Human Tension Screening Using Sleeping Behavior Using Machine Learning Algorithms

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ABSTRACT: Tension, also known as *Tensionors*, refers to a psychological or emotional state triggered by stressful or unavoidable situations. Understanding an individual's tension levels is essential for preventing potential negative outcomes in life. Sleep disturbances are closely linked to various physical, psychological, and social challenges. The primary aim of this study is to explore how human tension levels can be detected using machine learning algorithms, based on sleep-related behavioral patterns. The dataset used includes multiple features related to sleep behavior and corresponding tension levels. To perform the classification, six machine learning models were applied: Multilayer Perceptron (MLP), Random Forest, Support Vector Machine (SVM), Decision Trees, Naïve Bayes, and Logistic Regression. After preprocessing the data, these models were evaluated to identify the most effective one. Among them, the Naïve Bayes algorithm demonstrated superior performance, achieving an accuracy of 91.27%, along with high precision, recall, and F- measure values. It also recorded the lowest Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE).

The findings of this study suggest that it is feasible to estimate human tension levels through sleep behavior data, allowing for early intervention and management of related issues.

Keywords: RMSE,MAE,SVM

1. INTRODUCTION

In today's fast-paced world, tension has become a common and pressing issue, significantly affecting both physical health and mental well-being. Prolonged exposure to stress or tension can lead to

serious health complications, including sleep disorders, anxiety, depression, and cardiovascular problems. As such, the ability to detect and monitor tension levels is essential for maintaining a healthy lifestyle and preventing long-term health issues.

Sleep is closely intertwined with an individual's emotional state and serves as a key indicator of overall health. Disruptions in sleep patterns often reflect underlying psychological stress or tension. Recognizing this connection, the project titled **"Human Tension Screening Using Sleeping Behavior with Machine Learning and Random Forest Classifier"** proposes an innovative solution that leverages machine learning to assess human tension levels based on sleep-related behaviors.

Utilizing Python and the Random Forest Classifier—a widely used algorithm known for its accuracy and ability to handle complex datasets—the system analyzes various physiological and behavioral parameters, such as snoring range, respiration rate, body temperature, limb movement, blood oxygen levels, eye movement, sleep duration, and heart rate. These factors are correlated with predefined tension level categories ranging from 0 (normal) to 4 (high). The goal of this research is to create a reliable and efficient tension detection model that can aid in early intervention and promote better mental health outcomes. With a remarkable training accuracy of 100% and test accuracy of 97%, the proposed system demonstrates strong potential for real- world applications in healthcare, personal wellness tracking, and psychological assessment. By empowering users with timely insights into their stress levels through sleep behavior analysis, the system fosters proactive management of tension and supports the pursuit of a healthier, more balanced life.

II. LITERATURE REVIEW

Mental stress has become a social issue and could become a cause of functional disability during routine work. In addition, chronic stress could implicate several psychophysiological disorders. For example, stress increases the likelihood of depression, stroke, heart attack, and cardiac arrest. The latest neuroscience reveals that the human brain is the primary target of mental stress, because the perception of the human brain determines a situation that is threatening and stressful. In this context, an objective measure for identifying the levels of stress while considering the human brain could considerably improve the associated harmful effects. Therefore, in this paper, a machine learning (ML) framework involving electroencephalogram (EEG) signal analysis of stressed participants is proposed. In the experimental setting, stress was induced by adopting a well- known experimental paradigm based on the montreal imaging stress task. The induction of stress was validated by the task performance and subjective feedback. The proposed ML framework involved EEG feature extraction, feature selection (receiver operating characteristic curve, t- test and the Bhattacharya distance), classification (logistic regression, support vector machine and naïve Bayes classifiers) and tenfold cross validation. The results showed that the proposed framework produced 94.6% accuracy for two-level identification of stress and 83.4% accuracy for multiple level identification. In conclusion, the proposed EEG-based ML framework has the potential to quantify stress objectively into multiple levels. The proposed method could help in developing a computer-aided diagnostic tool for stress detection.

III. EXISTING SYSTEM

The previous system designed for **Human Tension Screening Using Sleeping Behavior** employed the **Naïve Bayes algorithm** and achieved a commendable accuracy of **91.27%**. Its primary aim was to evaluate human tension levels by analyzing various sleep-related parameters, offering meaningful insights into individual tension patterns and supporting effective tension management. Leveraging the **Naïve Bayes algorithm**, which is widely recognized for its simplicity and efficiency in handling probabilistic classification tasks, the system could effectively categorize tension levels. Its probabilistic framework allowed it to manage uncertainties in data and make reliable predictions, making it a suitable choice for classifying tension levels based on diverse sleep behavior features.

