Emotions in Mental Healthcare and Psychological Interventions: Towards an Inventive Emotions Recognition Framework Using AI

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Abstract. One of the major impacts of COVID-19 in the nations is mental health issues. Constant mental health issues can cause disorders, as well as mortality. The growing demand for mental healthcare treatment and limited healthcare resources across the world has shown the need for an inventive framework solution. Artificial Intelligence (AI), Big Data Science, 5G, and Information Communication Technology (ICT) have proven to be able to bring many great improvements and could be the potential way forward to develop such a framework. AI could be a very effective tool to help the healthcare sector to provide more efficient services to patients with mental health issues through their emotions. This paper presents the initial overview and outcomes of the ongoing research programme to develop a proactive multimodal emotion AI recognition framework that detects emotion from various input data sources for early detection of mental health illnesses, as well as provides the required psychological interventions effectively and promptly when required. The data will be collected from various smart wearables and ad-hoc devices, facial expressions, and speech signals. Then, these data will be interpreted using AI into emotions. These emotions will be utilised using AI-based psychological system, which will provide immediate and customized interventions, as well as transmit critical data to the healthcare provider's central database system for monitoring and supplying the required treatments.

Keywords. Artificial Intelligence, Emotion Detection, Emotion Recognition, Mental Healthcare, Psychological Intervention.

1. Introduction

Artificial intelligence (AI), Big Data Science, 5G, Distributed Networking, and Information Communication Technology (ICT) are increasingly employed in the healthcare sector. Early disease identification, greater knowledge of disease development, optimum treatment dosages, and the discovery of innovative remedies are all made possible by AI. AI can be a very effective tool to help the healthcare sector to provide effective service to patients with mental health issues by collecting and analysing signals and then recommending the appropriate psychological intervention based on their emotions [1].

Emotion plays a significant role in daily life interaction and communication. Humans can communicate their emotions through feelings, text, and speech. Our mental health is impacted by emotions, which also alter our physical health and interfere with our ability to think. Our face, voice, and gestures are modulated by our emotions. Emotion recognition can help healthcare practitioners not only in the effective diagnosis of mental health issues but also in quick intervention to provide the required treatment or therapy at the right time [2]. Based on the statistics [3], one in four people experience mental health issues of some kind each year in England. Also, one in six people report experiencing a common mental health problem in any given week. The same statistics indicated that one in five people have suicidal thoughts. Although this big number of patients with mental health issues, the statistics indicate that only one in eight adults was able to get the required help or treatment.

Emotion AI is a promising new technology that gives medical practitioners another way to support their patients' well-being. This technology can interpret signals in people's voices, writing, and facial expressions into emotions and react accordingly. Emotion AI is a multimodal sentiment analysis that uses AI to determine a person's psychological state based on cues like their posture, speech, tone, and facial expression [4]. Emotion AI could provide a very effective solution for the healthcare sector to tackle mental health issues. Therefore, this paper proposed a multimodal emotion AI framework to detect emotion from various input data sources for early detection of mental health issues and provide the required help and psychological interventions effectively and promptly.

The remainder of this paper is structured as follows: Section 2 presents related work; Section 3 presents some of the use cases of AI in mental healthcare and psychological intervention; Section 4 provides a detailed discussion of the proposed framework, and Section 5 is the conclusion.

2. State-of-the-Art of AI and Emotions Recognition

AI can accurately predict individual mental health issues by collecting the person's emotions and behaviour using smart wearables devices and other data collection methods. Although AI has been for a while, the effective use of AI in mental healthcare and psychological interventions was not discussed adequately in the literature. AI can be a very effective tool to help the healthcare sector to provide effective service to patients with mental health issues.

Several studies indicated the necessity to utilize AI effectively in mental healthcare as AI can help with the proactive and objective assessment of mental health symptoms to support diagnosis and administration of treatment [4]–[6]. Some researchers utilized AI to provide psychological interventions to help patients with mental health issues. For example, Rathnayaka et al. [7] proposed a chatbot with cognitive skills to provide recurrent emotional support, personalised assistance, and remote mental health monitoring. Wei and Li [8] demonstrated that AI can reduce the depression of manufacturing workers in China. Deshpande and Rao [9] also utilize emotion AI to detect depression from Twitter feeds using a natural language processing technique. Also, Danieli et al. [10] proposed an AI-based mobile app to provide psychological intervention for stress management based on behavioural theory.

Some researchers indicated the importance of utilizing AI for monitoring mental health using smart wearables. Long et al. [11] advocate the need to utilize AI-based wearable devices to collect physiological signals for mental health detection. The authors

indicated that HRV (Heart rate variability), EEG (Electroencephalography), ST (Skin temperature) and GSR (Galvanic skin response) signals are the most effective parameter indicators for detecting the mental health condition. Betti et al. [12] utilized wearable devices to collect adult EEG, electrocardiography (ECG) and electrodermal activity (EDA) and then analysed this data using the support vector machine (SVM) to detect individual stress levels. Also, Goumopoulos et al. [13] suggested a method to detect mental fatigue. The authors utilized smart wearables to collect person's HRV and then utilize machine learning to predict mental fatigue. Using wearable devices and smartphones, Sano et al. [14] investigated the relationship between college students' academic performance, sleep quality, stress perception, and mental health. The authors discovered that these factors can significantly predict a student's mental health level.

3. Use Cases of AI in Mental Healthcare

AI can overcome traditional access barriers of cost, time, distance, and stigma, all of which are relevant for older adults. AI can be implemented successfully and effectively in many applications and use cases in mental healthcare, which include:

3.1. Medical Assistant for Clinical Diagnosis

AI can utilize unusual data sources and merge data from multiple heterogeneous data streams to build models that can be used in the clinical diagnosis of mental health illnesses [15]. AI also can allow the doctors or clinicians to spend more time with their patients by performing tasks related to analysing patient records, performing administrative responsibilities, and helping in suggesting the treatment or intervention. AI also can effectively utilize speech analysis to help patient with mental health difficulties to utilize their emotions to manage various situations even in a highly stressful or traumatic situations [16].

