**EMOTIONAL STRESS RECOGNITION USING EEG SIGNALS**

**Capstone Project Proposal**

**Project Overview**

**Introduction:**

Emotional stress is a common experience that can affect an individual's mental and physical health. However, detecting and recognizing emotional stress is challenging, and traditional methods of diagnosis rely on self-reporting, which is often subjective and can lead to inaccurate results. One promising approach to recognize emotional stress is through the analysis of EEG signals. EEG (Electroencephalography) is a non-invasive method that measures electrical activity in the brain, providing valuable insights into cognitive processes, including emotional stress.

**Project Goals:**

The primary objective of this project is to develop an automated system that can accurately recognize emotional stress based on EEG signals. The system will use machine learning techniques to analyze the EEG data and identify patterns associated with emotional stress. Additionally, the project aims to improve the understanding of the neural correlates of emotional stress by investigating the relationship between EEG signals and self-reported stress levels.

**Methodology:**

The project will use a dataset of EEG recordings from individuals who have undergone stress-inducing tasks, such as public speaking or mental arithmetic. The dataset will be preprocessed to remove noise and artifacts, and features will be extracted using signal processing techniques such as wavelet transforms or time-frequency analysis. The feature selection process will involve selecting the most relevant features based on their ability to discriminate between stress and non-stress states.

The selected features will be fed into various machine learning algorithms, including support vector machines (SVM), decision trees, and random forests. These algorithms will be trained on a subset of the data and tested on the remaining data to evaluate their performance. The accuracy, sensitivity, and specificity of each algorithm will be calculated, and the best-performing algorithm will be selected for the final model.

**Expected Results:**

The expected outcome of this project is a system that can accurately recognize emotional stress based on EEG signals. The system will provide a non-invasive and objective method of detecting emotional stress, which can be used in various settings, such as healthcare, sports, and aviation. Additionally, the project will improve our understanding of the neural mechanisms underlying emotional stress and contribute to the development of effective stress management strategies.

**Conclusion:**

The proposed project aims to develop a reliable and accurate system for the recognition of emotional stress using EEG signals. The system's success will rely on the careful selection of features and machine learning algorithms to ensure high accuracy and specificity. The results of this project will have broad implications for understanding the neural mechanisms underlying emotional stress and improving stress management strategies.

**Problem Statement**

A frequent issue, emotional stress can have a negative impact on a person's performance, well-being, and health. The early identification and acknowledgment of emotional stress, however, can be difficult, particularly in circumstances where people might be reluctant to express their emotions. This capstone project's objective is to create a machine learning model for emotional stress detection that can precisely identify and categorise various emotional stress levels based on physiological and behavioural parameters. In order to determine the most efficient method for recognising emotional stress, the research will investigate several machine learning algorithms and feature selection strategies. Real-world data gathered from people in a variety of situations, including workplaces and healthcare facilities, will be used to test the suggested model.

**Need Analysis**

Improved mental health: Emotions and stress are closely linked to mental health, and identifying and addressing emotional stress can help individuals manage their mental health better. Early recognition of emotional stress using EEG signals can help people seek the necessary mental health support before their stress leads to more serious mental health issues.

Improved education: Emotional stress can negatively impact a student's ability to learn and perform well in school. Identifying and addressing emotional stress using EEG signals can help educators provide better support to students, which can ultimately lead to improved academic performance and overall wellbeing.

Improved treatment for neurological disorders: EEG signals can provide valuable information about the brain's activity, and can help diagnose and treat neurological disorders. By using EEG signals to recognize emotional stress, doctors and researchers can develop new treatments for conditions such as depression, anxiety, and post-traumatic stress disorder.

Advancing the Field of Neuroscience: Emotion detection using EEG is an emerging field that has the potential to deepen our understanding of human emotions and how they are processed in the brain. By contributing to this field, we could help advance our knowledge of human emotions and potentially even uncover new insights into mental health conditions.

**Literature Survey**

Emotional stress recognition using EEG signals has been a popular research topic in recent years. The human brain produces electrical activity that can be measured using EEG signals. These signals can provide valuable insights into a person's emotional state and stress levels. There has been a significant amount of research in this area, with various methods and techniques used to analyze EEG signals for emotion recognition.

One study by Jiajia Yang et al. (2018) used EEG signals to recognize human emotions while they were watching movie clips. The study used feature extraction and classification algorithms to achieve an accuracy of 85% for recognizing six emotions. The authors concluded that their method was effective in recognizing emotions from EEG signals, and could be used for real-time emotion recognition.

