

# A New Development Approach of Intelligent Monitoring System for Library Patrons Behavior Based on University Regulations

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## Abstract

The modern technology of video surveillance systems has proved to be the best solution in direct supervision of property, individuals, and the environment. This article addresses the design approach of a smart surveillance system for university library to ensure compliance with library usage rules. The solution proposed for the surveillance system depends on innovative integration of intelligent algorithm, cameras and motion detectors in the web application. An algorithm was created according to the instructions of attending the university library of Al-Nahrain University. This algorithm has the ability to analyze video and extract the effectiveness that does not comply with the library's rules and regulations that the student can do in the library. The PX1-C415 Single Board Computer type is programmed with a smart algorithm and integrated with motion detectors and video cameras to create the proposed system. It has ability for detection, processing and rapid response through capturing images and transferring them to a wireless module on the administrative desk and thus activating the alarm system. The accuracy of the detection algorithm used was 91% for a distance of 1-5 meters. In addition, the admin received the violations with accuracy of 93%. The proposed system offers a perfect solution that is accurate, fast and scalable to support comprehensive and economical monitoring.

**Keywords:** Embedded System; PX1-C415 SBC; Surveillance System; Libraries Rules; Motion Detection.

## 1. Introduction

As consequence of the low cost of video surveillance equipment, the demand to protect and monitor wide area has increased. In contrast to the use of other technology where location monitoring is expensive, embedded systems offer flexible, low-cost and high-resolution solutions in many applications. Therefore, PX1-C415 built-in device as SBC was used as a basis for building a student behavior control system in the university library. [1] [2].

The university and public libraries have rules and conditions that compel their visitors to comply with them in order to provide the required calm for students to read and study. Therefore, the administration of the university library has set conditions such as not eating and drinking, not using the mobile phone, and any behavior that may bother others. These conditions have been used as a basis for building a smart surveillance system for public or university libraries.

In this research, from a practical point of view, PX1-C415 single board computer was adopted with wireless internet to build the system. While from the software side, PX1-C415 has been programmed with an intelligent algorithm that can diagnose the individual and determine the type of rejected cases he or she is doing in the library. Thus reproducing and documenting the images of rejected cases in a special place in the memory of the device. In addition to sending a warning to the employee who oversees the library, the proposed system has the potential to remotely administer and monitor libraries. The scarcity of research on solutions to such a problem, so construct a special algorithm and linking it to artificial intelligence is one of the new solutions to this problem.

The proposed system can be adapted to work in different fields, such as monitoring patients in hospitals, monitoring and managing seminars, observing celebrations, meetings, etc.

## 2. Research motivation and objectives

Preserving the conditions for reading and studying at libraries has attracted the attention of administrators of library management to encourage students to take advantage of reading and browsing time. Integrated systems are therefore the best choice to provide this environment; the motivation can be classified as follows:

- Ensuring calm and order in libraries.
- To dispense with human monitoring and limit its role by scrutinizing and preventing violations.
- Intelligent and cheap control system for large spaces.

Through this research, embedded systems will be evaluated for the level of performance, effectiveness and accuracy of the proposed application and similar applications. The proposed system must include an algorithm that can be developed, analyzed and control a number of cameras at the same time.

This can be done through a major program that manages and supervises all cameras, while the secondary program collects video images, data analysis and ordering. The current surveillance systems that use cameras are video or wireless video transmission systems to surveillance screens, where a number of security staff monitors the screens around the clock. The process of surveillance by security is cumbersome for them and therefore the possibility of an incoming security breach.

The objectives of research are to design a smart surveillance system that can maintain the system in the libraries through which this system earns a large role in encouraging students to go to libraries. For this purpose, this research has the following methodology:

- 1) Implement a new and smart algorithm for the restrictions imposed by each library separately.
- 2) Design and development of intelligent surveillance system using a single-board computer.
- 3) Finally, evaluate the performance of the system.