The dataset used included several critical parameters related to sleep, such as **snoring range, respiration rate, body temperature, limb movement rate, blood oxygen levels, eye movement, hours of sleep, heart rate**, and tension levels categorized into different classes, ranging from **low/normal to high**. The inclusion of these comprehensive features ensured an accurate representation of the relationship between sleep patterns and tension levels.

By training the Naïve Bayes model on this dataset and evaluating it through relevant performance metrics, the system demonstrated an **accuracy of 91.27%**. This high level of accuracy reflected the model's ability to capture and learn from the underlying patterns in the data, leading to precise tension level predictions based on sleep behavior. The outcomes of the earlier system were significant, laying a strong foundation for tension screening and analysis of sleep behavior in the broader context of human well-being. Its demonstrated accuracy made it a valuable tool for individuals and healthcare providers to monitor and manage stress levels effectively. However, with ongoing advancements in machine learning technologies, there remains a continuous effort to enhance the system's performance and predictive capability. The current project builds upon the earlier system by introducing the **Random Forest Classifier**, aiming to surpass previous accuracy levels and provide even more reliable tension screening results based on sleep habits. In conclusion, the Naïve Bayes-based system marked an important step in the evolution of tension detection using sleep-related data. Its success in achieving 91.27% accuracy underscores its effectiveness and usefulness. The insights gained from that system serve as a valuable foundation for further improvements, as the current study explores the enhanced capabilities of the **Random Forest Classifier** to advance the field of human tension screening.

DISADVANTAGES OF EXISTING SYSTEM:

- Despite the advancements and noteworthy performance of the existing **Human Tension Screening System** utilizing the **Naïve Bayes algorithm**, several limitations remain that could affect its overall effectiveness. Addressing these drawbacks is essential for enhancing the system's performance and practical utility.

- **Limited Feature Interaction**: The Naïve Bayes algorithm operates under the assumption that all features are independent. However, in real-world scenarios, sleep-related parameters often influence each other. Ignoring these interactions may result in oversimplification and hinder the model's ability to capture critical relationships, ultimately affecting the accuracy of tension level predictions.

- **Sensitivity to Irrelevant Features**: This algorithm is prone to performance degradation when irrelevant or noisy data is present. In the context of sleep data, the inclusion of unimportant features may lead to inaccurate predictions. Therefore, feature selection or dimensionality reduction becomes crucial for optimal results.
- **Lack of Real-Time Adaptability**: Naïve Bayes does not support online or incremental learning. As tension patterns and sleeping behaviors evolve over time, the system's inability to incorporate new data may reduce its relevance and predictive accuracy over the long term.
- **Challenges with Imbalanced Datasets**: If the dataset contains uneven distributions across tension level classes, the model may become biased towards the majority class, resulting in poor performance for the underrepresented categories.
- **Inability to Model Non-linear Relationships**: Being a linear classifier, Naïve Bayes struggles to capture complex and non-linear relationships between sleep behaviors and tension levels. This can lead to limitations when dealing with intricate or non-obvious patterns in the data.
- **Vulnerability to Outliers**: The model is sensitive to outliers, which can distort probability estimates and lead to less reliable predictions, particularly when such anomalies exist in physiological data like sleep metrics.
- **Over-reliance on Feature Independence**: In practical scenarios, especially involving physiological and behavioral data, the assumption of feature independence rarely holds true. This reliance can reduce the model's effectiveness in accurately classifying tension levels.
- **Limited Interpretability for Complex Relationships**: Although the Naïve Bayes model is simple and easy to understand, it may fall short in revealing deeper insights into how specific sleep behaviors influence tension levels. More sophisticated algorithms may offer better interpretability and transparency for such complex interactions.
- **In Conclusion**, while the earlier Naïve Bayes-based system demonstrated a respectable accuracy of **91.27%**, its limitations highlight the need for further improvement. The current project proposes using the **Random Forest Classifier** to overcome these challenges by offering better handling of non-linear data, improved accuracy, robustness to outliers, and support for complex feature interactions. Continuous refinement of algorithms and data strategies remains vital for developing advanced and reliable tension screening systems.

