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Recognizing Drug Addiction Using Multimodal Data Fusion and Machine Learning Models

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ABSTRACT

This study addresses the urgent need for early detection and intervention in cases of drug addiction by proposing a comprehensive model that integrates questionnaire analysis, blood test analysis, and voice analysis. Leveraging machine learning techniques, questionnaire analysis aids in identifying behavioral patterns indicative of drug addiction. Optical Character Recognition (OCR) facilitates blood test analysis, extracting relevant information efficiently. Voice analysis employs a recurrent neural network model, specifically LSTM, to discern subtle vocal cues associated with drug addiction. Additionally, treatment assistance is offered through a chatbot powered by Natural Language Processing (NLP). By encompassing conventional methods alongside advanced Artificial Intelligence (AI) techniques, this study underscores the pivotal role of artificial intelligence in combatting drug addiction and facilitating timely intervention for individuals in need.

Keywords — Machine Learning, Optical Character Recognition, Recurrent Neural Network, Natural Language Processing

I. INTRODUCTION

Drug abuse is a pervasive and complex issue that poses significant challenges to individuals, families, communities, and societies worldwide. Substance Use Disorder (SUD), characterized by recurrent and compulsive drug-seeking behaviour despite adverse consequences, represents a critical manifestation of this problem. The detrimental effects of drug abuse extend beyond the individual user, impacting public health, socioeconomic stability, and overall well-being. The consequences of drug abuse are far-reaching and encompass various aspects of physical, mental, and social health. Chronic substance misuse can lead to a range of adverse health outcomes, including organ damage, neurological impairment, and increased susceptibility to infectious diseases. Moreover, substance abuse often co-occurs with mental health disorders, exacerbating symptoms and complicating treatment efforts. Additionally, the societal impact of drug abuse is evident in increased crime rates, strained healthcare systems, and disrupted family dynamics.

Artificial intelligence (AI) presents a promising avenue for addressing the complexities of drug addiction. AI, as a field of computer science, endeavours to develop algorithms and technologies that can analyse vast amounts of data to personalize treatment plans, predict relapse risks, and improve overall outcomes. By harnessing the power of AI, healthcare providers can potentially revolutionize the way drug addiction is treated, ultimately leading to more successful rehabilitation efforts. AI can also help in early detection of substance abuse patterns and provide real-time interventions to prevent relapse. Overall, the integration of AI in addiction treatment can greatly enhance patient care and support efforts to combat the opioid crisis. With advancements in technology, there is hope for more effective and efficient approaches to addressing substance use disorders. to develop systems capable of tasks requiring human-like intelligence. Its integration into healthcare has seen notable advancements in diagnosis, treatment, research, and management. This project aims to leverage AI to create a framework for self-diagnosis and support systems for individuals struggling with addiction.

II. OBJECTIVE

Our goal is to develop a student-centric AI framework for the diagnosis and treatment assistance of drug addicts, utilizing advanced technologies like machine learning and natural language processing to provide personalized interventions, coping strategies, and educational resources, ultimately empowering individuals to take control of their recovery process and break down barriers to accessing addiction treatment, with the aim of fostering healthier lifestyles and societal well-being.

III. LITERATURE REVIEW

Addiction, particularly drug addiction, poses significant challenges globally, necessitating innovative approaches for identification, prevention, and intervention. Kaur et al. [1] propose an Artificial Intelligence (AI) Framework utilizing Markov Decision Processes (MDPs) to identify populations affected by drug addiction. Leveraging MDPs allows for dynamic decision-making, crucial in understanding addiction's complex nature. Similarly, Chhetri, Goyal, and Mittal [2] conduct a systematic review on addiction using Machine Learning (ML) models, revealing diverse methodologies to comprehend addiction's multifaceted aspects. Rekabdar, Albright, McDaniel et al. [3] extend this discourse by exploring ML and Deep Learning (DL) techniques within primary healthcare strategies, emphasizing the potential of these techniques in enhancing substance use screening and intervention efficacy through the questionnaires collected through the screening process of drug addicts.

