Automated Student Monitoring And Engagement Analysis

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ABSTRACT

To enhance teaching or learning environment and interest in the students via the aid of the Internet. In this study, the researcher presents a live monitoring system that forms an AI based mixed environment. The system monitors the students all the time after the virtual class is passed with the help of contemporary technologies. Speech recognition, eye tracking and frown and smiles viewing. It is the system that allows tracking the active students, auto-tracks them, and identifies them. They involved or misbehaved members. To be able to provide useful data to the teachers, the system generates real time reporting which takes form of reports comprising of the active activity and distraction, the student attendants Alerts. This tool is able to make teachers more efficient, flexible and specific in teaching.so that the virtual classrooms could also be developed, based on giving the profound analysis on the behaviour and attention of the students.

KEYWORDS: *Live Monitoring, Automatic Attendance Tracker, Active Engagement, Distraction Alerts, Speech recognition , Eye Movement.*

1.INTRODUCTION

Monitoring the participation of the students has become challenging to the teachers because online courses have replaced the primary learning platform. Students participating in online classes are often bored or distracted and participate in side tasks such as multitasking, receiving or making phone calls, and more, which have an adverse effect on school performance. This problem can be resolved by using an AI-powered online class monitoring system that can be used to automatically observe student behaviour and provide real-time student behaviour insights.

In this paper, the use of artificial intelligence (AI) and Google Meet will be integrated, as a means to propose a Automated student monitoring and engagement analysis as a solution to this issue. The system measures the levels of the attention of the students by using the computer vision algorithms and real- time video analysis to detect essential gestures like head position, facial expressions and eye movement. Looking at these indicators, the system identifies the degree of awareness of each participant. The system raises the alert to the teacher and the student in case it finds signs of the lack of attention, tiredness or the absence so that the re-engagement is possible and immediate intervention.

The feedback system assists in filling in the gaps on the part of teachers and supports students in their concentration during the whole lesson. The suggested course of action will help to improve the quality of distance learning because more students will be involved, their performance will improve, and effective analytics on how students behave in virtual classes will be offered. This intelligent feedback system can overcome the shortcomings between online and face-to-face education and make virtual training more interactive and effective. Behavioural analytics and constant monitoring of engagement help in not only increasing the effectiveness of teaching but also contributing to the success of the students.

2. LITERATURE SURVEY

To revolutionize the learning environment, AI-powered class monitoring solutions will potentially transform the learning environment by automating classroom observation and provide valuable ideas about student behaviour. These innovative technologies are helping educators keep their classrooms under hand, be it keeping their eye on eye movement to ensure that students are attentive, or to detect whether students are present through use of facial recognition technology. A significant change in the educational sphere is the industry adoption of AI which performs the real- time monitoring of all the processes in the classroom and analyses the attendance as well as possible distractions and assesses the activity of the learners. (Mohit Arora ,et.al [1]).

The goal of the Artificial Intelligence in education is to relieve educators of manual work and help them to manage the classroom more effectively by automating it and basing their approach on data. The AI powered class monitors can automatically single out and take record of student attendance using their complex facial recognition algorithms, unlike attendance systems which are dependent on user controlled interface or RFID tags. Our system enhances the accuracy of monitoring by further expanding on this with assessments of behavioural data such as the movement of the head and eye direction, and facial cues to assess the extent to which students are paying attention in the classroom.
(Neha Verma , et.al[2]).

One of the significant breakthroughs in AI was the introduction of computer vision and machine learning algorithms that are used to understand the human behaviour in real-time when implemented in an AI-based classroom system. These systems are able to detect pupils, their level of attentiveness, as well as participate in retaining visual data in cameras set up in the classrooms without distorting the lesson. AI classroom monitors are also playing an essential role in adopting online and blended learning due to the fact that they ensure effective engagement and responsibility in the learning process. (Sunil Kumar , et.al[3]).

