Enhancement of Safety and Security of Student's Hostel through Automation Scheme

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ABSTRACT

Creating a safe and secure environment will decrease the chance of security threats, avoid damages caused by fire, and protect the lives and properties of students residing in a hostel. The protection offered by mechanical measures and guards is often not sufficient and reliable. Building automation offers enhanced control of the safety and security of hostels. This paper presents the design of building automation systems capable of detecting and responding to the presence of unwanted hazards such as a rise in temperature above the normal level and preventing unauthorized access to the hostel. The system comprises sensors connected to a programmed PLC, SCADA system that provides real-time status of the sensors placed around the hostel, and a closed-circuit television camera (CCTV) for providing the live display of the activities happening around the hostel. The proposed design if implemented will prevent unauthorized entry to the hostel, provide alerts of suspicious activity and enhance the safety, security, and peace of mind of the students.

KEYWORDS: Building Automation, Hostel, Safety and SCADA.

1. INTRODUCTION

Building Automation System (BAS) is a centralized network of hardware and software components used to monitor and control the electrical devices for safety, security, and comfort in a building, and also, used for energy savings such as light control, Heating, Ventilation, and Air Conditioning (HVAC).

Following the recent attacks in the facilities of some educational institutions in the northeastern region of this country especially, higher education institutions need to provide powerful solutions to protect the lives and properties of students, despite constrained resources. The conventional safety and security system which utilizes locks and security guard is not reliable; the security personnel may be absorbed in other activities at a particular point in time (Ali et al., 2015). This calls for the integration of automation to the student hostels to provide reliable security and safety services to the students' hostels.

The main objective of this paper is to design an automation system for the enhancement of the safety and security of the students' hostel using appropriate technology. In this system, contact sensors, cameras, proximity sensors, and alarms are deployed throughout a building to quickly detect suspicious activities (Arun & Reza, 2015), prevent intrusions, and detect potentially dangerous behavior. Safety devices are also installed to continuously monitor the environment to detect fires, leaks, or other potentially dangerous conditions (Building Safety and Security, 2020).

2. INTRUSION DETECTION SYSTEM

Intrusion detection system is essential in security because when a person has forced entry into a student's room or other building within the hostel (U.S. Department of Veterans Affairs, 2015), an alert is sent to the monitoring station (Manager's office) or security desk to notify them of the time and location of the incident. Security officers respond in person to evaluate the situation. The following sensors were proposed for this design based on their sensing range, detection area and efficiency in detecting the specified change in the parameter.

A Passive Infrared motion detector is the most common security sensor used to detect movement. The PIR is an electronic device that detects and measures a temperature change when someone occupies space under monitoring (Ali et al., 2015). All objects with a temperature above absolute zero degrees emit heat energy in the form of radiation. This radiation is invisible to the human eye, but it can be detected by electronic devices designed specifically for such a purpose. The term "Passive" in this instance means that the PIR sensor does not generate or radiate any energy for detection purposes, but merely passively accepts incoming infrared radiation.

A glass breakage detector can help ensure security in buildings and homes. It is a simple mechanism to detect illegal entry through glass windows and doors of our buildings. The glass break detector works using two different technologies which are acoustic detection and shock detection. Acoustic detection senses the sound of breaking glass and triggered an alarm when a noise occurs that is on the same decibel level as the sound of breaking glass, while a shock detector or surface-mount sensor, senses, and responds to the vibration and shock of breaking glass. These sensors can be used to provide security in our homes or hostels when we are away from home and during night time to alert us on the presence of an intruder trying to access or enter our premises. The glass break detector is to be placed at the edge corner of the window because the sound or vibration of the glass is concentrated more at the edge corner. Certain natural obstacles such as high-speed air and other things must be put into considerations before choosing the right sensor.

To sense illegal access through the doors, during class hours, holidays, and other times when the students are engaged in some particular activities outside the hostel area, an electromagnetic door lock is utilized. Door sensors are magnetic switches that activate an alarm signal when a door is opened after the system is placed in an "armed" mode. They are also commonly called contacts and can be used on windows as well.

To provide surveillance service an Internet Protocol camera, or IP camera is used. An IP camera is a type of digital video camera commonly employed for surveillance, and which, unlike analog cameras; has an embedded video server having an IP address, capable of streaming the video (and sometimes, even audio) and can also send and receive data via a computer network and the internet. IP cameras were proposed because they will allow the authorized person and security divisions to monitor and access the cameras from remote locations over the Internet

3. SAFETY DEVICES

Safety devices considered in this work are those that detect the presence of unwanted hazards in the protected spaces by monitoring environmental changes such as a rise in temperature above the normal level, or changes associated with combustion. These devices include a fire detector, smoke detector, gas leak detector, and water leakage detector.

