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Activity Recommendation System Based on Emotion Recognition

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Abstract: ***Activity Recommendation System for Emotion Recognition is a mobile app designed to identify people's emotion and suggest them suitable activities based on those emotions. The emotion analysis takes place based on three types of inputs: text; voice and facial expression, via mobile device. Emotion identification occurs through the use of machine learning models and natural language processing with the following classifiers included in the application: happy; sad; angry; frustrated; and stressed. Once the emotion has been identified, various independent activities will be recommended to the user, such as: listening to music, meditating, exercising, or socializing. The user's age is also taken into consideration, thereby allowing a specific and personalized recommendation for each user. The application is built using TensorFlow, OpenCV, and Android Studio. The goal of this system is to help promote a positive mental state in the user by providing support in their understanding of emotional states and providing the user with recommendations of suitable activities to help them improve their emotional state. Experimentation indicates that emotion-based recommendation systems can provide substantial support in stress management and mood enhancement through identifying appropriate activities for users.***

Keywords: Emotion Recognition, Machine Learning, Activity Recommendation System, Facial Expression Detection, Natural Language Processing, Android Application.

I. NTRODUCTION

The presence of human emotion has direct impact on daily lives, how we make decisions and how we relate to others or perceive ourselves. Over the past few decades, rapid increases in technological advancement and busy lives have contributed to an increase in stress, lack of calmness, anxiety, discontentment and imbalance in emotional condition. Understanding our emotional condition and reacting accordingly results in improvement of mental wellness and productivity. There is a body of research that indicates recognition of emotion is achievable. Emotion recognition systems (ERS) use computational methods including machine learning, natural language processing (NLP), acoustic analysis (speech) and visual analysis (computer vision) [1], [2] to identify and interpret human emotional state.

Recognition of emotion has emerged as a major area of research in Artificial Intelligence (AI) and Human-Computer Interaction (HCI). Researchers have developed various means to recognize emotion from a variety of sources (facial expression, acoustic signal(s), text) [3], [4]. Of these human expression systems, recognition of facial expressions is the most reliable method for recognition of all human emotions, as facial expression reflects the emotional condition of the person producing it most often. Several specialised deep learning techniques like Convolutional Neural Networks (CNNs) [5], [6] have been developed to support facial expression recognition. Similarly, Speech Emotion Recognition Systems assess acoustic characteristics (frequency, modulation, loudness) of the voice to assess or identify the emotional state of the person speaking [7], [8].

With the increase of social media users connecting through text, research on recognizing human emotion with text-based data is growing. By utilizing natural language processing (NLP) methods, researchers can examine the sentiments expressed by users through written communication [9], [10]. Emotion recognition of text is now being performed more effectively because of the advent of machine learning models such as recurrent neural networks (RNN) and attention-based methods such as transformers and BERT [11], [12]. The use of multiple modalities (i.e., text, sound, facial expression) allows for even greater accuracy of emotion recognition than just using text alone because of the increase in contextual information available [13], [14].

Using emotion recognition in conjunction with intelligent recommendation systems can enhance a user’s experience and support their emotional well-being. Emotion aware recommendation engines will look at a user’s emotion and provide personalized recommendations including music, activities and entertainment content [15], [16]. Such an implementation may be applicable in mental health support applications, stress relief applications, and individualized digital assistant systems [17], [18].

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Emotion-aware applications can be implemented on mobile platforms, which are widely used and contain many sensors such as cameras and microphones. Using mobile phones, users can collect multimodal data (including: facial expressions, audio input via voice and text) that can be analyzed in order to identify emotions and behaviors [19][20]. Consequently, there is potential for users of emotion-aware mobile applications to understand their emotional patterns and receive personalized recommendations to improve mood and productivity [21][22].

Emotion-aware recommendation systems have been developed in research studies (for example, in relation to recommending music, stress management and planning activities) to provide users with suggestions based on their current emotional state, thereby improving emotional stability and mental health [23][24][25][26]. However, most current systems only use one input form which can limit the ability to accurately identify emotions.

