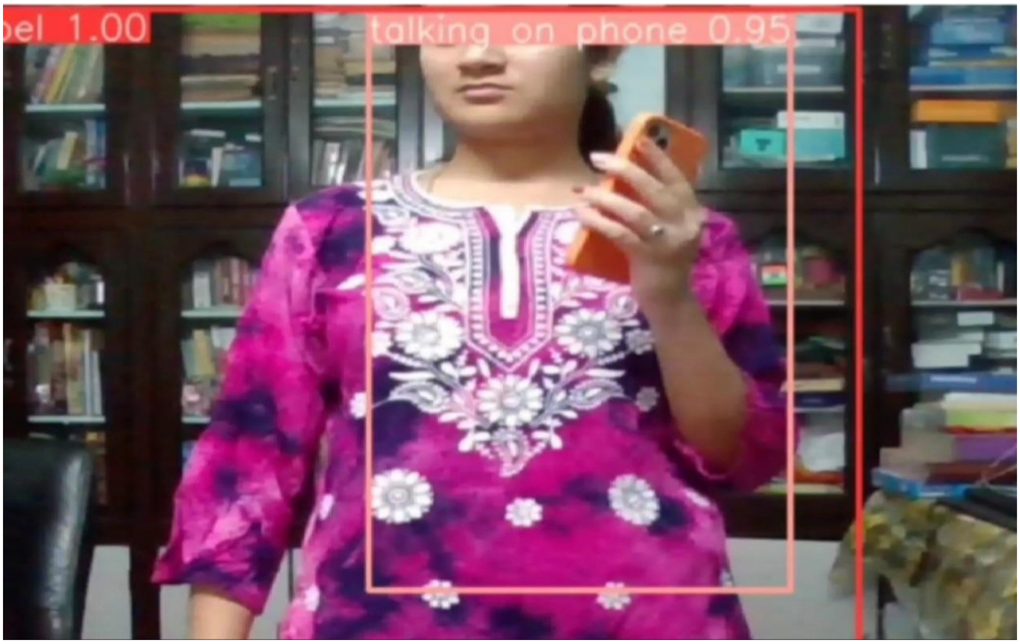
Classroom Phone Usage Detection System

Institution: Heritage Institute of Technology, Kolkata
Members:
- Ankana Datta – 2nd Year B.Tech in CSE (AIML)
- Anidipta Pal – 2nd Year B.Tech in CSE (AIML)

Introduction

In today's educational environments, unauthorized use of mobile phones in classrooms presents significant challenges. Phone conversations can disrupt the learning process, distract both students and teachers, and reduce overall academic engagement. To address this issue, we propose a **Classroom Phone Usage Detection System** designed to identify and mitigate the problem of students talking on phones during class. This system leverages advanced object detection models to detect mobile phone usage in real-time, issue alerts, and record instances for further analysis.



System Overview

The proposed system utilizes state-of-the-art computer vision techniques, specifically designed to operate in real-time within a classroom setting. By analysing video footage from classroom surveillance cameras, the system can detect students engaging in phone conversations, trigger alerts, and store relevant data for future review.

Methodology

1. Data Collection and Annotation

- Data Sources → We collected video footage from CCTV and surveillance cameras in classroom settings. Images were extracted from these videos at a rate of 40 frames per second (FPS).

- Annotation Process → Using LabelImg, the images were annotated with bounding boxes to identify students and their respective mobile phones. This step is crucial for training the detection model.

2. Image Pre-processing

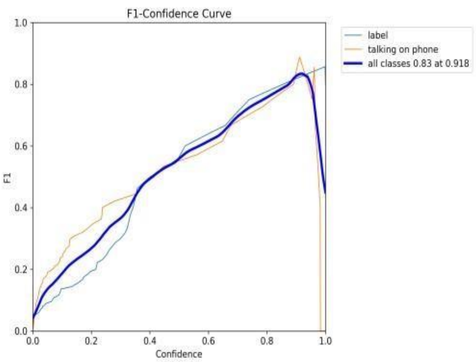
- Normalization and rescaling → The collected images were normalized and resized to ensure consistency in input data. Pre-processing also involved filtering to reduce noise and enhance image quality.
- Data Splitting → The dataset was divided into training, validation, and testing sets using a 70-20-10 split. This ensures a robust evaluation of the model's performance.