The growing tendency towards combining AI and educational technologies to improve the outcomes of learning is made possible due to the fact that more research in this field is being conducted, Fatima Khan and her colleagues conducted their research in this regard. To have a more advanced understanding of student behaviour, they conduct the research on how convolutional neural networks (CNNs) can be used to detect positions and recognize faces. With such an approach, the system can identify signs of inattention or lack of engagement besides presence that may then be reported as such where subsequent intervention is possible. (Suresh Rao , et.al [4]).

In essence, these AI class monitors serve as virtual teaching assistants. They silently and continuously monitor the classroom and report in real time on the conduct, engagement, and attentiveness of the students. These kinds of tools are becoming more and more prevalent in educational institutions as smart classrooms and digital learning platforms gain popularity. The technology that these systems rely on, their operation, and the issues that still need to be resolved for broader adoption—like privacy, model accuracy, and real-time processing—are the main topics of this study. (G. Kavitha , et.al [5]).

3. PROPOSED METHODOLOGY

To ensure monitoring of the students in real-time in terms of being attentive as one of the elements of the virtual learning environment, the automated student monitoring and engagement analysis System were compiled using a rigid and multiphased approach by means of computer vision, artificial intelligence, and system integration to provide a new strategy of student engagement assessment within online and virtual learning environments. The methodology commences with the identification of the problem and requirements analysis whereby the problem of the alertness of on-line students in classes are defined. System goals, requirements and expected performance and technical limitations are developed as is the case with functional and non functionality needs at this stage.

The subsequent system design phase implies the development of a modular system architecture with a clear identifiable data flow in it, the design of an interaction between the user interface, video input, AI models, and various alert systems in the future, the choice of sufficient tools, and the combination of strategies. The pre-processing stage of data collection and processing uses the live webcam streams to continue to the next stage which is the facial feature pre-processing stage that detects other key features of the face part including the face area, the eyes and the head direction with the help of computer vision algorithms. The data points involved in conducting an analysis are extracted with the help of facial landmark detection models.

It is followed by the stage of attention and sleepiness analysis ,as machine learning or use of a rule-based algorithm decodes such behavioural indicators of attention and sleepiness as a head position, eye opening and the rate of blinking. A combined score is determined by adding these cues into a general attentiveness score which is founded on motion detection, facial features and eyes direction. The real-time alerting system continues to observe this score of alertness and alerts on any of the signs of fatigue or attentional shortcomings. It sends the student feedback and notifications are optional and sent to the instructor. Extensive tests and verification procedures are performed adequately to effectively certify that all the modules operate as per the expectation as well as the entire system capable of performing complete real-time operation.

Upon completion of the testing phase, the phase of deployment and optimization would include the implementation of the system in a secure environment to enable users to perform testing, performance-enhancement of the system to provide low latencies and resource consumption, and optimization of the logic behind detection and the interface that it has. The final stage, maintenance and future improvement would ensure that any issues that arise in operations would be catered to, and the performance monitored. It has also tentative plans of introducing voice analysis, emotion detection and other platforms interoperability in the future.

