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Real-time Student Attendance System with Emotion and Feedback Analysis

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Abstract: This study covers the construction of a machine software prototype targeted at automating student attendance management, overcoming the limitations of old manual systems such as human errors and time-consuming maintenance. Leveraging available digital tools in the present world, this paper strives to revolutionize attendance tracking by merging facial recognition, mood detection, and feedback gathering into a comprehensive attendance scheme. By utilising computer vision technology, the system recognises persons based on facial traits and assesses their emotional states in real-time, assuring improved accuracy and saving manual labour. Furthermore, the introduction of a feedback mechanism allows users to provide input on their experience, promoting ongoing improvement and user involvement. At its heart, this system utilizes facia recognition technology to uniquely identify pupils, removing the need for human attendance marking, while the incorporation of emotion detection adds a fresh layer, enabling the system to monitor emotional states during attendance capture. Together, these traits contribute to the construction of a smart and efficient attendance management tool for educational institutions

Keywords: OpenCV, OpenPyXL, tkinter, FER (Facial Expression Recogniton), Face Detection, Face Recognition.

INTRODUCTION

Attendance performs a significant part in every business whether it be educational institutions or agencies. So, it is very vital to maintain the report of the attendance. The old ways of taking attendance, relying on manual access or cumbersome techniques, often fall short in areas of accuracy, performance, and engagement. In the dynamic world of education, the combining of superior technologies has become crucial to match the expanding needs of present-day lecture halls. Recognizing the restrictions of existing attendance methods, this task presents a comprehensive remedy — the real-time student Attendance system with Emotion and feedback evaluation.

The projected device features cutting - edge technology to not just revolutionize attendance tracking nevertheless also go into the emotional dynamics of the study room. By methods of leveraging the facial popularity era, the machine automates the attendance approach, ensuring real-time accuracy and easing the administrative load on educators. Emotion detection in addition offers a layer of intensity to this gadget, presenting insights into the emotional conditions of college pupils at some moment in school room periods. Past those technical components, the venture includes a revolutionary remarks technique that permits college students to proportion their thinking at the learning level. This manner of communication channel works as a precious instrument for educators to measure the success of their teaching techniques and make statistics informed improvements.

This multimodal strategy now not simplest modernizes the attendance-taking way but also leads to a more thorough information of the classroom dynamics. As we go into the information of this task, it is vital to comprehend its capacity impact on altering established academic procedures and creating a technologically enriched learning environment. As we continue the exploration of this progressive task, it is far important to understand its capacity to redefine the traditional instructional panorama. thru embracing technology now not as a mere device yet as an enabler of critical ideas and verbal exchange, the real-time pupil Attendance gadget with Emotion and feedback analysis aims to contribute to the production of additional adaptive, appealing, and scholar-centric getting to know settings. The research regarding the existing technique is discussed in the next section.

LITERATURE SURVEY

As mentioned in [1], this study seeks to offer an automated system for student attendance management, using real-time face recognition technologies inside educational organizations. This endeavour is essentially hard due to the complexity of background subtraction in real-time image processing, a problem that has persisted in the field. Face detection and recognition have emerged as crucial areas of research in image processing during the past two decades, as illustrated in [2]. And [3] demonstrates a system capable of detecting faces in color photos.

Computer Vision, a key element of Artificial Intelligence, acts as the cornerstone for realizing such

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systems. It serves as a channel between software and visual data in our surroundings, enabling software to interpret and learn from its surroundings, as expounded about in [4]. The implementation of Computer Vision is facilitated with technologies like OpenCV, a Python package extensively detailed in [5]. OpenCV, short for Open-Source Computer Vision Library, offers a variety of features for real-time image and video processing, making it important for applications like augmented reality, object detection, and facial recognition, as underlined in [6].

To determine the emotional states of students, the paper introduces the Facial Emotion Recognition (FER) algorithm, which utilises deep learning techniques such as Convolutional Neural Networks (CNNs) to analyse facial expressions and predict emotions, as discussed in [7]. Additionally, Movement Detection, critical for detecting and tracking movements in front of the camera, is addressed.
[8] illustrates a technique that leverages OpenCV to identify and measure movements, rendering bounding boxes around newly presented objects in the frame.

As we know, emotion detection is one of the activities that includes executing both emotion detection and sentiment analysis on pictures. [9] offers a technique that facilitates in doing sentimental analysis and detecting emotions from visuals.

To automate the Face Recognition Attendance System, an Automation Framework utilising Python is indispensable, as discussed in [10]. Furthermore, [11] elucidates on the integration of Python with Excel using the openpyxl library. Ultimately, the system will leverage openpyxl to easily store students' attendance details in Excel sheets. This holistic strategy amalgamates cutting-edge technology and practical answers to modernise attendance management methods inside educational institutions.

