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AI-Based Smart Examination Invigilation System Using Deep Learning

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Abstract:

Maintaining discipline during examinations becomes difficult when a limited number of invigilators are responsible for monitoring large classrooms continuously for long durations. In many situations, suspicious activities such as looking toward neighboring students, passing answer sheets, checking mobile phones, or communicating through gestures may remain unnoticed during manual supervision.

This paper presents an AI-based smart examination invigilation system developed using deep learning and computer vision techniques for automated classroom monitoring. The proposed framework uses the YOLOv8n object detection model together with live webcam or CCTV video streams to identify suspicious student activities during examinations in real time.

One of the important parts of this work was the preparation of a custom classroom dataset using recordings collected under realistic examination conditions. Twenty-seven classroom videos were captured under different seating arrangements and lighting conditions. The recorded videos were processed using Python and OpenCV libraries to extract image frames for training.

During preprocessing, several extracted frames were found to be repetitive or blurred because consecutive frames contained very little variation. To improve dataset quality, additional preprocessing operations such as frame skipping, duplicate frame removal, blur filtering, and annotation correction were performed manually.

The final dataset contained 870 annotated images prepared using Roboflow for training and evaluation. Experimental observations showed that careful preprocessing and annotation refinement improved overall detection consistency during classroom monitoring. The proposed framework demonstrates how AI-assisted surveillance systems can support educational institutions in improving examination transparency and automated monitoring.

Index Terms—Artificial Intelligence, Computer Vision, Deep Learning, YOLOv8n, Examination Monitoring, Smart Invigilation System, Object Detection

I.INTRODUCTION

Examinations continue to play an important role in evaluating aca- demic understanding and student performance. Because of this, main- taining fairness and discipline inside examination halls is essential for educational institutions. In most colleges and schools, invigilation is still handled manually by human supervisors. Although this method has been followed for many years, monitoring becomes difficult when a large number of students are seated inside the same classroom.

During long examination sessions, invigilators may experience re- duced concentration or observation fatigue. As a result, suspicious activities such as exchanging papers, using hidden chits, checking mobile phones, or repeatedly looking toward neighboring students can sometimes remain unnoticed. These challenges become more notice- able in large classrooms where only a few invigilators are responsible for supervising many students simultaneously.

Recent developments in artificial intelligence and computer vision have created opportunities for building automated monitoring systems capable of analyzing classroom video streams in real time. Deep learn- ing models are capable of identifying objects and activities directly from video feeds with good speed and accuracy. Among the available object detection models, YOLO-based architectures are widely used because they provide faster inference speed while requiring compara- tively lower computational resources.

In this work, an AI-based smart examination invigilation framework is proposed for automatically monitoring classroom activities during ex- aminations. The system uses YOLOv8n together with live classroom video streams to identify suspicious activities such as looking side- ways, passing papers, hand signaling, chit usage, and mobile phone interaction.

Apart from model development, considerable effort was also spent on preparing a realistic classroom dataset. Instead of depending entirely on publicly available datasets, classroom examination recordings were collected manually so that the system could be trained under practical examination conditions.

II. LITERATURE SURVEY

Several researchers have explored the application of artificial intelli- gence and computer vision techniques for automated surveillance and behavioral monitoring systems. Earlier monitoring approaches mainly depended on traditional image processing and motion-based analysis methods. However, such systems often struggled in complex envi- ronments because they were highly sensitive to lighting conditions, background movement, and camera positioning.

The introduction of deep learning significantly improved the perfor- mance of object detection systems. Convolutional Neural Networks enabled models to learn complex visual features directly from image data, making detection systems more reliable for real-time applica- tions. YOLO-based object detection models became widely adopted because they perform detection and classification within a single stage, reducing computational delay while maintaining good accuracy.

Recent studies have applied AI-based monitoring techniques in traffic surveillance, industrial safety systems, crowd analysis, and smart security applications. Some research works also explored automated examination monitoring using face detection, eye tracking, and activity recognition. However, many existing systems mainly focused on online examinations rather than classroom-based offline examination environments.

Another limitation observed in earlier works was the lack of realistic classroom datasets representing actual examination behavior. Publicly available datasets often contain limited variations in student posture, classroom arrangement, and suspicious activities. In several cases, annotation inconsistency also affected model training quality.

To address these limitations, the present work focuses on building a custom dataset using realistic classroom recordings captured during examination sessions. Additional preprocessing and annotation re- finement operations were also performed manually to improve dataset quality before training.

III. PROPOSED SYSTEM

The proposed smart invigilation system was developed to monitor classroom environments automatically using computer vision and deep learning techniques. The framework processes live video streams captured from webcams or CCTV cameras and continuously analyzes student activities during examinations.