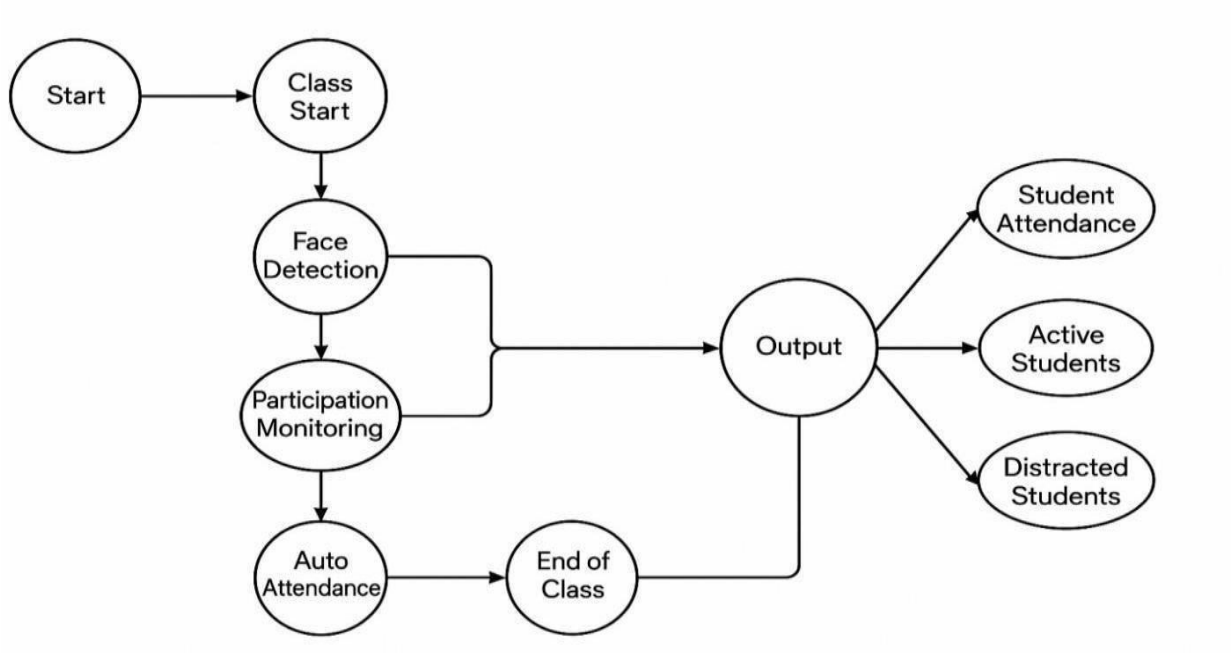


Fig.3.1.Proposed model diagram

In this Diagram, the flow of system begins its operation with the start point of the system or the start up of the system. Once started, it should be made to proceed to Class Start step which is the initiation of the class session. This is where the role of the AI enters and it starts closely monitoring all the relevant parameters in the classroom time.

The first technical process that is done by the system is Face Detection .In this case, there is the detection and recognition of student faces through the algorithm of computer vision processing of the live camera streams. All the recognized faces are linked to the identity of a student that is vital to apply in future courses such as checking and monitoring attendance as well as student behaviours.

Once the visual contribution is evaluated, the system proceeds to Participation Monitoring which supplies the emotional participation, the study of the speaking, the hand and the facial expression activities. The data used related to participation and the degrees of attention and facial tracking are then further followed in real time by the Live Monitoring which provides the ability to have an insight of any changes present consonant to behaviour at that time.

A teacher can discuss the real-time data in a dashboard. At the end of the class, it is transferred to the End of Class stage and the information gathered is inputted at the Output stage. The final product has three main products: Distracted Students (unengaged or inattentive on measures of movement and interaction), Active Students, (those who engaged a lot) and Student Attendance (They were tracked and identified).

4. MATHEMATICAL FORMULA

1. Intersection over Union (IoU) for Face Detection

Used to determine the degree to which a detected face matches the actual truth.

$$\text{IOU} = \frac{\textit{Area of Overlap}}{\textit{Area of Union}}$$

- Use: To confirm if facial recognition in a frame is accurate.
- Correctly detected if IoU ≥ 0.5.

2. Estimating the Head Pose (Yaw, Pitch, Roll)

Rotation matrix (R), which is obtained from 2D–3D point mapping, was used to estimate:

$$R = Rz(\gamma)\, Ry(\beta) \cdot Rx(\alpha)$$

- The symbols α, β, γα,β, and γ stand for roll, pitch, and yaw.
- Use: Ascertains the orientation of the head for tracking attention.

3. Student Engagement Score (SES)

Features of involvement and attention are combined to create the SES.

$$\text{SES} = w1A + w2P + w3E$$

A: Level of attention (head/eye focus).