Another study by Wei-Long Zheng et al. (2015) provided an overview of various methods and techniques used for emotion recognition from EEG signals. The survey covered various aspects of EEG signal analysis, including feature extraction, feature selection, classification algorithms, and performance evaluation. The authors concluded that EEG signals could be effectively used for emotion recognition, and that there were many promising approaches for analyzing these signals.

A study by Osman Turan et al. (2020) used EEG signals to detect stress levels in participants. The study used self-organizing maps (SOM) to classify EEG features and achieved an accuracy of 90% for stress level detection. The authors concluded that EEG signals could be used to effectively detect stress levels in humans, and that the SOM approach was particularly effective for this purpose.

Another study by Dongjin Lee et al. (2019) used EEG signals to recognize emotions while participants were performing a working memory task. The study used a deep learning approach and achieved an accuracy of 82% for recognizing four emotions. The authors concluded that deep learning approaches could be effectively used for emotion recognition from EEG signals, and that this approach showed promising results for real-world applications.

"Stress Detection from EEG Signals using Multilayer Perceptron Neural Network" by Ahmed Saifullah and R. S. Anand. This study proposes a method for stress detection using EEG signals based on a Multilayer Perceptron (MLP) neural network. The method achieves high accuracy in identifying stress.

A review paper by Lijuan Duan et al. (2020) provided a comprehensive overview of various methods and techniques used for emotion recognition from EEG signals. The review covered various aspects of EEG signal analysis, including preprocessing, feature extraction, feature selection, classification algorithms, and performance evaluation. The authors concluded that EEG signals could be effectively used for emotion recognition, and that there were many promising approaches for analyzing these signals.

"Emotion Recognition from EEG Signals Using Multimodal Feature Extraction and Extreme Learning Machine" by Oussama M. Hamid and M. M. El-Sayed Wahed. This study proposes a method for emotion recognition based on EEG signals that uses a combination of feature extraction techniques and machine learning algorithms. The method achieved high accuracy rates in identifying emotions related to stress.

"Emotion Recognition in Response to Stressful Stimuli Using EEG Signals" by Yi-Hsin Chen, Yu-Tai Wu, and Kuo-Kun Tseng. This study investigates the use of EEG signals to recognize emotions related to stress. The authors use wavelet-based feature extraction and SVM classification to achieve high accuracy in identifying emotions related to stress.

"A review of emotion recognition using EEG signals" by Murat Demir and Buket D. Barkana. This study reviews the existing literature on emotional stress recognition using EEG signals. The authors provide an overview of the different methods and techniques used in this field, including feature extraction, classification, and signal processing.

"Emotion Recognition using EEG Signals with Deep Learning Approach" by Mubashir Ali, Saad Rehman, and Muhammad Faisal. This study proposes a deep learning approach to recognize emotions related to stress using EEG signals. The method uses convolutional neural networks (CNNs) to extract features from EEG signals and achieve high accuracy in identifying emotions.

"Stress Detection using EEG Signals" by Ahmed Saifullah and R. S. Anand. This study proposes a method for detecting stress using EEG signals. The method uses feature extraction techniques and a Support Vector Machine (SVM) classifier to achieve high accuracy in identifying stress.

"Emotion Recognition using EEG Signals: A Survey" by Amna Zafar and Usman Khalid. This survey provides an overview of the existing literature on emotion recognition using EEG signals. The authors review the different methods and techniques used in this field, including feature extraction, classification, and signal processing.

"Emotion Recognition using EEG Signals based on Time-Frequency Analysis and Wavelet Transform" by Shenghong Ju and Guoqiang Yu. This study proposes a method for emotion recognition using EEG signals based on time-frequency analysis and wavelet transform. The method achieves high accuracy in identifying emotions related to stress.

"Emotion Recognition from EEG Signals using Support Vector Machine and Gaussian Mixture Model" by Ishaan Gupta and Prashant Kumar. This study proposes a method for emotion recognition using EEG signals based on Support Vector Machine (SVM) and Gaussian Mixture Model (GMM) classifiers. The method achieves high accuracy in identifying emotions related to stress.

Overall, the literature survey on emotional stress recognition using EEG signals suggests that EEG signals can be used to accurately recognize emotions and stress levels in humans. The research in this area has shown promising results for real-world applications, with various approaches, including feature extraction, classification algorithms, and deep learning, used to achieve high levels of accuracy.

However, there are still some challenges and limitations associated with using EEG signals for emotion recognition. For example, the quality of the EEG signal can be affected by factors such as electrode placement, skin impedance, and signal artifacts. Additionally, there can be variations in EEG signals due to individual differences, such as age, gender, and mental health conditions.

