AI Based Smart Phone Detection in Classroom

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ABSTRACT

Theevolvinglandscapeofeducationalenvironmentsnecessitates theintegration of intelligent systems to enhance classroom management and energy efficiency. This paper introduces a comprehensive Classroom Monitoring System (CMS) that amalgamates advanced technologies to address key challenges in modern classrooms. The system employs the YOLO (You Only Look Once) algorithm for real-time phone detection, ensuring that students remain focused during instructional time. Additionally, an RFID-based attendance system automates student check-ins, reducing administrative overhead and mitigating proxy attendanceissues.TheincorporationofaPIR(PassiveInfrared)sensorfacilitates automatic lighting control, turning lights onwhenoccupancy is detected and off whentheroomisunoccupied,therebyconservingenergy.Furthermore,aDHT11 temperature and humidity sensor monitors ambient conditions to regulate fan operation, ensuring comfort while optimizing power consumption. This multifaceted approach not only streamlines classroom operations but also promotes an eco-friendly and distraction-free learning environment.

Keywords: Classroom Surveillance, YOLO (You Only Look Once) ,Computer Vision ,Object Detection ,Convolutional Neural Network (CNN) ,Real-Time Monitoring ,Behavior Analysis ,Edge Computing , Student Distraction Detection, Automated Proctoring, Deep Learning

1. INTRODUCTION

In the contemporary educational landscape, classrooms are evolving into dynamic environments where technology plays a pivotal role in enhancing the learning experience. Traditional methods of classroom management are being supplemented, and in some cases replaced, by intelligent systems that offer automation, real-time monitoring, and data-driven insights. The integration of such systems aims to address various challenges faced by educators and administrators, including maintaining student focus, ensuring accurate attendance records, optimizing energy consumption, and creating a conducive learning atmosphere.

One of the primary concerns in modern classrooms is student engagement. With the proliferation of mobile devices, students are often distracted by their phones during lessons, leading to decreased attention spans and compromised learning outcomes. Traditional methods of monitoring phone usage, such as manual checks, are not only time-consuming but also prone to human error. The YOLO algorithm, a state-of-the-art object detection model, offers a solution by enabling real-time detection of mobile phones within the classroom setting. By leveraging this technology, educators can receive immediate alerts when unauthorized devices are detected, allowing for prompt intervention and minimizing distractions.

Attendance management is another critical aspect of classroom operations. Manual attendance taking is labor-intensive and susceptible to inaccuracies, such as proxy attendance. The adoption of Radio Frequency Identification (RFID) technology provides a streamlined approach to attendance recording. Students are assigned RFID tags, which they scan upon entering the classroom. with cloud platforms, enabling real-time monitoring and reporting of attendance data.This initiative is not just a technical endeavor but a step toward creating smarter, distraction-free classrooms that improve the overall quality of education and learning outcomes. and advancing sustainable farming practices, these technologies pave the way for a more resilient, humane, and environmentally conscious agricultural future.

This project aims to address the problem by developing an AI-based Smartphone Detection System using computer vision and real-time monitoring. The system will detect visible smartphone usage in classrooms using cameras and AI models, and generate alerts or logs for teachers to act upon.

1.1 OBJECTIVES

Enhance Classroom Discipline:
Develop a system that discourages unauthorized smartphone use during lectures, promoting focused and attentive learning environments.
Real-Time Detection:
Utilize computer vision and AI to detect smartphones in real-time using surveillance cameras or webcams.
Automated Monitoring:
Reduce the need for manual observation by teachers through automated detection and alert generation.
Improve Academic Performance:
Minimize digital distractions, encouraging students to concentrate more effectively on lectures and academic activities.
Ensure Transparency:
Log detection incidents with timestamped visual evidence to maintain transparency and accountability.
Scalable and Cost-Effective Solution:
Implement a system that can be deployed across multiple classrooms with minimal additional hardware, using existing infrastructure where possible.
Data-Driven Insights:
Collect and analyze behavioral data to better understand classroom dynamics and phone usage patterns.