3.2. Treatment and Psychological Intervention

AI approaches can be used effectively in clinical treatment. AI can be used to anticipate therapy responses, thereby avoiding time-consuming psychotherapies, invasive and costly brain stimulation therapies, and failed drug trials. Also, AI can directly assist in the search for novel treatments [17]. Since AI can detect emotions as well as monitor patient behaviour, AI can be beneficial to provide customized and tailored psychological interventions to patients. For example, chatbot technology can be utilized to provide therapy to patients.

3.3. Emotional Support

AI can be used as a "nurse bot" to check in with elderly patients on long-term medical programmes every day to assess their physical and mental health as well as remind them to take their medications. This also can help to monitor patient reactions to new treatments and patient behaviour and response to that medication. Meng and Dai [18] investigated the impact of utilizing a chatbot's emotional support to reduce patients' stress and worry. The results of the study indicated that the current chatbot does not

provide the same support as humans, but when emotional support was absent, the chatbot managed to reduce the stress and worry.

3.4. Predict Suicide Risks

Although emotion AI provides therapeutic alternatives, it can also be extremely useful in anticipating patient behaviour, such as a person's risk of engaging in suicide conduct. For example, Facebook started to use emotion AI to monitor users' posts that could signal that a user is suicidal and alert local authorities. AI can be very beneficial to help doctors and practitioners to predict suicide risk. AI also can help to understand the risk factors behind suicidal behaviour. Walsh et al. [19] implemented an AI approach that utilizes patient health records to predict suicide risk with 84 to 92 % accuracy within one week of a suicide event and 80 to 86% within two years.

4. Proposed Emotions Recognition Framework using AI

Despite rising costs and demand, healthcare services face a variety of obstacles to enhancing the quality and effectiveness of care delivery. Patient safety, staff happiness, and the overall standard of care are all impacted by internal inefficiencies and limited resources [20]. In addition, COVID-19 exposed the public to a wide range of mental issues, especially with social distance and limited resources. Hence, the need for mental healthcare is increasing. The growing demand for mental healthcare coupled with limited resources has created opportunities for digital and technological solutions where emotion AI can be utilized effectively. Emotion AI aims to utilize machine learning techniques for emotion detection. This can help healthcare providers to provide the required help regarding various mental issues as well as maintain patient safety.

Figure 1. Proposed Emotions Recognition Framework using AI

The proposed framework provides a multimodal emotion AI solution to detect emotions from various input data sources for early detection of mental health issues and provide the required help and psychological interventions effectively and promptly. The flow of the proposed framework starts at the data collection /acquisition module where patient data is collected from various sources. Smart wearables devices are used to collect

various body signals that can be used to extract features to recognize emotions. We propose utilizing smart wearable devices such as smartwatches, smart glasses, smart shirts, etc. to collect signals from the body. These signals will differ based on the wearables and signals that each wearable device will be able to measure or collect. Also, according to the needs of users and the functions achieved by the wearable device, the device will be worn on different parts of the body. In addition, facial expressions and speech signals will be used in conjunction with wearable signals to detect and specify the individual's emotion, as shown in Figure 1. Several studies have identified six basic recognized emotions: anger, disgust, fear, happiness, sadness, and surprise [21]. These facial expressions play a significant role in human social interaction and can be used to identify and classify individual emotions. The collected data will be sent to the cloud servers where advanced AI models will be used.

After collecting the data, it will be pre-processed to remove any noise or issues and make it ready for the next phase. At the feature extraction phase, corresponding features related to each input data source are extracted for training the emotion AI system. The last phase includes automatic emotion classification or recognition by AI approaches, where the emotion will be determined. This process is continuously working, and various emotions of the patient will be identified. The results of the automatic emotion detection will be then utilized by an AI-based psychological intervention system which will provide a customized and tailored psychological intervention to help the individual based on the identified emotion. For example, if the patient was classified as depressed, this AI-based psychological intervention system will create a customized and tailored intervention for that individual based on his/her preferences. Also, if the patient was classified as suicidal, then this system can first alert the local authorities as well as provide immediate therapy or help to the patient. The same result of the automatic emotion detection system will be transferred to the patient's healthcare provider database who can use these emotions to monitor the patient's behaviour as well as suggest the required treatment. By monitoring early signs connected to a change in a person's daily behaviour, AI can successfully predict who requires mental health therapy before they recognize it—or before the symptoms become too difficult. Also, monitoring the patient's behaviour can be used to assess the effectiveness of the treatment given in which once treatment has begun, AI can assist clinicians in tracking patient response to care and illness progression, for example, by passively capturing behavioural data with wearable sensors.

5. Conclusion

Emotion AI is a promising technology that can give medical professionals another way to support the mental health of their patients. This technology can interpret signals in people's voices, writing, and facial expressions into emotions and react accordingly. This paper proposed a multimodal emotion AI framework that detects emotion using various input data sources. This can be used by healthcare providers to early detection of mental health issues and provide the required psychological interventions effectively and promptly. The proposed framework collects input data from smart wearables devices, facial expressions, and speech signals. Then, by using AI, this data is interpreted into emotions which can be utilised by an AI-based psychological intervention to provide immediate help and customized intervention as well as transmit it to the healthcare provider for monitoring and delivery of the required treatment. The next stage of this

research programme will be identifying features or signals from data sources that can be used in emotion detection as well as building the AI-based psychological intervention to provide customized and tailored interventions that suit everyone's preferences.

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