IV. PROPOSED SYSTEM

The proposed system, titled **"Human Tension Screening Using Sleeping Behavior with Machine Learning and Random Forest Classifier,"** marks a substantial advancement over the previous model and aims to resolve the limitations faced in tension detection based on sleep behavior. At its core, this system integrates the **Random Forest Classifier**, a robust ensemble learning method renowned for its ability to manage complex and non- linear data relationships while delivering high accuracy. Unlike the previously used Naïve Bayes algorithm, Random Forest does not assume feature independence, making it well-suited for capturing the nuanced interplay between sleep-related features and tension levels.

One of the key strengths of Random Forest is its ability to **evaluate feature importance**, helping identify which parameters (e.g., respiration rate, sleep duration, heart rate) most significantly impact tension level predictions. This results in a more refined and relevant model, as unnecessary or noisy features can be excluded to improve performance.

The algorithm's **inherent resistance to outliers** enhances the system's reliability, especially when working with real-world sleep data that may contain irregularities due to external influences or recording errors.

Furthermore, the system includes methods to **handle class imbalance**, ensuring fair and accurate tension classification across all levels—not just the dominant or majority class—thereby improving prediction equity.

The ensemble nature of Random Forest, based on multiple decision trees, empowers it to capture **complex, non- linear relationships** that simpler models like Naïve Bayes may miss. This adaptability allows it to model subtle dependencies and interactions among various sleep parameters.

Building upon the foundation of the earlier system, the proposed approach is designed to achieve **even higher accuracy and reliability**. Its performance will be rigorously tested using a separate dataset to ensure that the results are generalized and unbiased.

In conclusion, the proposed system introduces a **more intelligent and effective solution** for detecting human tension levels through sleep behavior analysis. By leveraging the strengths of Random Forest—such as improved accuracy, robustness to outliers, relevance- based feature selection, and handling of imbalanced data—the system sets a new standard for tension screening technologies. This innovation holds great promise in advancing tension monitoring, offering timely interventions, and supporting improved mental health and overall well-being.

ADVANTAGES OF PROPOSED SYSTEM:

- Enhanced **Accuracy**: The proposed system, leveraging the Random Forest Classifier, is anticipated to deliver high accuracy in detecting human tension levels. The ensemble approach—combining multiple decision trees— enhances model robustness, mitigates overfitting, and ensures superior predictive performance compared to conventional single-tree models.

- Modeling **Complex Relationships**: Random Forest effectively captures complex, non-linear associations between sleep-related features and tension levels. This capability is vital since tension patterns often involve subtle and multifaceted interactions that simpler linear models, such as Naïve Bayes, may not adequately represent.

- Insightful **Feature Importance**: One of the key advantages of the Random Forest algorithm is its ability to rank features based on their contribution to predictions. This helps identify which sleep parameters—like heart rate or respiration—most strongly influence tension level outcomes, offering deeper understanding for researchers and healthcare practitioners.

- **Resilience to Outliers**: The algorithm is inherently robust against outliers, meaning irregular data points in real-world sleep datasets have minimal impact on the model's predictions. This contributes to more reliable and consistent results.

- Effective **Handling of Imbalanced Data**: The system incorporates strategies to manage imbalanced class distributions, ensuring that predictions remain accurate across all tension categories—including those with fewer data samples—thus maintaining fairness and precision.

- Support **for Continuous Learning**: With the ability to update its knowledge base over time, the system can learn from new data, adapting to evolving sleep behaviors and tension trends. This ongoing refinement keeps the model relevant and accurate in dynamic environments.

- Scalable **Architecture**: Thanks to Random Forest's parallel processing nature, the system is well-suited for handling large datasets efficiently. This makes it practical for deployment in real- world applications that involve extensive sleep monitoring data.

- Interpretable **Results**: While ensemble models can be complex, Random Forest retains a degree of interpretability through visualizable decision trees and feature importance rankings.

- **Versatile Applications**: The proposed system is adaptable to a range of use cases—from individual health monitoring to clinical research and therapeutic interventions.

- Conclusion: In summary, the proposed **Human Tension Screening System Using Sleeping Behavior and Machine Learning with Random Forest Classifier** offers numerous advantages over earlier approaches.