In response to the identified limitation, a new multimodal (using different modes of input) activity recommendation system is proposed which can read text input, recognize voice input through a smartphone or other mobile device, and analyse facial expressions. Utilizing machine learning models will classify emotion as either happy, sad, angry, frustrated or stressed; once identified, emotion will be matched to user's profile and appropriate activities will ultimately be recommended that will help improve mood and provide positive well-being.

The frictionless system will ultimately provide users with an intelligent app that provides assistance in assisting them identify her/his current emotional state and accordingly provide suggestions for activities to complete according to emotion. This system integrates emotion recognition and recommendation systems into creating a technology-based solution that improves emotional awareness and reduces the stress and anxiety caused by emotional distress and increases an overall healthier lifestyle [27][28].

II. LITERATURE SURVEY

The use of emotion recognition as a field of study has grown in importance within both AI and HCI. While earlier research focused on using the face and other models of the psyche to identify a person's emotions, face emotion recognition (FER) is now widely regarded as one of the most effective ways to determine how someone feels based on facial movements (which provide strong indications of emotional state). Earlier attempts at FER relied heavily upon the feature-created solutions provided through Local Binary Patterns (LBP), Gabor, and other similar filters, to identify emotions in the face; however, recent advancements in deep learning and the ability of convolutional neural networks (CNNs) to learn properties from images have greatly enhanced FER accuracy by enabling the CNNs to produce unique discriminating features from the actual face images [3], [4]. An abundance of studies supporting the effectiveness of using deep neural network architectures VGG, ResNet, and Inception in real-world scenarios have been conducted to identify emotions from facial expressions [5], [6]. Facial recognition will continue to support various industries, including but not limited to, healthcare, security, monitoring drivers, and providing assistance to intelligent agents [7].

Another significant method of detecting emotion is the emotion recognition of speech (illustrated by the analysis of the acoustic characteristics of spoken language including intonation, loudness, voice quality, and frequency). An approach using machine-learning algorithms such as support vector machines, hidden Markov models, and deep neural networks has been used to distinguish emotion in speech signals [8-9; see also 10 for examples of using deep neural networks with feature extraction methods such as Mel-Frequency Cepstral Coefficients (MFCC)] [10]. Speech emotion recognition systems are commonly used in applications including virtual assistants, analysis of telephone customer interactions with businesses, and monitoring patient emotions in a mental healthcare setting [11]. However, the performance of speech-based emotion recognition systems can be affected by ambient noise and variability in speech, which may lead to incorrect identification of the emotional expression [12].

Besides facial and speech emotion recognition analysis, emotion recognition in text is increasing in popularity with the rise of social networking and instant messaging. Emotion analysis using natural language processing (NLP) is often accomplished through an analysis of the textual data to determine the emotional content in writing [13]. Examples of algorithms used for emotion identification within textual data include Naive Bayes, Support Vector Machines, and deep learning models like recurrent neural networks (RNN) and transformers [14]. Advanced NLP language models can provide contextual analysis to improve the accuracy of identifying if emotional sentiment is present in text [15].

Recent trends in research have focused on multimodal emotion recognition systems that integrate emotion recognition from facial expressions, speech/audio, and text. By utilising multiple methods to capture contextual data related to emotions, multi-modality improves upon the accuracy of emotion recognition systems [16]. Multimodal emotion recognition models based on deep learning incorporate visual, audio, and textual emotion features to increase the accuracy of emotion classifications [17]. Such systems have demonstrated their effectiveness in applications involving human-computer interaction and intelligent personal assistants [18].

The recommendation systems that are based on emotion recognition technology are also increasingly being integrated to provide suggested activities based on the users' emotions. Emotion-aware recommendation systems provide a personalized analysis of the emotional state of the user and recommend activities, music, or entertainment to help improve his/her mood or/and overall emotional well-being [19]. These types of systems can be particularly helpful within the field of stress management and/or mental health assistance. Numerous studies have shown that the combination of emotion detection and recommendation algorithms results in increased user engagement and satisfaction [20].