There are two types of a heat-sensing element in fire detectors; the rate of rise and fixed temperature. Rate-of-Rise (ROR) heat detectors operate on a rapid rise in element temperature of 12° to 15°F (6.7° to 8.3°C) per minute, irrespective of the starting temperature. This type of heat detector can operate at a lower temperature fire condition than would be possible if the threshold were fixed. It has two heat-sensitive thermocouples or thermistors. One thermocouple monitors heat transferred by convection or radiation and the other thermocouple responds to ambient temperature. The detector responds when the first's temperature increases relative to the other. This type of detector may not respond to low energy release rates of slowly developing fires. To detect slowly developing fires combination detectors add a fixed temperature element that will ultimately respond when the fixed temperature element reaches the design threshold. As the temperature of the surroundings rises above a predetermined threshold an alarm signal is triggered and the signal is sent to PLC in which the output will be seen in the monitoring room for immediate action. A heat detector is selected for use in kitchen or utility areas where smoke detectors should not be installed, and the use of a heat detector may not replace smoke detectors in student rooms, common rooms, and corridor of the hostel.

Smoke detectors detect smoke and issues an alarm to alert nearby people of the threat or potential fire (Jane & Nigel, 2002). There are many different smoke detectors based on different mechanisms and designs. Which include: ionization smoke detector, photoelectric smoke detector, and air sampling smoke detector.

A gas detector is a device that detects the presence of gas leakage in an area, often as part of a safety system. Many types of equipment are used to detect a gas leak and interface with a control system so a process can be automatically shut down the gas supply. A gas detector can send an alarm to operators in the area where the leak is happening and allowing them to leave. This type of device is important because many gases can be harmful to humans or animal's life.

A water leak detector is an electronic device that is designed to detect the presence of water in a particular building and provide an alert in time to allow the prevention of water damages against properties. A common design is a small cable or device that lies flat on a floor or above some certain distance from the floor. It relies on the electrical conductivity of water to decrease the resistance across two contacts. The device then triggered an alarm to the control panel or station. These are useful in a normally occupied area near any infrastructure that has the potential to leak water, such as heating ventilation and air conditioning (HVAC), water supply pipes, and water drainage.

4. HOSTEL ACCESS CONTROL SYSTEM

The student hostel usually has many students and visitors; both authorized and unauthorized. The security guard at the reception may not be able to know or identy the bonafide hostel students. thus many cases are reported to the security divisions involving thefts of student's items like computer, tablet, handset, and accommodating outsiders by some students without proper permission from the authority. This is addressed in the designed work as discussed in the following sections

In physical security, the term access control refers to the practice of restricting entrance to a property; a building or room to an authorized person. Physical access control can be achieved through mechanical means such as lock and keys or using an advanced access control system. Lock and key have been used to control access to buildings and rooms for hundreds if not thousands of years. Today, the traditional key-based Lock is still the most popular means used for access control of buildings, rooms, and even commercial spaces. However, electric (or electronic) locks are commonly used nowadays to provide more effective or more secure access control. There are usually three groups of credentials used for access control; Biometric access control, Card access control, PIN access control and, Video telephone. This work proposes card access.

4.1 Card Access Control

Based on the working principles of the cards, they might be grouped into two categories; conventional cards and smart cards. Based on the means of reading the cards, they can also group into two categories: contact cards and contactless cards. Different types of cards are used for access control which comprises Magnetic cards, Wiegand cards, Proximity cards, Smart cards.

4.1.1 Access Control System Components

The conventional access control utilizes a security operator and a lock. The lock is unlocked by a security operator with a key at a given time in the morning and lock in the night. To automate this, operator intervention is replaced by an electronic door and reader. The reader could be a keypad, a card reader, or a biometric reader.

The reader does not usually make an access decision, Access control decisions are made by comparing the credential to an access control list. This look-up can be done by a host or server, or by an access control panel. To monitor the door position a magnetic door switch can be used. In concept, the door switch is not unlike those on refrigerators or car doors. Generally, only entry is controlled, and exit is uncontrolled, free exit, a device called a request-to-exit (REX) is used. Request-to-exit devices can be a push-button or a motion detector. When the button is pushed, or the motion detector detects motion at the door, the alarm is temporarily ignored while the door is called mechanical free egress. This is an important safety feature. In cases where the lock must be electrically unlocked on exit, the request-to-exit device also unlocks the door.

