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Empowering Virtual Education and Lecturing through AI and ML Advancements

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***Abstract* - The fast rise of online learning, intensified by the COVID-19 issue, highlighted operational challenges such as manual grading, student apathy, and irregularities in attendance. This study presents an enhanced e-learning system with four major innovative components: facial recognition based attendance combined with interaction heat maps; machine learning-driven evaluation of subjective replies; Enhanced lecturing by using automated whiteboard drawing; and student engagement analysis using facial and postural measurements. Our solution merges cutting-edge machine learning and computer vision to reduce instructors' manual labour, increase student interaction, and improve the learning experience. According to our findings, these changes provide a comprehensive and engaging online educational environment. Future developments will concentrate on iterative feedback, the exploration of various machine learning frameworks, the expansion of visual tool capabilities, and the development of biometric attendance systems.**

Keywords: E-learning, Deep learning, Natural language processing, Computer vision, Machine learning, Text-to-image generation.

I. INTRODUCTION

E-learning, which at first served as a useful complement to traditional classrooms, has since taken center stage in contemporary education. E-learning platforms were first intended to serve as a supplemental teaching tool by giving students access to materials and tutorials outside of regular class hours. But just as technology advanced, so did e-learning. It changed from being a supporting tool to many people's primary platform, especially when life required flexibility. More people started using online learning as a form of education, whether it was because of distance, health issues, or personal preferences. With the growing popularity of smartphones, tablets, and laptops, e-learning has become the preferred method of education for organizations and businesses. They realized that through e-learning, education could be more inclusive, breaking down the barriers of geography and time.

The impact of online learning was highlighted by the sudden emergence of the COVID-19 pandemic. Traditional classrooms suddenly felt unsafe, and society needed to quickly adapt. We now have Google Meet, Microsoft Teams, and Zoom. These platforms changed from being basic communication tools to the center of business training and education almost immediately. These platforms were used by organizations including schools, colleges, businesses, and even unofficial study groups to carry on their operations. The rush to adapt meant that millions were now logging in, turning on their cameras, and attending classes or meetings from their homes. The bedroom, living room, or even the kitchen became the new classroom or office. These platforms provided a semblance of normalcy in times of unprecedented change.

However, as days turned into months, and months into a year and more, the sparkle of these platforms began to diminish. The deeper challenges began surfacing. Teachers and educators found that while platforms like Teams or Google Meet facilitated the delivery of lectures, they were not entirely suited for the comprehensive needs of a classroom. Grading assignments, especially those that demanded subjective analysis, remained an arduous task. Essays and lengthy answers needed manual review in contrast to multiple-choice questions, which could be automatically evaluated. Along with being time-consuming, this technique also included a risk of accidental bias or inconsistent results. The issue of student engagement was still another important challenge. In physical classrooms, physical distance and direct eye contact helped teachers more easily assess how focused students were. It got harder online, especially on services like Zoom. There were many distractions, and teachers found it difficult to figure out whether or not students were focused because there were no clear physical signs. Additionally, the way that topics are explained has altered. To clarify hard subjects in actual classrooms, teachers may pivot, and utilize a whiteboard or even physical models. While they could share screens and use digital whiteboards on platforms like Teams or Google Meet, the spontaneity and fluidity of teaching

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sometimes got compromised. Lastly, attendance became a tricky subject. Sure, one could log into a Zoom class, but were they genuinely present? It wasn't just about logging in genuine learning required engagement.

Given these challenges, there was a clear gap, and that's where LECTA comes into the picture. Conceived with a vision, LECTA aims not just to imitate the traditional classroom experience but to elevate it. LECTA harnesses the latest in technology to provide a streamlined grading system, especially for subjective answers. Through the power of advanced algorithms and Natural Language Processing (NLP), it promises an efficient, consistent, and unbiased evaluation. When it comes to engagement, LECTA is a game changer. Using cutting-edge facial recognition and body movement analytics, it offers insights into real-time student involvement. This allows educators to adjust their teaching techniques on the go, ensuring that their message is not just delivered but is truly absorbed. Furthermore, LECTA revolutionizes the teaching process. It converts vocal explanations into clear and accurate illustrations using a voice-activated diagram generator. There will be no more struggling with large digital whiteboards. What about attendance? It is LECTA. Being involved is more important than just being present. LECTA gives a true image of a student's involvement by combining superior face recognition with interaction heatmaps, guaranteeing that sincere effort receives the credit it merits follow.

