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A CHATBOT-BASED APPROACH FOR STRESS LEVEL DETECTION AND MANAGEMENT

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ABSTRACT

This paper presents a novel approach for stress level management by seamlessly integrating smartwatches and a chatbot-based system. Users manually input their stress levels into the smartwatch, which then employs a sophisticated classification model to determine whether the stress level is low, high, or normal. By leveraging deep neural network (DNN) models, our system accurately assesses the user's stress state. When a high-stress level is detected, the data is transmitted to a chatbot, which generates personalized suggestions and recommendations to help users alleviate stress. This user-centric strategy not only empowers individuals to actively manage their stress but also enhances their mental well-being. The proposed system offers an effective and convenient solution for stress reduction and psychological wellness.

Keywords—Stress Detection, Chatbot, Mental Health.

I. INTRODUCTION

Stress is a common issue that affects many individuals in their daily lives nowadays. All are engaged in their work and almost all people including students, and employees all are working restlessly to meet their deadlines, targets etc. Quite often, people are aware of being under heavy work pressure and mental stress levels but neglect their state of health. They also forget to have medicine at the right time and it could have lead to fatal effects sometimes death. A certain level of stress is normal, while chronic stress can lead to serious health problems. Therefore, it is important to detect stress levels early and take steps to reduce stress.

In recent years, wireless technology is playing a crucial role in various sectors as well as biomedical to provide better healthcare. Many devices are being developed for continuous monitoring IoT (Internet of Things) devices have become increasingly popular in recent years due to their ability to collect and analyze data from the physical world. IoT devices can be used to detect stress levels by collecting and analyzing physiological data such as heart rate, acceleration magnitude and temperature. Stress tightens muscles and makes it difficult to engage in regular physical activity. High amounts of stress can cause complex mental diseases like borderline personality disorder (BPD), which causes extreme mood swings, behavioral changes, and food issues, and compels the stressed person to make unhealthy decisions [1].

According to recent neurobiological research, stress has an impact on heart rate variability (HRV), which can be used to measure stress and psychological health objectively [2]. The time gap between two successive R wave peaks on an ECG signal is known as the HRV or R-R interval. The HRV metric must be calculated in order to assess stress levels, which enables a full analysis of the effects of stress as a measurement of psychological stress and insight into the stress system's autonomic nerve reactions.

In this study, we demonstrate and validate an IoT edge system for real-time stress level detection. We created and developed software that uses a chatbot and a deep neural network model. We conducted research to verify our system using tried-and-true techniques to create various levels of stress. Our findings show how our approach may be used as a practical instrument for widespread stress monitoring, detection, and prevention. Overall, the recommended IoT-based stress level detection system is a novel and promising method for identifying and managing stress. The well-being of people and society as a whole could be significantly impacted by the implementation of such a system.

II. RELATED PRIOR WORKS

Recent advancements in miniaturized sensors and low-cost wearables have facilitated the monitoring of lifestyle through heart rate variability (HRV) analysis. AI and deep learning models have revolutionized stress prediction using HRV data. In a study by Haque et al [3] , they analyzed 43 research works applying various AI algorithms for stress prediction. They delve into sensing technologies, data preprocessing, and prediction models. Machine learning techniques are evaluated

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for their effectiveness. Notable features enhancing model performance are identified. The review outlines HRV-based stress prediction challenges and suggests mitigation strategies. This work contributes to the development of meticulous stress prediction techniques.

Daud Muhajir et al[2] in the paper titled 'Stress level measurements using heart rate variability analysis on android-based application' demonstrated a system for measuring stress levels using heart rate variability (HRV) in an Android-based application. To determine how much stress a person feels, stress levels are frequently measured subjectively. By examining how stress affects the autonomic nervous system (ANS), they were able to use HRV to determine the true presence of stress. They had ten participants in their investigation. They also conducted linear and nonlinear analyses of HRV. They concluded that subjects with higher stress levels have a higher HRV.

The report 'Stress Detection Using Low Cost Heart Rate Sensors', by Salai et al [4] addresses the critical challenge of automated stress detection in ambient assisted living. Two studies involving a low-cost heart rate sensor, a chest belt, are presented. The device validation study (n = 5) compared sensor data to a gold standard, revealing highly correlated and reliable data segments. In the clinical study (n = 46), a stress detection method utilizing only three time-domain features achieved impressive accuracy (74.6%), sensitivity (75.0%), and specificity (74.2%). Notably, this method's efficiency on mobile devices sets it apart from state-of-the-art alternatives. This research contributes to practical stress monitoring solutions in assisted living environments.