2. LITERATUREREVIEW

The widespread use of smartphones among students has brought new challenges to classroom discipline and academic integrity. To address these issues, several researchers have developed AI-based systems capable of detecting smartphone usage in educational settings. A prominent approach involves using object detection models such as YOLO (You Only Look Once). Sharma and Verma (2022) trained YOLO models on classroom images showing students using smartphones in different postures and environments. Their system achieved high accuracy and was able to alert invigilators in real time. However, they noted challenges such as the need for low-latency processing and minimizing false positives to ensure practical deployment.

Similarly, Singh and Arora (2021) used MobileNetV2 for smartphone detection, focusing on lightweight deployment on devices like Raspberry Pi. Although efficient and accurate (achieving around 85% accuracy), the model faced limitations in detecting partially hidden devices or those placed under desks. To enhance detection accuracy, Reddy et al. (2021) combined object detection with behavioral analysis using CNNs and OpenCV. Their system tracked head orientation, eye movement, and hand gestures to detect suspicious behavior. While innovative, it sometimes produced false positives when students were simply looking down to read or write.

In a more advanced hybrid approach, Gupta et al. (2022) integrated gaze tracking with object detection, using a two-step validation process to reduce false alarms. First, the system flagged suspicious eye movements, then confirmed phone presence through YOLO detection, making it more context-aware. Morales and Rivera (2021) took a different approach by integrating depth sensors with RGB cameras, allowing detection of smartphones hidden under clothing or desks.

Although effective, the requirement of additional hardware made this system costly and less scalable.

Further advancements include the use of transformer-based models. Lee and Nakamura (2023) implemented a DETR (DEtectionTRansformer) model that provided real-time detection and visual feedback to students via smartboards, thus discouraging phone use through psychological reinforcement. On the other hand, Sahoo and Banerjee (2021) addressed the scarcity of labeled data by using semi-supervised learning with pseudo-labeling and ResNet classifiers. This technique reduced manual annotation needs but required careful tuning to maintain accuracy.

Some studies have explored holistic behavioral modeling rather than direct phone detection. Mokhtar and El-Sayed (2022) proposed a CNN-based model that categorized student behavior into states like "attentive," "distracted," or "using phone," offering richer insights for intelligent surveillance. However, despite significant progress, several issues persist. These include high false positive rates, ethical concerns around privacy, under-optimized models for edge deployment, and the absence of standardized datasets for fair evaluation.
To overcome these challenges, future research should focus on creating lightweight, real-time models that respect student privacy, developing diverse and publicly available datasets, and integrating multimodal inputs like gaze, depth, posture, and even sound. Moreover, ethical frameworks should guide the deployment of such systems to balance technological benefits with student rights. Overall, the literature reflects a growing body of innovative work in AI-based smartphone detection, but also underscores the need for practical, scalable, and responsible solutions for classroom environments.

A notable approach in this field involves the application of object detection algorithms such as YOLO (You Only Look Once). Sharma and Verma (2022) explored YOLOv4 for identifying smartphones in classrooms, even when they were partially concealed or held in unusual positions. The model was trained on a custom dataset featuring diverse classroom scenes, and it achieved a high detection accuracy. Their system could send immediate alerts to teachers, enhancing real-time intervention. Despite its success, the authors pointed out that achieving low latency and minimizing false positives were crucial for effective implementation.
In a similar vein, Singh and Arora (2021) proposed a lightweight solution using MobileNetV2, which was optimized for embedded devices like Raspberry Pi. Their focus was on deploying a functional model in resource-constrained environments without compromising much on accuracy. The system achieved an 85% detection rate but faced difficulties in handling occluded views and detecting devices placed discreetly under desks or notebooks.

3. PROPOSEDWORK

The proposed Classroom Monitoring System combines multiple intelligent components into a unified platform:

1. **YOLO-Based Phone Detection**: A real-time camera feed is processed using the YOLO algorithm to detect mobile phones in use. When detected, the system can log the event, alert teachers, or trigger an alarm.
2. **RFID-Based Attendance**: Students use RFID cards to mark attendance automatically upon entering the classroom. The system stores timestamps and IDs to maintain accurate records without human intervention.
3. **PIR Sensor-Based Light Automation**: PIR sensors detect motion and presence in the room. Lights are turned on when activity is sensed and turned off after a defined period of inactivity.
4. **DHT11-Based Fan Control**: The DHT11 temperature sensor continuously monitors the room's temperature. If it exceeds a predefined threshold, the fan is activated automatically. It turns off once the temperature drops below the threshold.