3. Model Building and Configuration

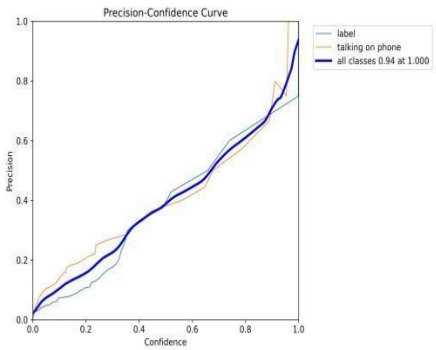
- Model Selection → Two models were developed for the system:
  - YOLOv8xA highly efficient object detection model, tailored to detect students talking on phones within the classroom.
  - Hybrid Architecture (YOLOv8 + ResNetv2A hybrid model combining the strengths of YOLOv8 with ResNetv2 to enhance the detection accuracy, particularly in complex and crowded scenes.
- Model Configuration → Key hyperparameters, such as image size, batch size, anchor boxes, and activation functions, were meticulously tuned to optimize model performance.

4. Model Training

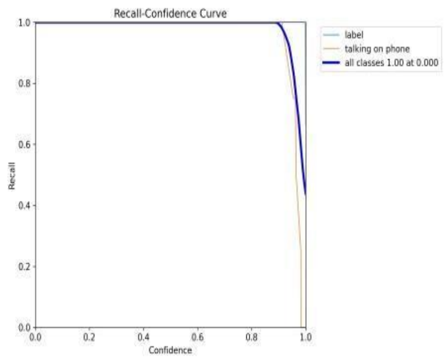
- Training Process → The models were trained on the annotated dataset, where they learned to detect objects (i.e., students and phones) by minimizing detection loss through iterative adjustments of model weights.
- Evaluation Metrics →Post-training, the models were evaluated using precision, recall, and mean average precision (mAP) to assess detection accuracy and overall performance.