II. RELATED WORKS

When it comes to advancing answer assessment, researchers have delved into scoring systems that encompass factors such as morphology, semantics, concept matching, typos, and spelling correction. An exemplar system, C-rater, achieved an 84% consensus with grades [1]. A case study oriented framework [2] introduces reward and penalty schemes. In the reward structure, students accumulating points receive bonuses, while fairness is ensured by enhancing the question case base with these answer points. In the case of unfair tactics by nearby peers, a penalty strategy reliant on a neighbourhood graph is enacted. It's important to note that this model lacks provision for disabilities or oral responses and omits error feedback. Conversely, another system [3] concentrates on term connections, employing machine learning techniques such as Latent Semantic Analysis, Generalized Latent Semantic Analysis, Maximum Entropy Technique, and BiLingual Evaluation Understudy. While robust in evaluation (yielding up to 90% correlation with performance), it lacks feedback components for rectifying student errors. Another innovative approach [4] prioritizes content in responses over grammar and vocabulary. This method employs learning techniques like Character level CNNs, Word level CNNs, Word level bi LSTMs, and BERT. BERT excels even with rephrased responses due to its contextual comprehension. It's important to clarify that this system exclusively identifies user generated answers.

Numerous studies have investigated strategies to amplify student engagement in online classrooms, employing factors such as emotion analysis, eye tracking, head movement, and body posture. Noteworthy among them, Prabin Sharma et al. [5] introduced a model employing emotion analysis, eye tracking, and head movement to differentiate engaged and disengaged students, achieving commendable outcomes. Similarly, Kehan Chen [6] spotlighted posture recognition, utilizing OpenPose for realtime identification of key points on the human body, including hands, face, and feet, contributing to insightful body language analysis. Tharaka et al. [7] offered a distinct perspective by enhancing engagement through gamified virtual learning environments, intensifying emotional and psychological investment.

Furthermore, [8] explored pose detection using an enhanced Faster R-CNN model, thereby dissecting student poses even in intricate classroom settings, augmenting understanding of engagement dynamics. These explorations provide the foundation for my research, aimed at integrating facial expression and upper body detection to enhance online student engagement detection accuracy and efficiency. This integration presents a novel contribution to the existing research landscape, merging established elements of natural language processing, real-time graph generation, and dynamic image positioning guided by spoken instructions. Leveraging advances in keyword extraction, context comprehension, and image location prediction, my project seeks to redefine automated diagram generation, poised to cater to education and accessibility domains.

In the realm of text-to-image generation, a burgeoning field within deep learning, the focus lies in crafting realistic images from textual input. Over time, various models including GANs and VAEs have emerged to tackle this challenge. However, a central concern remains the production of high-quality images that genuinely reflect the input text. Noteworthy studies provide potential solutions. "Text2Scene: Generating Composite Scenes from Text Descriptions" (Zhu et al., 2019) [9] effectively merges GANs and RNNs to construct 3D scenes from textual descriptions, opening avenues for innovative image placement strategies. Moreover, another study explores text-to-image synthesis with extended text descriptions [10]. Their deep learning model employs an inventive GAN strategy to generate convincing images from textual descriptions.

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Prior research in automated diagramming has primarily centred on functional requirements, with limited attention given to the creation of software architecture diagrams. Notably, the emphasis has been on generating UML diagrams, sequence diagrams, and ER diagrams by analyzing textual requirements (Narawita and Vidanage, 2017; Abdelnabi et al., 2020) [11]. However, there remains an unexplored area concerning the effective interconnection of these generated diagrams.

The existing systems, as described by Ghosh et al. (2019) and Maatuk and Abdelnabi (2021) [12], rely on rule based methods driven by predefined rules. Nonetheless, this methodology restricts the extraction of relationships and entities due to its inflexible nature. It's noteworthy that these previous studies have predominantly targeted enterprise-level diagram generation. In contrast, my research has a distinct focus on the automated creation of whiteboard diagrams.

To bridge this gap, my study introduces an innovative approach to whiteboard diagramming, particularly in the context of online lectures. This novel method utilizes a combination of Natural Language Processing and rule-based techniques to precisely extract relevant entities and relationships, effectively addressing the existing research gap.