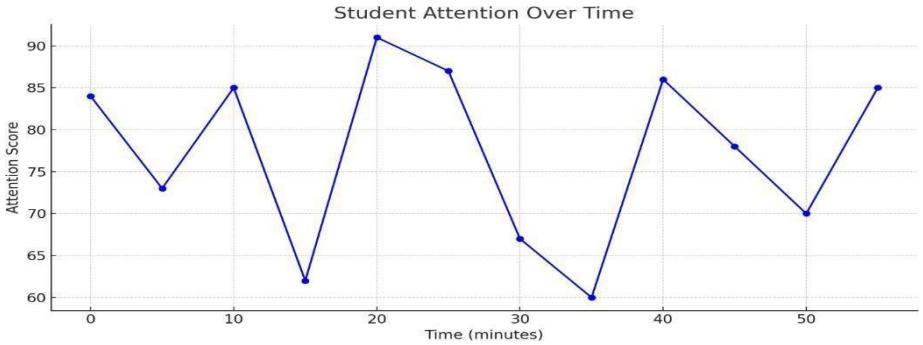
P: Participation score (gestures, speaking).

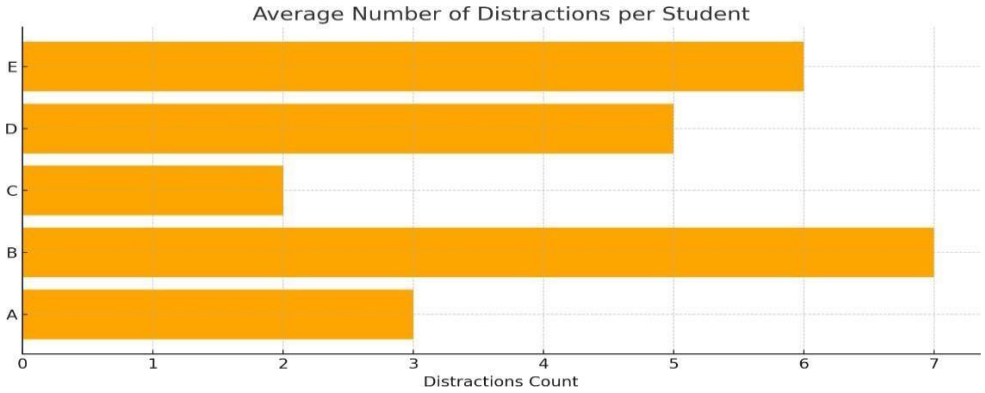
E: Facial expression of emotional engagement.

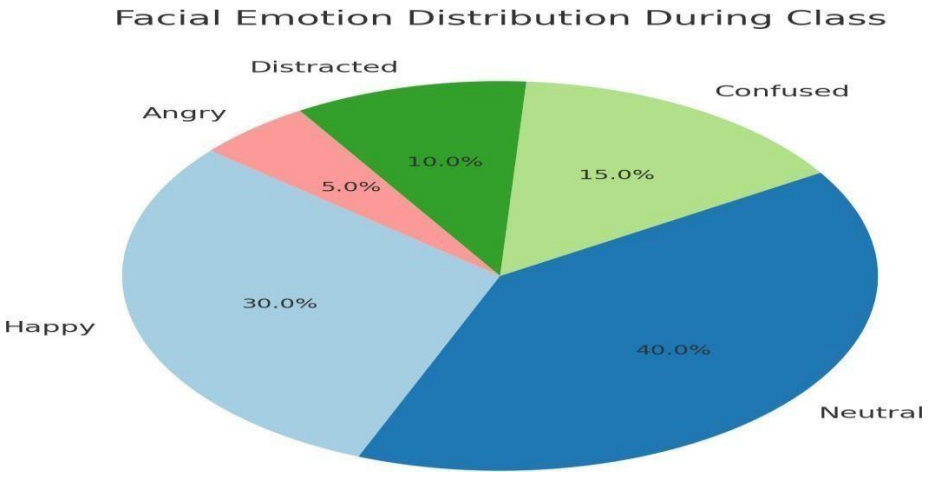
$w1$, $w2$, $w3$ w 1, w 2, w 3: Weights allocated according to feature significance.