4.2 The Architecture Of The Access Control System

The student's hostel Identification (ID) cards are designed to be used for access control to the hostel and also the same to be applied for other staff and security operators working in the hostel. The card is presented to the reader to read and process the encoded data on the card and send it to the control panel requesting and the command to release the door, if the stored data in the control panel is marched then the access is granted. If the stored data didn't match access will be denied. Figure 1 shows the proposed access control system.

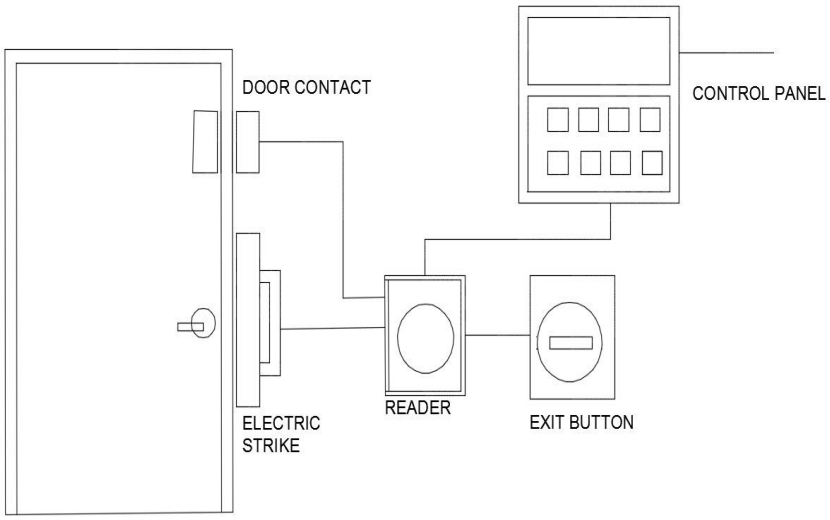

Fig. 1: Card access control system architecture

5. FIRE DETECTION AND ALARM ZONES

5.1 Detection Zones

A hostel should be broken down into smaller compartments to enable quick and early detection of fire. The maximum floor area of a zone should not be greater than 2000 m^2 in a closed plan. A detection zone must not cover more than one story except in a situation whereby the total floor area is less than 300 m^2. The detectors' outputs are connected to the PLC inputs placed closed to the distribution box on every floor.

5.2 Alarm Zones

The alarm zone may cover many detection zones. There must be a gap between alarm zones to ensure alert and evacuation messages are not overheard from adjacent areas. It is therefore important that care should be taken to ensure only one message is heard at any one time particularly where two-alarm zones are attached. Figure 2 shows how the student hostel should be divided into different zones to improve the accuracy and reliability of the detections.

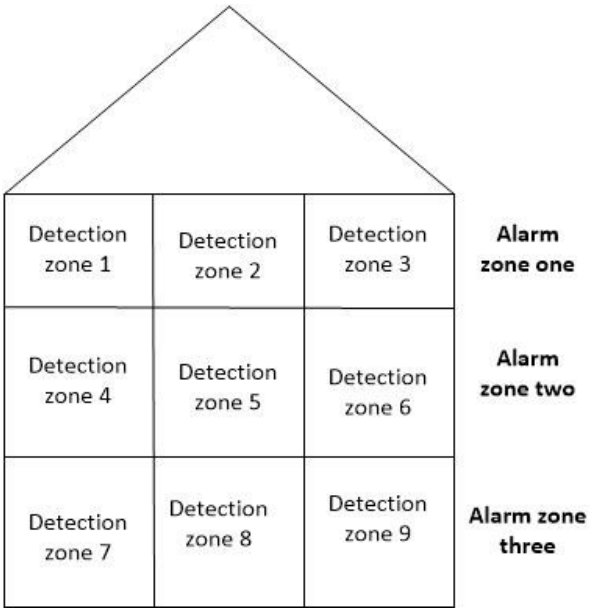

Fig. 2: Detection and Alarm Zones

5.3 Detector Placement

Detector placement is critical to early warning functions. Smoke and fire detectors should be installed in all areas of the protected premises. Total coverage as defined by NFPA 72 should include all student rooms, corridors, common rooms, kitchens, and other places on the ground floor. The manufactures guide is also to be observed and followed accordingly. Under a flat ceiling, the horizontal distance between any protected zone and the nearest detector should not be more than (1) 7.5 m if the nearest detector is a smoke detector (2) 5.3 m if the nearest detector is a heat sensor (Honeywell).