The culmination of my research project showcases a unique amalgamation of natural language processing, realtime graph generation, and dynamic image positioning guided by spoken instructions. This distinctive interaction, while groundbreaking, draws inspiration from well established research domains. Leveraging advancements in keyword extraction, context comprehension, and image positioning, my project introduces pioneering contributions to automated whiteboard diagram generation, poised to serve education and accessibility domains.

In the realm of education, attendance management plays a pivotal role; however, conventional systems often grapple with errors [13] [14]. This research advances an inventive solution by integrating face recognition and interaction heatmaps to optimize attendance tracking. Drawing upon the principles of computer vision and interaction analysis, this intelligent system not only ensures precise attendance monitoring but also provides valuable insights into student engagement during online lectures. Through the implementation of advanced facial recognition algorithms, false positives are curtailed, thus augmenting the accuracy of attendance data.

For the assessment of engagement, interaction heatmaps are seamlessly embedded within the attendance management system. These heatmaps are a product of the meticulous analysis of students' mouse movements, clicks, and keystrokes as they interact with lecture materials. The data aggregated from these interactions offers the system a comprehensive view, thereby identifying focal points of heightened student interest within the lecture slides. Armed with this insightful knowledge, educators can refine content and adapt pedagogical strategies to create a more effective learning experience. This study advocates for the adoption of an innovative facial recognition algorithm and interaction heatmap-driven intelligent attendance management system tailor-made for e-learning platforms. By harnessing these cutting-edge technologies, the system not only facilitates real-time attendance tracking but also provides educators with a trove of engagement metrics, enabling data-driven decision-making. The deployment of this system holds the potential to elevate student engagement, streamline attendance procedures, and ultimately enhance the overall educational journey [14].

III. METHODOLOGY

The proposed system aims to elevate the e-learning and e-lecturing, e-learning experience by offering the following capabilities:

- Streamline and standardize grading in educational institutions, potentially increasing fairness and allowing educators to focus more on personalized student feedback.
- Evaluates student engagement through facial and postural cues, allowing educators to refine online teaching methods and overcome e-learning platform constraints.
- Auto-generates clear diagrams, enhancing online learning clarity, reducing manual errors, and saving time for educators.
- Uses face recognition and interaction heatmaps to streamline attendance and enhance e-learning engagement.

Implementing an improved e-learning platform involves navigating numerous considerations to ensure success. As a foundational step, we began the project with a feasibility study and in-depth user research.

A) User Research and Feasibility Study

To implement an improved E-learning system, the research team undertook an initial investigation to assess the practicality of introducing such a solution and to identify the needs and expectations of the users.

In the context of online lectures, we've identified two key user groups: the educators (lecturers) and the students. These two groups often encounter challenges during online learning. To make our research more accurate, we decided to directly

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collect information from these user groups. We conducted face-to-face interviews with both educators and students to understand the issues they were facing.

To get a broader perspective, we also distributed a feedback survey. This survey helped us figure out which solutions were most effective in tackling the problems these groups are dealing with. By doing this, we were able to see which solutions were preferred by them and how well these solutions worked in addressing their specific challenges.

B) Identified Problems

This research delves into multiple challenges faced within the e-learning sector, such as the intricacies of manual paper correction, online diagram illustration, attendance management, and student engagement in online classrooms. We aim to identify potential areas for technological advancements and recommend system integrations to improve these facets of e-learning.

• *Manual Paper Correction in E-learning*

In e-learning contexts, traditional correction techniques for structured question papers require a significant amount of time and resources. Such practices affect the e-learning platforms' built-in scalability and efficiency. Additionally, these procedures involve dangers like human error, coding errors, and biases that may affect student learning outcomes. Maintaining the quality of education requires a change in direction toward a more effective, scalable, and precise correction mechanism.

• *Student Engagement Detection*

The traditional dynamics of student-lecturer interaction have changed as a result of the historically unusual shift toward distant learning, which was primarily sparked by the COVID-19 epidemic. Despite the increasing popularity of video conferencing tools like Zoom and Microsoft Teams, they frequently fail to maintain sustained student participation. Investigating additional methods or instruments to improve attention retention becomes essential.