The overall workflow of the system includes:

- Capturing live classroom video streams
- Extracting image frames
- Applying preprocessing operations
- Detecting suspicious activities using YOLOv8n
- Performing behavioral analysis
- Generating alerts during abnormal activity detection

The system was trained to identify suspicious examination behaviors including:

- Looking repeatedly toward neighboring students
- Looking backward frequently
- Passing answer sheets
- Mobile phone usage
- Hand signaling
- Chit usage
- Unusual interaction patterns

YOLOv8n was selected because it provided comparatively faster de- tection speed while also requiring lower computational resources. This made the model suitable for continuous classroom monitoring applications where low-latency processing is important.

DATASET PREPARATION

One of the major contributions of this work was the preparation of a realistic classroom examination dataset. Instead of relying completely on publicly available datasets, classroom recordings were collected manually to represent practical examination conditions more accu- rately.

A total of 27 classroom video recordings were captured using mobile cameras inside classroom environments. Different seating arrange- ments, student positions, and lighting conditions were intentionally included so that the dataset would contain sufficient environmental variation.

Some recordings were captured under natural lighting conditions, while others were recorded under indoor fluorescent lighting. The dataset included both normal student behavior and suspicious exami- nation activities such as:

- Looking left
- Looking right
- Looking backward
- Passing answer sheets
- Hand signaling
- Mobile phone usage
- Talking during examinations
- Chit usage
- Normal writing posture

The collected videos were converted into image frames using Python and OpenCV libraries. During initial extraction, it was observed that extracting every frame generated excessive redundancy because consecutive frames appeared highly similar. To reduce unnecessary duplication, frame skipping was introduced so that only useful frames were retained periodically.

Approximately 1102 image frames were extracted from the recorded videos. Several preprocessing operations were then carried out manu- ally to improve dataset quality before training.

IV. PREPROCESSING AND ANNOTATION

The preprocessing stage played an important role in improving dataset consistency and training quality.

The following preprocessing operations were applied:

- Duplicate frame removal using image similarity comparison
- Blur detection using Laplacian variance analysis
- Filtering of low-quality frames
- Organized dataset categorization
- Manual annotation refinement

During annotation, some automatically generated bounding boxes covered unnecessary body regions instead of focusing mainly on suspicious activity areas. To improve annotation consistency, several annotations were manually refined using the Roboflow platform.

Certain frames also contained overlapping students or partial visibil- ity because of classroom seating arrangements. Such frames were reviewed carefully, and unclear annotations were either corrected or removed from the final dataset.

After preprocessing and annotation refinement, the final dataset con- sisted of 870 high-quality annotated images prepared for model train- ing and evaluation.

V. RESULTS AND DISCUSSION

The proposed framework produced encouraging results during class- room monitoring experiments. One important observation during implementation was that dataset quality had a major influence on detection consistency.

Initially, several extracted frames contained blur, duplicate images, and unclear activity regions, which affected model performance dur- ing testing. To improve training quality, additional preprocessing operations such as frame skipping, duplicate removal, and annotation refinement were introduced manually.

The system was able to identify suspicious activities such as abnormal head movement, passing papers, hand signaling, and mobile phone usage under different classroom conditions. However, slight variations in detection accuracy were noticed when lighting conditions changed or when students partially occluded each other.

Among the tested models, YOLOv8n provided better real-time per- formance while also requiring comparatively lower computational resources. This made the framework more suitable for continuous classroom monitoring applications.

Overall, the experimental observations showed that combining proper dataset preparation with lightweight deep learning models can provide a practical solution for AI-assisted examination monitoring.

VI. ADVANTAGES

The proposed framework provides several advantages compared to conventional manual invigilation approaches:

- Continuous automated classroom monitoring
- Reduced dependence on manual supervision
- Faster identification of suspicious activities
- Improved examination transparency
- Real-time alert generation
- Reduced monitoring fatigue for invigilators

VII. SCALABILITY FOR LARGER CLASSROOMS LIMITATIONS

Although the system achieved encouraging results, certain limitations were observed during implementation and testing:

- Detection accuracy may reduce under poor lighting conditions
- Student occlusion can affect visibility and detection consistency
- Similar student movements may occasionally generate false detec- tions
- Large classroom deployment may require higher computational resources

VIII. CONCLUSION AND FUTURE WORK

This paper presented an AI-based smart examination invigilation system developed using deep learning and computer vision techniques for automated classroom monitoring. The framework integrates YOLOv8n with live video processing to identify suspicious student behavior during examinations in real time.

A realistic classroom dataset was prepared using examination record- ings captured under practical classroom conditions. Multiple preprocessing and annotation refinement stages were performed manually to improve dataset quality before training.

Experimental observations indicated that careful preprocessing sig- nificantly improved overall detection consistency during monitoring. The proposed framework demonstrates the practical applicability of AI-assisted surveillance systems in educational environments.

Future improvements may include eye-gaze estimation, facial expres- sion analysis, multi-camera synchronization, audio-based suspicious activity detection, and cloud-based monitoring support for large-scale examination environments.

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