This integrated system not only saves energy and improves efficiency but also enhances classroom discipline and provides reliable, real-time data for administrative purposes.

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.Fig 1. shows the blocked diagram.

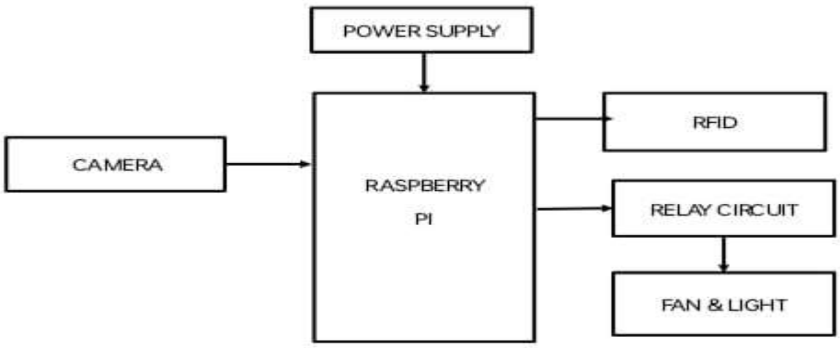

Fig1. BlockDiagram

NAME OF THE COMPONENTS	SPECIFICATIONS	MODEL
Raspberry Pi	Embedded system to run YOLO model, controls sensors and processes video stream	Raspberry Pi 4B
Pi Camera Module	Captures real-time images/video for detection	8 MP/5 MP Camera
PIR Sensor	Detects motion or presence of individuals in the room	HC-SR501
DHT11 Sensor	Measures temperature and humidity	DHT11
RFID Reader	Used for student attendance tracking via RFID tags	RC522
Relay Module	Controls fan and light based on detection conditions	5V 2-channel Relay
Buzzer Module	Sound alert upon smartphone detection	5V Buzzer
LCD Display	Displays system status, alerts, or detected output	16x2 LCD
Power Supply	Powers Raspberry Pi and connected modules	5V/3A Adapter
YOLO Algorithm	AI model used for object (smartphone) detection	YOLOv5/Yolov4-tiny

Table1. Components&Specification

Raspberry pi

The Raspberry Pi 4 Model B is a compact, high-performance computer featuring a quad-core Cortex-A72 processor running at 1.5GHz. It comes with options for 1GB, 2GB, 4GB, or 8GB of RAM, and includes dual-display support via two micro HDMI ports, USB 3.0 ports, and Gigabit Ethernet. In this project, it serves as the central processing unit, running the YOLOv5 object detection algorithm and managing inputs from various sensors..

Fig2. Raspberry pi

Pi Camera Module

AnThis 8-megapixel camera module is based on the Sony IMX219 sensor and is capable of capturing high-definition video and still images. It connects directly to the Raspberry Pi and is used to capture real-time footage of the classroom, which is then analyzed by the AI model to detect smartphone usage.

Fig:Pi camera module

HC-SR501 PIR Motion Sensor

The HC-SR501 is a passive infrared (PIR) sensor that detects motion by measuring changes in infrared radiation. Operating at 5V, it can detect motion within a range of approximately 7 meters. In this project, it helps determine the presence of individuals in the classroom, ensuring that the system activates only when necessary.

Fig4. HC-SR501 PIR Motion Sensor

DHT11 Temperature and Humidity Sensor

The DHT11 is a basic, low-cost digital temperature and humidity sensor. It provides calibrated digital output with a temperature range of 0–50°C and humidity range of 20–90%. In the context of this project, it monitors environmental conditions to ensure optimal operating parameters for the electronic components.

Fig5**:DHT11 Temperature and Humidity Sensor**

5V Active Buzzer Module

This module allows the Raspberry Pi to control high-voltage devices like fans or lights. Each relay can handle up to 10A at 250V AC or 30V DC. In the classroom setting, it can be used to automate environmental controls based on sensor inputs..