• *Automated Whiteboard Drawing*

The research problem addressed in this study is the challenge of generating clear and concise diagrams during online lectures. In traditional classroom settings, lecturers often use whiteboards or blackboards to draw diagrams and graphs, which can help students better understand complex theories. However, in online lecture environments, drawing on a whiteboard with a computer mouse can be challenging and time-consuming, leading to unclear diagrams that can hinder the learning experience for students.

• *Online Attendance Management and Engagement Metrics*

Traditional attendance control methods, such as physical roll calls and sign-in sheets, are gradually falling out of use, particularly in digital learning environments. Real-time engagement metrics are absent. More sophisticated systems that give rapid feedback on student attendance and involvement during live sessions are essential as a result of the trend towards online education.

Global events and technical breakthroughs have sped up the growth of e-learning, making several problems demanding creative solutions. This study aims to identify these problems and open the door for integrative systems that can improve the virtual learning environment.

The high-level architectural layout of the platform we designed is shown in Figure [No]. The program is divided into two primary sections, one designed for lecturers and the other for students. The platform has two important student-focused features: "Engagement Tracking," which continuously assesses students' participation in sessions, and "Automated Attendance," which simplifies attendance reporting and minimizes human mistakes. Two cutting-edge innovations are introduced in the educators' module: "Smart Paper Grading," which offers uniform and impartial evaluation of organized tests, and the "Digital Whiteboard Illustration" function, which makes it easier to quickly create diagrams. These diagrams are designed for a digital context while maintaining the clarity of conventional classroom images. A user-friendly online interface delivers real-time statistics on student involvement, enhancing instructors' user experience and further optimizing the learning strategy.

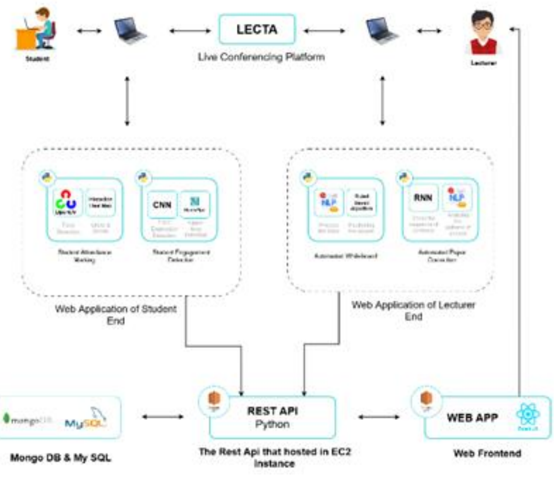

Figure 1: High Level System Architecture

1) Automated Paper Correction

The research aims to create an automated system using machine learning and natural language processing to

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standardize and streamline subjective response evaluation in educational settings. This system intends to reduce manual grading time and costs while ensuring consistent assessment across different evaluators. A custom dataset was prepared, featuring IT-related questions and student responses. These responses were manually corrected and graded in collaboration with knowledgeable teachers. Data preprocessing involved text tokenization and padding for uniform sequence lengths, facilitating model training.

The study employed Recurrent Neural Network (RNN) and Long Short-Term Memory (LSTM) models, suitable for sequential data analysis. The Keras library in Python facilitated model development, and the dataset was split into training and testing sets. The training set was used to train the model, and its performance was evaluated on the validation set for generalization assessment. Training history, loss, and accuracy metrics were recorded for analysis.

Post-training, the evaluation system's performance was tested on a separate test set, measuring loss and accuracy. To demonstrate practicality, new student question-answer pairs were preprocessed during training. The trained model predicted grades on a 10-point scale, showcasing its ability to automate evaluation.

The proposed system exhibits promise in addressing subjective answer evaluation challenges by potentially reducing costs, expediting grading, and ensuring consistent assessment. However, rigorous testing and validation using diverse datasets and real-world scenarios are crucial for assessing its generalizability and robustness. Comparative studies with traditional evaluation methods and statistical analyses will offer insights into system efficiency and reliability.

2) Student Engagement Detection

The objective of this research is to enhance student engagement in online classes by employing facial expression detection and upper body part detection as indicators of engagement. There are three main components of the methodology: facial expression analysis, upper body detection, and the combination of these two methods.

Images are scaled and normalized using the FER-2013 dataset from Kaggle for facial expression analysis. For recognition, a Convolutional Neural Network (CNN) is used, iterating through many architectures to achieve the best outcomes. To prevent overfitting, the dataset is divided into training and testing subsets. The model uses a webcam to capture live facial expressions during online sessions. Due to the temporal nature of emotions, the system evaluates them over time and chooses the feeling that is identified the most often to represent the student's mentality.