The study highlights the significance of user interface development, particularly the role of Python Graphics with Tkinter [13]. Tkinter serves as a vital tool for generating interactive and user- friendly interfaces, increasing the accessibility and usability of the automated attendance management system. Through Tkinter, developers may design intuitive interfaces that encourage user engagement and input, contributing to a seamless user experience. This integration underlines the holistic approach of the proposed system, which not only promotes technological functionality but also emphasizes the necessity of user-centric design principles in educational technology solutions.

The previous system does not have the capabilities Emotion Detection, Feedback Gathering, Dynamic Visualization and Excel interaction. The recommended approach is explained in the next section.

MATERIALS AND METHODS

Problem Statement

The prior study publications do not include the features like emotion recognition, dynamic visualization, feedback collecting from the user and excel integration. The major purpose of this study is to increase a clever attendance machine that leverages facial recognition and emotion detection technology. The device intends to automate the attendance marking method, deliberating lateness and sudden feelings. By method of merging these technologies, the assignment tries to design a more comprehensive and effective attendance tracking gadget for various packages, which comprises instructional establishments or corporate places. The attendance is marked properly in the Excel file. It can also capture new things if needed. The attendance is updated in the database. The design of our research in detailed in the next sub- section.

DESIGN

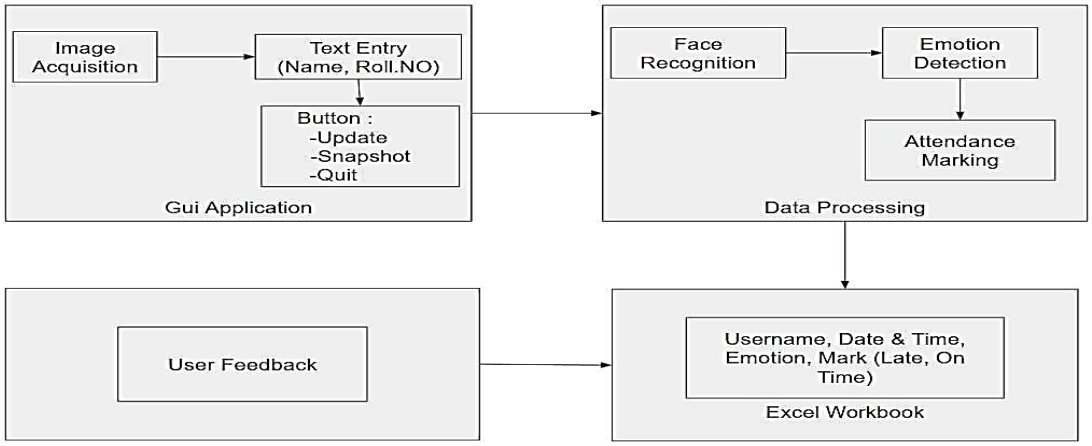

Figure 1: Automated Attendance Workflow

Firstly, the system gathers images from the webcam using OpenCV, enabling real-time acquisition of student face data. These photos are then processed by a facial recognition algorithm, which detects and records

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the detected faces into a designated folder for future reference. During attendance sessions, the system compares the faces taken in real time with those stored in the folder. If a match is obtained, indicating the presence of a registered student, attendance is marked for that individual.

Additionally, the system incorporates emotion detection algorithms to capture the emotional states of pupils during the attendance procedure. Furthermore, the system contains a feedback mechanism where students are requested to provide feedback on the session. This feedback is collected using text-based questions displayed on the interface, encouraging student involvement and interaction. All important information, including attendance recordings, detected emotions, and student comments, is then recorded in an Excel sheet using the Open Py XL module.

The technologies or libraries used in the design are:

Python: It is an object-oriented, interpreted, high-level programming language with dynamic semantics. Dynamic typing, dynamic linking, and high levels of embedded data, make it ideal for rapid application development and use as a script or linked message for existing languages. Python's easy-to-understand syntax improves readability, thus reducing program maintenance costs. Python provides modules and packages that support program modularization and code reuse. The Python best-in-class libraries and the interpreter are freely available in source or binary form for all major platforms and can be freely distributed.

Open CV: OpenCV (Open-Source Computer Vision Library) is a library of programming functions and a cross-platform library focused on real-time computer vision. Intel first developed OpenCV and was later supported by Willow Garage and Itseez (eventually acquired by Intel). The OpenCV library is available free of charge under the open-source BSD license. Python is dynamically typed and also has built-in garbage collection. Python has good support for functions and supports many functions, including methods (especially methods) and object orientation. Python is sometimes touted as a "battery-rich" language because of its rich library.