Recent studies have experimented with emotion-based activity recommendations for such systems. By capturing emotional data through facial expression or speech signals, these systems recommend activities such as relaxation techniques, music listening, or seeking out social interactions based on emotional state [21]. When using multi-modal systems, combining emotion recognition with recommendation algorithms has demonstrated an increased ability to predict user choices and emotional needs compared to using either method alone [22]. Furthermore, mobile devices create an ideal platform for deploying emotion-aware applications as many smartphones are equipped with the devices such as cameras, microphones, and processing units for performing emotion analyses [23].

Recent research has demonstrated the use of deep learning frameworks (e.g., TensorFlow and PyTorch) alongside computer vision toolkits (e.g., OpenCV and MediaPipe) for developing emotion-recognition systems for mobile apps [24]. Utilizing sensors in mobile devices allows for real-time emotion detection; thus, apps can provide tailored recommendations to users [25]. By logging user activity history, the app can analyze emotional trends and develop increasingly accurate recommendations over time [26].

While advances have been made in both emotion recognition and recommendation systems, many challenges still exist. Accuracy when detecting emotions is influenced by environmental factors, unbalanced data sets, and differences in people's expressions [27]. Further, most current systems utilize a uni-modal approach, failing to capture the totality of a user's emotional state [28]. However, researchers believe that multi-modal systems may enable more accurate emotion detection by fusing multiple modalities of information [29]. Therefore, attaching multi-modal emotion detection to intelligent recommending systems would allow for creating tailored recommendations for activities, while assisting the user in managing their emotional health [30].

III. PROPOSED SYSTEM ARCHITECTURE

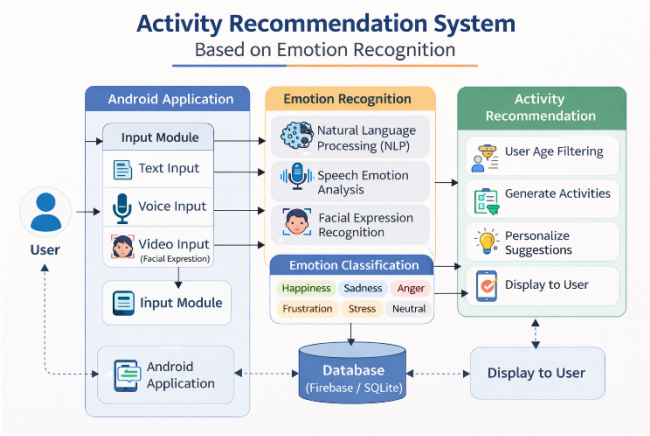


Fig. 1. System Architecture

The diagram shows the System Architecture of the Activity Recommendation System Based on Emotion Recognition. It explains how the system collects user inputs, detects emotions, and recommends suitable activities.

1) User

The process begins with the **user**, who interacts with the Android application. The user provides information about their emotional state using different input methods such as text, voice, or facial expressions.

2) Android Application (User Interface)

The Android application acts as the front-end interface of the system. It allows users to:

- Register and log in

- Provide emotional input
- Receive activity recommendations

The application also manages communication between different modules of the system.

3) Input Module

The Input Module collects user data through three types of inputs:

- Text Input – The user types a message describing their feelings or daily experiences.
- Voice Input – The system records the user's speech using the mobile microphone.
- Video Input (Facial Expression) – The mobile camera captures facial expressions to detect emotions.

These inputs are then sent to the emotion recognition module.

4) Emotion Recognition Module

This module analyzes the collected inputs to identify the user's emotional state.
It consists of three main components:

- Natural Language Processing (NLP) – Processes textual input to detect emotional sentiment.
- Speech Emotion Analysis – Analyzes voice signals such as pitch, tone, and intensity.
- Facial Expression Recognition – Uses computer vision techniques (e.g., OpenCV) to detect facial emotions.

