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Evaluating Facial Expressions to Determine the Degree of Participation in Virtual Lectures

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Abstract— The goal of this study was to create a technique for determining a student's attention state during an online lecture based on their facial expressions. By assessing students' reaction times (RT) to identify a target sound that was unrelated to the presentation, we were able to gauge their degree of attention during a video lecture. We reasoned that participants would respond to such a stimulus more slowly when they were paying attention to the lecture than when they weren't. Using RT measurement, we attempted to gauge how much attention students paid throughout a presentation. In the experiment, a video camera captured the learner's face as they watched a lecture on video. In order to predict reaction time (RT) to a task-irrelevant stimulus—which was thought to be a measure of attention level—facial features were examined. We used an open-source program called Open Face to extract facial features as action units (AUs), or the movements of the face muscles, and then we employed a machine learning technique called light Gradient Boosting Machine (Light GBM) to estimate RTs from these AU's. According to the model created with Light GBM, RTs to the irrelevant stimuli can be calculated from AUs, indicating that the attention states of students during lectures can be predicted from their facial expressions. To investigate if lower general arousal due to tiredness was a significant factor in the RT lengthening found in the experiment, we re-analyzed the data, removing RT data with drowsy faces of the students. It is possible to predict learners' degree of attention to video lectures based on their facial expressions, as the results were consistent even when RTs with drowsy faces were included.

Keywords— Feature extraction, Face recognition, Online services, Electronic learning, Particle measurements

I. INTRODUCTION

Improving learning outcomes requires an understanding of students' study engagement levels. Estimating the degree of student engagement with their studies is essential to raising the standard of instruction. Encouraging learning environments may benefit from automated engagement level monitoring. Webcams can be used in online learning to record students' facial expressions, which can be used to infer their emotional states. For online learning, webcams can be used to capture learners' facial expressions, which can be used to estimate their mental states. In education related studies face images in a classroom while they were studying with video material on a screen and estimate the level of engagement from students' facial expressions. With the increasing prevalence of online education, understanding and enhancing student engagement in virtual learning environments have become crucial for the effectiveness of educational initiatives. It is difficult for teachers to pay attention to all students, particularly in online classes. The present study aimed to develop a method for estimating students' attention state from facial expressions during online lectures.

Problem Identification

To create a system that measures the degree of participation in online lectures by examining facial expressions. Using advances in machine learning and computer vision, the project will develop algorithms that can recognize and understand different types of facial expressions participants make during virtual lectures. The system will record nonverbal signs like smiles, frowns, eyebrow lifts, and eye movements and use these to interpret participant interest, attentiveness, and engagement levels during the presentation.

Objectives

- To analysis of the body of research on computer vision methods, engagement assessment approaches, and facial expression analysis in educational contexts.

- A curate dataset will be created from video recordings of online lectures and ground truth labels showing the degree of involvement.
- Modern face expression recognition models, like recurrent neural networks (RNNs) and convolution neural networks (CNNs), will be investigated and modified to meet the project's unique needs.
- The curated dataset will be used to train algorithms so they can recognize and categorize participant facial expressions during online courses.

II. Mode of Python-Platform

Frameworks provide functionality in their code or through extensions to perform common operations required to run web applications.

A. Web frameworks

A web framework is a code library designed to facilitate the development of dependable, expandable, and easily maintained web applications for developers. Web frameworks incorporate all of the knowledge that developers have gained over the previous 20 years while creating websites and web apps.

Frameworks facilitate the reuse of code for frequently used HTTP operations and the organization of projects so that other developers who are familiar with the framework may rapidly construct and manage the application. Typical functionality of web frameworks offer capability to carry out typical tasks needed to run web applications, either directly in their code or through extensions. Web framework resources:

- Understanding the functionality of the code below web frameworks is beneficial when understanding how to use them.
- The short film Frameworks, which demonstrates how to select between web frameworks, is quite well done.
- Developers use Visual Studio code extensively to write and modify code in many different programming languages.

B. Existing System

A web framework is a code library designed to facilitate the development of dependable, expandable, and easily maintained web applications. Current systems frequently use facial recognition algorithms and computer vision techniques to analyze the emotions on students' faces during online lectures. For the purpose of facial landmark identification and expression analysis, open-source libraries and technologies such as Dlib and OpenCV are frequently utilized.