Tkinter: Tkinter is a Python package used for designing graphical user interfaces (GUIs). It gives a simple and easy-to-use interface for constructing desktop programmes using a range of widgets such as buttons, labels, input fields and more. Tkinter is based on the Tk GUI toolkit, which is commonly used for constructing cross platform GUI applications. With Tkinter, developers may construct interactive and visually appealing apps by arranging and modifying widgets in a window. It also supports event handling and allows users to interact with the application through mouse clicks, keyboard input, and other events.

Open Py XL: OpenPyXL is one of the Python package used to read, write and manipulate Excel files in. xlsx format. It provides a straightforward approach to automate processes connected to Excel spreadsheets, such as data analysis, report production, and data extraction. With OpenPyXL, users can generate new Excel files, update old ones, add or remove sheets, apply formatting, insert charts, and conduct numerous Operations on cell data. It offers a simple and easy interface for working with Excel files, making it a popular choice among Python developers for handling spreadsheet-related activities in their papers. OpenPyXL is open open and actively maintained, with a significant community of users and volunteers offering support and updates.

Image processing: The face recognition process can be divided into two main stages: processing that occurs before detection involving alignment and face detection, and then face recognition is done using matching stages and feature extraction.

Face Detection: The main purpose of this stage is to detect the face and its position in the image. The expected output at this stage is a patch containing all faces in the input image. To get a more robust and readily developed facial recognition system. Face alignment is done to clarify the orientation and proportions of these boxes.

Feature Extraction: After the face detection, the human face region is extracted from the image. After this stage, the face patch is converted into a vector with fixed coordinates or a set of landmarks.

Face Recognition: The last step after face mapping is the face recognition. We need to create a face database for automatic authentication. Take different photos of each person, extract their features, and keep them in the database. Then, when the image is entered, face detection and feature extraction are performed, compared to the features of each face, and stored in the database.

The elements of the proposed approach are explained in the next sub-section.

FEATURES

The features used in the proposed approach are:

Emotion Detection: Emotion analysis provides insight into students' emotional states during attendance marking. Recognizing emotions such as happiness, sadness, and rage boosts the system's potential to understand the student's state of mind.

Feedback Gathering: Prompts for feedback from users before opening the camera window allows for direct interaction with students. User experience questions and the ability to ask questions contribute to a more engaging and user-friendly system.

***Corresponding Author:** Gurram Venkata Sai Suhas

Graphical User Interface (GUI): The system includes a graphical user interface developed using the tkinter library, which offers users a visually appealing and interactive experience.

The algorithm used in the research in discussed in the following sub-section.

ALGORITHM

We can use an algorithm called FER (Facial Expression Recognition) library for emotion detection. It utilizes deep learning techniques, such as Convolutional Neural Networks (CNNs), to analyse facial expressions and predict emotions as discussed in [6].

Input: Input to the FER algorithm is an image or a frame containing a human face. This image can be in various formats, such as JPEG, PNG, or in-memory representation like NumPy arrays.

Output: The output of the FER algorithm is a list of detected emotions along with their probabilities. Each detected emotion is associated with a probability score indicating the likelihood of that emotion being expressed in the input image. The emotions typically include happiness, sadness, anger, surprise, fear, disgust, and neutrality.

ALGORITHM STEPS

Step 1 - Preprocessing: The input image undergoes preprocessing steps to enhance its quality and prepare it for analysis. These preprocessing steps may include resizing, normalization, and conversion to a format suitable for input to the neural network model.

Step 2 - Feature Extraction: The pre-processed image is fed into a deep neural network model, such as a Convolutional Neural Network (CNN). The CNN extracts feature from the input image that are relevant for recognizing facial expressions. These features capture patterns related to facial landmarks, textures, and overall facial expressions.

Step 3 - Forward Propagation: The extracted features are propagated forward through the layers of the neural network. Each layer applies a series of mathematical operations, such as convolutions, activations, pooling, and fully connected layers, to transform the input features and extract higher-level representations.

Step 4 - Emotion Prediction: At the output layer of the neural network, the transformed features are used to predict the probabilities of different emotions being expressed in the input image. Each neuron in the output layer corresponds to a specific emotion class, and its activation value represents the probability of that emotion.

Step 5 - Post-processing: After obtaining the emotion probabilities from the neural network model, post-processing steps may be applied to refine the results. These steps may include thresholding to filter out low-probability emotions, normalization to ensure that the probabilities sum to one, and smoothing to remove noise or fluctuations in the predictions.