6. THE ARCHITECTURE OF THE AUTOMATION SYSTEM

As shown in fig 3, detectors from every room are connected to a PLC (remote terminal units). The number of rooms on a floor determines the number of RTUs required. The RTUs at each floor are connected using a network switch; the size of the network switch is determined by the number of the remote terminal units on the floor. Another network switch is required to connect all the floors to a master PLC. A switch is a device that connects individual devices (PLCs) on an Ethernet network so that they can communicate with one another.

The IP addresses of the individual PLCs connected are used as an identifier for easy communication among the devices in the network. The Internet Protocol is a Network Layer protocol that contains addressing information and some control information that enables the packet to be routed. The 32-bit IP address is grouped 8 bits at a time, separated by full stops (‘dots’), and represented in a decimal format called dotted decimal notation. Each bit in the octet has a binary weight (128, 64, 32, 16, 8, 4, 2, 1). The minimum value for an octet is 0, and the maximum value for an octet is 255.

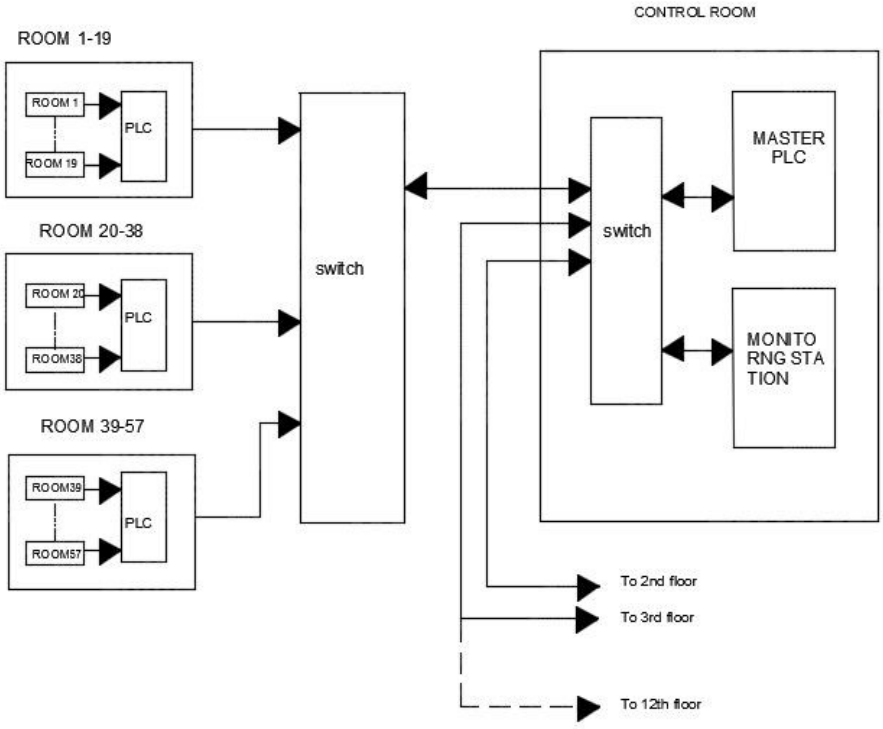

Fig. 3: The Architecture of the Automation System

6.1 PLC Programming

The PLC program is written using RSLogix 500 software. The RSLogix is developed by Rockwell Automation and is compatible with Allen Bradley PLCs. Fig 4 and 5 show the ladder program used. In the ladder program, the safety sensors are connected in parallel to reduce the number of inputs to the PLC hardware and separate connections for security sensors are implemented for each room. One safety indicator and one security indicator is used.