Consolidating insights from these studies, the literature emphasizes the pivotal role of advanced technologies, particularly AI and ML, in addiction research and healthcare. From using ML for predictive modelling to integrating DL for nuanced screening, these studies underscore the versatility and potential of technology in addressing addiction-related challenges. However, it's essential to navigate limitations, including model refinement, data robustness, and ethical considerations, ensuring the responsible and effective application of technology in addiction research and healthcare. Moreover, comprehensive and holistic approaches, integrating causative analysis with proactive intervention strategies, are vital for tackling the multifaceted challenge of addiction effectively.

Furthermore, emerging research, such as that by Hadjahmadi, Ziyaaddini, and Omid [4], Hassan et al. [5], Phan et al. [6], and Ghosh et al. [7], highlights the evolving landscape of addiction research, encompassing diverse methodologies and platforms. From utilizing speech signals and social media data for addiction diagnosis to identifying influencing factors among student populations, these studies demonstrate the interdisciplinary nature of addiction research and the need for multifaceted approaches. Importantly, ethical considerations, privacy protection, and user-centric approaches are integral to leveraging technology, such as ML and social media, for addiction support and intervention.

In essence, the literature underscores the transformative potential of technology, particularly AI and ML, in addiction research and healthcare. But the reviewed research faces limitations due to its reliance on a restricted dataset, hindering comprehensive conclusions and potentially introducing biases. Although it offers insights into psychological disorders from substance abuse, it lacks specific treatment methodologies and predictive capabilities for addiction severity and progression. Moreover, the absence of monitoring methods for addiction recovery is a significant gap. Addressing these shortcomings requires broader datasets, integration of treatment strategies and predictive models, and the development of monitoring tools. Presently, there's a noticeable gap in dedicated systems for drug addiction diagnosis and treatment, with existing online resources offering limited support. A pressing need exists for reliable and comprehensive online tools that can accurately diagnose and treat drug addiction, filling a critical void in current addiction support services.

A survey conducted among students and teachers of various schools and colleges in Kerala yielded insightful results. Out of the 32 responses received, a significant portion, accounting for 37%, expressed suspicion regarding drug addiction among students within their respective organizations. Additionally, 31% of respondents conveyed uncertainty regarding this matter. Notably, an overwhelming majority, comprising 96% of participants, voiced the opinion that implementing a system capable of predicting drug addiction within educational institutions would be beneficial. This strong consensus underscores the recognition of the importance of early detection and intervention in addressing substance abuse issues. Furthermore, the unanimous agreement among respondents regarding the significance of detecting drug addiction at the earliest possible stage highlights the collective commitment to safeguarding the well-being and welfare of students within the educational environment. These findings underscore the pressing need for proactive measures and support systems to address and mitigate the impact of substance abuse within educational settings.

IV. METHODOLOGY

The system as in Fig. 1, accessible via a website interface, is strategically tailored for implementation within school and college environments, aimed at identifying students exhibiting tendencies toward drug addiction. Notably, the system not only determines the presence of addiction but also predicts its severity level. Furthermore, to extend support beyond identification, a chatbot feature is integrated into the website, offering motivational messages and counselling sessions to individuals struggling with addiction. To ensure the system's efficacy, student details are securely entered into the platform directly from the institute. Additionally, to uphold accountability and ensure prompt intervention, copies of the results are automatically forwarded via email to the designated guardians. This proactive measure ensures that participation is mandatory and that results reach the appropriate individuals who can facilitate the necessary support and aid in the recovery process. Through this comprehensive approach, the system aims to foster a supportive environment conducive to student well-being and recovery from addiction.

The system employs three distinct models for predicting drug addiction: a questionnaire-based approach, report analysis using Optical Character Recognition (OCR), and voice analysis. Each model offers unique advantages and limitations. By integrating these models, the system achieves a more comprehensive and accurate prediction mechanism. While traditional questionnaires provide a foundational method, they are vulnerable to manipulation due to the sensitive nature of addiction-related inquiries. In contrast, report and voice analyses offer more comprehensive evaluations, reducing the potential for user interference and ensuring heightened privacy, especially with voice analysis. Integration leverages the strengths of each model while mitigating their weaknesses, enhancing overall prediction accuracy. Additionally, the system's website features a chatbot for providing personalized treatment assistance to individuals dealing with addiction, further augmenting support for recovery. The subsequent section will provide a detailed analysis of each feature, elucidating their functionalities and contributions to the system's efficacy.