Output- Finally, the algorithm outputs a list of detected emotions along with their corresponding probability scores. The emotions with higher probability scores are considered more likely to be expressed in the input image.

THEMATICAL MODEL

The proposed mathematical model begins with the acquisition of an input image, which undergoes skin tone detection to isolate human body parts. This process yields a binary image representing the detected skin tones, which serves as the feature input for the initial layer of a background removal Convolutional Neural Network (CNN), referred to as the first-part CNN as described in [6]. The skin tone detection algorithm employs YCbCr color thresholds, where the Y-value should exceed 80, and the Cb and Cr values fall within specific ranges. These thresholds were determined through a trial-and-error approach and demonstrated effectiveness across various skin tones. In cases where the input image is grayscale, the accuracy of the skin tone detection algorithm is notably reduced. To mitigate this, the CNN incorporates a circles-in-circle filter, leveraging Hough transform values for circle detection. Regardless of the input image type, the Hough transform is consistently utilized as the secondary input feature for the background removal CNN. The Hough transform formula is an integral over the image domain, incorporating the accumulator function A (x, y) and the Dirac delta function δ. This model ensures robustness and uniform performance in background removal tasks across diverse image types

$$H(\theta, \rho) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} A(x, y)\ \delta(\rho - x\cos\theta - y\sin\theta)\, dx\, dy \quad (1)$$

This formula can be interpreted to evaluate the quantity A(x, y) along a straight line extending through angle θ and the distance ρ from the origin, using the Dirac delta function to ensure that only points lying on that line contribute to the integral.

Before extracting the human face from the input image, it is better to detect edges so that the accuracy of the resultant output will be higher. Therefore, we can utilize Sobel edge detection, which is a fundamental technique used in image processing to identify edges within an image based on variations in intensity. This technique operates by convolving the image with a pair of Sobel kernels, typically one for detecting changes in intensity along the horizontal axis and another for changes along the vertical axis. Equation:

***Corresponding Author:** Gurram Venkata Sai Suhas

Let Gx and Gy represent the Sobel kernels for horizontal and vertical gradients, respectively. The gradient magnitude M and orientation θ are computed as follows:

$$M = \sqrt{(G_x^{\,2} + G_y^{\,2})} \quad (2)$$

$$\theta = \tan^{-1}(G_x / G_y) \quad (3)$$

The magnitude M indicates the strength of the edge, while θ represents its orientation.

RESULTS

The system provides output in the form of:

Loading Images: The system captures facial images from the webcam and saves them in a specific folder for subsequent processing as shown in Fig 2.

Figure 2: Loading Images

Student Feedback: The system prompts students to provide feedback on the session using text-based questions displayed on the interface. All feedback provided is collected and stored for further analysis as shown in Fig 3

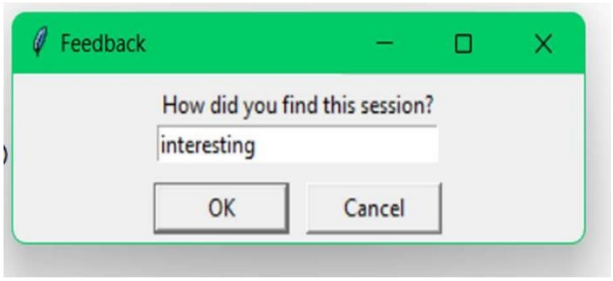

Figure 3: Student Feedback

Attendance Marking with Emotion Detection: The system automatically marks attendance for recognized individuals based on face recognition results. It also analyses facial expressions to determine the emotional states of individuals during the attendance process as shown in Fig 4.

Figure 4: Attendance Marking with Emotion Detection

Excel Sheet Output: All relevant information, including attendance records, detected emotions, and student feedback, is stored in an Excel sheet using the OpenPyXL library. This facilitates easy access to attendance data and enables in-depth analysis of student engagement and emotional well- being over time as shown in Fig 5.