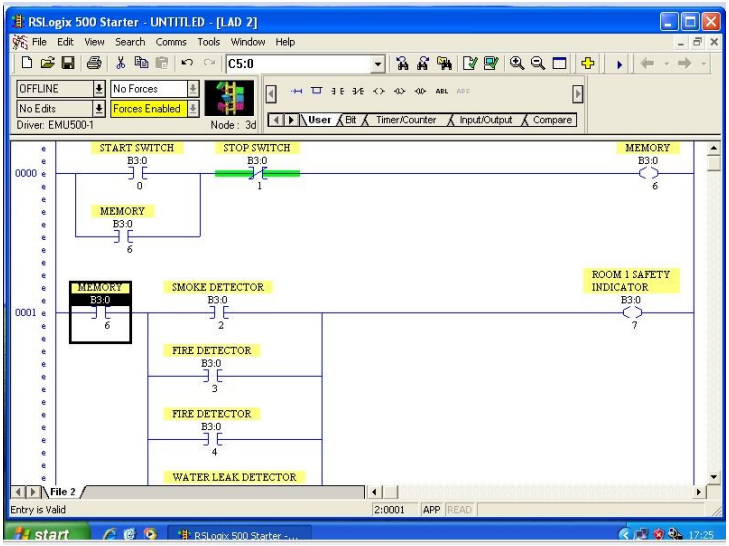

Fig. 4: Ladder programming 1

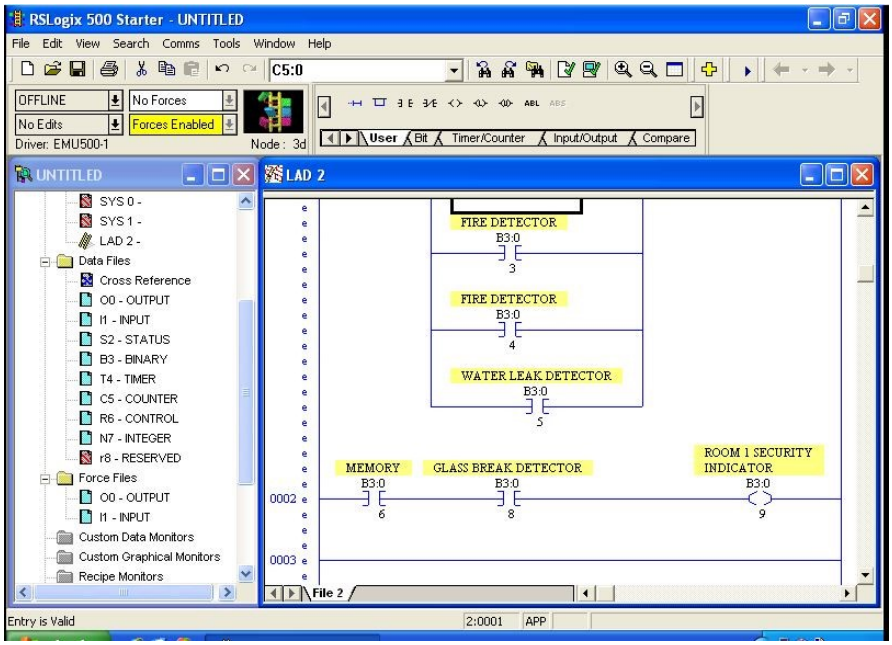

Fig. 5: Ladder programming 2

6.2 SCADA Software interface

FactoryTalk View Studio is the configuration software used for developing the SCADA application. FactoryTalk View Studio contains editors for creating complete applications and the software for testing the applications you create. You can also use FactoryTalk View Studio to set up FactoryTalk Security services for the applications you develop.

The SCADA interface designed has a welcome menu from which one can navigate to the floors menu and rooms menu. By clicking on a room on a particular floor, another panel opens to indicate the status safety and security detector in the room. Figure 6 shows the welcome menu while figure 7 shows the SCADA Panel of a single room, where the safety and security indicators have been shown.

