRAIE, 2020. https://doi.org/10.1109/ICRAIE51050.2020.9358337
[20]. V. Jain, M. S. Pillai, L. Chandra, R. Kumar, and M. Khari, "Sensor systems CamAspect: An Intelligent Automated Real-Time Surveillance System With Smartphone Indexing," IEEE Sensors Letter, vol. 4, no. 10, pp. 3–6, 2020. https://doi.org/10.1109/LSENS.2020.3019172