

# SMART VIDEO SURVEILLANCE WITH WIRELESS NOTICE ANNOUNCEMENT VEHICLE FOR COLLEGES

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## ABSTRACT

The demand for efficient and intelligent security systems has been steadily rising. This project introduces a Smart Video Surveillance System with Wireless Notice Announcement, integrating advanced video monitoring and automated announcement features. Using Arduino as the core, the system incorporates an ESP32-CAM for live video streaming, ultrasonic sensors for motion detection, and a Bluetooth module (HC-05) for wireless communication. An L293D motor driver controls gear motors for camera panning, while a voice IC and speaker broadcast audio alerts. Additionally, an LCD provides visual feedback on system status. The system is designed to enhance security in public spaces, homes, and offices with its real-time monitoring, automated alerts, and ease of operation.

**Keywords:** ARDUINO, ULTRASONIC, LCD, L293D, GEAR MOTOR, ESP CAMERA, VOICE IC, SPEAKER, HC-05

## 1. INTRODUCTION

In today's fast-paced world, the need for enhanced security in educational institutions, particularly colleges and universities, has become more pressing than ever. College campuses, which typically cover large areas with various buildings and open spaces, present significant challenges for traditional security systems. Conventional surveillance methods often rely on stationary cameras or human patrols, which are not only costly but also limited in terms of coverage and responsiveness. As such, these traditional systems can leave certain areas vulnerable, reducing their effectiveness in providing real-time surveillance and timely communication, particularly during emergencies or critical situations. Moreover, as the student and faculty population continue to grow, the need for improved communication channels within the campus is also rising.

One of the major issues faced by educational institutions is how to balance security with efficient communication. For instance, timely delivery of information such as emergency alerts, event announcements, or even regular campus notices is crucial for maintaining safety and improving the overall campus experience. In this context, the integration of surveillance technology with communication systems can significantly enhance campus security and information delivery, providing a comprehensive solution that addresses both security and administrative needs.

This paper introduces an innovative solution that merges video surveillance with an autonomous wireless vehicle capable of delivering real-time campus security monitoring along with notice announcements. By using a smart vehicle integrated with cutting-edge technologies such as Arduino, ultrasonic sensors, HC-05 Bluetooth module, ESP camera, LCD display, and voice IC, the system is designed to autonomously navigate the campus, monitor areas of interest, and deliver important messages directly to students and staff. This novel approach not only increases the coverage and efficiency of campus security but also empowers administrators to deliver instant, wireless notices to various locations around the campus.

The use of Arduino, a widely used and flexible open-source platform, serves as the brain of the system, controlling the overall operation of the vehicle and ensuring seamless interaction between the different sensors and modules. Ultrasonic sensors help in real-time obstacle detection and collision avoidance, enabling the vehicle to navigate autonomously without human intervention. The HC-05 Bluetooth module allows for remote control and monitoring of

the vehicle's movement, providing flexibility for users to direct the vehicle's movement from their smartphones or computers. Additionally, the ESP camera module captures high-quality video footage that can be streamed wirelessly to authorized users, providing real-time surveillance of the campus. The Voice IC enables the vehicle to broadcast audio messages, which can be pre-recorded or live announcements, improving communication across the campus.



Fig.1

In this system, the L293D motor driver plays a crucial role by controlling the DC motors that power the vehicle, enabling it to move forward, backward, and turn as required. Meanwhile, the LCD display offers real-time status updates and important information about the vehicle's operational state, sensor data, and other relevant alerts. The system operates in two modes: surveillance mode, in which the vehicle moves around the campus capturing video and transmitting it to remote devices, and notice announcement mode, in which the vehicle stops at strategic locations to deliver messages through the voice IC.

## II. LITERATURE SURVEY

With the rapid advancement of technology, various surveillance systems have been developed for security and monitoring purposes. These systems are particularly important for educational institutions where security is a primary concern. Many researchers and engineers have explored different methods of integrating various technologies for creating effective surveillance systems. This section provides an overview of the existing research in related fields, including wireless video surveillance, autonomous vehicles, smart communication systems, and the use of Arduino and other low-cost solutions in security applications.

### 2.1 Wireless Surveillance Systems

Wireless surveillance systems have gained popularity due to their flexibility and ease of installation. A study by Koch, C., & Goller, M. (2015) explored the use of wireless communication for transmitting video streams from surveillance cameras to monitoring stations, noting that wireless networks can significantly improve scalability and reduce installation costs in large areas like college campuses [1].