5) Emotion Classification

After analyzing the inputs, the system classifies emotions into predefined categories:

- Happiness
- Sadness
- Anger
- Frustration
- Stress
- Neutral

This classification helps determine the user's current emotional state.

6) Activity Recommendation Module

Based on the detected emotion, the Activity Recommendation Module suggests appropriate activities.
The recommendations are generated using:

- User Age Filtering – Activities are selected based on the user's age group.
- Generate Activities – The system creates activity suggestions.
- Personalized Suggestions – Activities are customized according to the user's emotional condition.

Examples include listening to music, meditation, exercise, or social interaction.

7) Database (Firebase / SQLite)

The system stores information in the database, including:

- User inputs
- Detected emotions
- Recommended activities
- User history

This stored data helps track emotional patterns and improve recommendations in future sessions.

8) Display to User

Finally, the recommended activities are displayed to the user through the Android application interface. The user can view these suggestions and choose suitable activities to improve their emotional state.

IV. METHODOLOGY

The proposed Emotion Recognition-based Activity Recommendation System aims to provide users with appropriate activity suggestions by analyzing the user's emotional condition. This will be accomplished through the use of a variety of techniques, including machine learning, natural language processing (NLP), speech analysis, and computer vision, for emotion detection from multiple input modalities. The overall methodology will consist of several steps: data collection, preprocessing, emotion detection, classification of emotion, generation of recommendations, storage of daily event data, and presentation of results.

1) User Interaction and Data Collection

In the first phase of the system (a) the user will interact with the Android app for the purpose of providing an emotional input to the system using three different emotional input modalities; (b) the user will also communicate their emotion to the system through their use of text message (when possible), voice recording (when possible), and facial image (when possible), and these multiple modalities will help improve the reliability of emotion detection by improving the accuracy of the system's detection output; and (c) all data will be collected via a communicating channel (the Android app), which is a source of data acquisition for the emotion recognition system.

2) Data Preprocessing

This initial stage leads to the collection of raw data being transformed into usable datasets that can then undergo further analysis. Raw data is full of noise, irrelevant data and inconsistencies will negatively impact the ability of emotion detection algorithms to perform at their best. For textual data, NLP techniques are used to tokenize data, remove stop words and normalize data so that useful information can come from each sentence. With audio input, preprocessing methods remove background noise and extract relevant acoustic characteristics of the audio signal (pitch, tone and intensity) for subsequent classification into emotion categories. For video data, image processing techniques can be used to detect region around eyes, mouth and nose to establish facial features that would aid in detecting emotion.

3) Emotion Recognition

The recognition of emotion is the central feature of all systems. Emotions are identified from the respective inputs provided by a user through data analysis. NLP techniques are used to examine text input and provide an emotional value for the expressed sentiment of the user. With respect to speech input, methods such as voice pattern analysis are used on the vocal characteristics of a user (i.e., pitch changes, speech rhythm, energy levels, etc.) to provide clues of what emotions a user may be feeling. Similarly, facial expressions can also be analyzed by a computer vision program to determine changes in the facial muscle and, in turn, identity the emotion of a user. In addition, pattern recognition through deep learning algorithms build on emotion datasets can also provide a likeness to that emotion.

4) Emotion Classification

The stage of Emotion Classification follows the extraction of relevant features from the input data. At this stage, emotion classification will be performed by using machine learning models to group the detected emotion into a category of predefined emotions. The system will be able to identify emotions such as happiness, sadness, anger, frustration, stress, or neutral. The classification algorithms will evaluate the features extracted from the input data, and determine what the most likely emotional state of the user will be based on those features. This is a critical step in the process of creating the activity recommendations because the accurate classification of emotions will greatly impact the overall quality of the activity recommendations that will ultimately be generated by the system.