A. Questionnaire Analysis

In the endeavour of detecting drug addiction, questionnaires serve as indispensable tools, offering structured insights into the intricate nuances of individuals' behavioural patterns, psychological states, and substance use habits. By delving into various aspects of an individual's experiences pertaining to substance use, these questionnaires play a pivotal role in gauging the likelihood of addiction. Once the

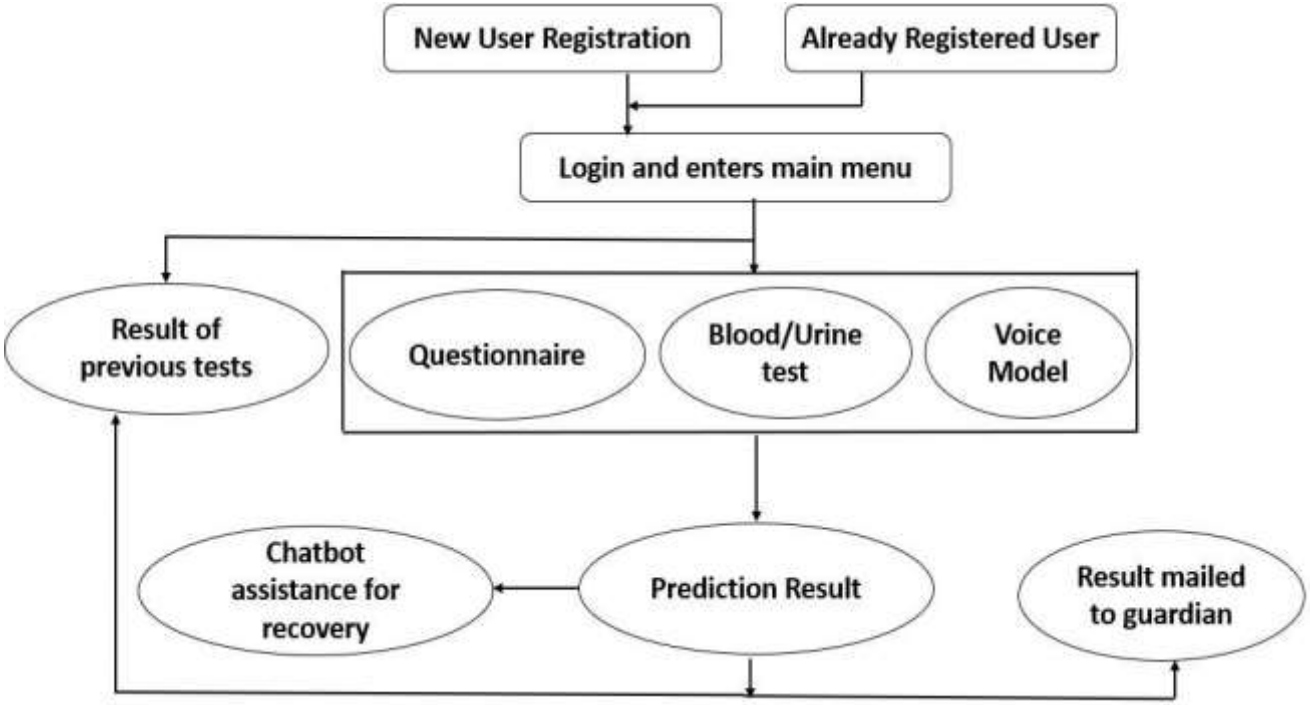

Fig. 1 Proposed system design

questionnaires are completed, the ensuing dataset undergoes a meticulous preprocessing phase, which includes addressing missing values through k-nearest neighbour imputation. This meticulous preparation ensures that the dataset is primed for subsequent modelling endeavours. In the realm of modelling, classification algorithms such as Support Vector Machine (SVM), Random Forest, and Decision Tree come to the fore. Each of these algorithms brings its unique approach to the table: SVM strives to pinpoint the optimal hyperplane for segregating different classes in the feature space, while Random Forest harnesses the power of ensemble learning by constructing multiple decision trees to output the mode of the classes. Conversely, Decision Tree methodically partitions the data based on feature values, aiming to maximize the purity of each subset with respect to the target variable. Post-training, the model undergoes rigorous evaluation to gauge its performance and effectiveness in predicting addiction risk levels. This rigorous assessment paves the way for timely interventions and support for individuals deemed to be at heightened risk of substance abuse.