### 3. Literature review

Currently, researchers and developers have produced many surveillance systems used in monitoring of activities related to profitable products or search platforms. Khandavalli M. A. and Katakala K., in 2014, present the integrated video acquisition and motion detection system. This system is based on ARM9 processing chip to implement an integrated web monitoring system. The researchers' work was characterized by the development of a control system that uses high performance embedded processors to manage key control, compression and web processing tasks. Besides the fact, that the proposed system has high stability and low cost. However, his work was not considered a reaction to unusual events [5]. By reducing the cost of motion recognition, the research team Padmashree A. S. and Sumedha S. B. (2014) introduced a new embedded home monitoring system. They worked on cheap implementation in price, low power consumption and Take good advantage of the resources and effective monitoring system using a range of different sensors. The microcontroller was used in home monitoring which is considered to be limited in capacity with SBC [6]. Uday Kumar et al. (2014) research team has been provided design of remote surveillance system using SBC IP and 3G dongle. The researcher was successfully implemented low cost wireless image acquisition system [7]. The ARM core was selected as a main processor for a low cost surveillance system produce by Jadhav, G. J. (2014). Various sensors are used to detect motion and vibration in the field of vision. The detection technique based PIR sensor is proposed, which detects the intruder and activates the alarm system. When the alarm system is activated, a short message service via the GSM module is send to a specific telephone numbers. To make the system more secure and difficult to penetrate, the system must operate with different types of databases [8]. Mahima F. C. and Gharge A. P. (2015) Design of video surveillance systems The proposed system is flexible in mobility and cost-effective. Where, these qualities are one of the goals sought by the researchers, which produces integrated security solutions. This system can be used in all industrial or military applications [9]. Sneha Singh et al (2015), employed the IP video camera and face detection algorithm to design an embedded system based Raspberry Pi. The implemented system enables live video streaming along with disclosure of human faces. Surveillance details were not included in this study [10]. A smart surveillance system based on PIR sensor and SBC is developed by Sanjana Prasad et. Al (2014). In this work, portable technology has been used to develop a surveillance system that provides vital security for our daily life. The goal of research team is to develop a home security system for smartphones based on an information acquisition module combined with a 3G technology transmission module. The proposed system has ability to detect, record, and determine the number of objects in the sight. [11]. another research group represented by D. Gefandand et al., in 2014, they designed a video capture system using Raspberry PI. The system distributes the video to the systems connected to the network,

besides notifying the administrator through the SMS alarm. The design has been proposed to work in elevators, accommodation and others, as these applications need a strong and effective control system and consume a simple capacity [12].

M. Takamatsu et. Al researchers team, have developed a new way to achieve stereoscopic vision using many images, where a stereogram can be created using a normal digital camera. The method provides for capturing one image, then the objects appearing on the image are fragmented, and a convex body is calculated for all areas of the object; our stereoscopic vision is created taking into account the foreground or background with interference between convex body and region. [13]

M. Hmaid et al. proposed design approach for Intruder Detection based Raspberry Pi SBC. Their research is focused on developing a surveillance system that detects strangers and to response speedily by capturing and relaying images to admin office based wireless module. [14]

J. Landa, C. Jun and M. Jun research team focus on family security issue which it is one of the key goals of a digital home system. they show the present, webcams weak points when used at home remote monitoring systems. This is due to the fact that its passive monitoring nature leaves a potential security problem and cannot be used for providing proactive security. To solve this problem, this paper proposes the design of a remote embedded intelligent security monitoring system based on the background modeling algorithm in computer vision which can proactively detect intruders. The system uses the ViBe algorithm to model the background image which is acquired from the camera, and then carries out the object detection in the monitored environment. [15].

### 4. Research scope

According to previous research, video surveillance systems cannot determine the behavior of the student or the person in the library hall. In this research a smart algorithm that can distinguish a person's behavior and effectiveness within the library hall .Where it is designed based on library administration rules to distinguish the situation that exceeding the library rules. The system consists of PX1-C415 SBC, wireless transmission unit, camera and motion sensors.

### 5. Brief methodology

The proposed system is characterized by three main work mechanisms: the detection, monitoring of irregularities and image storage, and the alert mechanism. The tasks of each mechanism can be summarized in Figure 6. The system will pre-load definitions of activities that violate library instructions such as eating, drinking, using a mobile phone, and any behavior that may bother others.