5) Activity Recommendation Generation

Once the emotional state of the user has been determined, appropriate activity recommendation will then be generated by the system. Activity recommendation engines are systems that can suggest user appropriate content or actions based on their preferences and contextual information about the user. In this case, the recommendation engine of the system will provide personalized activity recommendations by taking the user’s detected emotion into account as well as the user’s age group at the time of activity recommendation generation. For example, if the detected emotion of the user is sadness or stress, the system may recommend activities that promote relaxation, such as meditation, listening to music, or talking with friends.

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Conversely, if the detected emotion is happiness, the system may recommend social/recreational type activities. By personalizing the recommendations for each user based upon their emotion, the system can help the user improve their emotional well-being.

6) Database and History Management

The system will utilize either Firebase or SQLite as the underlying database for storage of user data and activity history. Data will include user input, emotions detected, recommendation on activity, time/date stamp of session, historical records of emotions, and previous recommendations. Historical data allows the system to track and analyze emotional patterns over time and for users to refer to their previous emotions and recommendations. The database management system will provide for the secure storage, quick access, and proper organization of user data.

7) Result Presentation and User Feedback

The last step in the methodology is to display to the user via the mobile application the suggested activities based on the detected emotional state for the respective user. The user can then select the suggested activities that they would prefer to perform. The user's interaction with the system will be recorded which will enable analysis based upon the user's preferences to improve upon the recommendations. This step will assure that the application will be user-friendly, and beneficial by providing effective support for the user's emotional success.

V. RESULT

The Activity Recommendation System Based on Emotion Recognition is an Android app that detects a user's emotion based on several sources of input (text, voice, and facial expressions) and provides activity recommendations based on the emotion the user is feeling. Testing of the system has involved the use of different types of user inputs to evaluate how well it detects the user's emotional state and makes appropriate recommendations for activities. The experimental results indicate that the emotion recognition part of the system properly identified the user's emotions (happiness, sadness, anger, frustration, stress, and neutral) based on the information provided by the different sources of input. Multiple sources of input (text, voice, and facial recognition) have provided a greater degree of reliability for the emotion recognition process since emotional signs can be gathered from multiple sources.

Also, the activity recommendation part of the system generated appropriate activity recommendations based on both the emotional state of the user at the current moment and the user's age. For instance, when the system detected that the user was sad or stressed, the system made suggestions for calming types of activities (e.g. meditation, listening to music, talking to a friend). If the system detected that the user was happy, the system would make suggestions for types of activities that would celebrate their achievement or for socializing with other people. Overall, when the two components (emotion recognition and activity recommendation) were combined together, the user was able to receive activity recommendations for improving their emotional health, and the history of the user's past activity recommendation and emotional patterns could be stored for future reference.

Combining data from machine learning, natural language processing, speech analysis, and facial recognition provides an effective way to support emotion-aware applications. The system has shown to be highly intelligent and able to interpret user emotion as well as suggest activities that are appropriate for that emotion. These types of systems can significantly aid in creating awareness around mental health and supporting emotional well-being through customized mobile applications.