C. Proposed System

It was discovered that the degree of attention that students pay to video lectures can be predicted from their facial expressions, providing a measure of their level of participation. Video camera collected facial features are predictive of reaction times (RTs), which are thought to be a measure of attention states. Certain facial expressions seem to be linked to paying attention during video lectures, including lip corner depression, blinking, and wrinkle on the nose. Facial expression technology has the potential to improve the standard of instruction.

III. System Design

The process of defining a system's architecture, parts, modules, interfaces, and data in order to meet predetermined requirements is known as systems design. It may be viewed as the product development of systems theory. The fields of systems analysis, systems architecture, and systems engineering share certain similarities. Design is the process of using marketing data to create the design of a product that will be made, if the more general topic of product development "blends the perspective of marketing, design, and manufacturing into a single approach to product development." Therefore, the process of defining and creating systems to meet specific user needs is known as systems design.

A. UML DIAGRAMS

A common language for business modeling and other non-software systems, as well as for defining, visualizing, building, and documenting the artifacts of software systems, is called Unified Modelling Language (UML). The UML is an assembly of top engineering techniques that have been successfully applied to the modeling of complicated and sizable systems. Creating objects-oriented software and the software development process both heavily rely on the UML. The UML primarily expresses software project design through graphical notations.

B. USE CASE DIAGRAM

In the Unified Modelling Language (UML), a use case diagram is a particular kind of behavioural diagram that is produced from and defined by a use-case study. Its goal is to provide a graphical summary of the terms that a system offers for functionality. In system analysis, a use case is a technique for organizing, defining, and identifying system needs. A use case is a collection of potential interactions between people and systems in certain setting that are all aimed at achieving a specific objective.

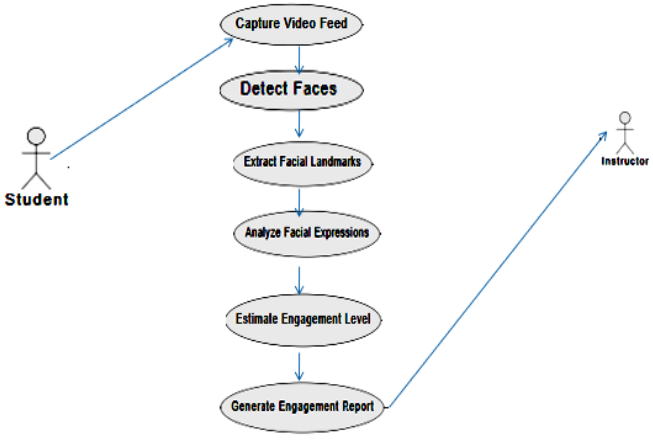

Fig. 1 Use case diagram of Facial Expression

C. CLASS DIAGRAM

Static class relationships that reflect the core system architecture are modeled by UML class diagrams. Keep in mind that the relationships shown in these diagrams are those between classes, not those between particular objects that are constructed from those classes. Consequently, the diagram is applicable to every object in the system.

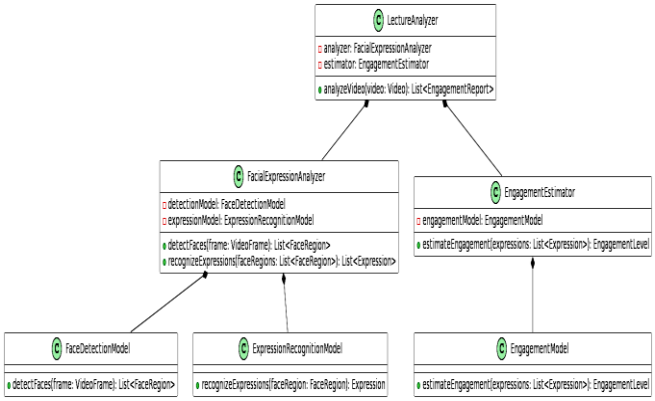

Fig. 2 Class diagram for Facial Expression

D. SEQUENCE DIAGRAM

In the Unified Modelling Language (UML), a sequence diagram is a type of interaction diagram that illustrates the relationships and sequence in which processes operate with one another. It is a Message Sequence Chart construct. A sequence diagram shows the order in which events happen within a system. A sequence diagram records the methods that are called on each object and the order in which they are called.

