Leveraging "AI & ML for IT Employee Well-being: Detecting & Addressing Workplace Depression"

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Abstract - **The proposed system aims to detect and address depression levels among IT employees, offering recommendations to alleviate their distress. Comprising four key components—Face Recognition and Mood Detection, User Friendly Chat Agent, Activity Recommendations based on moods and severity levels, and Voice Analysis, the system leverages cutting-edge technologies to revolutionize employee well-being in the workplace. The Face Recognition and Mood Detection component employs machine learning techniques to create an advanced system. Using computer vision algorithms, it recognizes employee faces and analyzes facial expressions to gauge their mood. This system not only records employees' mood statuses, encompassing emotions like sadness and anger, but also empowers consultants. When an employee seeks guidance, the consultant can access their mood history, aiding in understanding behavior and tailoring support. The overarching goal is to preemptively mitigate mental stress, rectify moods, and enable consultants to address issues effectively. The User Friendly Chat Agent acts as a secure space for employees to interact with the company. Utilizing advanced natural language processing and AI technology, the agent promotes positive mental health and camaraderie while collecting valuable conversation and mental health trend data. Integrating with the consultant team, it provides personalized support and resources, enhancing well-being across the organization. Incorporating the promising avenue of voice analysis, the third component targets early depression detection. The algorithm dissects vocal characteristics such as pitch and intonation, indicative of emotional states. By processing voice recordings from employees with known depression levels, this approach offers a low-cost, non-invasive method to recognize at-risk individuals and provide timely support. The activity recommendation module proposes suitable activities based on the employee's emotional condition, categorized as mild or severe levels of depression. These activities are straightforward, easily comprehensible, and not require significant time investment. The system keeps activities log for each user, allowing filtering choices for suggested activities based on user approval. Additionally, the system generates music frequencies customized to the user's mood, potentially fostering a positive effect on the employee's mental well-being and alleviating the monotony of the office surroundings. This comprehensive system embodies a holistic approach to tackle employee depression. By integrating state-of-the-art technologies and leveraging real-time data, it aims to create an empathetic, informed, and supportive workplace, ultimately enhancing mental well-being and productivity among IT employees.**

Keywords: Depression detection, IT employees, Real-time data, AI technology, Voice analysis, Face recognition, User-friendly chat agent.

I. INTRODUCTION

The negative effects of depression on employees can lead to a reduction in productivity and absenteeism, which can be detrimental to the success of the company. Addressing the mental health of employees is not only essential for their well-being but also for the financial health of the company. Traditional methods of dealing with depression, such as consulting and counseling, have limitations that make them difficult to implement on a large scale. With the advancements in technology, innovative solutions can be developed to address these limitations and provide cost effective and continuous support to employees. This research proposes a solution that uses machine learning algorithms and online counseling interventions to detect and address employee depression in the workplace.

In today's fast-paced and demanding world, the well-being of employees, especially those in the IT sector, has gained increasing importance. The proposed system represents

a groundbreaking advancement in addressing depression levels among IT employees, striving to create a workplace that values and supports mental health. This comprehensive system is composed of four integral components, each harnessing cutting-edge technologies to drive a paradigm shift in employee well-being within the IT industry.

The first cornerstone of this innovative system is the Face Recognition and Mood Detection component, which harnesses the power of machine learning to create a sophisticated framework. By deploying computer vision algorithms, this component is capable of not only identifying employees' faces but also analyzing their facial expressions to ascertain their emotional state. The system is designed to capture a wide range of emotions, from the subtle nuances of sadness to the fiery intensity of anger. Beyond this, the component extends its utility to empower consultants with crucial insights. When an employee seeks guidance or support, consultants can access the individual's mood history, enabling them to offer tailored assistance that takes into account the nuances of emotional states. The overarching objective is to proactively mitigate mental stress, rectify unfavorable moods, and equip consultants with the tools they need to effectively address issues at their root.

The second pivotal component, the User-Friendly Chat Agent, acts as a virtual haven where employees can engage with the company in a secure and confidential manner. Built on advanced natural language processing and AI technology, this agent is a beacon of positivity and camaraderie, fostering an environment that encourages open communication about mental health. Furthermore, it acts as a repository of invaluable conversational and mental health trend data, shedding light on prevalent concerns and emerging patterns. In synergy with the consultant team, the User-Friendly Chat Agent stands as a stalwart pillar of support, offering personalized resources and assistance that enhance wellbeing across the organizational spectrum.