F1-confidence curve



Precision-Confidence Curve



Recall-Confidence Curve

5. Database Integration

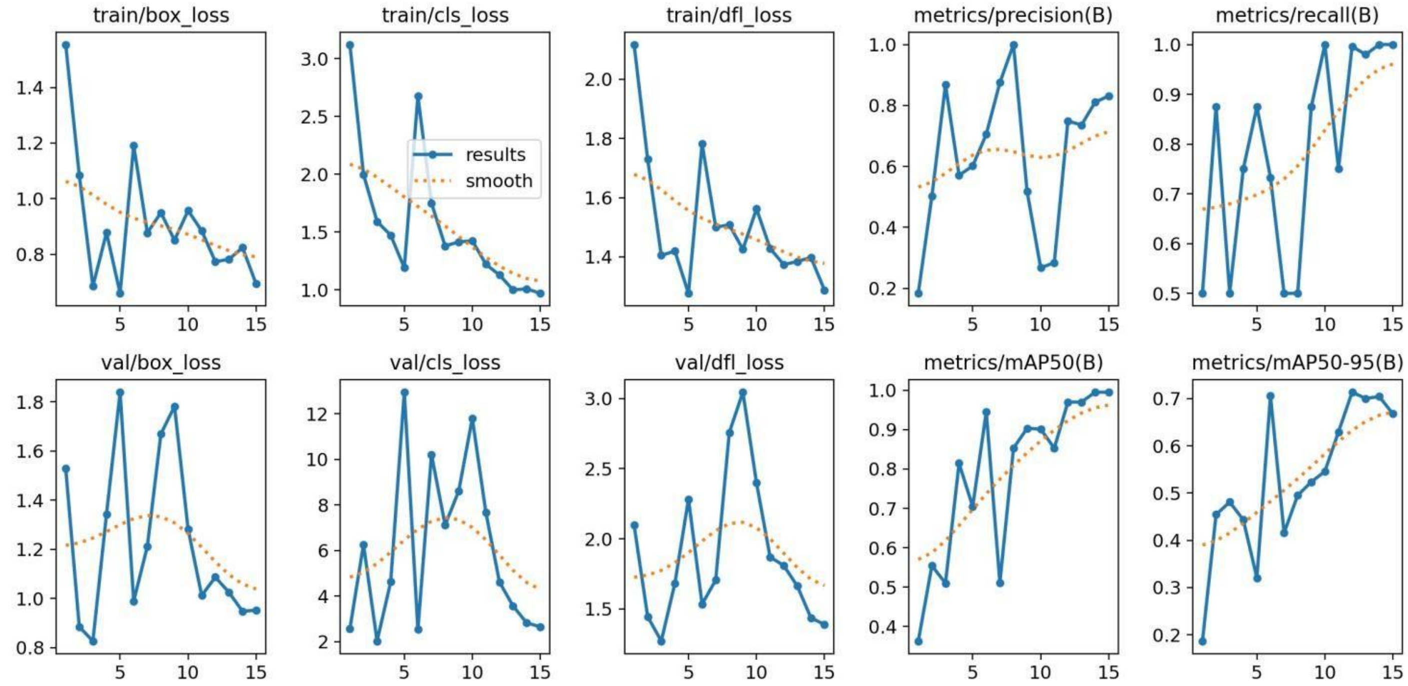
- SQL Database → The system will connect to an SQL database where details of detected phone usage instances are temporarily stored. This database enables the generation of reports and charts for further analysis and accountability.
- Data Logging → Each detected instance is logged with relevant details, such as timestamp, student identity, and the nature of the phone activity.

6. Model Fine-Tuning

- Optimization → The models were fine-tuned by introducing additional convolutional layers and extending training epochs. This process improved the model’s accuracy and reduced log loss, enhancing performance metrics such as the Receiver Operating Characteristic (ROC) and Intersection over Union (IoU) scores.

7. Model Testing

- Fusion and Testing → The YOLOv8x and Hybrid models were fused to create a comprehensive detection system. The final model was tested on unseen classroom footage to evaluate its generalization capabilities and real-world performance.



8. Deployment

- Cloud Deployment → The final model is packaged and deployed using Azure Machine Learning infrastructure, ensuring scalability, reliability, and easy integration with existing classroom management systems.

Practical Use Cases

1. ***Educational Institutions*** → Detect and mitigate phone usage during lectures to maintain focus and discipline in classrooms.
2. ***Examination Halls*** → Ensure exam integrity by identifying students attempting to use phones during tests.
3. ***Training Centres*** → Enhance engagement during professional training sessions by reducing distractions caused by unauthorized phone use.
4. ***Conference Rooms*** → Monitor and manage phone usage during critical meetings and presentations to maintain professionalism.

Challenges Faced

- ***Dataset Collection*** → Acquiring real-time CCTV footage posed significant challenges due to privacy concerns and the restricted availability of such data, which is often protected under surveillance policies.
- ***Image Processing*** → The pre-processing stage was particularly challenging due to the need for standardization across diverse and noisy datasets, compounded by the limited availability of high-quality images.

Technologies and Tools

- ***Computer Vision Libraries*** → OpenCV, YOLOv8x, ResNetv2
- ***Data Processing*** → Scikit-Learn, Pillow
- ***Visualization and Deployment*** → Matplotlib, Streamlit, Azure ML

Conclusion

The **Classroom Phone Usage Detection System** demonstrates the potential of leveraging image processing and deep learning to enhance classroom management and maintain academic integrity. By detecting unauthorized phone usage, this system contributes to a more focused and productive learning environment. Future work may involve expanding the dataset, refining model architectures, and exploring additional applications in other contexts where mobile phone usage needs to be monitored.

GitHub Repository

For more details on the implementation and to access the code, visit our GitHub Repository →
https://github.com/anda05/Student_phone_use_detector