SMART AUTOMATION SYSTEM FOR SCHOOL SAFETY SENSORING USING ARDUINO

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ABSTRACT

This project introduces a School Safety Sensoring using Arduino, integrating sensors and actuators to enhance school safety. A DHT11 sensor monitors temperature and humidity, an MQ135 detects harmful gases, and an IR sensor identifies unauthorized movements. A vibration sensor ensures structural stability, while a fire sensor enables early fire detection. Safety responses include activating a buzzer, controlling a water pump for fire suppression, and regulating lighting via an LDR sensor. An LCD displays real-time data, and a GSM module sends emergency SMS alerts. This automated system ensures prompt hazard detection, creating a safer school environment.

KEYWORDS

Arduino, DHT11Sensor, Temperature Monitoring, Humidity Monitoring, MQ135 Gas Sensor, Harmful Gas Detection, IR Sensor, Unauthorized Movement Detection, Vibration Sensor, Fire Sensor, Fire Detection Buzzer, Water Pump, LDR Sensor, LCD Display, GSM Module, Emergency SMS Alerts, Hazard DetectionNetwork Protocol

1. INTRODUCTION

School safety is a critical concern that requires advanced and efficient systems to ensure the well-being of students and staff. This project introduces a comprehensive School Safety and Sensoring System using Arduino, designed to detect and respond to hazards in real-time. The system integrates multiple sensors and actuators to monitor various safety parameters. A DHT11 sensor tracks temperature and humidity to maintain a comfortable indoor environment, while an MQ135 gas sensor detects harmful gases or air pollution. An IR sensor monitors unauthorized movements, a vibration sensor identifies structural instability, and a fire sensor enables early fire detection. To address safety threats, the system activates a buzzer for audible alerts and controls a water pump via relays for fire suppression. Additionally, an LDR sensor adjusts lighting automatically, and a CPU fan manages airflow during overheating scenarios. The system features an LCD display for real-time data and a GSM module for sending emergency SMS notifications to ensure timely responses. This versatile and automated solution significantly enhances the safety protocols of schools, creating a secure and protected learning environment. Ensuring safety within schools is a fundamental priority in today's world, where both environmental and security challenges can pose risks to students and staff. This project presents an innovative School Safety and Sensoring System built using Arduino, combining cutting-edge technology with practical safety measures. The system is designed to proactively detect hazards, automate responses, and provide real-time alerts, fostering a secure and protected school environment at its core, the system employs advanced sensors to monitor key safety parameters. A DHT11 sensor measures

temperature and humidity, promoting a healthy and comfortable indoor atmosphere. The MQ135 gas sensor detects the presence of harmful gases, preventing exposure to air pollution or toxic substances. Unauthorized movement is detected using an IR sensor, while a vibration sensor monitors structural stability to address potential building-related hazards. Additionally, a fire sensor offers critical early warning for fire incidents, allowing swift response. To further enhance safety, the system integrates actuators for automated responses. A buzzer provides instant audio alerts, and a water pump, controlled by relays, activates to extinguish fires. An LDR sensor optimizes lighting levels by controlling a connected bulb, and a CPU fan helps manage overheating. All sensor data is displayed on an LCD screen for real-time monitoring, while a GSM module sends emergency SMS notifications to alert authorities or designated contacts immediately.

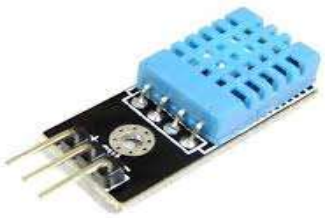


Figure 1 DHT11 Sensor

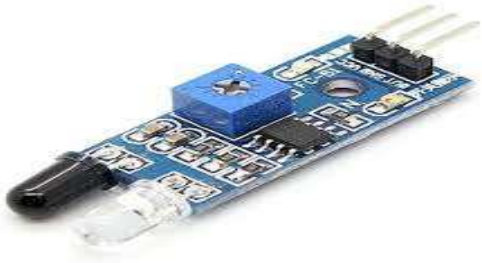


Figure 2 IR Sensor

Figure 3 Temperature Sensor

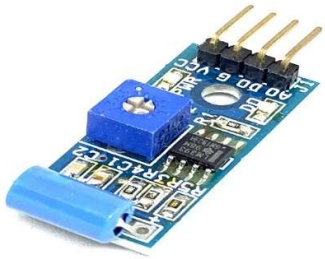


Figure 4 Vibration Sensor

Figure 5 Fire Sensor

Figure 6 LDR Sensor

2. LITERATURE SURVEY

[1] This Study talks about Student Monitoring and Security System over IOT Present day world is getting unsafe for children. Many cases of kidnapping and child abuse are reporting day by day. In light of this, our proposal is very suitable for monitoring students on their way to school and back. Modern technologies like RFID suitably controlled and data are sending to mobile phones of parent by utilizing IOT. This proposal eliminates the need of supervising and tracing the pupils during their drive to and from school. In addition to this, a drunk and drive prevention mechanism ensures safety to child inside school bus and safe and smooth ride in roads. Also, this system can be made practical cost effectively.