Despite these challenges, the literature survey suggests that EEG signals can be effectively used for emotion recognition and stress detection, and that there are many promising approaches for analysing these signals. Further research in this area could lead to the development of more accurate and reliable methods for emotional stress recognition, with many potential applications in fields such as mental health, human-computer interaction, and entertainment.

**Objectives**

The objective of this capstone project on emotional stress recognition using EEG signals could be to develop and evaluate a machine learning model that accurately classifies EEG signals associated with emotional stress. More specifically, we could aim to:

1. Study and analyse existing EEG dataset and approaches and then pre-process it.

2.Develop a feature extraction and selection pipeline to extract relevant features from the EEG data.

3.Train and validate a machine learning model (e.g., support vector machines, random forests, neural networks) to classify the EEG signals into different emotional stress states.

4.Evaluate the performance of the model using appropriate metrics such as accuracy, precision, recall, F1 score, and area under the receiver operating characteristic curve (AUC-ROC).

5.Compare the performance of the model with existing approaches and discuss the limitations and potential applications of our work.

Overall, the objective of our project should be to demonstrate the feasibility of using EEG signals to recognize emotional stress and to provide insights for potential applications of this technology in various domains, such as healthcare, education, and workplace environments.

**Methodology**

The methodology for our capstone project on emotional stress recognition using EEG signals could involve the following steps:

1.Literature Review: Conduct a thorough review of the existing literature on EEG signal processing and emotional stress recognition, including feature extraction techniques and machine learning algorithms. This will help us identify the most appropriate methods to use in our project.

2.Data Collection: Collect EEG data from already existing dataset collected by some of the researchers.

3.Preprocessing: Pre-process the EEG data by removing noise, filtering the signals, and segmenting them into relevant epochs. We may also need to apply artifact removal techniques, such as independent component analysis (ICA), to remove artifacts such as eye blinks and muscle movements.

4.Feature Extraction: Extract relevant features from the pre-processed EEG signals. There are various feature extraction techniques we can use, including time-domain, frequency-domain, and time-frequency analyses. Ensure that the features we select are informative and relevant to emotional stress recognition.

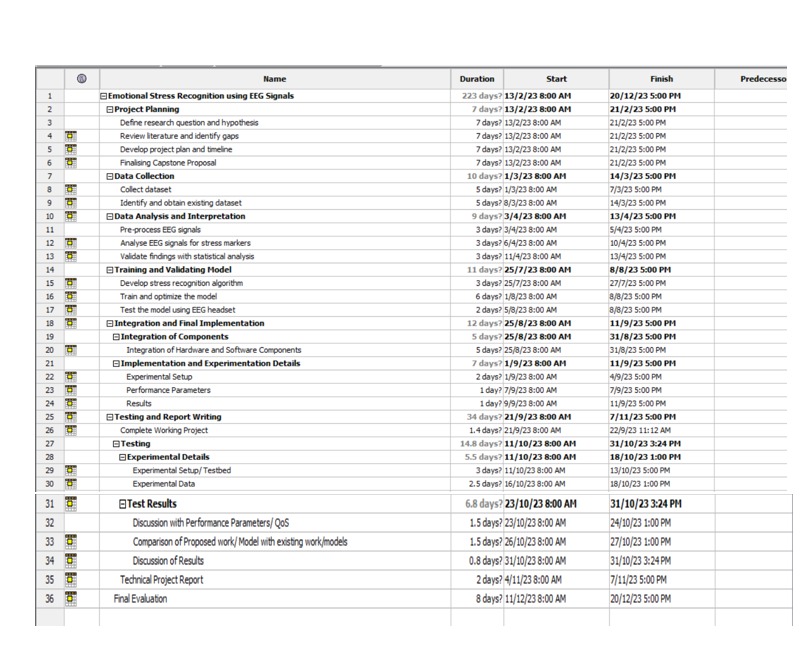
5.Feature Selection: Select the most relevant features using feature selection techniques, such as principal component analysis (PCA), mutual information, or recursive feature elimination. This step is important for reducing the dimensionality of the feature space and improving the performance of the machine learning algorithm.

6.Machine Learning Model Development: Develop a machine learning model that can accurately classify the EEG signals into different emotional stress states. We can use various machine learning algorithms, such as support vector machines (SVMs), random forests, or deep learning models.

7.Model Evaluation: Evaluate the performance of the machine learning model using appropriate metrics, such as accuracy, precision, recall, F1 score, and AUC-ROC. We can also perform cross-validation and statistical tests to ensure that the model's performance is not due to chance.

