Anxiety Recognition of College Students using Deep Learning with Fuzzy Logic

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Abstract - In today's fast-paced digital world, anxiety has become a significant mental health issue, particularly among college students facing various pressures. This project aims to develop an innovative system for recognizing anxiety levels through the analysis of anxiety related data. By leveraging deep learning techniques integrated with fuzzy logic, it can process text data fetched from popular social media platforms like Twitter and Facebook. Advanced Natural Language Processing (NLP) techniques are employed to extract meaningful features indicative of anxiety, using linguistic resources like SentiWordNet for sentiment analysis. Deep learning model that classifies user's emotional states based on the extracted features. It integrates with fuzzy logic enhances the model's ability to handle uncertainties in language, providing a nuanced understanding of anxiety expressions. The realtime reports and analytics that offer mental health professional's insights into students' emotional well-being.

Key words: Anxiety, Deep learning, Fuzzy Logic, SentiWordNet, Natural Language Processing, Mental health.

I.INTRODUCTION

Anxiety is an increasing concern among college students, who often face academic stress, social pressures, and career uncertainties. If left unaddressed, it can lead to severe mental health challenges. Traditional diagnosis methods, such as self-reporting and clinical evaluations, may not always capture a student's true emotional state. This project aims to identify anxiety levels in students by analyzing their behavior on social media platforms.

Social media has become an integral part of student life, where thoughts and emotions are frequently shared. This digital footprint presents an opportunity to detect signs of anxiety through language patterns, keywords, and sentiment analysis. By leveraging this data, early interventions can be implemented to support students before they seek help.

To achieve this, the proposed system employs deep learning techniques to analyse social media content. Neural networks help interpret complex language structures, while fuzzy logic enhances the model's ability to handle uncertainties in expression. This combination provides a more refined and accurate detection of anxiety levels.

The system utilizes APIs to gather real-time data from various social platforms. After filtering irrelevant content, advanced feature extraction methods identify key indicators of anxiety. These insights are then processed through the deep learning model, where fuzzy logic further refines sentiment interpretation for more precise assessments.

By offering mental health professionals a tool for monitoring emotional well-being, this approach enables proactive intervention. It bridges the gap between struggling students and available resources, fostering a supportive environment that prioritizes mental health care.

II.LITERATURE SURVEY

Yang Yu et al. [1] and Judy Hanwen Shen et al. [3] explored anxiety detection through social media platforms, leveraging natural language processing (NLP) techniques. In [1], the researchers analyzed Sina Weibo posts to predict anxiety levels, using the Simplified Chinese-Linguistic Inquiry and Word Count (SC-LIWC) for feature selection and training. The study involved 1,039 Weibo users who also completed the Self-Assessment Scale for Anxiety (SAS). The best model, XGBoostRegressor, achieved a Pearson correlation of 0.322 between predicted and self-reported anxiety scores, with a model reliability of 0.72. The findings suggest that analyzing digital footprints offers an efficient, cost-effective method for screening individuals with high anxiety. Similarly, in [3], researchers analyzed anxiety disorders using personal narratives from Reddit. Their classifier achieved a 91% accuracy using word vector embeddings and 98% when combined with lexicon-based features. They found that anxiety-related

posts frequently contained first-person singular pronouns and expressions of seeking connection. The study highlighted Reddit as a valuable source for mental health analysis due to its structured discussions and longer post lengths compared to platforms like Twitter. Both studies demonstrate the effectiveness of NLP techniques in analyzing social media posts to detect anxiety and highlight the potential for real-time intervention strategies through digital platforms.