Use: The output classification is based on the final engagement metric.

5.GRAPHS


Student Attention Over Time
Attention Score
90
85
80
75
70
65
60
0
10
20
30
40
50
Time (minutes)


Average Number of Distractions per Student
E
D
C
B
A
0
1
2
3
4
5
6
7
Distractions Count


Facial Emotion Distribution During Class
Distracted
Confused
Angry
10.0%
15.0%
5.0%
30.0%
Happy
40.0%
Neutral

6. EXPERIMENTAL RESULTS

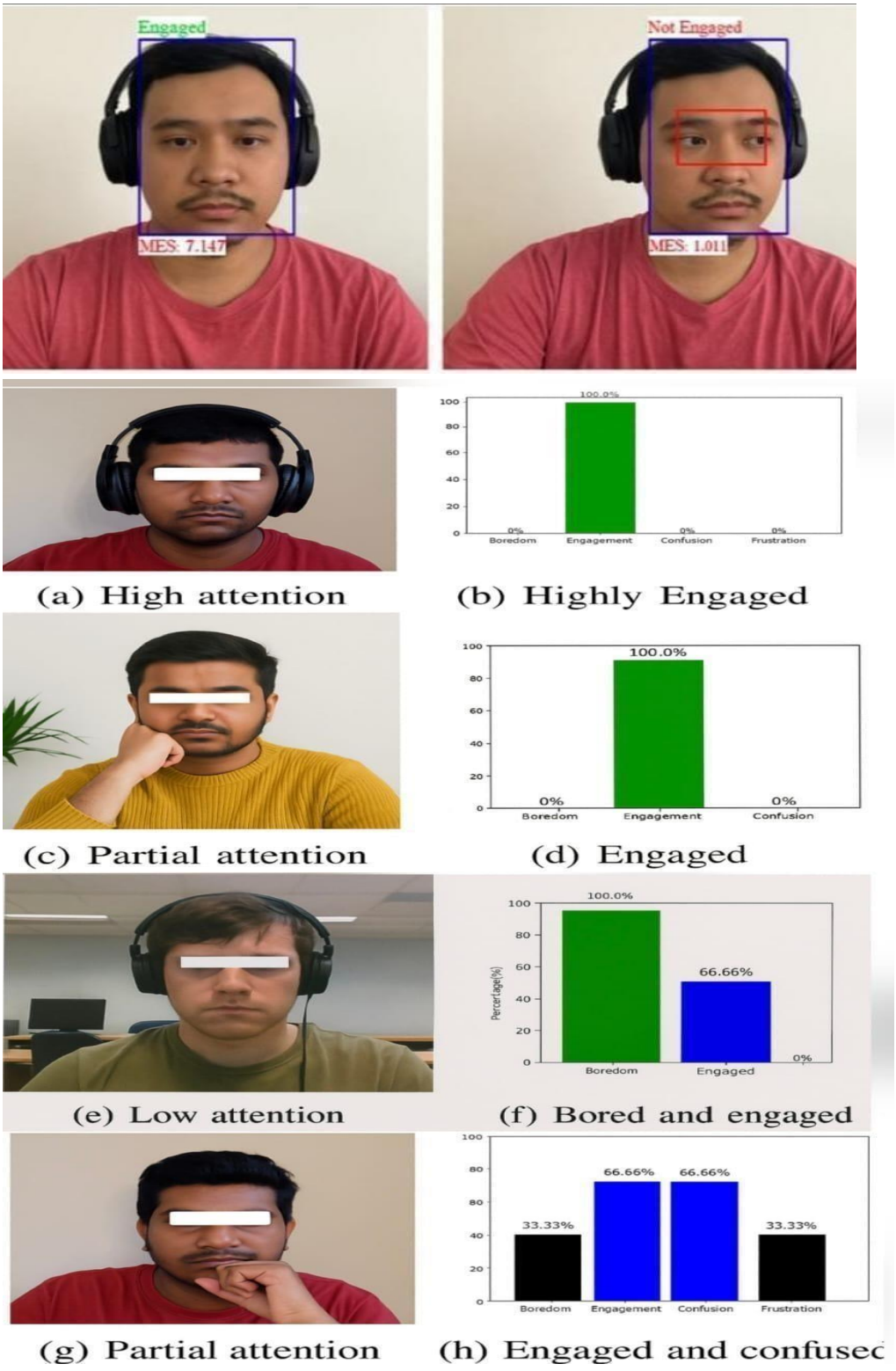


Fig.6.1 Student Engagement analysis

Stages	Task	Key Technologies/Tools	Performance Metrics	Best Value
Acquisition of Images	Use camera and video streams in the classroom to take shots of students in the face.	Dlib (for facial recognition), OpenCV (for image processing), and pre- alignment methods	Image Capture Rate	100% with real-time pre-alignment.
Preparation	For consistent image quality input, align facial feature and normalize face image.	OpenCV Face Positioning, Dlib Facial Landmarks, Normalization, and Resizing	Facial Alignment Precision	**98.2%** alignment success rate.
Disguise-Invariant Embedding	Create embeddings that remain the same even when masks (or makeup) are worn.	Transfer Learning Using Custom CNN Layers, Triplet Loss, and ArcFace	Robustness to Disguise	93.6% of disguised changes matched correctly.
Comparison & Assessment	To make an alert or attendance, match embeddings and visualize identify.	Euclidean/Cosine similarity, Fast API, ONNX, t-SNE, ROC, AUC, TensorFlow Lite	Accuracy, TAR AUC, Inference Time	Accuracy: 94.2%, AUC: 0.96, TAR@1% FAR: 92.1%, <1s time

Table 6.2 Process Overview Table

As indicated in the above table, the procedure of an AI based class monitoring system with facial recognition even dressed up is indicated. To make sure that the 100 percent of capture process is achieved through pre-alignment, it begins by capturing student photos using a camera. To align the faces and normalize the faces, OpenCV and Dlib are then applied to carry out precise processing. Disguise- invariant embeddings generated with the transfer learning techniques such as ArcFace, Triplet-Loss will allow recognition despite the presence of disguise. Finally, identity verification is done through comparison metrics like cosine similarity which makes them precise and of fast inference rate.