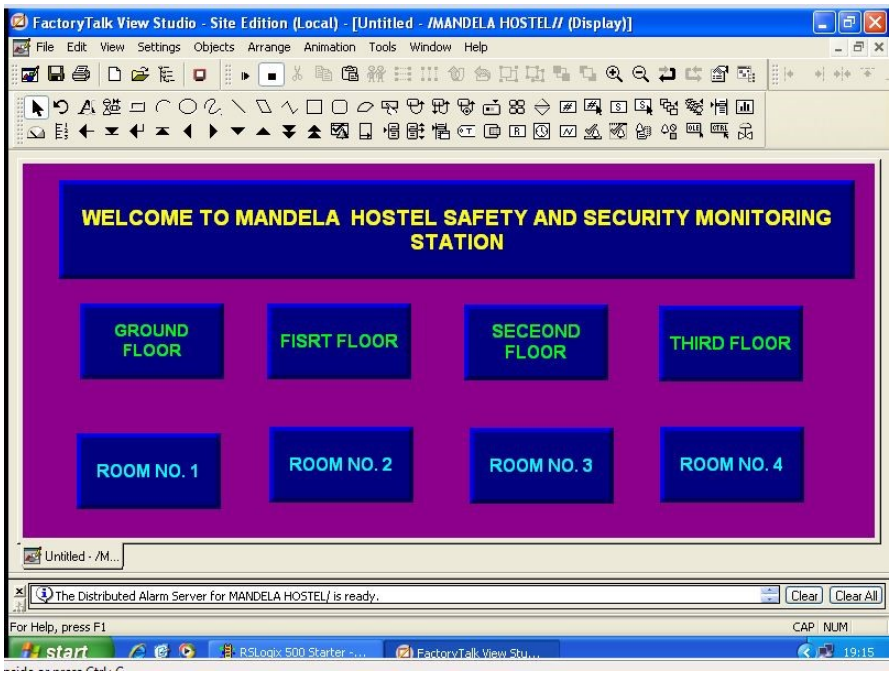

Fig. 6: Welcome Menu

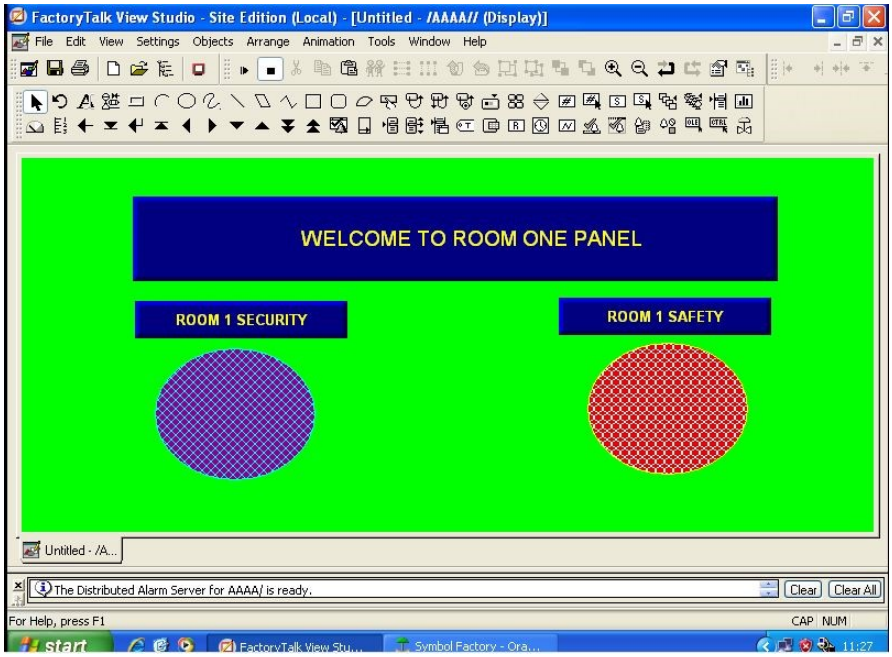

Fig. 7: Room Menu

7. CONCLUSION

This paper considers an automation system for the enhancement of the safety and security of students' hostel. We considered intrusion detection system, safety/hazards detection system, access control system using the students' hostel ID/Cards as credentials for getting entry to the hostel, and CCTV cameras installed at various places in the hostel to

provide real-time surveillance of the hostel area from a remote place. These different parts are connected to PLCs for data acquisition and monitoring through the SCADA interface designed to provide the operators real-time status of the sensors placed at various points around the building. The proposed design if implemented will prevent unauthorized entry to the hostel and protect the lives and properties of the students.

REFERENCES

Ali, M. H., Rahman, A. M., Kamaruzaman, F., & Shafie, A. A. (2015). Automated Secure Room System . *2015 4th International Conference on Software Engineering and Computer Systems (ICSECS)* (pp. 73-78). Kuantan, Pahang, Malaysia: Research Gate.

Arun , C. J., & Reza, M. (2015). Smart Home Automation Security: A Literature Review. *Smart Computing Review, V*(4), 269-285.

Building Safety and Security. (2020, september). Retrieved from ST life.augmented: https://www.st.com/en/applications/home-building-and-city-automation/building-safety-and-security.html

Honeywell. (n.d.). *Fire Detection System: Pocket Design and Installation Guide.*

Jane, B., & Nigel, B. C. (2002). *Health and Safety In welding And Allied Process* (5th ed.). Woodhead Publishing Series in Welding and Other Joining Technologies.

Microsoft. (n.d.). Smart and secure campus.

U.S. Department of Veterans Affairs. (2015). *Physical security Design Manual For Life Safety Protected Facilitie.*