Chandra Mani Sharma et al. [2], Kairit Sirts [5], and Asra Fatima et al. [6] explored machine learning techniques for detecting depression and anxiety disorders (DAD) using text data.In [2], the authors conducted a comprehensive review of 103 research papers on machine learning-based text analytics for detecting DAD. The study found that Support Vector Machines (SVM), Naive Bayes, and Long Short-Term Memory (LSTM) networks were the most commonly used models, with word embeddings being the preferred text representation method. Social media, particularly Twitter, served as the primary data source. The study emphasized that depression detection has been extensively researched, while anxiety detection remains relatively underexplored. Similarly, in [5], researchers collected blog posts from both diagnosed individuals and healthy controls to identify at-risk individuals. They applied various text encoding techniques such as Bag-of-Words, TF-IDF, and topic modeling, achieving the best classification results with Convolutional Neural Networks (CNN) using pretrained GloVe word vectors (78% accuracy, recall 0.72). The study also highlighted the impact of blog post length on CNN performance. Expanding on this, [6] introduced a semi-supervised learning model called DASentimental, designed to detect depression, anxiety, and stress from written text. The model was trained on recalled emotional words from 200 individuals and their Depression Anxiety Stress Scale (DASS-21) scores. Using cognitive network science, DASentimental achieved correlation scores of 0.7 for depression, 0.44 for anxiety, and 0.52 for stress. The study also tested the model on a dataset of 142 suicide notes, confirming expected emotional patterns. All three studies emphasize the importance of NLP and machine learning in mental health detection. While [2] provides a broad review of text analytics, [5] focuses on blog data, and [6] explores a cognitive network-based approach for deeper emotional analysis.

Jorge Rodríguez-Arce et al. [8] and Subigya Nepal et al. [9] explored non-text-based approaches for anxiety and stress detection, utilizing physiological signals and mobile sensing technology. In [8], researchers developed a system to detect anxiety and stress in academic settings using physiological signals rather than self-reported questionnaires. They collected heart rate, skin temperature, and oximetry data from 21 students using Arduino-based low-cost sensors. Their model classified stress with over 90% accuracy using the k-Nearest Neighbors (KNN) algorithm and achieved 95% accuracy in anxiety detection using a Support Vector Machine (SVM) classifier with galvanic skin response (GSR) signals. This study highlights the reliability of physiological markers in monitoring mental health. Similarly, [9] analyzed student mental health through a four-year longitudinal study at Dartmouth College. Using a mobile sensing app, researchers tracked over 200 students' behavior before, during, and after the COVID-19 pandemic. They examined gender-based behavioral differences, changes in student well-being, and long-term mental health trends. The de-identified College Experience dataset was released to support future research.

Both studies emphasize objective, sensor-based methods for anxiety detection. While [8] focused on real-time physiological signal analysis, [9] leveraged long-term mobile sensing data to assess mental health trends.

Morgan Byers et al. [4], Tahani Alshammari et al. [7], Gökmen Arslan et al. [10], and Nahal Salimi et al. [11] investigated how anxiety manifests in student populations, particularly in relation to social factors.

In [4], researchers analyzed social anxiety in student veterans with PTSD. Using deep learning, transformers, and SVM classifiers, they processed transcribed patient interviews to classify anxiety levels. Topic modeling was applied to identify key stress factors affecting veterans transitioning to civilian life. The study showed that text-based anxiety detection is feasible and can support psychologists in decision-making.

Similarly, [7] examined how virtual learning during the COVID-19 pandemic affected anxiety and stress in health sciences students. A survey of 418 students found that 51.44% were at risk of moderate to severe generalized anxiety disorder (GAD), with anxiety more prevalent in women (72.09%) than men (27.91%). First-year students and single individuals faced a higher risk of anxiety than senior students and married individuals.

The study emphasized the need for gender-based mental health programs and institutional support.

In [10], researchers explored the relationship between coronavirus anxiety, college belongingness, and psychological adjustment in 315 undergraduate students. They found that social media addiction played a role in this relationship, with lower social media use strengthening the connection between coronavirus anxiety and college belongingness. The study suggested that fostering a sense of belonging helps mitigate anxiety.

Expanding on this, [11] highlighted the growing mental health challenges faced by college students during the pandemic. The paper emphasized the need for proactive and comprehensive mental health responses from institutions to prevent academic dropouts and promote student resilience.

