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Enhancing Student Satisfaction Through Emotion Detection and Recognition Using Computer Vision with Predictive Analytics

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Abstract

This study proposes an innovative method to enhance student satisfaction[1] by integrating emotion detection[2] and recognition using computer vision[3] with visualization techniques[4]. Traditional methods like surveys often fail to capture the full scope of students' experiences. Our approach leverages real-time monitoring of students' emotional states to gain deeper insights into engagement and motivation, thereby improving overall satisfaction.

The objectives include developing a real-time emotion monitoring system, integrating facial API and computer vision for emotional recognition, using visualization techniques for data analysis, and assessing system effectiveness using the FURPS criteria. The study's significance spans various stakeholders: students benefit from improved academic outcomes, educators can tailor their teaching methods, parents can better support their children, and institutions can enhance their programs.

The research employs a quantitative descriptive design with participants from the computer science and digital animation programs, instructors, guidance counselors, and IT experts. Data will be collected through interviews, observations, and secondary sources. The project will be conducted over two semesters, with preliminary testing in the 2023-2024 academic year and full implementation in the 2024-2025 academic year.

Using the Agile Model for development, the system will feature a virtual YouCam web camera for emotion detection, visualization techniques for data analysis, and facial recognition for attendance monitoring. Despite challenges like privacy concerns and data accuracy, the integration of predictive analytics aims to provide actionable insights to enhance student satisfaction and educational outcomes.

Keywords: Student Satisfaction [1], Emotion Detection[2], Computer Vision[3], Visualization Techniques[4], FURPS criteria[5].

1. Introduction

In the rapidly evolving education landscape, fostering an environment that promotes academic excellence and student satisfaction has become a paramount goal for educational institutions. Student satisfaction is intricately linked to retention rates, academic performance, and the overall success of educational programs. Traditionally, assessing and addressing student satisfaction has relied on conventional methods such as surveys and feedback forms, which, while valuable, may lack the depth needed to comprehensively understand the multifaceted nature of students' experiences.

Recognizing the limitations of traditional approaches, this research project proposes an innovative methodology for enhancing student satisfaction through integrating emotion detection and recognition using computer vision, complemented by visualization techniques. The motivation behind this innovative approach stems from the acknowledgment that students' emotional well-being plays a pivotal role in shaping their overall satisfaction with the learning environment. The contributions of the proposed work are as follows:

1. to develop and implement of real-time monitoring system dedicated to student emotions detection;
2. to integrate facial API and computer vision for live emotional recognition;
3. to utilize visualization techniques for emotional data; and
4. to assess system effectiveness using FURPS.

By leveraging computer vision technologies, we aim to capture and interpret the intricate nuances of students' emotional states in real-time. This goes beyond the surface-level feedback typically obtained through surveys, allowing us to gain insights into the emotional dynamics that influence engagement, motivation, and overall satisfaction. Through the lens of computer vision, we seek to create a more holistic understanding of the student experience, one that considers not only academic performance but also the emotional journey of each learner.

2. Review Related Literature

Enhancing Emotion Recognition in Intelligent Tutoring Systems (Maria Lucia Barron-Estrada, 2023)

This study focuses on improving emotion recognition in intelligent tutoring systems (ITS) by detecting secondary emotions like boredom and frustration. It introduces a sentiment analyzer for recognizing emotional polarities in Spanish textual phrases within computer science education, achieving an accuracy of 88.26%. The research aims to enhance adaptive teaching software by combining insights from various fields and focuses on text-based sentiment analysis over traditional methods like facial expression or voice analysis.

Student Retention and Dropout in Higher Education (Valentim Realinho, 2022)

This research addresses the critical issue of student retention and dropout in higher education, highlighting its impact on economic growth and societal well-being. Utilizing a comprehensive dataset, the study develops a learning analytics tool with classification models to predict dropout risks and academic performance. The tool aids tutoring teams in timely interventions, providing targeted support to improve retention rates and academic success.

Learning Analytics to Prevent Student Dropout (Catarina Felix de Oliveira, 2021)

This study investigates student retention and dropout through the lens of learning analytics. It explores the utility of learning analytics in converting large student data into actionable insights, particularly in the context of online and remote learning. The research emphasizes the predictive power of learning analytics in addressing high dropout rates and aims to guide stakeholders in leveraging these insights to enhance educational outcomes.