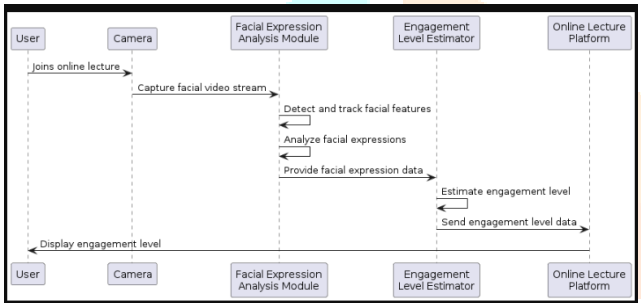

Fig. 3 Sequence diagram for Facial Expression

- Set the context for the interaction, whether it is a system, subsystem, operation or class.
- Set the stage for the interaction by identifying which objects play a role in interaction.
- Set the lifetime for each object.
- Start with the message that initiates the interaction.
- Visualize the nesting of messages or the points in time during actual computation.
- Specify time and space constraints, adorn each message with timing mark and attach suitable time or space constraints.
- Specify the flow of control more formally, attach pre and post conditions to each message.

E. ACTIVITY DIAGRAM

An additional crucial UML diagram for describing the system's dynamic elements is the activity diagram. An activity diagram is essentially a flow chart that shows how an activity flows from one to the next. One could refer to the activity as a system operation. As a result, the control flow is transferred across operations. This flow may occur concurrently, forked, or sequentially. Activity diagrams use several features, such as join and fork, to cope with various forms of flow control.

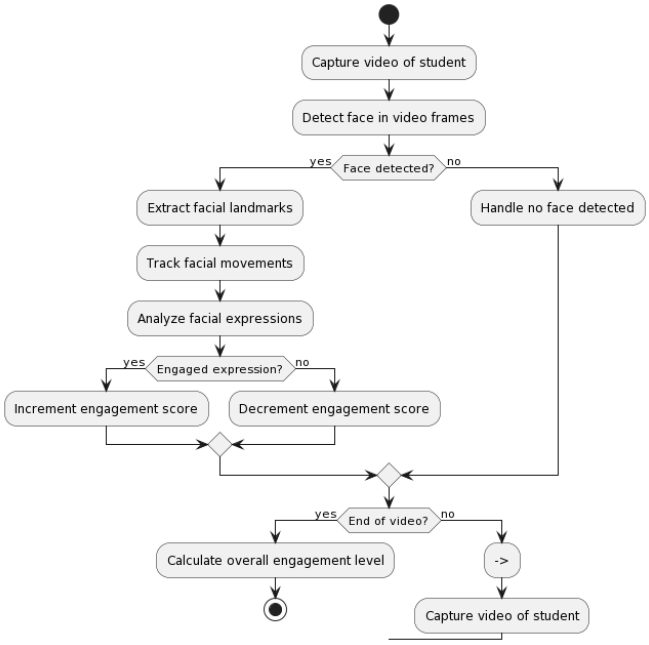

Fig. 4 Activity diagram for Facial Expression

F. System Testing

The goal of testing is to find mistakes. The goal of testing is to find every potential flaw or vulnerability in a work product. It offers a means of testing the functionality of individual parts, assemblies, subassemblies, and/or final products. It is the process of testing software to make sure it satisfies user expectations and needs and doesn't malfunction in a way that would be unacceptable.

Fig. 5 Various modes of face expressions

Functional tests offer methodical proof that the functions being tested are available in accordance with the technical and business requirements, system documentation, and user manuals. Invoking interface systems or procedures is necessary.