We've combined a Convolutional Neural Network (CNN) with the Mediapipe library for upper body detection to increase student engagement in online classes. The training is built upon a unique dataset that records various student postures throughout online sessions. Preprocessing procedures such as resizing and normalizing after data collection provide consistent CNN inputs. Real-time upper body part detection is facilitated by Mediapipe utilizing a trained model. This system analyzes video frames and extracts relevant positions to determine the sitting positions of students.

$$ES = \begin{cases} 10 & \text{if BP = Correct Sitting and FE = Happy} \\ 6 & \text{if BP = Correct Sitting and FE = Neutral} \\ 3 & \text{if BP = Wrong Sitting and FE = Sad} \\ 2 & \text{if BP = Wrong Sitting and FE = Neutral in all other situations} \\ 1 & \end{cases}$$

Figure 2: Engagement Score

$$EL = \begin{cases} \text{Highly Engaged} & \text{If } ES \geq 7 \\ \text{Moderately Engaged} & \text{If } 4 \leq ES < 7 \\ \text{Low Engagement} & \text{In all other instances} \end{cases}$$

Figure 3: Engagement Level

The assessment of student engagement involves analyzing both facial expressions and body posture using specialized detection models. This holistic assessment generates an engagement score (ES), closely tied to detected facial expressions (FE) and observed body positions (BP). The engagement computation is followed by determining the student's engagement level (EL). Our system employs facial expression and body position weightings derived from observational data and heuristic methodologies to evaluate student engagement in online learning. The resulting Engagement Score (ES) is indicative of the level of engagement: a high ES signifies strong engagement, a moderate range indicates substantial engagement, while a lower score suggests decreasing interest. Students can be categorized as highly engaged, moderately involved, or disengaged by setting a threshold based on educational requirements. Preliminary findings highlight the system's accuracy: higher ES values correspond to positive emotions and appropriate posture, indicating substantial involvement, while lower scores suggest potential disinterest. Ultimately, the ES offers educators a valuable tool for promptly assessing student engagement in online learning environments.

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3) Diagram Drawing

The research problem addressed in this study is the challenge of generating clear and concise diagrams during online lectures. In traditional classroom settings, lecturers often use whiteboards or blackboards to draw diagrams and graphs, which can help students to better understand complex theories. However, in online lecture environments, lecturers use their computer mouse to draw diagrams and graphs on the shared screen. Drawing on a whiteboard with a computer mouse is challenging and time-consuming, leading to unclear diagrams that can hinder the learning experience for students.

In this research, this issue was solved with the use of lecture voice to diagram conversion. In the usual online lecture environment, lectures are used to explain what he/or she is drawing on the screen. While drawing the diagram or the graph, the lecture explains each component by component. In this approach, we use that lecture diagram explanation to generate the respective diagram. Throughout this research, we narrowed down the research scope to Computer Science and IT-related fields.

In the scope of Computer Science and IT field, the majority of the diagrams can be created with the combination of smaller components. In this work, to make this research a success, we must focus on how the diagram objects are chosen and how they link according to the lecture explanation.

To generate the diagrams according to the lecture explanation, the entire process can be divided into 4 steps:

- Capture the lecture voice and convert it to the text.
- Identify the keywords out of the converted text.
- Find the object that matches with the keywords.
- Link the selected object according to the lecture explanation.

A) Capture the lecture voice and convert it to the text

Once the lecture explains the diagram features, the explained voice will be captured and converted into text. React speech recognition "react-speech-recognition" is used for this voice-to-text conversion. The React react-speech-recognition library is a versatile and easy-to-use package that allows us to perform speech recognition in the front end. It serves as a wrapper around various speech recognition engines and APIs, providing a unified interface for working with different speech recognition systems.