Measuring Student Engagement Using Computer Vision (Pieter Vanneste, 2021)

This research leverages computer vision techniques to measure student engagement, a complex construct involving behavioral, cognitive, and emotional components. The study focuses on hybrid virtual classroom settings, aiming to develop methodologies for assessing engagement at both individual and collective

levels. It addresses the challenges of using computer vision to assess nuanced human behaviors and emotions.

Improved Face Recognition Algorithm for Attendance Management (Serign Modou Bah, 2020)

The study develops an improved face recognition algorithm to address challenges in existing facial recognition systems, such as lighting conditions and pose variations. The proposed method demonstrates high accuracy, reliability, and robustness, making it suitable for real-life applications in automatic attendance management systems.

Visual Sentiment Analysis for Facial Emotion Recognition (Cheguru, 2020)

This research presents a visual sentiment analysis system focused on facial emotion recognition. It involves three phases: face identification, facial recognition, and emotion detection. Using convolutional neural networks (CNN), the system identifies seven emotional states. The study showcases advancements in machine learning and computer vision applied to facial emotion recognition.

Emotions in Consumer Behavior and Tourism (M. Rosario Gonzalez-Rodriguez, 2020)

The research examines the role of emotions in consumer behavior, particularly in travel and tourism. It discusses how emotions drive responses to various stimuli and their importance in understanding consumer preferences. The study categorizes emotions into positive and negative, emphasizing their impact on consumption experiences.

Facial Expressions and Stakeholder Relationships (Alexandra M. Cadayona, 2019)

This study focuses on the role of emotions in stakeholder relationships, emphasizing the importance of facial expressions in communication. It discusses challenges in emotion recognition, particularly distinguishing between similar emotions, and proposes steps to enhance accuracy. The use of video analytics to evaluate customer emotions is highlighted.

Facial Expression Recognition Using ANN (Limuel Z. Ruiz, 2018)

The study develops a facial expression recognition system using an artificial neural network (ANN) to detect seven core emotions in response to commercials. It aims to improve recognition rates and understand the impact of different genres of advertisements on consumer emotions and sales effectiveness.

Fire Incident Data Visualization (Mary Jane Samonte, 2019)

This study involves the development of a data visualization tool for fire incidents in Metro Manila from 2015 to 2018. Pie charts are used to represent the distribution of fire incidents by type, time, and location, aiding in decision-making and resource allocation for fire prevention and response efforts.

Assessing Student Performance in Statistics Education (Jessica T. Obrial, 2020)

The research assesses students' performance in statistics education using the GAISE framework. Pie charts visualize the distribution of students' performance levels and the challenges they face, helping educators identify areas for improvement and enhance teaching practices.

3. Predictive Analytics Process

Figure. 1.0 Predictive Analysis Process

The software integrates a predictive analysis capability to provide insights through emotion detection. This feature is organized into four distinct phases, collectively contributing to the comprehensive analysis.

The first phase will capture the face data (image) of the person to be identified so that it can be recognized and labeled. In this stage, a video stream will also be recorded.
On this second, it will create a folder where it will store facial samples and name them datasets/models. It will feed the face data and the respective IDs of each face to the recognizer so that it can learn.
In the third phase, the model recognizes patterns in the data based on what it learned during training.
The final phase of the process has been reached; the model generates predictions or classifications for the data. The model's predictions should be analyzed and assessed, and the results interpreted.

Visualization Technique Used

Data visualization techniques encompass a range of methods aimed at visually representing data or information to extract insights, convey concepts effectively, and facilitate comprehension. These techniques are vital in exploring data, yielding presentable outcomes, and serving as a crucial pre-processing step in data mining. They aid in data cleaning by identifying inaccuracies and missing values and assist in variable derivation and selection, determining which variables to incorporate and discard in analyses. Among these techniques, the pie chart stands out as a prominent tool, presenting numerical proportions through circular slices, with each slice's arc length corresponding to its quantity. Pie charts are particularly useful for comparing parts of a whole, especially when accompanied by text and percentages (Kumar, 2024).

Formula:

The total value of a pie chart always equals 100%. To calculate the percentage for each segment of the pie chart, follow these steps:

1. Categorize the data into segments.
2. Calculate the total sum of all data values.
3. Divide each category's value by the total sum.
4. Convert the result into a percentage.
5. Finally, calculate the angle for each segment by multiplying the percentage by 360°.