#### 5.1. Design hardware

PX1-C415 single board computer (SBC) is used as embedded system for control, monitoring and security. It's new generation of Winsystems company (as shown in figure 1 and 2) and it has the following features: small size, Intel Apollo Lake-I (E3900) Processor 2GHz , 8 GB RAM, multiple Displays Supported, USB Type C 3.0, 24 GPIO, 4 Serial Ports, Intel i210 LAN controller, +10 to 30V DC power supply, and compatible with Linux, Windows. SD Card is the storage space, memory unit that is used for Operating system, booting task. The memory size is 64 GB of Flash M.2 SSD. [2]

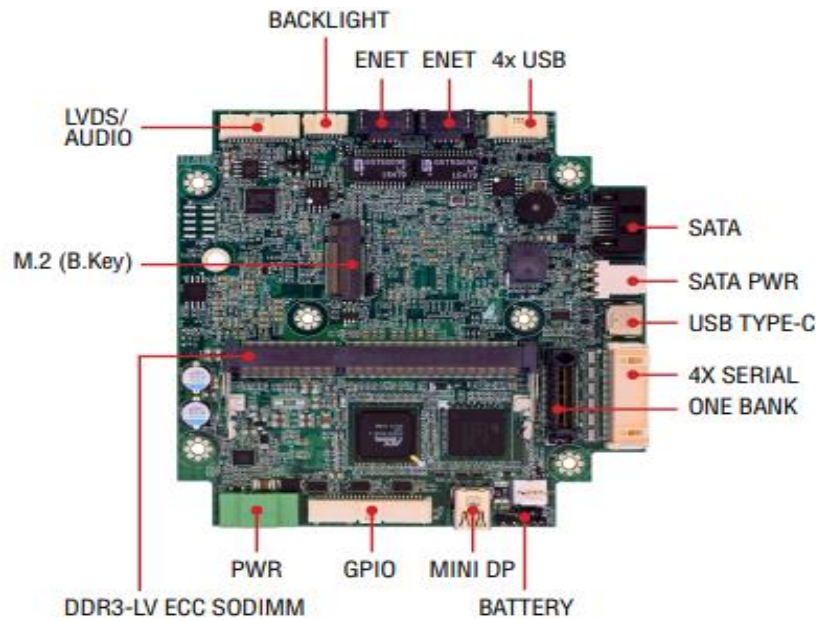


Fig. 1: Connectors of PX1-C415 SBC [2].

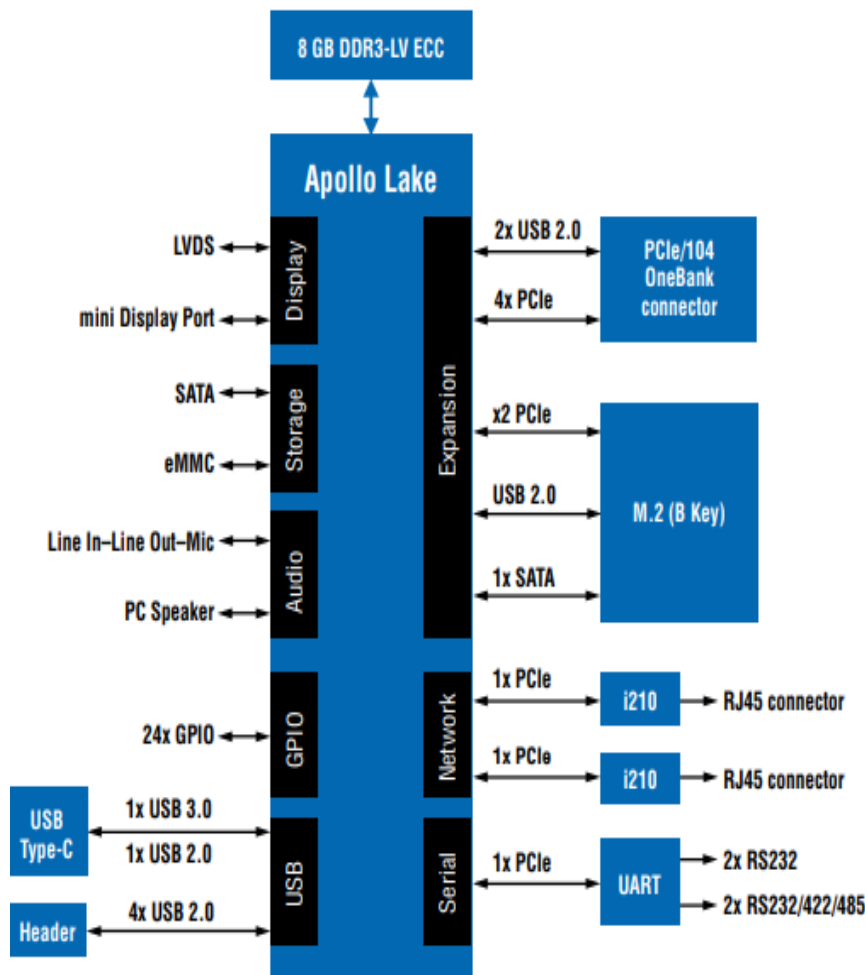


Fig. 2: Block Diagram of PX1-C415 SBC [2].