Rachakonda et al[5] in their paper ' Stress-Lysis: A DNN-Integrated Edge Device for Stress Level Detection in the IoMT' proposed a novel deep learning-based system. The learning system is programmed to monitor a person's stress levels by means of human body temperature, rate of motion, and sweat during physical activity. In order to monitor a person's stress levels in real time, the collected data is sent and stored in the cloud. By enabling computing on edge devices, it has a big impact on the state of the art.

Sano and Picard[6] in their paper ' Stress Recognition using Wearable Sensors and Mobile Phones' reported that they have discovered physiological or behavioral stress markers, For 18 participants, they collected data over 5 days using a wrist sensor (accelerometer and skin conductance), mobile phone usage (call, short message service, location, and screen on/off), and surveys (stress, mood, sleep, tiredness, general health, alcohol or caffeinated beverage intake, and electronics usage). They employed correlation analysis to identify statistically significant variables linked to stress and machine learning to determine whether or not the subjects were stressed. Their correlation study revealed that higher levels of reported stress were associated with activity level, SMS, and screen on/off habits.

III. PROPOSED SYSTEM

In this paper, we propose a system made up of two parts: stress level detection and activity suggestion. The stress level detection component will receive data from users using their IoT edge device like smart watch and analyze it to determine the user's stress level using the DNN model. The activity suggestion component recommends activities to the user based on their stress level. The data will be entered by the user manually on the website which can be the heart rate, total steps and temperature of an individual from their smartwatch. This data is then processed and analyzed using deep neural network algorithms to determine the stress level of the individual. When a high or low stress level is detected, the system will start to interact with the user and offer suggestions or activities to do based on an individual's current state of stress. This enables the use of stress-reduction strategies and early intervention.

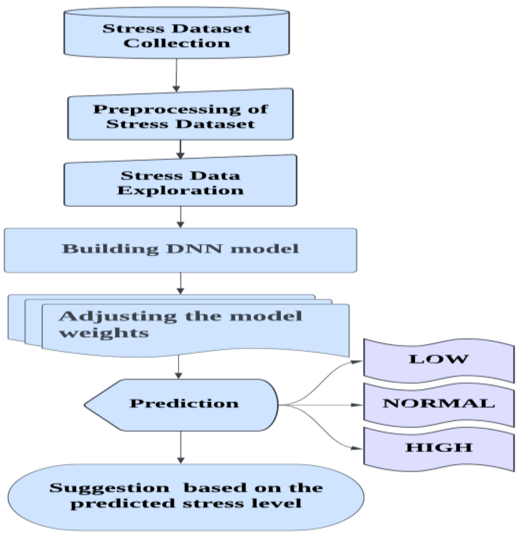

Fig. 1. Flowchart for the Stress Detection model

The proposed system has a number of advantages, including the capability of real-time stress monitoring, usability, and potential integration with Chatbots. It has the potential to enhance people's quality of life by assisting them in controlling

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their stress levels and avoiding the emergence of chronic stress-related health issues.

IV. STRESS PREDICTION MODEL

To train a deep neural network (DNN) to identify stress, a labeled dataset of heart rate, steps count and temperature were collected. After preparing the data by converting the input features to a common scale and ensuring that they have a consistent range, Using one-hot encoding, we converted the output stress levels into categorical labels such as normal, low, and high. We chose the architecture of the DNN model based on the input dimensions and complexity of the challenge. The input layer was designed to accept normalized heart rate. Hidden layers were added to extract significant features from the incoming data.