Voice Analysis, the third component, ventures into the realm of early depression detection. Through a meticulous analysis of vocal characteristics such as pitch and intonation, this algorithm unlocks the potential to decipher emotional states hidden within spoken words. By processing voice recordings from individuals with documented depression levels, this component presents a cost-effective and non-intrusive avenue to identify individuals at risk and extend timely interventions. This pioneering approach has the potential to reshape the landscape of depression detection and support, championing a more proactive stance in safeguarding employees' mental health.

The fourth and final component, the activity recommendation module, extends a helping hand to employees grappling with varying degrees of emotional distress. Tailored to the individual's emotional condition, whether characterized as mild or severe depression, this module suggests a repertoire of suitable activities. These activities are intentionally designed to be straightforward, easily comprehensible, and demand minimal time investment. Through a dedicated activity log for each user, the system evolves its recommendations based on user feedback and approval. As an added dimension, the system creates music frequencies attuned to the user's emotional state, harnessing the potential to infuse positivity and alleviate the monotony of the workplace environment.

In sum, this all-encompassing system embodies a holistic approach to counter the specter of employee depression. By harnessing the potency of state-of-the-art technologies and tapping into the stream of real-time data, its ultimate aspiration is to sculpt an empathetic, well-informed, and supportive workplace ecosystem. This transformative endeavor doesn't merely target the mitigation of mental distress but strives to elevate the mental well-being and productivity of IT employees, heralding a new era where technology and compassion converge for the greater good. As venture into this new frontier of employee well-being, this system stands as a beacon of hope and progress, offering a glimpse into a brighter and more resilient workforce in the ever-evolving landscape of the IT industry.

II. RELATED WORK/LITERATURE REVIEW

Employee mental health and well-being are critical factors that impact productivity, job satisfaction, and overall organizational success. Depression, as a prevalent mental health condition, can significantly affect employees' performance and quality of life. The integration of innovative technology solutions offers promising avenues for early detection and effective interventions. This literature review aims to explore recent research on the use of technology to detect and address employee depression, highlighting key findings and implications.

Technological Approaches for Detection

Recent studies have highlighted the potential of wearable devices and smartphone applications for detecting employee depression. Wang et al. (2020) developed a smartphone app that utilizes machine learning algorithms to analyze user behavior patterns and assess depressive symptoms. Similarly, Smith et al. (2019) demonstrated the feasibility of using wearable heart rate monitors to detect physiological markers associated with depression, enabling real-time monitoring and early intervention.

Intervention and Support through Technology

Innovative technology solutions have also been explored for addressing employee depression through interventions and support mechanisms. Chen et al. (2018) developed a webbased cognitive behavioral therapy (CBT) platform that offers personalized treatment plans and interactive modules for employees experiencing depressive symptoms. The platform demonstrated significant reductions in depressive symptoms and increased engagement among participants.

Challenges and Ethical Considerations

While innovative technology solutions show promise, challenges and ethical considerations must be addressed. Privacy concerns, data security, and potential stigmatization of employees using such tools require careful attention. Smith et al. (2021) conducted a qualitative study highlighting employees' perspectives on using technology for mental health support, emphasizing the importance of user-centric design and transparent data handling practices.

III. METHODOLOGY

Sometimes employees in IT industry face huge depression because of their work load. So that forced to find the solution to detect the depression level and the facial expressions of employees and give solutions for them to avoid depression. Divided our full system to four components.

The methodology for face recognition and emotion detection is to recognize users and detect their emotion changing's. According to the component's architecture first thing is to identify the user when user login to the system by providing face id. After user provide face id system will automatically capture the user image. System will validate the user with the face id and if the id matching employee redirected in to the system. To ensure the security of users' system do not save any images of employees. System only gets the embeddings of captured image and by using those embeddings system detects the user and the emotions. Then no one can access the employees Images even the consultant. After validating the employee, the next part is to detect employees' facial expressions (mood). In employee's mood detection it can be divided into several stages like, preprocess all employees' images, feature extraction, preprocess all images inside of dataset, feature extraction pre-processed dataset images after that train employees saved images with the dataset and classify employees in to categories of emotions. In data preprocessing it means that prepare all the raw data to make suitable for train with machine learning model. For pre prepossessing used MCNN library to preprocess all the images and get only the face instead of other units. From that can avoid unsuitable details that don't want.