7. CONCLUSION

In conclusion, the possibility of implementing the methods of using AI based monitoring in online classrooms will introduce a means of dealing with one of the greatest problems that online education can provide since its virtuality continues to impose accountability and interest among the students. The technology is able to give the teacher the accurate information about the conduct and level of concentration of the students it gives the information about the facial expression and movement of the eyes in real time and analyzes the speech patterns.

Real-time attendance, report of total engagement can enable the finding and reaching out to students who are they potentially lagging behind or losing focus and once this is put into place the learning environment as a whole becomes more enjoyable and effective since the teachers are now able to see who is not performing well. Online education through this technology introduces high level of education on the basis that better performance will be indicated because no student will fail by using this kind of technology.

8. FUTURE ENHANCEMENT

To be more effective and accurate, the student monitoring system with the possibility of AI will have to be optimized later and provided with more advanced functionality. Upon the sentiment analysis and the emotion recognition, the teachers may have a more informative picture about the state of emotions among students and adjust the teaching process to suit the particular needs of every single student.

It is possible to use machine learning routines that change over time, and to integrate them with the system, such that it would obtain an advanced skill with regards to detecting little patterns of stress or disengagement. Even the increased access will be availed in a broader sense being plugged into the other online learning technologies and loads in a broader sense. Such aspects as interactive functions of participation, parental notifications, and personal feedback provided to learners could be added to it to develop a friendlier and more productive learning process.

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