B) Identify the keywords out of the converted text

When the voice-to-text conversion is completed, keywords should be identified. To find the keywords out of the converted text, the text will be processed with the NLP library (NLTK). All the Computer Science and IT field-related keywords are stored in an array. (Keyword - object image-related tag names)

C) Find the object that matches the keywords

In the scope of Computer Science and IT field, most of the diagrams and flowcharts can be driven in the Draw.io web-based software. Draw.io is a free, web-based diagramming and flowcharting tool that allows you to create a wide range of visual representations, such as diagrams, flowcharts, process maps, organizational charts, network diagrams, and more. It provides an intuitive and user-friendly interface for designing and editing diagrams, making it popular among individuals and teams for various purposes. As we explained above, each diagram is built with a combination of small objects. All the related diagram objects are included in the Draw.io platform. In this work, SVG-formatted images were utilized for the generation of diagrams.

By changing the left, right, top, and bottom values, the image position can be changed. Each image object in SVG tags is stored with its corresponding keyword. After the speech is converted to text, the stored keywords are searched in the translated text. Once the keywords are identified, we can load the corresponding image object SVG tags. The next step is to position the images according to the lecture speech.

D) Link the selected object according to the lecture explanation

In the context of image positioning, divide the computer screen as a grid and position each image in grid cells. Randomly placing the image doesn't depict the exact lecture-explained diagram. A two-step procedure is taken to place the images. First, the converted text will be processed to identify the diagram features and special keywords out of the lecture explanation (Consist of, Conncted, Linked, Send to). NLP is used for text processing. As a second step, a ruled-based approach is used for image positioning. Some predefined rules need to be checked before placing each image object in the grid cell.

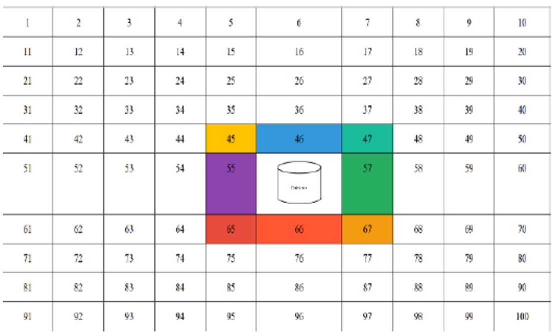

Figure 4: Grid-patterned Display (10x10)

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As mentioned above in the Figure, the entire screen is represented as a grid. The database object is positioned in the cell “56”. The following possible image positioning cells after the “Database” image are 45, 46, 47, 55, 57,65,66 and 67. A list of rules is checked before deciding the next image positioning cell.

The diagram below illustrates a sample scenario explained during a lecture: "Frontend connected to Backend. To access the data Backend, link with Database."

Figure 1: Sample diagram for a lecture explanation

4. Smart Attendance Marking

The goal of this research component is to integrate facial recognition technology, interaction heatmaps based on clicks, scroll events, and mouse movements, and a website categorization API aimed to increase student engagement into a unique strategy for tracking student attendance.

1. Algorithms

A) Face Recognition Algorithm:

To achieve accurate identification and verification of students, a deep learning-based face recognition algorithm is utilized. The algorithm incorporates Convolutional Neural Networks (CNNs) for facial feature extraction and matching. The CNN model is trained on a large dataset of facial images to learn discriminative features. Face detection algorithms such as Haar cascades or deep learning algorithms are employed to locate and extract faces from the captured images. The extracted faces are then passed through the trained CNN model for identity verification.

B) Interaction Heatmap Generation:

The interaction heatmap generation algorithm analyzes students' mouse movements, click frequencies, and scrolls during online lectures to determine their level of participation. Mouse movements, clicks and scrolls are recorded using event listeners. The heatmap is generated using techniques such as kernel density estimation or weighted heatmaps based on interaction intensity.

C) Website classification API used for student engagement:

Website classification API for student engagement utilizes a methodology based on a linear SVC algorithm. The algorithm analyzes the content and structure of a given website to determine its relevance and suitability for student engagement. It examines factors such as the presence of educational resources, interactive features, and user-generated content. By employing advanced machine learning techniques, our API provides accurate and efficient website classification, enabling educators to identify and recommend platforms that maximize student engagement.

2. Development Process:

The development of a face recognition-based attendance management system involves several key steps. In the beginning, a large collection of student face photographs is created, recording diverse situations via the cameras in the online classroom. Students give their consent, and data anonymization methods safeguard student privacy. After that, captured facial pictures go through preprocessing that includes data augmentation, normalization, and face alignment. The preprocessed dataset is used to train the actual face recognition system. The system learns to extract discrete face characteristics using a CNN model initialized with suitable weights, creating embeddings that carry personal identity information in real-world situations that are used in educational settings during lectures or class sessions are used to assess the system's effectiveness. The system's capacity to precisely identify and authenticate pupils is assessed by comparing results to real data. The effectiveness of the algorithm is used to generate interaction heatmaps which are clicks, scrolls, and mouse movements to measure student engagement. User feedback and teacher comments are used to evaluate the system's usefulness, potency, and influence on attendance control.