Therefore, the formula for a pie chart is:

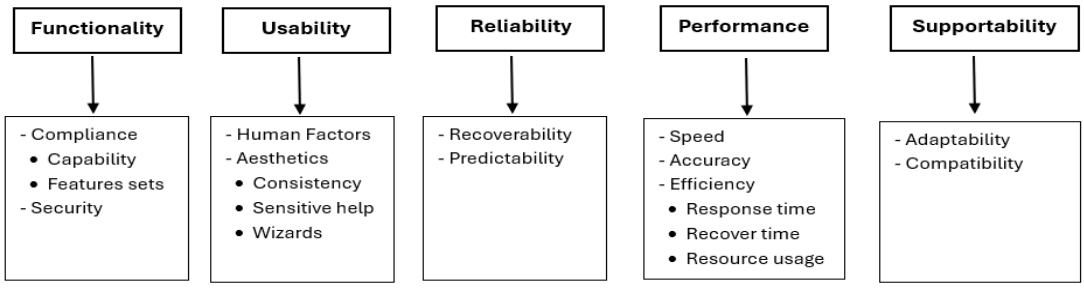
$$\text{Angle of Segment} = \left(\frac{\text{Value of Data Segment}}{\text{Total Sum of Data}}\right) \times 360^\circ$$

Research Instrument

The researcher will create a set of questions and present them to the appropriate participants to assess the proposed system.

The researcher will be using FURPS (1987)/FURPS+ (2000) stands for Functionality, Usability, Reliability, Portability, and Supportability. A framework for evaluating the quality of software used in project management and software engineering. Throughout the software development process, requirements are identified and prioritized using the FURPS model, representing several aspects of software quality.

Figure 2: FURPS (1987)/FURPS+ (2000)

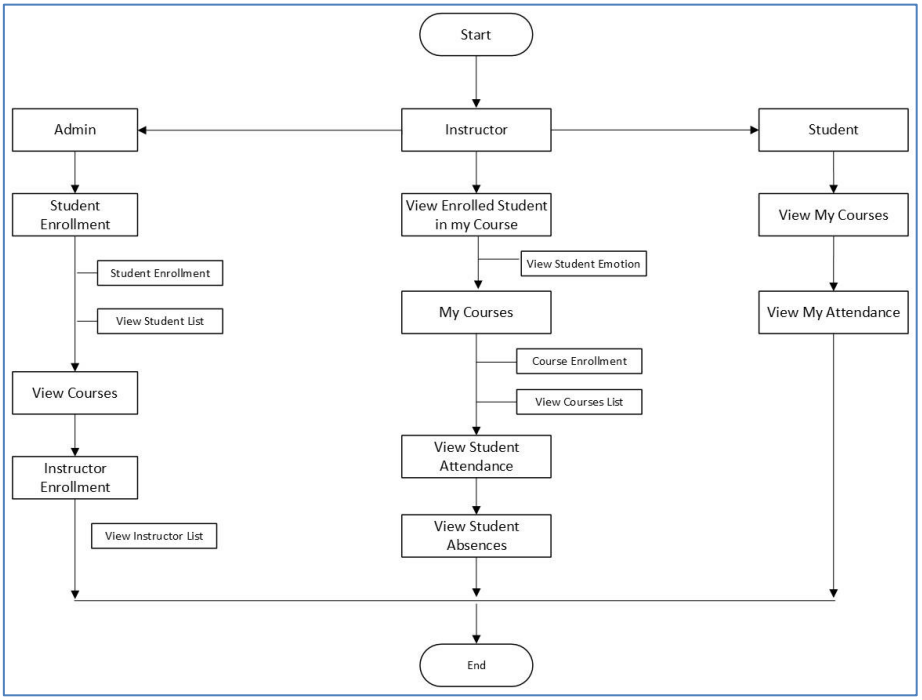


System Flowchart

There are three types of accounts depicted in the diagram.

1. **Admin Account:** This account is for administrators. Its functionalities include enrolling students into courses and viewing the list of enrolled students after enrollment. Additionally, there's a module to view courses, and the last function is to enroll instructors or add them to their respective subjects.
2. **Instructor Account:** This account is for instructors. Its functionalities include viewing the enrolled students in their courses and accessing a summary report of their emotions through a pie chart. There's also a section called "My Courses" where the instructor can view course enrollments and lists of courses. Additionally, there's a feature to view student attendance and their absences.
3. **Student Account:** This account is for students. The only functionalities available to students are viewing their courses and monitoring their attendance.

Figure 3: System Flowchart



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