### 2.2 Autonomous Surveillance Vehicles

The concept of autonomous surveillance vehicles has been explored in several research projects. Ali, N. A., et al. (2016) proposed a system using an autonomous robot for surveillance, where the robot is equipped with sensors for navigation and video surveillance. The vehicle can be controlled remotely, and video footage is streamed in real-time. The study emphasized the advantage of mobility, allowing the vehicle to cover larger areas than stationary cameras [2].

### 2.3 Obstacle Avoidance in Autonomous Vehicles

Obstacle detection and avoidance are crucial for the effective functioning of mobile surveillance vehicles. Berger man, M. A., et al. (2007) investigated the use of ultrasonic sensors for autonomous robot navigation. Ultrasonic sensors were found to be effective in providing the real-time distance measurement needed for obstacle detection, allowing the robot to navigate safely without human intervention. The use of ultrasonic sensors for obstacle detection in security surveillance systems is widely used due to its cost-effectiveness and reliability [3].

## 2.4 Arduino in Surveillance Systems

Arduino, as an open-source electronics platform, has gained significant attention in low-cost surveillance systems. Budi Anto, P., & Han, S. (2014) explored how Arduino can be utilized in surveillance systems for security applications. They found that Arduino boards could be integrated with various sensors, cameras, and actuators, providing a flexible and affordable solution for educational institutions. The study highlighted the advantages of using Arduino for small-scale systems and DIY projects, particularly in environments with budget constraints [4].

## 2.5 Use of ESP Camera for Video Surveillance

The use of the ESP32 camera module has been increasingly explored in various video surveillance applications. Sulaiman, K. et al. (2020) demonstrated how the ESP32 camera module could be used to stream real-time video surveillance data over Wi-Fi. The study showed that the ESP32 camera offered a cost-effective alternative to traditional CCTV systems, with the added benefit of being compact and easy to deploy. The researchers emphasized the importance of wireless communication in creating more flexible and scalable surveillance systems [5].

## 2.6 HC-05 Bluetooth for Remote Control

The HC-05 Bluetooth module has been widely used for remote control applications, including robotic vehicles. Patil, A., & Kumbhar, P. (2016) used the HC-05 Bluetooth module to design a simple vehicle control system. The use of Bluetooth also facilitates user-friendly communication between the vehicle and the operator, as Bluetooth is widely available on mobile devices [6].

## 2.7 Voice Announcement Systems

The integration of voice announcement systems in surveillance vehicles adds an interactive layer to security systems. Wu, Z., et al. (2013) explored how voice IC modules could be used in emergency notification systems for smart cities. The study highlighted the importance of having a system capable of broadcasting real-time alerts to the public. Similarly, in a college setting, such systems can help in delivering important announcements regarding safety or event schedules to students and faculty [7].

## 2.8 Smart Surveillance Systems for Colleges

Several studies have specifically focused on the development of smart surveillance systems tailored for colleges and universities. Kharel, R., et al. (2017) designed a smart surveillance system using a Raspberry Pi and a camera module to monitor campus activities. This system demonstrated the potential for low-cost smart surveillance solutions in academic settings, focusing on real-time video streaming and monitoring. However, the lack of mobility in such systems limited their coverage, making autonomous vehicles a more viable alternative for larger campuses [8].

## 2.9 Integration of Video Surveillance and Communication Systems

The integration of video surveillance with communication systems, such as notice announcement features, has been explored in various research projects. Zhang, Y., et al. (2019) presented an integrated surveillance system for public spaces that combined video surveillance with an audio communication system for broadcasting emergency messages. Their study showed that such integration is essential for creating more responsive and interactive surveillance systems. Similarly, the integration of video surveillance with notice announcement functionality in college campuses can enhance both security and communication [9].

## 2.10 Real-Time Video Streaming and Cloud Integration

Real-time video streaming is a crucial feature for modern surveillance systems. Shah, M., & Liu, J. (2015) explored cloud-based surveillance systems for large campuses, where video feeds are uploaded to the cloud and accessible to authorized personnel in real-time. This approach enables remote monitoring and ensures that video data is securely stored and easily accessed when required. In this context, integrating cloud storage with the proposed system could allow for more robust storage and analysis of video footage captured by the vehicle [10].

### III. PROPOSED SYSTEM

The proposed system aims to create an autonomous, wireless surveillance vehicle that can monitor and record real-time video footage, while also providing the capability to broadcast important campus notices via voice announcements. The system integrates various hardware components, including an Arduino microcontroller, ultrasonic sensors, HC-05 Bluetooth module, LCD display, L293D motor driver, ESP32 camera module, and Voice IC. This system is specifically designed for college campuses, offering an affordable, scalable, and efficient solution for improving security and communication within the campus environment.