Through the fusion of advanced machine learning techniques and insightful questionnaire responses, the predictive model endeavours to furnish accurate assessments of addiction risk levels, thus facilitating proactive intervention strategies and support mechanisms for individuals grappling with substance abuse concerns. By assigning scores to each of the response ranging from 1 to 5 to denote the severity or level of addiction risk, the model harnesses the rich information gleaned from the questionnaire data. Leveraging this data, coupled with sophisticated machine learning algorithms, enables the model to discern patterns and trends indicative of addiction risk. Armed with these insights, the model aims to proactively identify individuals at elevated risk of substance abuse, thereby empowering stakeholders to initiate targeted interventions and support programs. Ultimately, this holistic approach to addiction detection not only underscores the importance of comprehensive assessment methodologies but also underscores the potential of machine learning in driving transformative advancements in the realm of substance abuse prevention and intervention.

B. Blood Test Analysis

The proposed system leverages Optical Character Recognition (OCR) technology to extract text from images capturing drug test results, streamlining the analysis process. Utilizing the EasyOCR library, the system seamlessly extracts textual information from the images, facilitating efficient result interpretation. Visualizations are generated to enhance clarity, with text regions meticulously annotated and labelled for easy comprehension. Following text extraction, the parsed data undergoes a crucial threshold comparison step, where predetermined threshold values corresponding to different drugs are juxtaposed against the detected quantities. A reference dictionary stores these threshold values,

streamlining the comparison process for swift analysis. If the detected quantity surpasses the threshold for any drug, the system flags a positive result, indicating potential addiction.

Within the EasyOCR library framework, the input image undergoes meticulous text detection and recognition processes.

Initially, the image is meticulously analysed to pinpoint areas containing textual content. Subsequently, these detected text regions are interpreted and transformed into machine-readable text, facilitating seamless integration into the analysis pipeline. Furthermore, the system meticulously extracts the cutoff value associated with each drug, contrasting it against the predefined threshold value for precise determination. In the event that the detected quantity exceeds the threshold for a specific drug, the model deduces that the user may be addicted to that particular substance, enabling proactive intervention and support measures.

C. Voice Analysis

Predicting drug addiction through speech patterns offers a promising avenue for early detection and intervention. This technique capitalizes on the distinct speech characteristics exhibited by individuals with substance use disorders, providing a non-invasive and potentially covert means of assessment. One significant advantage lies in its secrecy; anyone can record their voice and assess their addiction status privately, without the need for intrusive procedures. Moreover, leveraging speech data for addiction prediction streamlines the process, bypassing the need for invasive tests or subjective self-reporting. However, the development of such models entails intricate processes, including data preprocessing, feature extraction, model training, and evaluation.

The model for predicting drug addiction begins by taking raw audio recordings from individuals undergoing assessment. These recordings are then subjected to noise removal and preprocessing techniques, including filtering, normalization, and denoising, to enhance their quality and accuracy for analysis. From the pre-processed audio data, essential acoustic features such as the Zero Crossing Rate (ZCR), Root Mean Square (RMS), and Mel-Frequency Cepstral Coefficients (MFCCs) are extracted. These features capture critical aspects of the audio signal, including its energy, spectral characteristics, and rate of sign changes

The extracted features are organized into feature matrices, which serve as input data for the LSTM (Long Short-Term Memory) neural network model. The LSTM model, a type of recurrent neural network (RNN) specialized in sequential data processing, then learns to analyse the temporal patterns in the input features. By leveraging this temporal understanding, the model can make predictions about the presence of drug addiction. The final output of the model is the predicted addiction status for each input sample, classifying them as either addicted or not addicted based on the learned patterns in the audio features

D. Chatbot

Building a chatbot to provide motivation and support during a relapse requires a compassionate approach, as it offers immediate assistance and encouragement. Key features include personalized interaction, non-judgmental language, motivational support, real-time intervention, crisis management, and relapse prevention strategies. Following formal treatment, individuals often struggle with transitioning back into daily life, making ongoing support vital. Chatbots can effectively aid users in maintaining their recovery efforts during this critical period, thereby serving as valuable tools in addiction treatment by offering support, information, and motivation throughout the recovery journey.