IV. RESULT & DISCUSSION

Numerous improvements have been introduced to various complex parts of our overall e-learning system, known as LECTA. One significant advancement was the implementation of an automated technique to evaluate subjective answers. This new approach has yielded revolutionary outcomes. The system not only ensured fairness and consistency in grading but also achieved remarkably high accuracy rates in its evaluations. The data collected serves as evidence of its excellence. A comparison between the results of this grading system and traditional methods showed striking similarities, underscoring the system's reliability. This suggests that it might eventually outperform manual grading. Furthermore, the system's versatility was evident as it effectively assessed writings from different academic fields. Besides accuracy, the method substantially reduces grading time and associated costs, making it a viable alternative to traditional grading. However, it's important to acknowledge the system's reliance on its fundamental training dataset, which must be diverse and well-maintained to enhance accuracy and applicability.

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In another aspect of our work, we developed a comprehensive set of parameters for analyzing body posture and facial expressions, culminating in an Engagement Score (ES). This score quantifies online educational engagement and provides a nuanced understanding of student interest levels. Our careful observational and analytical methods ensured that these engagement measures accurately represent fundamental student interactions. Different levels of student engagement can only be accurately identified using these validated parameters. Our advanced tools, including ES and EL measures, offer valuable insights to teachers, potentially revolutionizing online learning practices.

Figure 6: Results output of student Face expression

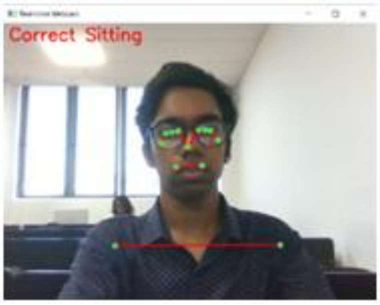

Figure 7: Wrong sitting posture recognition result

Through our efficient algorithms, spoken lecture content is seamlessly transformed into text. This initiates a sophisticated process involving keyword extraction from the transcriptions, forming the basis for relevant visual aids. It's important to highlight that these visual elements are not added merely for decoration; instead, they are thoughtfully integrated to match the structure of presentation diagrams. This automation accelerates graphic creation while ensuring each new visual aid harmoniously fits the overall presentation framework.

Finally, our thorough analysis of the student attendance marking system has led to transformative results. We have developed an exceptional method to assess online student engagement by combining deep learning in facial recognition with interaction heat maps. The precision of facial recognition software combined with the visual representations of heatmaps yields impressive outcomes. Another testament to the system's comprehensive approach is its ability to categorize educational platforms using our website classification API. Real-world testing in learning environments confirmed the system's capability to authenticate student attendance.

V. CONCLUSION & FUTURE WORK

Our research has led to the creation of a comprehensive online education platform that consists of four crucial elements. These elements include automated whiteboard drawing, an advanced attendance system using facial recognition and interactive heatmaps, automated paper grading using deep learning and natural language processing, monitoring of student engagement through facial expressions and upper body recognition, and automated whiteboard drawing (for presentations). This integrated solution not only improves the online classroom experience for teachers and students but also uses machine-learning techniques to keep track of various activities. We've also introduced a capable chatbot that swiftly addresses program-related queries, showing our commitment to solving problems in real-time. Our study focuses on leveraging cutting-edge technology to enhance online learning's engagement, grading, visualization, and active participation.

Looking forward, we anticipate several improvements. We aim to enhance the assessment of subjective responses by exploring more advanced deep learning structures, potentially utilizing transformer models. We expect to boost the system's reliability by integrating feedback mechanisms and benefiting from educators' insights. Combining neuro-linguistic programming with personalized engagement tracking to reflect individual learning paths can offer detailed insights into student engagement. Furthermore, we are enthusiastic about expanding the toolkit for visual representations, accommodating a wide range of academic and professional needs, including flowcharts and intricate network diagrams. The potential integration of our system with established educational and collaborative platforms opens up a diverse array of application possibilities.

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