[2] This Study talks about IoT Based Surveillance Model for Monitoring School Children Existing IoT-based surveillance models for monitoring children present several weaknesses that limit their effectiveness and raise concerns. One of the primary issues is privacy, as these systems often collect sensitive personal data, including location information, which can be vulnerable to unauthorized access or data breaches if not properly secured. Additionally, the cost of implementing and maintaining such systems can be prohibitively high, particularly for schools with limited resources, as expenses include hardware, software, and regular maintenance. Data security is another critical concern, as IoT devices

are susceptible to hacking and cyberattacks, especially if encryption methods and security protocols are weak or outdated. Furthermore, these models heavily rely on stable network connectivity, and in areas with poor internet infrastructure, the system may experience disruptions, leading to delays or missed alerts. Inaccuracy and false alerts are also Common issues, as some systems may trigger unnecessary alarms when children are still within the designated safe zones, undermining trust in the system

[3] This Study talks about IOT-Based School Children Transportation Safety System Combining RFID, GPS and IoT advances for safety and security reason is incredibly vital. Presently, as a result of an increase in mishaps of kids getting out at the wrong stations or children getting missed on the bus, this may lead to demise due to suffocation. This proposal shows that RFID-based school bus tracking technology is a feasible alternative for supervising and tracing pupils during their drive to and from school. Additionally, the expense associated with tagging material is moderately low. Also, the IOT prevention system and the gate control system play a major role to help the children commute safely. In this manner the system is capable of notifying parents/guardians thru text notification once the child enters/leaves the varsity, enabling parents/ guardians to trace the bus, helping smooth and safer rides to the various destinations.

[4] This Study talks about IOT Based School Bus Monitoring and Security System We developed and tested a vehicle tracking system to track the exact location of a vehicle. This paper has described the design and implementation of the school bus tracking system. A panic switch is placed inside the vehicle for the safety of the students. A smartphone application can be downloaded by the parents which will continuously show the location of the bus. The system was able to experimentally demonstrate its effective performance to track the school bus; thereby ensuring the parents of their child's safety.

2.1. Existing work

1.Manual Monitoring Systems

Security personnel monitor school premises for unauthorized access or suspicious activity. Regular inspections are carried out to check fire safety equipment and building stability. Maintenance teams ensure electrical and mechanical systems are functional.

2. Standalone Fire and Gas Detection Systems

Smoke detectors and fire alarms are widely installed to detect and alert occupants about fire hazards. Gas detectors monitor for harmful gases like carbon monoxide or natural gas leaks.

3. CCTV Surveillance Systems

Closed-circuit television (CCTV) cameras are installed throughout the school to monitor and record activities in real-time. These systems are useful for identifying unauthorized movements and incidents retrospectively.

4. Access Control Systems

Card-based or biometric entry systems restrict access to authorized personnel and students only. These systems ensure that intruders or unauthorized persons cannot enter restricted areas.

5. Emergency Response Protocols

Schools implement safety drills (fire drills, earthquake drills, etc.) to prepare students and staff for emergencies

6. Environmental Control Systems

HVAC (Heating, Ventilation, and Air Conditioning) systems are used to regulate indoor temperature and air quality. These systems, however, may not actively detect harmful gases or pollutants without additional sensors.

7. Standalone Alarm and Notification Systems

Alarm systems are triggered manually in case of emergencies like fires, earthquakes, or other threats. Public address (PA) systems are used for announcements and emergency instructions.

8. Lighting Systems with Timers or Motion Sensors

Timed lighting systems provide illumination at pre-set intervals, ensuring safety during school hours. Motion sensors are sometimes used for energy efficiency but may not be integrated with broader safety measures.

9. Structural Stability Inspections

Structural engineers periodically inspect school buildings for cracks, foundation weaknesses, or other signs of instability. This approach is labour-intensive and does not provide real-time monitoring.

10. Mobile and SMS Alert Systems

Many schools have implemented mobile apps or SMS-based notification systems to send emergency alerts to parents, staff, and students. These systems are often used manually during emergencies and may lack real-time automation.