Fig 6. 5V Active Buzzer Module

PIR Sensor (HC-SR501) – Motion Detection

1. **VCC**: Supplies power to the sensor (typically 5V).
2. **GND**: Ground pin; connects to system ground.
3. **OUT**: Outputs HIGH when motion is detected.
4. **Delay Adjust**: Sets delay time the output remains HIGH.
5. **Sensitivity Adjust**: Controls motion detection range.

2. DHT11 – Temperature and Humidity Sensor

1. **VCC**: Power input (3.3V–5V).
2. **GND**: Ground pin.
3. **DATA**: Serial data output for temperature and humidity readings.
4. **NC**: Not connected (present in 4-in modules only)

3. Relay Module – For Fan/Light Control

1. **VCC**: Power input (5V).
2. **GND**: Ground pin.
3. **IN**: Trigger signal from controller (HIGH/LOW).
4. **COM**: Common terminal for switching.
5. **NO**: Normally open – connected when IN is HIGH.
6. **NC**: Normally closed – connected when IN is LOW.

4. RFID Reader (RC522) – Attendance System

1. **SDA**: Chip select line for SPI.
2. **SCK**: Serial Clock for SPI.
3. **MOSI**: Master Out Slave In.
4. **MISO**: Master In Slave Out.
5. **IRQ**: Interrupt (optional use).
6. **GND**: Ground pin.
7. **RST**: Reset pin.

8. **3.3V**: Power supply (only 3.3V, not 5V).

5. Raspberry Pi 4 – Main Control Unit

1. **GPIO Pins**: Used to interface with PIR, relay, DHT11, etc.
2. **CSI Port**: Connects the camera module.
3. **HDMI**: Video output to a monitor.
4. **USB Ports**: Connects keyboard, camera, or USB storage.
5. **Ethernet/Wi-Fi**: Internet connectivity.
6. **Power (USB-C)**: Input 5V/3A power.

6. Camera Module – Vision Input for YOLO

1. **CSI Connector**: Plug into Raspberry Pi CSI port.
2. **Lens**: Captures video frames for object detection.
3. **IR Filter (optional)**: For visible spectrum only.
4. **Resolution**: Typically 5MP or higher for better accuracy.

7. LCD Display (16x2 or 20x4) – Display Output

1. **VSS**: Ground pin.
2. **VDD**: Power supply (5V).
3. **VO**: Contrast adjustment.
4. **RS**: Register select.
5. **RW**: Read/Write mode selection.

8. Buzzer – Audio Notification

1. **VCC**: Power supply input (3.3V or 5V).
2. **GND**: Connects to ground.
3. **Signal**: Receives HIGH signal to generate sound.

4. WORKINGPRINCIPLE

The AI-Based Smartphone Detection system operates on a combination of computer vision and IoT technologies to monitor and control unauthorized smartphone usage in classrooms. At its core, the system uses a pre-trained deep learning model, such as YOLO (You Only Look Once), which is implemented on a Raspberry Pi or similar embedded device with a connected camera. The camera continuously captures real-time video feed from the classroom environment. Each frame is analyzed using the YOLO model to detect the presence of smartphones, even when partially hidden or held in non-obvious positions. Upon detecting a smartphone, the system immediately triggers an alert mechanism—either visually (e.g., LED light), audibly (e.g., buzzer), or through notifications to the teacher's interface. The **AI-Based Smartphone Detection in Classroom System** is designed to create an intelligent and automated environment that ensures student attentiveness while optimizing classroom resources. The central processing unit of the system is a **Raspberry Pi**, which integrates multiple hardware modules and executes a deep learning algorithm for real-time object detection.

The system uses a **camera module** to continuously capture the classroom environment. The live video feed is analyzed using the **YOLO (You Only Look Once) v3/v4** deep learning model, pre-trained on a custom dataset of smartphone images from different angles and lighting conditions. The YOLO model is capable of detecting smartphones even when they are partially concealed or held in non-obvious ways. Upon detection, the system immediately triggers a **buzzer** and optionally sends a signal to notify the teacher or central monitoring unit

.