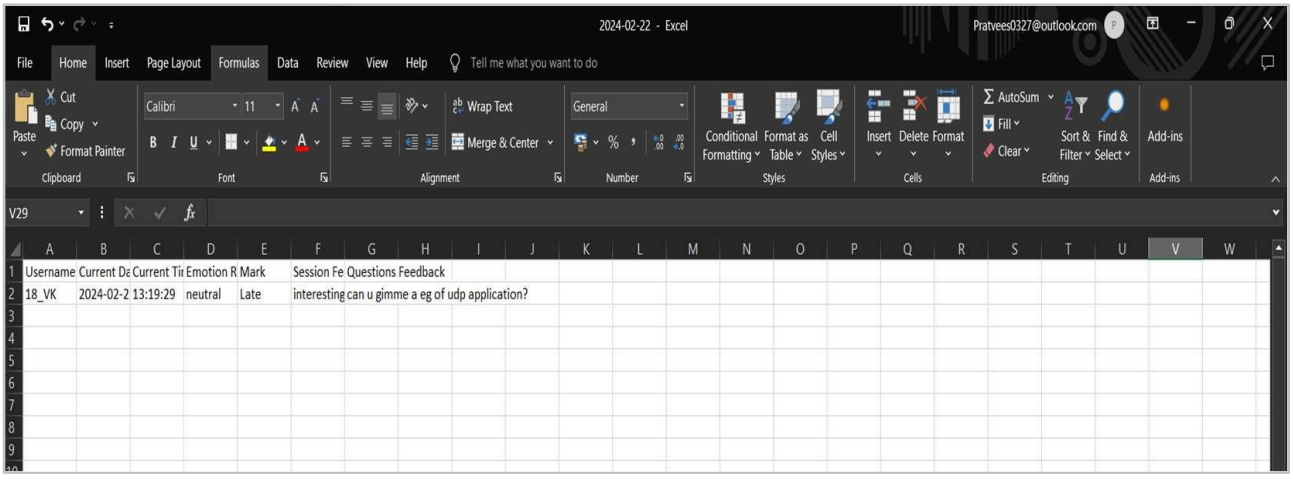

Figure 5: Excel Sheet Output

***Corresponding Author:** Gurram Venkata Sai Suhas

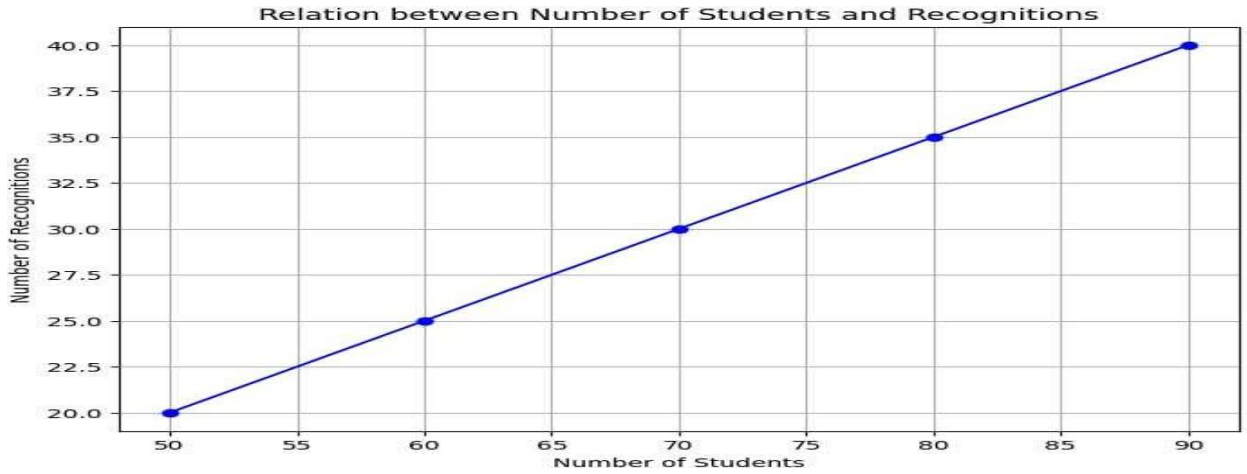

Figure 6: Students Vs Recognitions

The line plot in Fig 6. illustrates the relationship between the number of students and the number of recognitions in a given scenario. As the number of students increases, there is a corresponding increase in the number of recognitions received. Each data point represents a specific combination of students and recognitions, with the trend depicted by the straight line connecting these points. This visualization allows for a clear understanding of how changes in the number of students impact the overall recognition rate. The x-axis represents the number of students, while the y-axis represents the number of recognitions. The graph demonstrates a positive correlation between these two variables, indicating that an increase in student participation leads to a proportional increase in recognition.

CONCLUSION

This paper introduces an advanced facial recognition method that can be used to manage attendance in OpenCV. The real-time Student Attendance System with Emotion and Feedback Analysis is a comprehensive solution for automatic attendance tracking, emotion, and feedback analysis in the learning environment. Through the integration of facial recognition and emotion analysis technologies, the system aims to improve the traditional attendance management process. Capturing images from a CC camera or camera and using facial detection and recognition technology, this claim can reduce human effort and increase security. Based on this, facial detection and facial recognition can be used for many applications such as automatic attendance based on facial recognition, staff attendance, safety, security, and police applications such as searching for a thief in an image to help catch thieves.

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