2.2. Disadvantages of Existing work

1.Lack of integration

Most traditional safety systems operate in isolation, such as standalone smoke detectors, gas sensors, or CCTV cameras. They do not communicate with each other, resulting in fragmented safety measures and delayed responses during emergencies.

2.Manual Dependency

Many systems require significant human intervention, such as monitoring surveillance cameras, conducting manual safety inspections, or triggering alarms. This reliance on human operators increases the risk of errors, oversights, or delays in addressing hazards.

3.No Real-Time Alerts

Traditional systems often lack real-time alert capabilities. For instance, conventional fire alarms or gas detectors may alert occupants on-site but do not send notifications to external authorities or stakeholders for immediate action.

4.Limited Hazard Detection

Existing systems may focus on specific hazards, such as fire or intrusion, but fail to address a wide range of threats like air quality issues, structural instability, or overheating. This narrow scope leaves critical safety gaps.

5.High Cost of Advanced Systems

Advanced safety solutions, such as biometric access control or integrated building management systems, are often expensive and not feasible for many schools, especially in underfunded or rural areas.

6.No Automated Responses

Many systems lack the ability to take automated corrective actions, such as activating water sprinklers, regulating lighting, or controlling airflow, which could mitigate hazards more effectively.

7.Delayed Communication

In emergencies, traditional methods of communication, such as manual phone calls or public announcements may result in delays and confusion, leading to ineffective evacuation or response.

8.Limited Scalability

Expanding existing systems to cover additional areas or hazards often involves significant costs and technical challenges, making them less adaptable to growing needs.

9.Maintenance Challenges

Traditional systems often require regular maintenance checks, which, if neglected, can lead to malfunctioning equipment. For example, expired fire extinguishers or non-functional alarms can compromise safety during emergencies.

10.No Environmental Monitoring

Conventional safety systems rarely include environmental monitoring, such as tracking temperature, humidity, or air quality, which are essential for ensuring a safe and healthy indoor environment.

11.Reactive Rather Than Proactive

Existing systems are largely reactive, alerting only after a hazard has occurred. They lack predictive capabilities, such as early detection of structural instability or potential overheating, which could prevent disasters.

2.3. Motivation

The safety of students and staff in educational institutions is a critical concern. Traditional safety measures often lack efficiency and immediacy during emergencies, highlighting the urgent need for a proactive and automated solution. This project aims to leverage technology to create a safer educational environment by integrating sensors, actuators, and real-time alert systems to detect and mitigate hazards, ensuring prompt responses and fostering a secure and comfortable space for learning and growth.

2.4. Objective

The primary objective of the School Safety Sensoring is to enhance school safety by creating a comprehensive, automated solution for real-time hazard detection, monitoring, and mitigation. The system aims to detect environmental hazards, such as fire risks, poor air quality, structural instability, and unauthorized access, using integrated sensors like DHT11, MQ135, IR, vibration, and fire sensors.

Additionally, it seeks to provide immediate alerts through a buzzer, LCD display, and GSM module for emergencies while automating safety responses, such as fire suppression and lighting control. The project strives to ensure a secure, efficient, and technology-driven safety protocol for schools.

2.5. Scope

The School Safety Sensoring is designed to enhance school safety by integrating real-time monitoring, automated hazard detection, and responsive actions. The system addresses key safety concerns, including fire risks, air quality, structural stability, unauthorized access, and optimal lighting. It incorporates sensors like DHT11, MQ135, IR, vibration, and fire sensors, along with actuators such as a buzzer, water pump, and lighting controls.

The project ensures a safer environment by providing real-time data via an LCD and emergency alerts through a GSM module. Scalable and adaptable, it can be implemented in schools of varying sizes, modernizing safety protocols

2.6. Proposed System

1. Integration of Multi-Sensor Technology

The system incorporates a variety of sensors to detect and monitor multiple safety parameters:

- DHT11 Temperature and Humidity Sensor: Monitors environmental conditions to ensure a safe and comfortable atmosphere.
- MQ135 Gas Sensor: Detects harmful gases or air pollution to prevent health hazards.
- PIR Motion Sensor: Identifies unauthorized movements or intrusions for enhanced security.
- Vibration Sensor: Monitors structural stability, enabling early detection of potential structural failures.
- Fire Sensor: Provides early warning of fire hazards, allowing timely evacuation and response.

2. Automated Responses

The system is equipped with actuators to respond automatically to detected hazards:

A buzzer is activated to provide audible alerts in emergencies.