These four studies collectively highlight the psychological impact of academic and social transitions on students. While [4] focuses on veterans, [7] and [11] analyze the broader student population, and [10] explores the role of social belonging in mitigating anxiety.

Asra Fatima et al. [6] and Chandra Mani Sharma et al. [2] discussed the importance of multimodal approaches for detecting mental health disorders. In [6], the DASentimental model utilized cognitive network science to analyze emotional recall sequences. The study demonstrated that semantic distances between recalled words were critical for estimating depression but less relevant for anxiety and stress. The model achieved high correlation scores and was validated using a dataset of 142 suicide notes. Similarly, [2] emphasized the need for interdisciplinary collaboration, ethical AI practices, and transparent classification models in depression and anxiety detection. The study suggested expanding datasets and incorporating multimodal inputs, such as combining text, audio, and physiological signals, to improve system generalizability and early intervention effectiveness.

Both studies advocate for a shift towards more sophisticated AI-driven techniques to enhance mental health detection accuracy..

III. GAP ANALYSIS

They had previously shown that the COVID-19 pandemic had the potential to harm the mental health of healthcare workers in earlier studies. Further research is needed on HCW mental health effects of the COVID-19 pandemic, as all of the studies included in our meta-analysis were crosssectional. In any problem where a system must quickly analyse a series of elements connected to an object and make a prediction about the object's class, flatency is an allencompassing measure. Flatency is only considered in the context of identifying early signs of depression on social media. Wilcoxon's Signed Rank significance test was used as before to compare each model to the baseline (vanilla BS). Affective word embeddings as input, affective loss functions, and affectively diverse decoding were compared in this study, which also demonstrated how they could be combined. Clinical depression and online social media activities are covered by MDL. Determining whether or not a user is depressed is a binary classification problem for their multimodal depressive dictionary learning model. MDL is used in conjunction with our labelling method to measure depression intensity.

IV. PROPOSED SOLUTION

Proposed System Design Overview

The proposed system is designed to enhance stress and anxiety detection among individuals using advanced machine learning algorithms and physiological signals such as EEG, ECG, and BVP. The architecture ensures modularity, scalability, and real-time processing, catering to diverse data sources and user environments. By integrating robust models and user-centric interfaces, the system addresses current limitations such as scalability, generalization, and real-world applicability.

System Components and Modules

1. Data Acquisition Module i

This module is responsible for collecting data from multiple sensors and sources, such as EEG, ECG, and BVP signals. It ensures that the data is captured in real-time with minimal noise. The module is compatible with wearable devices and IoT sensors and applies data pre-processing techniques like filtering and normalization to ensure clean input for analysis.

2. Data Processing and Analysis Module

The processing module applies machine learning and deep learning algorithms to analyze collected data for detecting stress and anxiety levels. It implements feature extraction techniques to process EEG, ECG, and BVP signals while utilizing advanced models such as CNNs,

Random Forest, and XGBoost for accurate predictions. It also supports both real-time and batch processing.

3.User Interface (UI) Module is a
A user-friendly interface provides insights and visualizations to end users, such as students or clinicians. The interface includes interactive dashboards for real-time data visualization, configurable alerts and notifications, and access to historical data and trends.

4.Security and Authentication Modul is a best Security safeguards the system from unauthorized access and protects sensitive user data. The system applies data encryption for both storage and transmission, multi-factor authentication (MFA), role-based access control (RBAC), and complies with privacy standards like GDPR or HIPAA.

5.System Monitoring and Management Module This module ensures that the system operates efficiently and remains reliable under varying conditions. It includes performance monitoring and automated anomaly detection, resource management to handle scalability demands, and self-healing mechanisms for system recovery.