5.1.1. IP security camera

An IP camera is transmits a digital signal using Internet Protocol over a network and have the following features: [3] [4]

- High resolution and scalability,
- Built-in video analytic software,
- Better system management than analog cameras, and
- Resolutions from VGA to 29 Megapixels

5.1.2. Wireless passive infrared sensor

PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range (figure 3). They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they are commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors. PIR sensor detects

a human being moving around within approximately 10m from the sensor. This is an average value, as the actual detection range is between 5m and 12m. PIR are fundamentally made of a pyro electric sensor, which can detect levels of infrared radiation. For numerous essential projects or items that need to discover when an individual has left or entered the area. PIR sensors are incredible, they are flat control and minimal effort, have a wide lens range, and are simple to interface with.



Fig. 3: Motion Detection Sensor.

### 5.2. Software design

The propose system is based window operating system as a software platform. It consists mainly of different functional modules figure 4, as follow:

Video Recording module: its start recording when interrupt signal is received from PIR sensor.

Image processing module: It is responsible for the extraction of the prohibited images according to the entry rules of the library.

Transmission module: used to transfer the image to the main supervision system of the administrator via wireless communication means.

The physical objects of the library surveillance system are formatted using C language. The work of the proposed system can be summarized in the stages shown in figure 5.

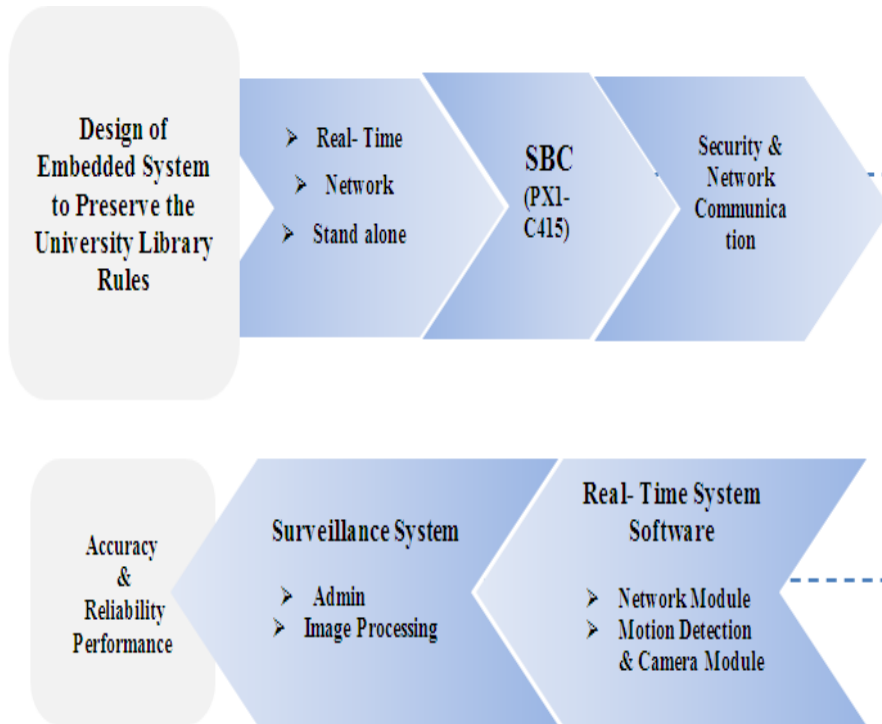


Fig. 4: Surveillance Embedded System Module.

