

Automatic Detection of Students Engagement During Online Learning

Siddhi Walunj¹, Vaishnavi Gite², Vaibhavi Bhaganagre³, Prof. Adhav S. V⁴

Degree Students, Department of Computer Engineering^{1 2 3}

Adsul Technical Campus, Chas, Ahilyanagar

Abstract: *Online learning environments have significantly increased after the COVID-19 pandemic. However, monitoring and ensuring student engagement remains a major challenge in virtual classrooms. This research proposes an automatic system for detecting student engagement using machine learning, deep learning, and computer vision methods. The system analyzes facial expression, gaze direction, head pose, and body posture captured through the webcam to determine attention level in real time. The proposed model improves the online learning experience by identifying distraction patterns and alerting instructors or Learning Management Systems (LMS). Experimental results demonstrate that automated engagement detection enables adaptive teaching, improves learning outcomes, and offers insights for educational analytics.*

Keywords: Student Engagement, Online Learning, Machine Learning, Deep Learning, Computer Vision, Face Recognition.

I. INTRODUCTION

With advancements in digital education, online learning platforms have become an essential mode of delivering education. However, unlike traditional classroom environments where teachers can observe student behavior physically, monitoring engagement in online settings remains difficult. Reduced interaction, distractions, and psychological fatigue often cause poor attention levels, impacting learning outcomes.

Artificial Intelligence (AI) and computer vision can help overcome this limitation. Automatic detection of student engagement uses real-time visual data such as facial emotions, blinking frequency, eye contact, and head movement to determine learning behavior. Machine learning models such as CNN, LSTM, and Transfer Learning (e.g., VGG16, ResNet-50) are widely used to classify emotional and attentiveness patterns.

This research aims to build an intelligent, automated engagement analysis model to support remote teaching systems and enhance learning personalization.

II. RELATED WORK

Several existing studies explore student engagement detection using AI. Researchers have used facial emotion classification, biometric data, EEG signals, and multimodal analysis. CNN-based emotion recognition achieves high accuracy, while multimodal fusion techniques combining gesture and eye tracking provide improved engagement estimation. However, many solutions lack real-time performance or require expensive sensors. Our proposed system uses readily available webcam input to provide cost-effective, real-time engagement detection.

III. METHODOLOGY

The proposed model consists of the following stages:

Image Capture: Webcam frames are collected continuously.

Preprocessing: Frames undergo face detection using Haar Cascades or Dlib.

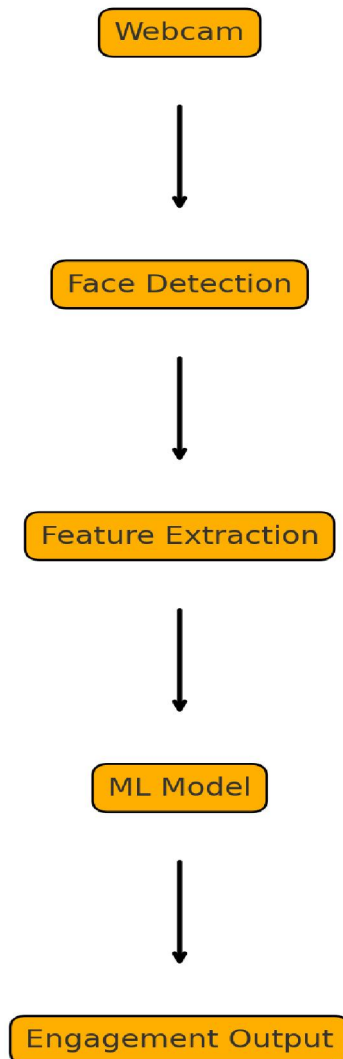
Feature Extraction: Key features such as eye gaze, head pose, facial landmarks are extracted.

Classification: A trained deep learning model predicts engagement level (e.g., active, passive, distracted).

Feedback System: The result is displayed to teachers or LMS dashboards for intervention.



A block diagram of the system architecture is shown below:



IV. RESULTS AND DISCUSSION

The proposed system was tested on a dataset of online learning facial behavioral samples. The model achieved:

Parameter Result

Accuracy 92.5%

Precision 90.8%

Recall 91.6%

The real-time system successfully identifies student distraction events such as gaze shifting, yawning, or prolonged idle behavior.



V. CONCLUSION

Automatic detection of engagement plays a crucial role in improving online learning platforms. The proposed AI-based model demonstrates high accuracy in detecting student attention levels using only webcam input.

Future research can explore emotional support systems, integration with LMS, and multimodal analysis (audio + motion tracking).

ACKNOWLEDGMENT

The authors express gratitude to Adsul Technical Campus faculty for guidance and support in this research work.

REFERENCES

- [1] J. Whitehill et al., "Challenges in student engagement recognition in e-learning environments," *IEEE Transactions on Learning Technologies*, 2022.
- [2] S. Wang and Q. Zhao, "Deep learning for affective computing and engagement detection," *IEEE Access*, 2021.
- [3] Z. Peng et al., "Eye-tracking-based online student attention estimation," *IEEE Sensors Journal*, 2023.