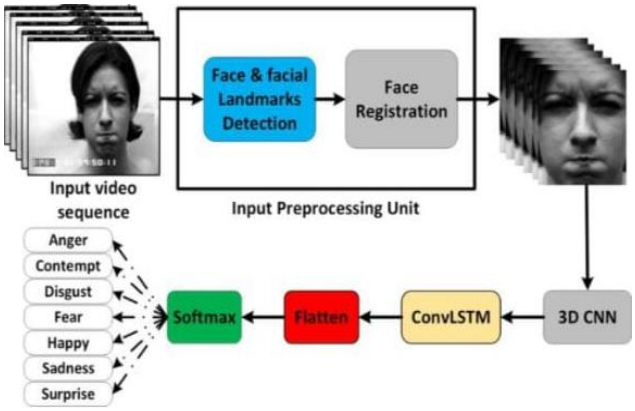

Fig. 6 Input pre-processing unit for face registration

Functional test preparation and organization are centred on requirements, important features, or unique test cases. Furthermore, testing needs to take into account data fields, specified procedures, sequential processes, and systematic coverage related to identifying business process flows. Additional tests are identified and the efficacious value of current tests is ascertained prior to the completion of functional testing.

IV. Results and Discussions

System testing verifies that all requirements are met by the integrated software system as a whole. It puts a setup to the test in order to guarantee dependable outcomes. The configuration-oriented system integration test is an illustration of a system test. System testing emphasizes pre-driven process connections and integration points and is based on process flows and descriptions.

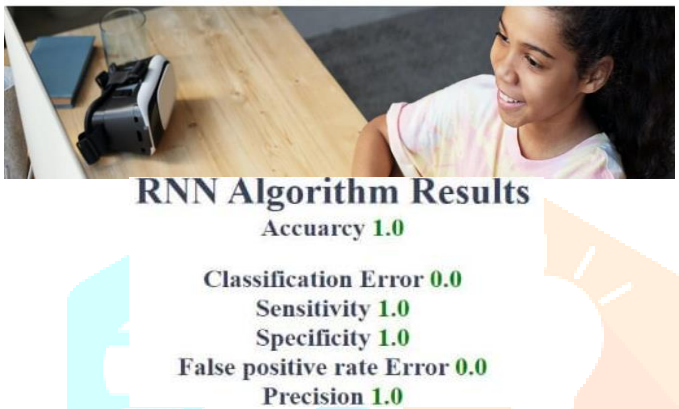

Fig. 7 Students engagement prediction for Online Classes

1) Unit Testing: Although it is fairly uncommon for coding and unit testing to be undertaken as two separate phases, unit testing is typically carried out as part of a combined code and unit test phase of the software lifecycle.

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2) Integration Testing: The process of incrementally integrating two or more integrated software components on a single platform to identify interface flaws that lead to failures is known as software integration testing. The purpose of an integration test is to verify that software applications or system components, or even higher up, company-level software applications, function together flawlessly.

3) Acceptance Testing: Acceptance by Users Any project's testing phase is crucial, and it involves a lot of end user input. It also guarantees that the system satisfies the functional specifications.

	Target	Time Chatted	Interruption	Not_Engaged	Physical Demand	Performance	Confused
0	1	0.004	-0.005	2.890	18.706	95.1440	11.579
1	0	-0.008	0.846	1.859	2.578	71.1150	34.964
2	0	0.003	0.724	1.477	3.357	66.7890	38.982
3	0	0.000	0.632	17.726	9.942	81.2410	32.815
4	0	-0.593	0.442	4.826	5.824	68.1320	39.392
5	1	-0.003	1.090	8.621	18.385	89.8880	34.327
6	0	-0.003	0.173	11.517	6.629	74.7160	36.288
7	0	-0.008	0.290	5.257	4.853	69.1420	47.998
8	0	-0.006	1.155	4.473	5.378	72.3140	39.369
9	0	-0.004	0.892	7.057	7.748	79.2260	34.466
10	0	0.001	0.282	5.028	6.400	69.5590	49.665
11	0	-0.004	0.279	4.509	12.510	84.6500	46.306
12	1	0.005	0.980	11.082	17.432	96.7990	38.317
13	1	0.003	0.980	11.082	17.341	110.0650	38.317
14	0	-0.001	0.947	6.213	6.173	71.0410	43.114
15	1	0.000	0.931	5.910	19.773	101.0650	35.590
16	0	-0.003	0.532	3.086	6.070	73.3550	37.487
17	0	-0.008	0.846	1.859	2.578	65.8920	36.898
18	0	0.003	0.724	1.477	3.357	82.4560	38.788
19	1	0.000	0.931	8.910	19.245	110.0650	32.598
20	0	0.000	0.632	10.234	10.567	77.2340	37.815
21	1	0.004	-0.005	9.890	18.798	99.1440	11.579
22	0	-0.500	0.442	4.826	5.824	56.6780	40.392
23	0	-0.003	0.255	11.517	8.298	74.7160	35.556
24	0	-0.009	0.450	5.257	4.853	72.4560	45.898
25	0	-0.008	0.855	4.473	5.378	72.3140	39.369