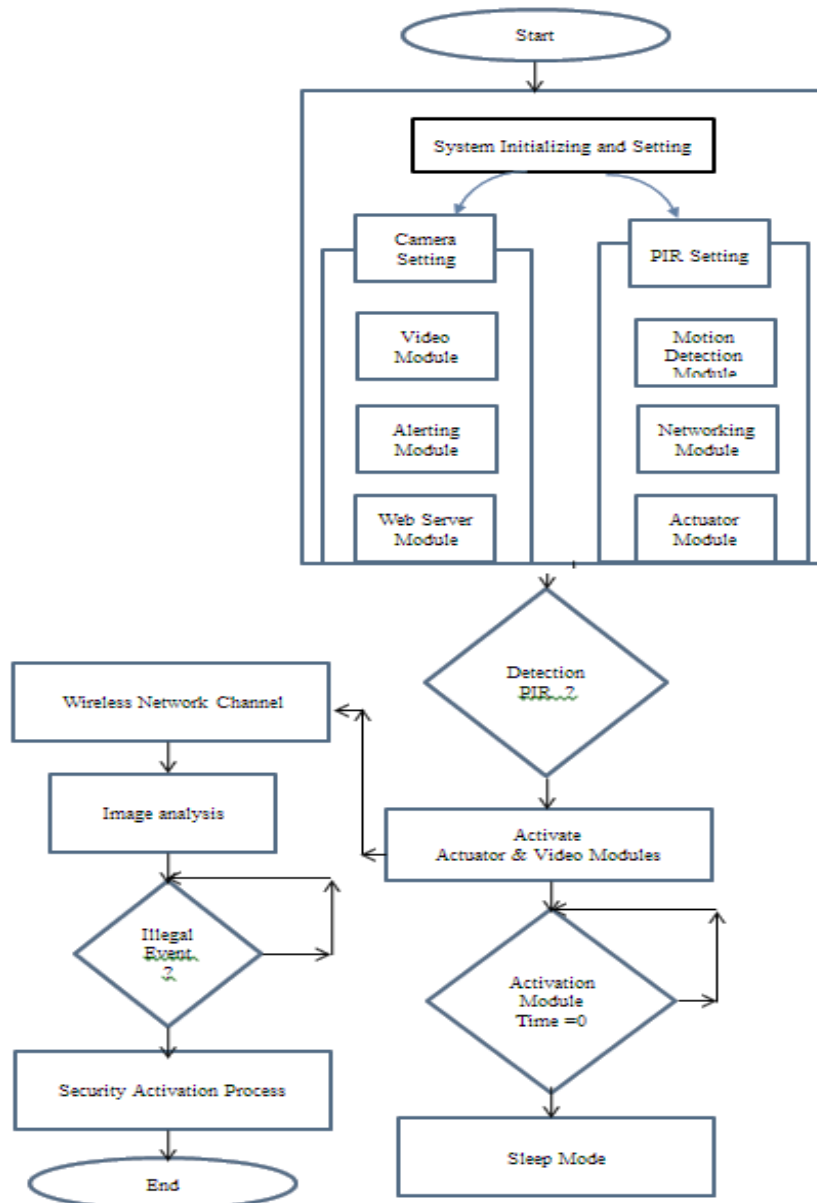


Fig. 5: Flowchart Processes of Proposed Surveillance System.

## 6. Results

In this paragraph, the results of the initial trials will be analyzed and discussed. In order to evaluate the performance of the proposed design, the experiments were divided into four sections. The first section shows the ability of the system to detect students' entry to the library. The second section is responsible for passing the detection signal to the main processor for analyzing it and issuing camera operation commands to start recording video. A figure of experiments was conducted on the students and staff of the library where the results showed the efficiency of the system in terms of detection. The analysis of the results was manifested by the distinction between the student and the employee. The ac-

curacy ratio was 91% for a distance of 1-5 meters. This indicates the accuracy of the detection algorithm. The third section has experiments on the capture and analysis of images according to the algorithm that was built on the basis of the laws of the library. The results of the third section of the experiments showed 90% accuracy in catching the students' illegal cases. The last section, focused on the examination of wireless transmission of signs of irregularities and receipt by admin. The accuracy of the last section of the results often depends on the accuracy of the stage that preceded it and thus the results were excellent and accuracy of 93%. Figure 6 and 7 shows the results of the experiments conducted on the surveillance system.