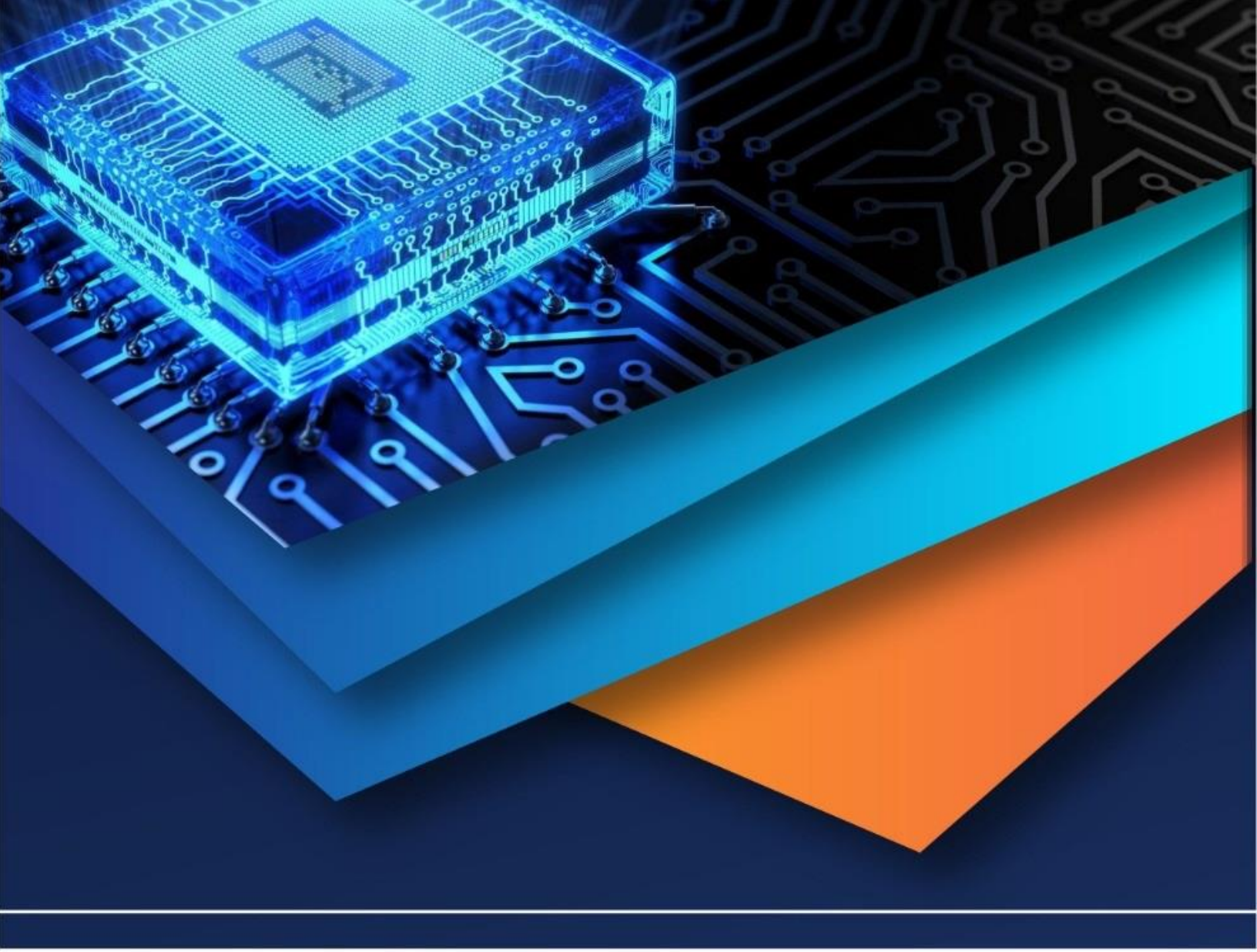
VI. CONCLUSION

The Emotion Recognition Activity Recommendation System (ERARS) is a smart system that uses different ways to find out how you are feeling and to suggest activities that might help you feel better. The system has different ways of detecting how you feel: through text, voice, and facial expressions. Some of the emotional states the system can detect include: happy, sad, angry, frustrated and stressed. With the help of machine learning, natural language processing, speech analysis, and facial expression recognition techniques, the system accurately interprets your feelings. Once the system identifies your emotional state and checks your user profile, it will suggest personalized activities to improve your emotional state. The suggested activities may include: listening to music, meditating, doing physical activity, or having some form of social interaction. By utilizing a database to store your user history, the system can monitor your patterns of emotion and improve on future suggestions. The research provides empirical evidence to demonstrate the benefit of emotion-aware recommendation systems in supporting an awareness of mental health as well as providing assistance to users in managing their emotional states using intelligent mobile applications.

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