Fig. 8 Resolutions

The process of designing test cases for unit testing ensures that the core logic of the program is operating correctly and that program inputs result in legitimate outputs. Validation should be done on all internal code flows and decision branches. It is the testing of the application's separate software components. Prior to integration, it is completed following the conclusion of a single unit. This is an intrusive structural test that depends on an understanding of its structure. Unit tests evaluate a particular application, system configuration, or business process at the component level.

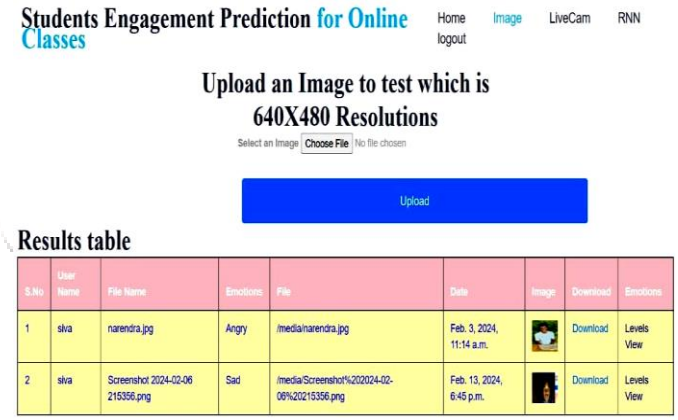

Fig. 9 Image to test of resolutions

In terms of future research and development, the project provides a wealth of opportunities in the areas of online learning and engagement measurement. The improvement of facial expression recognition algorithms to better take into consideration subtle variances in expressions across age groups, cultural backgrounds, and individual differences is one possible subject for future research.

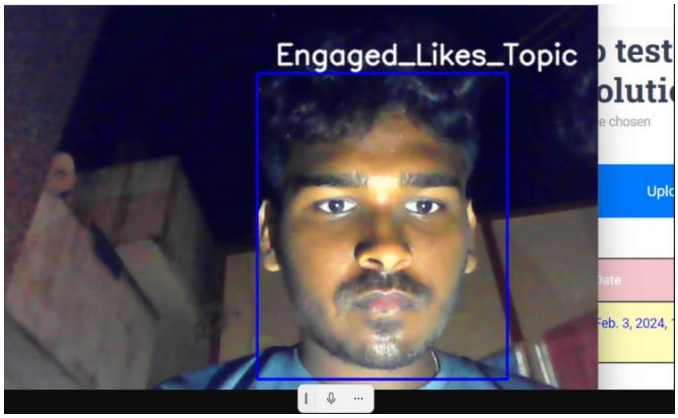

Fig. 10 Image engaged making involvement

Furthermore, adding multimodal data sources like chat conversations, audio signals, and eye tracking data could improve the analysis and offer a more thorough comprehension of the dynamics of involvement during online lectures. Furthermore, there is a lot of promise for improving educational experiences in digital environments by expanding the use of facial expression analysis beyond online lectures to

V. Conclusions

It was discovered that the degree of attention that students pay to video lectures can be predicted from their facial expressions, providing a measure of their level of participation. Video camera collected facial features are predictive of reaction times (RTs), which are thought to be a measure of attention states. Certain facial expression seem to be linked to paying attention during video lectures, including lip corner depression, blinking, and wrinkles on the nose. Facial expression technology has the potential to improve the standard of instruction. However, there are a few things to think about before putting it into practice in real classroom settings. First off, and this is crucial for generalization, the underlying mechanisms driving the contributions of these traits are not yet understood. Second, notable individual variations have been noted.

other educational contexts like virtual classrooms, group discussions, and cooperative activities.

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