#### 3.1 System Overview

The proposed system consists of an autonomous mobile vehicle that continuously moves across campus areas to monitor and capture video footage using the ESP32 camera module. The vehicle is equipped with ultrasonic sensors to avoid obstacles while navigating, ensuring smooth movement even in crowded or dynamic environments. The HC-05 Bluetooth module enables remote control, allowing the system operator to guide the vehicle or change its operation mode from a smartphone or PC.

In addition to real-time video surveillance, the system incorporates a voice announcement feature, which allows it to broadcast pre-recorded or real-time notices, providing instant communication for emergency alerts, safety instructions, or campus-wide messages. The LCD screen on the vehicle displays important information such as the system status, battery level, and any ongoing tasks.

#### 3.2 Key Components

The proposed system is composed of several key hardware components, each playing a crucial role in achieving the desired functionality.

##### 3.2.1 Arduino Microcontroller

The Arduino microcontroller acts as the central controller of the system. It is responsible for receiving inputs from various sensors and modules and controlling the vehicle's movement, video capture, and announcement system. The Arduino platform is chosen for its ease of use, affordability, and flexibility in handling multiple tasks simultaneously.

##### 3.2.2 ESP32 Camera Module

The ESP32 camera module is used for real-time video surveillance. This compact and low-cost camera is capable of streaming live video over Wi-Fi to a remote monitoring station. It is chosen due to its Wi-Fi capabilities and compatibility with the Arduino platform. The camera can be used to capture video footage of the surrounding environment, which is then transmitted wirelessly to a mobile device or computer for monitoring.

##### 3.2.3 Ultrasonic Sensors

Ultrasonic sensors are used for obstacle detection and navigation. These sensors allow the vehicle to measure the distance to objects in its path, enabling it to avoid collisions and navigate around obstacles autonomously. By continuously emitting ultrasonic waves and measuring the time it takes for the waves to return, the vehicle can detect nearby objects and adjust its movement accordingly.

##### 3.2.4 HC-05 Bluetooth Module

The HC-05 Bluetooth module enables wireless control of the vehicle. The Bluetooth connection allows the system operator to send commands from a smartphone or computer to guide the vehicle's movement. The Bluetooth module also facilitates communication between the vehicle and the monitoring station, ensuring seamless operation.

##### 3.2.5 L293D Motor Driver

The L293D motor driver is used to control the DC motors that power the vehicle's movement. This motor driver enables the vehicle to move forward, backward, and turn left or right, providing the mobility required for autonomous navigation. It receives control signals from the Arduino and drives the motors accordingly.

### 3.2.6 Voice IC Module

The Voice IC module is integrated into the system to allow the vehicle to broadcast audio messages. This module is capable of storing and playing pre-recorded audio files, such as announcements or emergency alerts. The audio messages are broadcasted through a speaker mounted on the vehicle, allowing it to communicate effectively with people on the campus.

### 3.2.7 LCD Display

The LCD display is used to provide real-time feedback to the system operator. It shows the operational status of the system, such as the battery level, current mode (e.g., surveillance or notice announcement), and other relevant information. This helps in monitoring the vehicle's performance and ensuring smooth operation.

## 3.3 System Workflow

The system operates in two main modes: Surveillance Mode and Notice Announcement Mode. The vehicle can switch between these modes based on the requirements of the operator.

### 3.3.1 Surveillance Mode

In Surveillance Mode, the vehicle autonomously navigates the campus, capturing video footage using the ESP32 camera. The ultrasonic sensors detect obstacles in the vehicle's path, and the vehicle adjusts its movement to avoid collisions.

The operator can control the vehicle's movement remotely via the HC-05 Bluetooth module, directing it to specific areas of the campus that require monitoring. The system can also be set to operate autonomously, moving through predefined paths or roaming freely while avoiding obstacles.

### 3.3.2 Notice Announcement Mode

In Notice Announcement Mode, the vehicle stops at strategic locations, such as lecture halls, dormitories, or common areas, to deliver important campus notices or emergency alerts. The Voice IC module plays pre-recorded audio messages or live announcements through a speaker mounted on the vehicle. This mode is useful for broadcasting emergency messages, event notifications, or safety instructions to the campus community.

## 3.4 Advantages of the Proposed System

The proposed system offers several advantages, especially for college campuses:

1. **Mobility:** Unlike stationary cameras, the autonomous vehicle can cover a wide area, allowing it to monitor different sections of the campus that may be outside the reach of fixed cameras.
2. **Real-Time Video Surveillance:** The ESP32 camera module streams live video footage, enabling real-time monitoring of campus activities. This allows security personnel or campus administrators to respond quickly to any suspicious activity.
3. **Wireless Communication:** The system uses wireless communication for both video streaming and remote control, reducing the need for extensive cabling and offering more flexibility in deployment.
4. **Notice Announcements:** The voice announcement feature enables the system to communicate important information to the campus community, improving awareness and safety.
5. **Low-Cost Solution:** The use of affordable components such as Arduino, ESP32 camera, and ultrasonic sensors makes this system an economical option for educational institutions.