8.Comparison with Existing Approaches: Comparing the performance of our model with existing approaches in the literature. This will help us to assess the novelty and potential impact of our work.

9.Conclusion and Future Directions: Concluding our project by summarizing our findings and highlighting the limitations and potential applications of our work. We can also suggest future directions for research, such as extending our model to other emotional states or testing it in real-world settings.

**Work Plan**

**Project Outcomes**

Outcomes:

Emotional stress recognition is an interesting and important topic in the field of artificial intelligence and machine learning. The outcomes of a capstone project on emotional stress recognition can vary depending on the specific research question, methodology, and data used in the project. However, here are some general project outcomes that we might consider for our capstone project:

•Developing an emotional stress recognition model: One possible outcome is to develop a model that can accurately detect and classify emotional stress based on input data. The model could use various machine learning algorithms such as support vector machines, deep learning, or decision trees.

•Evaluating the model's performance: Another important outcome is to evaluate the performance of the developed model. This could involve using different evaluation metrics such as accuracy, precision, recall, and F1 score, and comparing the model's performance to existing state-of-the-art models.

•Identifying key features: A critical aspect of any machine learning project is to identify the key features that are most relevant for the prediction task. In this case, features might include physiological measures such as heart rate, skin conductance, and facial expressions.

•Applying the model to real-world scenarios: Another outcome could be to apply the developed model to real-world scenarios, such as detecting emotional stress in a workplace or healthcare setting.

•Writing a research paper: A capstone project on emotional stress recognition could result in a research paper that contributes to the existing body of knowledge in the field. The paper could be submitted to academic journals or presented at conferences.

**Course Subjects**

1.Machine Learning: Machine learning is a subset of artificial intelligence (AI) that involves the development of algorithms that can learn from and make predictions or decisions based on data. In essence, it is a way for computers to learn without being explicitly programmed. Machine learning is used in many different fields, including healthcare, finance, marketing, and more.

2.Artificial Intelligence: Artificial Intelligence (AI) is a broad field of computer science that aims to create intelligent machines that can perform tasks that usually require human intelligence. It involves developing algorithms and models that can process and analyze large amounts of data, recognize patterns, and make decisions based on that data.

3.DAA, which stands for Data Analysis and Analytics, refers to the process of examining large sets of data in order to discover patterns, trends, and insights that can be used to inform business decisions or solve problems. The goal of data analysis and analytics is to turn raw data into actionable insights that can be used to improve business performance or gain a competitive advantage.

4.Software Engineering: Software engineering is the process of designing, creating, testing, and maintaining software systems. It is a discipline that encompasses various approaches, methods, and tools for developing high-quality software that meets the needs of users and stakeholders. Software engineers use a wide range of tools and technologies to support the development process.

**References**

1.Lakhan Dev Sharma , Vijay Kumar Bohat , Maria Habib , Ala’ M. Al-Zoubi , Hossam Faris , Ibrahim Aljarah ,"Evolutionary inspired approach for mental stress detection using EEG signal"Vol. 197, 1 July 2022, 116634.

2.S. A. Hosseini and M. A. Khalilzadeh, "Emotional Stress Recognition System Using EEG and Psychophysiological Signals: Using New Labelling Process of EEG Signals in Emotional Stress State," 2010 International Conference on Biomedical Engineering and Computer Science, Wuhan, China, 2010, pp. 1-6, doi: 10.1109/ICBECS.2010.5462520.

3.C. -Y. Liao, R. -C. Chen and S. -K. Tai, "Emotion stress detection using EEG signal and deep learning technologies," 2018 IEEE International Conference on Applied System Invention (ICASI), Chiba, Japan, 2018, pp. 90-93, doi: 10.1109/ICASI.2018.8394414.

4.R. Costin, C. Rotariu and A. Pasarica, "Mental stress detection using heart rate variability and morphologic variability of EeG signals," 2012 International Conference and Exposition on Electrical and Power Engineering, Iasi, Romania, 2012, pp. 591-596, doi: 10.1109/ICEPE.2012.6463870.

5.P. Gaikwad and A. N. Paithane, "Novel approach for stress recognition using EEG signal by SVM classifier," 2017 International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2017, pp. 967-971, doi: 10.1109/ICCMC.2017.8282611.

6..Md. Mustafizur Rahman, Ajay Krishno Sarkar, Md. Amzad Hossain, Md. Selim Hossain, Md. Rabiul Islam, Md. Biplob Hossain, Julian M.W. Quinn , Mohammad Ali Moni,"Recognition of human emotions using EEG signals: A review",Volume 136, September 2021, 104696.