The process begins with a reading text corpus, which serves as the foundation for training chatbots to effectively communicate. Preprocessing steps are then applied to this corpus, including tokenization to break sentences into individual words, lemmatization to reduce words to their base form, and the creation of a bag of words representation. Additionally, data imbalance is addressed, and irrelevant characters are removed to ensure the quality of the data.

The model architecture, crucial for learning patterns and making predictions, involves a neural network with multiple layers. Implemented using a Sequential model in Keras, this architecture includes layers such as Dense for fully connected neurons, Dropout for regularization, and Activation for non-linear transformations. Optimization techniques are employed to enhance the model's accuracy and generalization, with parameters optimized through multiple epochs of training using labelled data. Stochastic gradient descent (SGD) with Nesterov accelerated gradient is utilized as the optimizer, and categorical cross-entropy serves as the loss function.

Finally, the trained model undergoes evaluation to assess its performance. Metrics such as accuracy and loss are calculated on a separate validation dataset to gauge the model's effectiveness in making accurate predictions. This comprehensive process ensures the development of a robust and reliable model for communication tasks in chatbot applications.

V. CONCLUSION

In the healthcare field, the importance of Artificial Intelligence (AI) has become increasingly apparent. With the global increase in drug abuse cases, there is a growing demand for AI to play a crucial role in early detection and treatment, particularly among students. This project strategically situates itself to employ AI and machine learning for facilitating the self-diagnosis and treatment of drug addiction among students. Its primary aim is to provide students with cutting-edge tools for self-awareness and proactive health management. By integrating diverse datasets encompassing biological, psychological, and sociological facets of drug addiction, the project aims to establish a comprehensive framework enabling early detection and personalized treatment approaches.

In conclusion, the integration of advanced technologies such as machine learning and artificial intelligence offers promising avenues for addressing the complex challenges posed by drug addiction. By leveraging multimodal data and

predictive models, we can enhance our capacity for early detection, intervention, and prevention across diverse sectors and settings. These models not only enable proactive intervention in healthcare but also extend to areas such as education, criminal justice, workplace safety, and community outreach. However, effective solutions require collaborative efforts that transcend disciplinary boundaries and embrace the multifaceted nature of substance abuse. By fostering partnerships and implementing holistic strategies, we can work towards a future where individuals affected by addiction receive timely support, resources, and opportunities for recovery, ultimately fostering healthier communities and societies.

REFERENCES

[1] S. Kaur, N. Nishi, Y. Kaur and S. Thakur, "Artificial Intelligence Framework for Identifying the Population Addicted to Drugs: Markov Decision Process", 2021 2nd International Conference on Computational Methods in Science & Technology (ICCMST), Mohali, India, 2021

[2] B. Chhetri, L. M. Goyal, M. Mittal, "How Machine Learning is Used to Study Addiction in Digital Healthcare: A Systematic Review", International Journal of Information Management Data Insights, 2023.

[3] B Rekabdar, D. L. Albright, J. T. McDaniel et al., "From Machine Learning to deep Learning: A comprehensive study of alcohol and drug use disorder", Elsevier Inc, 2022.

[4] S. A. Amin et al., "Data Driven Classification of Opioid Patients Using Machine Learning: An Investigation", IEEE, 2023.

[5] M. M. Hassan, Z. J. Peya, S. Zaman, J. H. Keya and A. U. Dulla, "A Machine Learning Approach to Identify the Correlation and Association among the Students' Drug Addict Behaviour",2020 11th International Conference on Computing, Communication and Networking Technologies,2020

[6] A. Hadjahmadi, M. H. Ziyaaddini, M. M. Omid, "Using End-to-End Deep Neural Networks for Diagnosing Drug Addiction from Speech Signals", 2020 6th Iranian Conference on Signal Processing and Intelligent Systems, 2020

[7] Nhathai Phan, Manasi Bhole,Soon Ae Chun, James Geller,"Enabling Real-Time Drug Abuse Detection in Tweets", IEEE International conference on Data engineering.

[8] Shalmoli Ghosh, Janardan Misra, Saptarshi Ghosh, Sanjay Podder, "Utilizing Social Media for Identifying Drug Dependent Population", IEEE International Conference on Big Data, 2020.