- A water pump, controlled via relays, extinguishes fires automatically.
- An LDR sensor adjusts lighting by controlling a connected bulb to optimize visibility.
- A CPU fan regulates airflow in overheating scenarios, reducing the risk of fire.

3. Real-Time Data Display

An LCD screen displays real-time sensor readings and alerts, allowing on-site personnel to monitor the system's status and respond proactively to any hazards.

4. Emergency Communication

A GSM module is integrated into the system to send SMS notifications to pre-designated emergency contacts, such as school authorities or first responders, ensuring timely external intervention.

5. Continuous Power Supply

The system includes a robust power supply to ensure uninterrupted operation, even during power outages, maintaining constant safety monitoring.

6. Centralized Control and Signal Processing

An ATMega328P microcontroller acts as the system's brain, processing input from all sensors and making intelligent decisions to activate appropriate safety measures.

7. Cost-Effectiveness and Scalability

The system uses cost-effective components, making it affordable for schools with limited budgets. Its modular design allows easy integration of additional sensors and functionalities, ensuring scalability to meet future needs.

8. Preventive and Proactive Approach

Unlike traditional systems, the proposed solution takes a preventive approach by identifying potential risks, such as overheating or structural instability, before they escalate into emergencies. This proactive detection minimizes damage and ensures safety.

9. Ease of Maintenance

The system is designed to be user-friendly and requires minimal maintenance. Regular self-diagnostics ensure that all components are functional and reliable.

10. Comprehensive Safety Coverage

By integrating environmental monitoring, intrusion detection, fire suppression, and real-time alerts into a single system, the proposed solution provides a holistic approach to school safety.

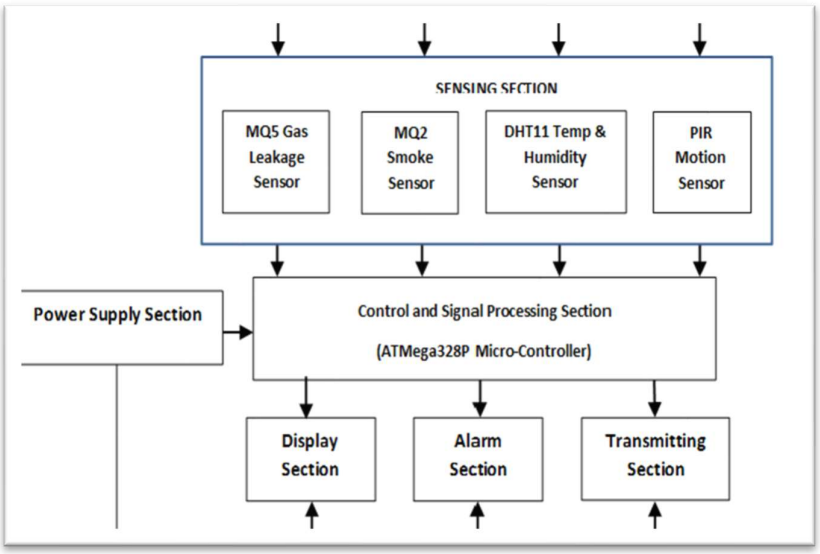
2.6.1. Advantages

This system offers significant advantages in enhancing school safety. Real-time monitoring of crucial parameters like temperature, humidity, gas levels, movement, vibration, and fire enables early detection of potential hazards. This proactive approach allows for swift responses, minimizing risks and ensuring the safety of students and staff. The system's automated responses, such as activating alarms, controlling water pumps, and adjusting lighting, further enhance safety measures.

Moreover, the integration of a GSM module facilitates remote monitoring and SMS notifications during emergencies. This enables authorized personnel to receive timely alerts and respond promptly to critical situations. The system also contributes to a more comfortable and conducive learning environment by maintaining optimal temperature and humidity levels and ensuring adequate lighting.

Furthermore, the system is cost-effective and energy-efficient, utilizing readily available components and incorporating features like automatic lighting control. Its ease of installation and minimal maintenance requirements make it a practical solution for schools. The system's scalability and flexibility allow for customization to meet the specific needs of different schools and environments

2.7. Design Methodology



The diagram depicts a comprehensive flow of a School Safety and Sensoring System using Arduino, designed to monitor, process, and respond to safety threats effectively. The system begins with the Sensing Section, which comprises multiple sensors for hazard detection. The MQ5 Gas Leakage Sensor and MQ2 Smoke Sensor identify hazardous gases and smoke, providing early warnings for potential fire or gas leaks. The DHT11 Temperature and Humidity Sensor ensures the indoor environment remains safe and comfortable by

monitoring environmental conditions. Additionally, the PIR Motion Sensor detects unauthorized movement, enhancing security against intrusions.