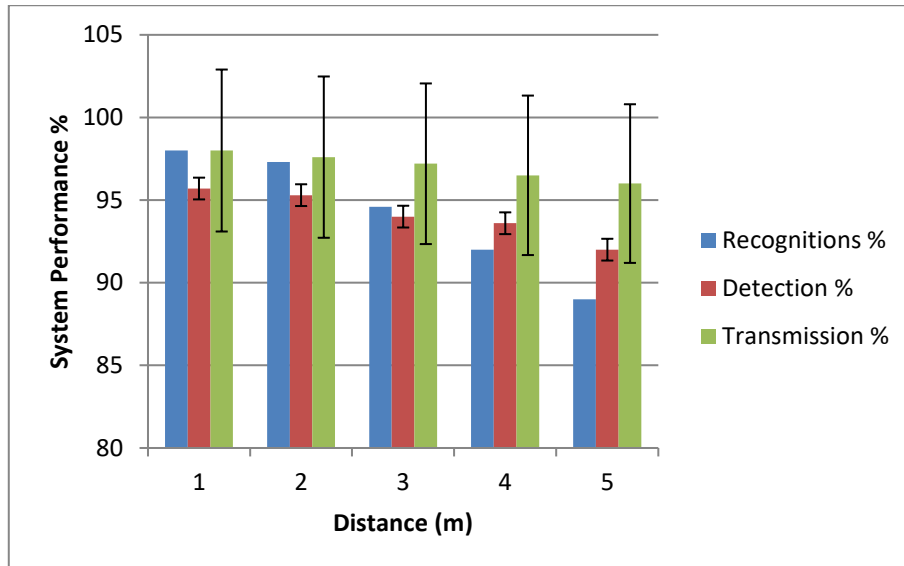


Fig. 6: Shows Proposed System Performance Included Recognition, Detection, and Transmission for 1- 5 Meter Distance.

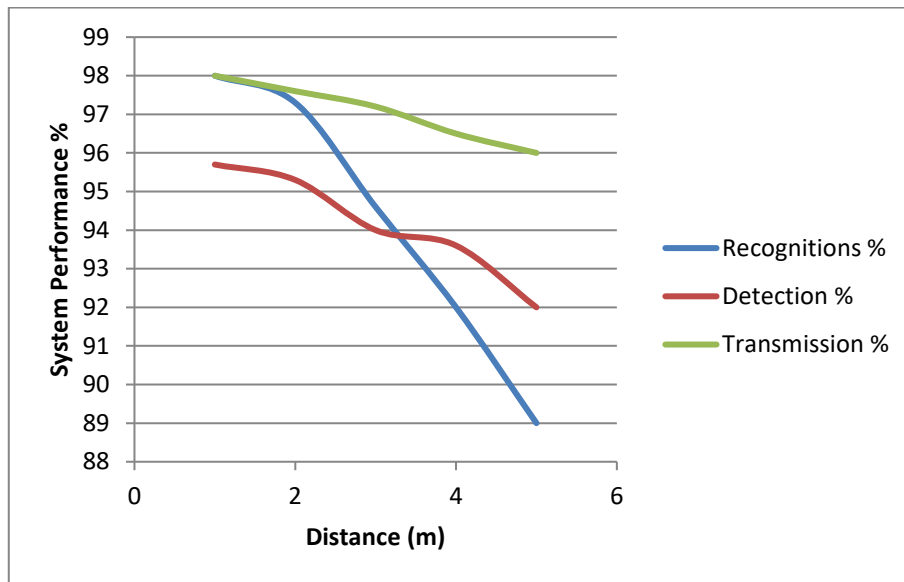


Fig. 7: Various Distance Effects on the System Performance.

### 7. Conclusion

An intelligent surveillance system was introduced to detect and track the illegal conduct of students in the University Library. Illegal behavior has been restricted to pre-determined conditions by the library administration. So these conditions are formulated with an algorithm in the SBC. The main components of the hardware and software modules are determined. This research focuses on the design and implementation of a cost-effective solution that can maintain the library hall as a suitable place to study by observing students and determining the source of noise that a student can issue. Human susceptibility is limited in follow-up monitoring for long hours, so surveillance systems based on analysis of video data are more efficient in the field of surveillance and detection. The accuracy of the detection algorithm was 91% for a distance of 1-5 meters. The experiments of capturing and analyzing of images according to the algorithm that was built on the basis of the laws of the library was showed 90% accuracy in catching the students' illegal cases. Supporting the proposed system with a smart algorithm has many benefits, such as saving energy by producing an alarm signal only to illegal events that appear suddenly. Consequently, the efforts of library staff reduce and ensure continuous monitoring.

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