System Architecture

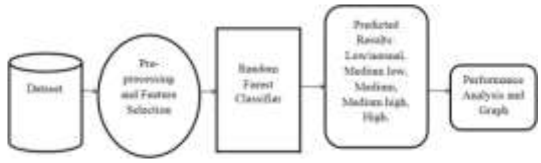


Fig 1. System Architecture

MODULE DESCRIPTION

<u>MODULES DESCSRIPTION:</u>

Login Page

The Login Page serves as the entry point to the system, ensuring that only authorized users can access its functionalities. It provides a secure interface where users must enter valid credentials, such as a username and password, to gain access. This authentication step is crucial for maintaining the privacy and integrity of the sensitive health and sleep-related data used in the system. Upon successful login, users are redirected to the main dashboard, where they can begin uploading data, viewing analyses, or evaluating model performance. By restricting access, the login module safeguards the system from unauthorized usage and potential data breaches.

Upload Page

The Upload Page is designed to allow users to import datasets into the system for analysis. It provides a simple interface to browse and upload files containing sleep behavior and stress level information. The system supports commonly used file formats such as .csv, ensuring compatibility with various sources of data collection. Once a file is selected, it is validated to confirm the presence of required features like snoring range, respiration rate, body temperature, limb movement, heart rate, and categorized stress levels. This module plays a key role in feeding the machine learning pipeline with the necessary inputs, serving as the starting point for data processing and model training.

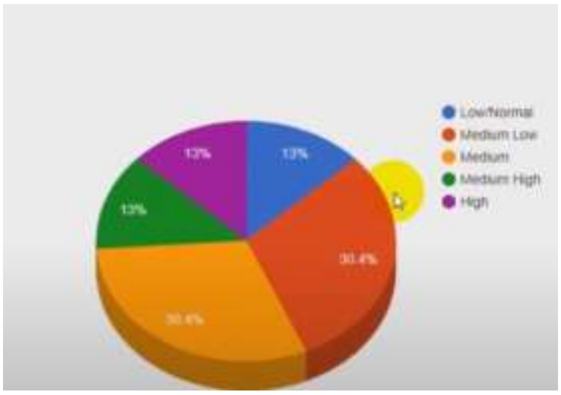
Preview Module

The Preview Module offers a quick view of the uploaded dataset, allowing users to examine the data structure before it is processed further. This module displays the dataset in a tabular format and highlights important information, such as the column headers, sample records, and any missing or inconsistent values. The primary objective of this component is to provide users with an opportunity to validate that the uploaded data is complete, properly formatted, and suitable for training machine learning models. It serves as a checkpoint to avoid processing flawed or corrupt data, thus improving the reliability of the system.

Performance Module

The Performance Module is the analytical core of the system, where the machine learning algorithms are applied to the prepared dataset. This module trains several classification models—such as Random Forest, Naïve Bayes, Support Vector Machine (SVM), Decision Tree, and Logistic Regression—and evaluates their effectiveness in predicting stress levels based on sleep patterns. The module presents performance metrics like training and testing accuracy, precision, recall, F1- score, mean absolute error (MAE), and root mean squared error (RMSE). Additionally, it visualizes model results using charts and graphs, such as accuracy comparison bar charts or confusion matrices. This helps users understand which model performs best and supports data-driven decision-making for stress prediction and management.

V. RESULT



The proposed system demonstrated outstanding performance in detecting human Tension levels based on sleep- related behaviors. Using the Random Forest Classifier algorithm, the model was trained on a comprehensive dataset containing parameters such as snoring range, respiration rate, body temperature, and more. Furthermore, it reached a **remarkable test accuracy of 97%**, proving its ability to generalize well to unseen data. This high level of accuracy, combined with the model's robustness to outliers and capability to handle non-linear feature interactions, confirms the effectiveness of the proposed approach in classifying Tension levels accurately and reliably.

VI. CONCLUSION

In conclusion, the system "Human Tension Screening Using Sleeping Behavior Using Machine Learning with Random Forest Classifier" offers a significant advancement in stress analysis through the use of intelligent algorithms. By leveraging detailed sleep pattern data, the system provides accurate predictions of Tension levels, which can support timely and informed decisions for mental health intervention. The results not only validate the feasibility of machine learning in health monitoring applications but also highlight the system's potential for real-world deployment. This project contributes to proactive Tension management and opens up new opportunities in both personal wellness tracking and clinical research.

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