The data collected by these sensors is sent to the Control and Signal Processing Section, powered by the ATMega328P Microcontroller, which serves as the brain of the system. This microcontroller processes the sensor inputs and determines appropriate responses to detected hazards. A Power Supply Section ensures the consistent and reliable operation of all components.

The processed data is used by three critical sections to deliver actionable outcomes. The Display Section shows real-time sensor readings and alerts on an LCD screen for on-site monitoring. The Alarm Section triggers a buzzer to produce audible alerts, warning occupants of potential dangers. Simultaneously, the Transmitting Section uses a GSM module to send emergency notifications via SMS to designated contacts, enabling quick responses from external parties.

2.8. Results

Figure 7 Monitoring

Figure 8 Survilience

The implementation of this School Safety and Sensoring System can lead to several positive outcomes. Primarily, it significantly improves student and staff safety by reducing the risk of injury or loss of life due to fire, gas leaks, structural instability, and exposure to hazardous environmental conditions. Furthermore, it enhances the learning environment by creating a more comfortable and conducive atmosphere with optimal temperature, humidity, and lighting. The system also provides a sense of security and reassurance for students, staff, and parents by allowing for proactive response to potential threats. Additionally, it enables faster and more effective emergency response through real-time monitoring and automated alerts. Finally, the system provides valuable data on environmental conditions and potential

hazards, allowing for informed decision-making regarding school safety protocols and maintenance.

Figure 9 Environment of school After installing all the sensors

1. Smoke Detectors: These are the most likely candidates. They often have a domed or flat shape and are designed to detect smoke particles in the air.

2. Motion Detectors: These could be the devices with a more angular shape. Motion detectors are used to detect movement in a specific area, often for security purposes.

3. Sprinkler Heads: While not explicitly sensors, sprinkler heads are often part of fire suppression systems and are typically found on ceilings. They might be mistaken for sensors.

4. Other Environmental Sensors: Depending on the specific application, there could be other types of sensors present, such as temperature sensors, humidity sensors, or carbon monoxide detectors. However, without more context or information about the specific devices, it's difficult to say for sure.

Feature	Existing Methods	School Safety Sensoring
Focus	Primarily reactive (response to incidents) & human-dependent	Proactive (early detection & prevention) & automated
Detection	Relies on human observation, surveillance footage review	Real-time sensor data analysis for environmental and safety parameters
Response	Manual intervention by security personnel, emergency responders	Automated actions (e.g., alarms, fire suppression, lighting control)
Data Collection	Limited to human reports, surveillance footage	Continuous real-time data from various sensors
Proactive Measures	Limited to drills, training, and general awareness	Continuous monitoring and early warning for potential hazards
Limitations	Potential for human error, delayed response, limited coverage	Requires initial investment, potential for false alarms (if not calibrated properly)
Key Advantages	Cost-effective, widely implemented, familiar approach	Enhanced situational awareness, faster response times, potential for data-driven decision making

Table 1

3. CONCLUSIONS

This comprehensive School Safety and Sensoring System, leveraging the power of Arduino, represents a significant advancement in safeguarding educational institutions. At its core, the system integrates a diverse array of sensors, including those for temperature and humidity, air quality, movement, vibration, and fire detection, to continuously monitor the school environment. This real-time data analysis enables proactive identification of potential hazards, such as extreme temperatures, harmful gases, unauthorized entry, structural instability, and fire outbreaks. In response to these threats, the system triggers automated actions, such as activating fire suppression systems, adjusting lighting levels, and sending emergency alerts via SMS to designated personnel. Furthermore, the system

promotes a healthier learning environment by maintaining optimal temperature and humidity levels, ensuring clean air quality, and optimizing energy consumption through automated lighting control. The collected data provides valuable insights into environmental conditions, enabling informed decision-making regarding school safety protocols, maintenance schedules, and resource allocation. While the effectiveness of this system hinges on factors like sensor accuracy, proper installation, and regular maintenance, its potential to significantly enhance school safety, create a more secure and conducive learning environment, and ultimately safeguard the well-being of students, faculty, and staff is undeniable.

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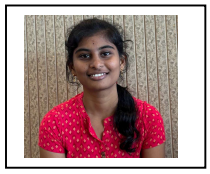

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"Passionate about artificial Internet of Things, with a strong interest in Sensors and Actuators and its application that's why I choose this project with great interest"