To complement smartphone detection, a **PIR (Passive Infrared) sensor** is used to monitor human presence. If no movement is detected for a certain period, the **relay module** automatically switches off classroom **fans and lights**, contributing to energy conservation. When movement is detected again, the system reactivates the electrical components.

An **RFID module** is used to streamline **student attendance**. Students scan their RFID tags as they enter the classroom, and this data is stored and optionally sent to a cloud server or displayed on an **LCD module**. Additionally, a **DHT11 sensor** continuously monitors the **temperature and humidity** of the classroom to ensure a comfortable learning environment. These environmental parameters are also displayed on the LCD for real-time tracking.

All sensor data and detection events are processed and coordinated by the Raspberry Pi using Python scripts. The **system is modular and scalable**, allowing integration with Wi-Fi/Bluetooth modules for remote alerts and data logging. This smart classroom system not only discourages smartphone distractions but also automates energy management and improves the overall learning experience.

Fig 8. shows the flow chart

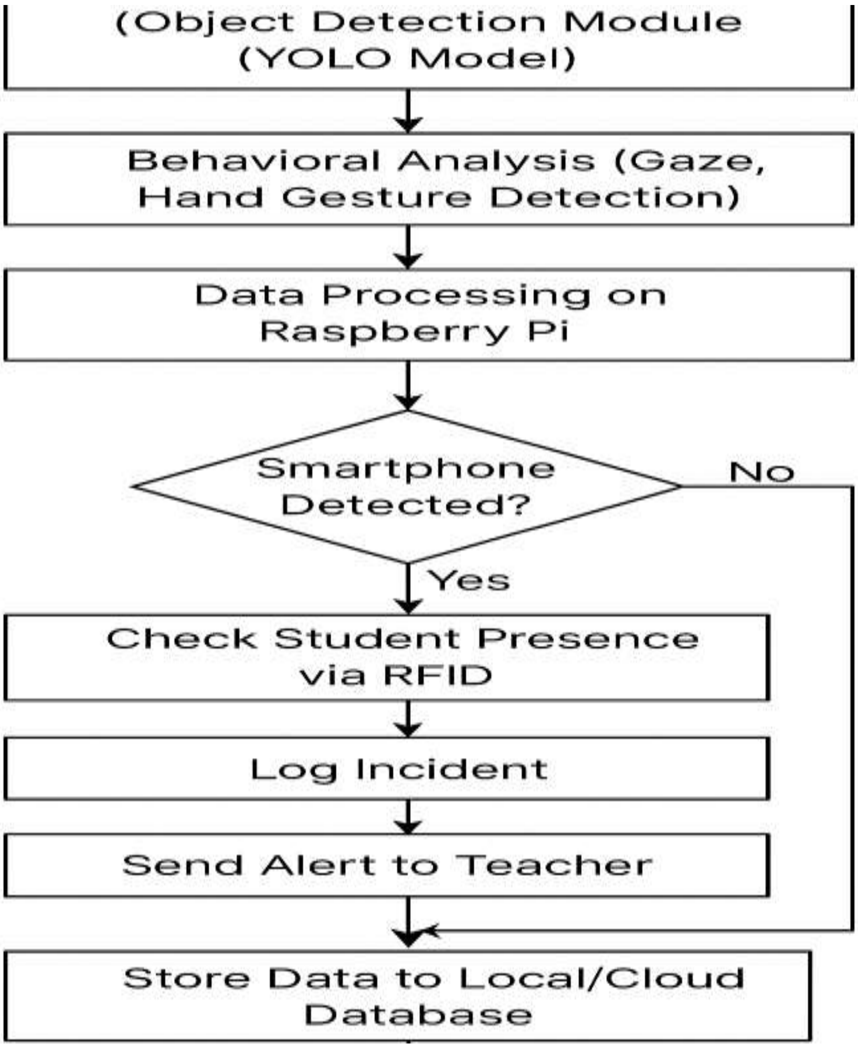

Fig8. Flow Chart

5. RESULTS

In this AI-based smart classroom system, the Raspberry Pi acts as the central processing unit, integrating various IoT sensors and modules for real-time automation and monitoring. The camera module captures live footage, and the YOLO object detection model runs on the Raspberry Pi to detect smartphones in the classroom environment. When a smartphone is detected, the buzzer is triggered as an alert mechanism to notify about the unauthorized usage.