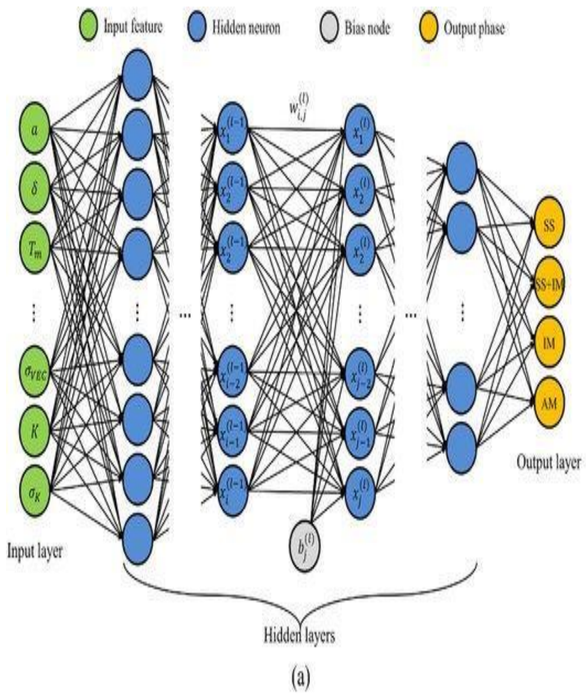

Fig. 2. Deep Neural Network

To introduce non-linearity and allow the model to learn complicated patterns, we used activation functions (e.g., ReLU, sigmoid) for the hidden layers. Then, using a suitable activation function (e.g., softmax for multi-class classification), we create the output layer with three neurons, each indicating the probability of normal, low, and high stress levels. Using an 80:20 ratio, divide the preprocessed dataset into training and testing sets.

TABLE I
Range of Sensor Values

Sensor	Low Stress	Normal Stress	High Stress
Steps count	0 - 91	92 - 129	130 - 200
Heart Rate (bpm)	50 - 70	60 - 100	100 - 130
Temperature (ºF)	79.01 - 84.00	84.01 - 95.00	95.01 - 99.00

Use an optimization approach such as stochastic gradient descent (SGD) to train the DNN model on the training set. The model learns to minimize the loss function (e.g., cross-entropy) during training by altering the weights and biases of the neurons using backpropagation and gradient descent.

V. RESULTS

Monitoring the model's performance on the validation set and adjusting hyperparameters such as learning rate, batch size, or regularization methods (such as dropout) to avoid overfitting Evaluate the trained model's performance on the testing set using metrics such as accuracy, precision, recall, and F1-score.

```
[ ]
# Make predictions on new data
new_data = np.array([[90.89, 61.84, 0.0206306]])
predictions = model.predict(new_data)
predictions
predicted_class = encoder.inverse_transform([np.argmax(predictions)])

1/1 [==============================] - 0s 27ms/step
```

```
[ ]
# Print predicted stress level
print(f"Predicted stress level: {predicted_class}")

if predicted_class == [0]:
    print("Low Stress level")
elif predicted_class == [1]:
    print("Normal Stress level")
elif predicted_class == [2]:
    print("High Stress level")

Predicted stress level: [0.]
Low Stress level
```

Fig. 3. Prediction of Stress level

We repeat the same experiment with multiple architectures, hyperparameters, and data preprocessing strategies to improve the model's performance. Obtaining a wide and balanced dataset will also help to improve the generalization and accuracy of the stress detection model.

VI. CHATBOT DEVELOPMENT

We created a chatbot that can engage with the user and offer personalized suggestions or activities based on their degree of stress. To enable the chatbot to interpret the user's input and create relevant responses, we applied natural language processing (NLP) techniques. The chatbot is programmed to deliver or propose activities based on the individual's stress level. If the stress level is low, the chatbot may recommend soothing activities such as yoga or meditation. If the degree of tension is medium, the chatbot may recommend taking a break or going for a walk. If the chatbot detects a significant degree of stress, it may suggest obtaining professional assistance or speaking with a friend or family member.

```
# Test the chatbot
stress_value = 2

while True:
    request = input('You: ')
    response = handle_request(request, stress_value)
    print('Chatbot:', response)
    if response == "Take rest, Bye!":
        break
```

```
You: I'm feeling so stressed today
Chatbot: You may want to try practicing mindfulness or meditation to help reduce your stress levels.
You: thank you
Chatbot: Take rest, Bye!
```

Fig. 4. Suggestion based on Predicted Stress level.

By combining the stress prediction model and chatbot, the chatbot will be able to access the user's stress level forecasts and deliver personalized suggestions or activities based on those predictions.

VII. CONCLUSION AND FUTURE RESEARCH

In this work, we have put forth a system for instantly accessible stress level detection and chatbot-based suggestion approach. We have discussed the research's methodology and findings in an effort to validate the system. Our system has the capacity to simultaneously record and interpret physiological information such as heart rate, steps count and body temperature, making it possible to identify three different levels of stress. The method has some drawbacks that have been discussed, such as accuracy, portability, and performance when dealing with artifacts. We are working on a final version that will provide real-time feedback through chatbots to the users.

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