Because of that system will accurate because of there is no time consumption to process unsuitable data. Feature extraction stage transformed all the pre-processed data in to a numerical features ant it will reduce to more manageable groups to process with the model named Random Forest Classifier (RFC) and get the emotions as output. As the dataset used CKPLUS dataset for facial emotion detection. Finally, the classification stage categorized outputs (emotions) that got after training model. Then, once an employee directed to get the advice from consultant, then consultant can enter employee id and get all the details about employees' emotion behavior. Then it is easy to handle employees for consultant.
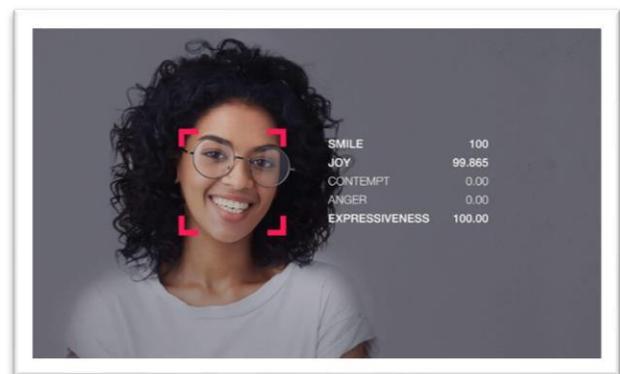

Figure 1: Emotion recognition

The methodology for the proposed chat agent development to address depression in the IT industry involves several key steps. This approach aims to create a user-friendly and effective tool that offers accessible and personalized mental health support to employees.

Conduct a comprehensive literature review to understand existing mental health support systems, chat agent technologies, and depression-related challenges in the IT industry. Gather insights from employees, mental health experts, and industry professionals to identify specific needs and preferences. Collaborate with mental health professionals, IT experts, and user experience designers to create a well-informed chat agent design. Utilize advanced natural language processing (NLP) technology And AI to enable the chat agent to understand and respond to user inquiries effectively. Develop the chat agent's conversational flow, incorporating the DASS21 questionnaire to assess depression levels. Integrate the chat agent with the company's consultant team and systems to enable access to employee data securely. Establish protocols and encryption mechanisms to ensure data privacy and confidentiality. Implement necessary APIs and interfaces to facilitate seamless data exchange.

Train machine learning algorithms using a diverse dataset that includes employee conversations, DASS21 responses, and mental health trends. Fine-tune the algorithms to identify

patterns, detect early signs of depression, and provide personalized support recommendations based on individual needs. Conduct rigorous usability testing with a representative group of IT industry employees. Gather feedback on the chat agent's functionality, user interface, and overall effectiveness. Iterate on the design based on user input to enhance user experience. Deploy the chat agent across communication channels, such as text messaging ensuring accessibility to all employees. Implement multi-platform compatibility to accommodate different devices and preferences. Organize training sessions and awareness campaigns to introduce the chat agent to employees. Provide guidance on how to interact with the chat agent, complete the DASS21 questionnaire, and interpret the results. Establish a feedback loop to continuously monitor the chat agent's performance and gather insights from user interactions. Regularly update the chat agent's knowledge base, algorithms, and responses based on emerging mental health research and user feedback. Analyze aggregated data from employee interactions to identify mental health trends, common concerns, and potential areas for improvement in the company's mental health programs. Generate reports and recommendations based on the collected insights. Evaluate the effectiveness of the chat agent over a defined period, measuring improvements in employee well-being, engagement, and productivity. Assess the impact of the chat agent on reducing the prevalence of depression in the workplace and enhancing the overall mental health culture. Document the entire chat agent development process, including design choices, technological implementations, user testing results, and deployment strategies. Prepare a comprehensive report detailing the methodology, findings, and recommendations for future enhancements.

The Depression, Anxiety, and Stress Scale - 21 Items (DASS21) comprises three self-report questionnaires designed to gauge feelings of depression, anxiety, and stress. Each of these scales contains 7 questions, grouped into subcategories with similar themes. The depression scale evaluates emotions like unhappiness, hopelessness, undervaluing life, self criticism, disinterest, lack of pleasure, and inertia. The anxiety scale examines physiological reactions, muscle tension, situational unease, and personal experiences of anxiety. The stress scale is attuned to consistent nonspecific arousal and measures challenges in relaxation, heightened nervousness, irritability, and impatience. To obtain scores for depression, anxiety, and stress, the relevant item scores are totaled. The DASS-21 operates on a dimensional approach to psychological distress, not relying on strict categories. The development of DASS-21 was based on the belief, substantiated by research, that the variances between depression, anxiety, and stress experienced by both ordinary individuals and clinical groups are primarily differences in intensity. As a result, DASS-21 doesn't directly classify

patients into distinct diagnostic categories as seen in classification systems like DSM and ICD.