SYSTEM ARCHITECTURE

The system designed for anxiety recognition in college students consists of multiple interconnected layers, each responsible for specific tasks. It begins with the data source layer, where information is collected from questionnaires and Facebook data. Questionnaires provide subjective responses from students, while Facebook data includes behavioral and social media activity that may indicate anxiety levels.Once data is gathered, it enters the data preprocessing layer. In this phase, data cleaning removes inconsistencies, noise, and irrelevant information to ensure quality and reliability.Next, feature extraction focuses on identifying relevant features related to anxiety, which enhances the data's usability for model training. Normalization is then applied to standardize feature values, optimizing them for the model's performance.

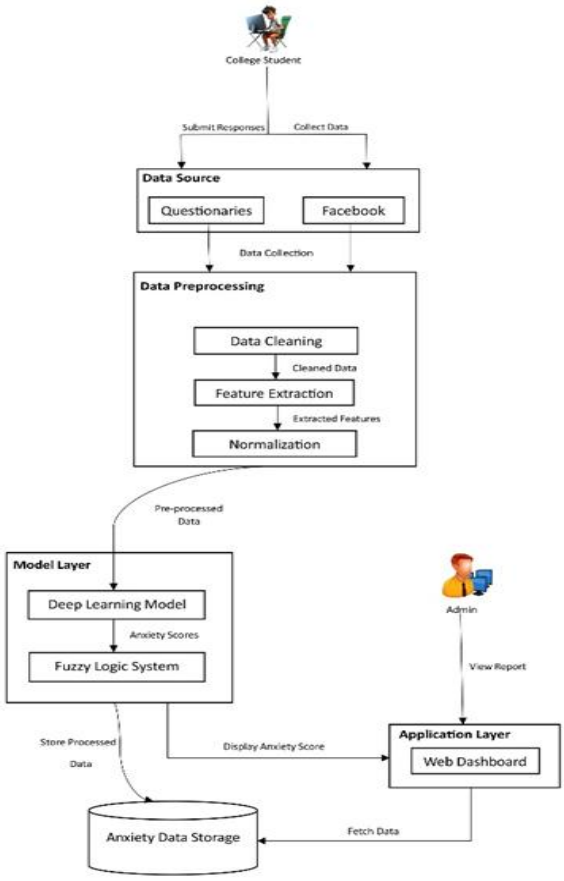

Fig – 1(System Architecture)

The preprocessed data is fed into the model layer, which includes a deep learning model and a fuzzy logic system. The deep learning model analyses the features to generate an initial anxiety score, while the fuzzy logic system refines this score, providing a final output that is more interpretable. Together, these components produce anxiety scores based on the student's data, reflecting their anxiety levels.

Processed data, including anxiety scores and related information, is stored in an anxiety data storage system, allowing the retention of data for future analysis and reference.

The application layer offers a web dashboard for administrators to monitor and manage anxiety analysis results. It displays anxiety scores and recommendations, helping in decision-making and interventions. Administrators can access detailed reports for further assistance, ensuring effective anxiety management in college students.

V. CONCLUSION AND FUTURE WORK

Conclusion

The project "Anxiety Level Recognition Using Deep Learning with Fuzzy Logic" represents a significant advancement in addressing the growing mental health concerns among college students. The study effectively demonstrated the efficacy of utilizing social media data, processed through deep learning and enhanced by fuzzy logic, to develop a nuanced model for anxiety detection. The project's findings underscore the potential of advanced computational techniques in identifying subtle linguistic patterns and emotional indicators within textual data. It is a proactive tool for timely intervention and support, bridging the gap between students and mental health resources.

Future Work

- Predictive Analytics: Implement machine learning algorithms to analyze patterns in anxiety-related data, allowing for early detection of mental health concerns. This can help institutions take proactive measures and allocate resources effectively to support students.
- Enhanced Reporting & Visualization: Develop interactive dashboards and advanced reporting tools to provide deeper insights into anxiety trends. These features will assist educators and mental health professionals in identifying students at risk and monitoring engagement over time.
- Mobile App Development: Enhance mobile applications with features such as real-time anxiety tracking, personalized coping strategies, and seamless integration with campus mental health resources. This will create a supportive digital environment for students, promoting mental well-being.

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