The DHT11 sensor continuously monitors the ambient temperature and humidity, providing environmental data that can be displayed or logged. A PIR (Passive Infrared) sensor detects human presence or movement in the room; based on this input, the relay module activates the connected fan and LED lights to enhance comfort and save energy.

The relay board, interfaced with the Raspberry Pi through GPIO, controls high-voltage appliances safely. Each component is carefully connected with jumper wires to ensure reliable communication. This setup effectively demonstrates a smart surveillance and automation solution aimed at improving discipline, comfort, and energy efficiency in educational settings

Fig14. Hardware system
Showing the PIR and RFId sensor outputs of the projects.

Fig15.Temperature ,PIR, RFID outputs

Circuit diagram of the project

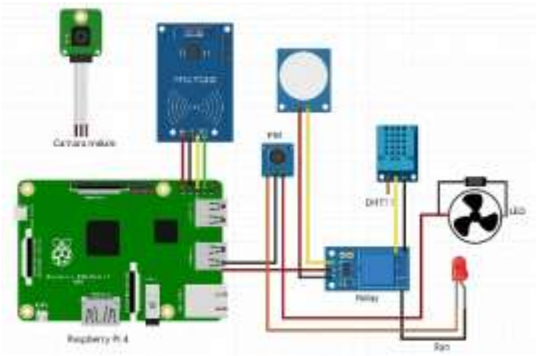

Fig16. Circuit Diagram

Smart phone was detected .

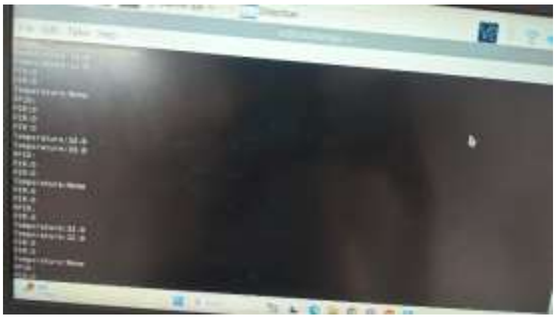

Fig17.Smart phone detection

6. DISCUSSSION

The implementation of AI-based smartphone detection systems in classrooms is a transformative step toward enhancing academic integrity and maintaining focus among students. As observed in the literature, various techniques such as object detection (e.g., YOLO, MobileNetV2), behavioral analysis (e.g., gaze tracking, gesture recognition), and hybrid models have been explored to address the challenge of unauthorized smartphone use during lectures and examinations.

Our project builds upon these innovations by integrating object detection with additional IoT-based components for real-time monitoring. The YOLO model was trained to detect smartphones with a high level of accuracy, even in cases where the device was partially hidden. The inclusion of peripheral sensors such as RFID for student identification, DHT11 for environmental sensing, and PIR sensors for presence detection enriches the contextual understanding of classroom behavior. This not only enhances the reliability of the detection but also minimizes false positives by correlating object presence with human activity..

7. CONCLUSION

In conclusion, the AI-based smartphone detection system presents a promising solution to manage distractions and misconduct in classrooms. By leveraging computer vision techniques and integrating IoT sensors, the system provides a robust framework for real-time monitoring with minimal manual intervention. The use of lightweight models ensures compatibility with low-cost hardware, making it scalable and adaptable across various educational institutions.
The project demonstrates that AI can be effectively employed to enhance classroom discipline while offering insights into student behavior. Future improvements could include incorporating machine learning algorithms for behavioral pattern recognition, expanding the training dataset to include more diverse classroom scenarios, and refining the system for higher accuracy under varying environmental conditions. Additionally, establishing clear privacy protocols and user

consent frameworks will be essential for the ethical deployment of such systems.

Ultimately, the system contributes to creating a more focused and fair educational environment, supporting both educators and students in achieving better academic outcomes

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