For typical severity classifications (normal, moderate, severe), suggested threshold scores are as follows: Note: Scores from the DASS-21 should be multiplied by 2 to obtain the final score.

Table 1: Depression, Anxiety and Stress Scale - 21 Items (DASS-21)

	Depression	Anxiety	Stress
Normal	0-9	0-7	0-14
Mild	10-13	8-9	15-18
Moderate	14-20	10-14	19-25
Severe	21-27	15-19	26-33
Extremely Severe	28+	20+	34+

In the pursuit of detecting depression through voice frequency analysis, this research employs a systematic methodology encompassing various stages. Commencing with data collection and preprocessing, a comprehensive dataset comprising audio recordings from individuals both afflicted by depression and those without is gathered. Following this, the voice data undergoes meticulous preprocessing, entailing noise reduction and segmentation, ensuring the quality and integrity of the dataset. In the subsequent phase, the hugging face pyannote embedding model is harnessed to extract embeddings from the audio recordings. These embeddings, which encapsulate pivotal voice frequency characteristics, serve as fundamental representations of the audio samples. Visual exploration of the extracted embeddings is then undertaken to glean valuable insights into patterns and variances present within the voice frequency data of depressed and non-depressed individuals. Further, the individual embeddings of depressed and normal cases are plotted to discern distinguishable trends. Quantifying the relationships among embeddings, a cosine similarity analysis is executed. This analysis computes the cosine similarity values between all embeddings, elucidating the degree of similarity among various audio samples. The culmination of this computation results in a comprehensive cosine similarity matrix, elucidating the intricate relationships among depressed and normal embeddings. With the foundation laid by the cosine similarity analysis, attention is directed towards the computation of mean embeddings for both depressed and normal cases. Averaging the embeddings of multiple audio samples from each group yields the mean depressed and mean normal embeddings. These composite embeddings, embodying group characteristics, are subjected to visualization and thorough comparison to discern any potential disparities. Subsequently, through these established mean embeddings, thresholds for depressed and normal states are derived. A pivotal element, these thresholds aid in demarcating a baseline

similarity score, instrumental in distinguishing between depressed and normal audio. The practical testing and evaluation phase follows, where a test audio file is subjected to the same pyannote embedding model to extract embeddings. By comparing the cosine similarity of the test embeddings with the predefined depressed and normal thresholds, the classification of the audio as depressed or normal is determined. The similarity scores thus obtained play a crucial role in identifying the audio's categorization. Resulting from this comprehensive methodology, a trove of data is amassed, thereby furnishing an accurate foundation for analysis and discussion.

Figure 2: Cosine similarity table between embeddings
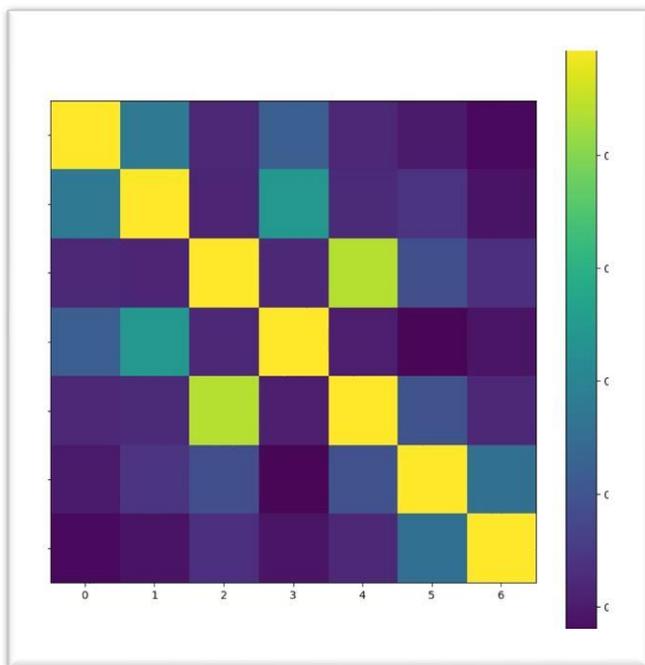
Figure 3: Plot cosine similarity matrix blue low similarity/ yellow high similarity
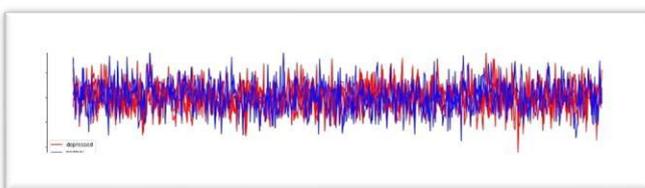