## 3.5 Future Enhancements

In the future, the system could be enhanced by integrating features such as:

- **Cloud Integration:** Storing video footage in the cloud for easy access and analysis.
- **Facial Recognition:** Incorporating AI-based facial recognition for identifying individuals on campus.

- **Battery Management:** Developing more efficient battery management and charging systems to extend the vehicle's operating time.

## IV. RESULTS

The proposed system for Smart Video Surveillance with Wireless Notice Announcement Vehicle for Colleges was developed, tested, and evaluated to assess its performance and functionality. The results of the system's functionality are presented below, with emphasis on the key aspects such as video surveillance, obstacle detection, remote control, voice announcements, and overall system performance.



Fig.2

### 4.1 Video Surveillance Performance

One of the core functionalities of the system is real-time video surveillance. The ESP32 camera module successfully captured and streamed high-quality video footage to a remote monitoring device over Wi-Fi.

- **Video Quality:** The video quality was adequate for surveillance purposes, with a resolution of 640x480 pixels. This allowed clear identification of individuals and objects in the monitored environment.
- **Streaming:** The streaming feature was tested over different Wi-Fi networks with varying strengths. The system successfully maintained a stable video feed even when the vehicle moved between different areas of the campus, as long as the Wi-Fi signal was strong. In areas with weak or no Wi-Fi, the video feed was interrupted or not transmitted.
- **Latency:** There was a small latency in the video feed due to the wireless transmission, but the delay was minimal and acceptable for real-time surveillance applications.

### 4.2 Obstacle Detection and Navigation

The vehicle was equipped with ultrasonic sensors for obstacle detection, and the performance in terms of navigation was evaluated:

- **Obstacle Avoidance:** The ultrasonic sensors effectively detected obstacles in the vehicle's path, allowing it to adjust its movement in real-time. The system was able to avoid both static obstacles (e.g., walls, tables) and dynamic obstacles (e.g., pedestrians, other vehicles) by altering its direction.
- **Navigation Accuracy:** The vehicle successfully navigated around obstacles with minimal intervention. The vehicle was able to move autonomously in open spaces, and it also demonstrated the ability to navigate tight areas such as hallways or crowded locations.

- **Limitations:** The system was tested with a variety of objects and environmental conditions, and it performed well in most cases. However, obstacles with complex shapes or transparent materials, like glass walls, sometimes posed detection challenges. **4.3 Remote Control and Bluetooth Communication**

The HC-05 Bluetooth module enabled remote control of the vehicle, and this functionality was tested under different conditions:

- **Control Responsiveness:** The Bluetooth communication worked smoothly, with minimal lag. Commands sent from a smartphone (through a dedicated app or Bluetooth terminal) were executed quickly by the vehicle. The operator could control the vehicle's movement (forward, backward, left, right) and toggle between operational modes (Surveillance or Notice Announcement).
- **Control Range:** The vehicle was operated within a range of up to 10 meters from the Bluetooth source. Beyond this distance, the signal strength diminished, causing intermittent connection loss. This range is acceptable for small to medium-sized campus areas but may need improvement for larger campuses.

#### 4.4 Voice Announcement System

The Voice IC module allowed the system to broadcast pre-recorded messages or emergency alerts. The performance of the voice announcement system was evaluated as follows:

- **Sound Clarity:** The sound quality of the announcements was clear, and the audio was loud enough to be heard in an open area, such as a quad or common space. However, in noisy environments or large lecture halls, the volume might need to be increased.
- **Message Storage and Playback:** The system could store multiple messages, including safety alerts, event notifications, or emergency instructions.
- **Real-time Announcements:** The system successfully delivered real-time voice announcements from the operator through the mobile device's Bluetooth connection. This feature was tested during emergencies, where the operator could broadcast live instructions directly from the vehicle.

## V. CONCLUSION

The Smart Video Surveillance with Wireless Notice Announcement Vehicle for Colleges successfully combines autonomous mobile surveillance, real-time video streaming, and wireless notice announcements, providing an effective solution to enhance campus security and communication. The integration of key components such as the Arduino microcontroller, ESP32 camera, ultrasonic sensors, HC-05 Bluetooth module, and Voice IC module has demonstrated the system's ability to operate efficiently in real-world scenarios.

While the system has proven successful in meeting its design goals, there are areas for future improvement, such as extending the range of wireless control, improving video resolution, and enhancing battery life. The integration of more advanced sensors or AI-based features could also enhance its functionality for more complex environments.

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