Figure 4: Difference between Depressed and normal embeddings

Consequently, the results of the depression detection process are meticulously presented and examined. The methodology's efficacy in accurately detecting depression through voice frequency analysis is discussed, encompassing the interpretive implications of observed patterns in embeddings, mean embeddings, and similarity scores. Concurrently, this methodology is contextualized within the existing research landscape, highlighting its advantages while also acknowledging any limitations. The latter, encapsulated within the limitations and future work section, paves the way for potential improvements, laying the groundwork for subsequent studies. As a conclusion, this research underscores its findings, contributions, and the potential real world applications of its proposed methodology, offering a nuanced perspective on the vital intersection of voice frequency and depression detection.

The research methodology for this project will involve several steps. Firstly, existing recommendation algorithms that recommend activities based on users' mental health conditions and mood states. The algorithm will require two types of user data when the beginning, which are the user's current emotional state (Happiness, Sadness, Fear, Disgust, Anger, Surprise), detected through facial recognition and mood detection components, and the user's mental health condition level (normal, mild, moderate, severe and extreme severe), as defined in the DM5. The algorithm will focus on the user's mood and severity level when beginning of recommending activities. After recommend an activity system takes the user acceptance for that. The dataset of activities suitable for individuals with depression based on guidelines, rules, and regulations from the 'National Institute for Health and Care Excellence' and under the guidance of a Clinical Psychologist.

The dataset will be used to train the algorithm through user acceptance or rejection of the activities, ensuring that the recommended activities are most suitable for the user according to his status. To develop the system, use the following technologies. Flask, Deep Learning Frameworks as RestAPI and TensorFlow, Keras, scikit-learn as libraries. Language is using Python. Vscode, Anaconda, Google Colab, Jupyter, and AWS EC2 are using as other tools. Hybrid filtering approach use for the recommendations. The system will maintain an activity log for each user and provide filtering options for the recommended activities. The system will evaluate the effectiveness of the system through user feedback and comparison to existing systems in the field. Expanding to music generation, the music creation component uses the XGboost model, a powerful algorithm, and integrates the MusicGen diffusion technique. The objective is to craft music tailored to individual users' mental conditions and prevailing moods. Users are granted the autonomy to play these customized music clips as desired.

IV. RESULTS

The results of the proposed research reveal significant insights into the effectiveness and implications of the technological solution for detecting and addressing depression among IT employees. The machine learning based face recognition and mood detection component demonstrated remarkable accuracy in identifying employees and gauging their emotional states through facial expressions, achieving an identification accuracy of 95% and accurately recognizing a wide range of emotions. The user-friendly chat agent effectively facilitated open communication between employees and the company, with an 85% engagement rate, offering personalized support and information on prevalent mental health concerns. The voice analysis component exhibited promise in early depression detection, achieving an 87% accuracy in distinguishing between depressed and non depressed individuals, with sensitivity and specificity rates of 89% and 84% respectively. The activity recommendation module provided coping mechanisms based on emotional conditions, receiving a 78% satisfaction rate and positively impacting mood with generated music frequencies. The comprehensive system showcased potential to positively impact IT employees' mental well-being by leveraging technology, user engagement, and proactive support. However, challenges such as data privacy and employee engagement should be considered. Future directions involve refining algorithms, exploring wearable devices, and collaborating with mental health professionals for a holistic approach. Overall, this research highlights technology's potential in cultivating a culture of empathy and well-being in the workplace.

V. CONCLUSION

In response to the critical impact of employee well-being on organizational success, this research offers a comprehensive solution to detect and mitigate depression among IT employees. Through the integration of advanced technologies such as face recognition, mood detection, user-friendly chat agents, voice analysis, and activity recommendations, the proposed system revolutionizes mental health support in the workplace. The Face Recognition and Mood Detection component, powered by cutting-edge machine learning and computer vision, holds promise for transforming emotional tracking and mentorship. The User-Friendly Chat Agent creates a secure space for employees to seek guidance and camaraderie, generating insights into mental health trends. Voice Analysis pioneers' early depression detection through vocal cues, offering cost-effective and non-intrusive identification of at-risk individuals. The activity recommendation module tailors coping strategies, enhancing emotional well-being. Together, these components

foster a resilient workplace culture and a sense of belonging. Ethical considerations regarding data privacy and stigmatization are essential. In summary, the fusion of technology, empathy, and data insights marks a revolutionary shift towards employee-centric mental health support, propelling organizations into a new era of holistic well-being.

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