Grenze International Journal of Engineering and Technology, Jan Issue

Detection of Stress through Sleeping Habits

Nirmala M B[1], Chandana H S[2], Amnah Rafeeq Khan[3] and Bhavana S Kumar[4]
[1-4]Department of Computer Science and Engineering, Siddaganga Institute of Technology, Tumakuru, Karnataka, India
Email: mbnirmala@sit.ac.in, 1si19cs031@sit.ac.in, 1si19cs010@si.ac.in, 1si19cs024@sit.ac.in

***Abstract*— Considering today's lifestyle, people tend to neglect their health, specifically when it comes to their sleep. Sleep quality at night will affect our day-to-day activities. Physiological and non-physiological parameters tend to vary during sleep and can affect the quality of sleep, which in turn can build up stress. Insufficient sleep or bad sleep can build up stress in people. Advancement in technology especially in the IoMT sector has provided us with designed tools which can help us in calculating stress. The proposed system represents the relation between stress and sleep and gives an idea on how the former affects the latter. It takes in consideration the various parameters like bodily movements that indicate the level of stress. A user interface is inculcated for user accessibility. The accuracy level of the proposed system is as much as 96%.**

***Index Terms*— Stress detection, Sleeping habits, Machine Learning algorithms, Sleep Monitoring.**

I. INTRODUCTION

When subjected to ample amount of stress, can cause a lot of health damage in humans, and can lead to mental breakdowns, hindering their day-to-day activities. Hence, this system aims at simplifying firsthand health, specifically stress checkup for users, making accessibility even easier. The various considerations like stressors, pressure sensors have been incorporated into IoMT devices for the same. The main aim of it is to represent and calculate the level of stress and its variations. Since this is an electronic based data set collection, various aspects like data storage, retrieval, access are key factors to look upon. The system is user friendly as it safeguards user information or data maintaining confidentiality, integrity of the user's privacy, hence assessing the several risks.

As a result, we suggest Pillow system, a device that monitors and controls a person's stress levels as they sleep. By safely monitoring data while sleeping and taking necessary actions the user may not only get ready for the next day, but also have a good night's sleep. The device helps in analyzing sleeping habits by continually monitoring sleep duration, snoring range are all observed in addition to physiological parameter changes. The data from the pillow system is kept in the cloud and analyzed at the edge. The pillow is a promising device eradicating the risks or threats and hence resulting in a very secured device. User interface allows the user to manage and navigate easily, ensuring accessibility.

The project proposes a smart Pillow which is an IoMT based smart device to automatically start working when a person sleeps on it. With the help of IoT sensors which are placed inside the pillow, data is collected on the hours of sleeping, movements while sleeping, and sounds of snoring.

Grenze ID: 01.GIJET.9.1.510_1

II. LITERATURE SURVEY

Table 1 gives the brief description of the related literature on various stress detection methodologies.

TABLE I. STUDY OF STRESS DETECTION SCHEMES

Reference No.	Observation
[1]	A proposed system in which the stress is calculated or segregated in 5 levels, i.e High, Medium-High, Medium, Medium-Low and Low.
[2]	This approach is a hands-off approach in which stress is detected in a natural fashion with the help of factors like user's sleep routines and the surrounding environment
[3]	As the name suggests, this approach inculcates various resistors, transistors or capacitors and also grabs studies or applications from the field of physics to create a semi-conductor device for analysing the various parameters to detect stress.
[4]	Applying deep learning in association with Edge computing, this approach helps in detecting, classifying and quantifying objects.
[5]	This is a very reflexive approach as the user immediately receives feedback of their health track, making it user friendly, easily accessible, and even provides edge computing benefits.
[6]	This study, is totally based on the cardiovascular activities of a human, hence taking in consideration heart rates which helps in detecting stress and is one of the major parameters.
[7]	The study primarily focuses on obese patients as well as those patients who portray an immense level of stress whose detection is of real concern.

III. PROPOSED SYSTEM

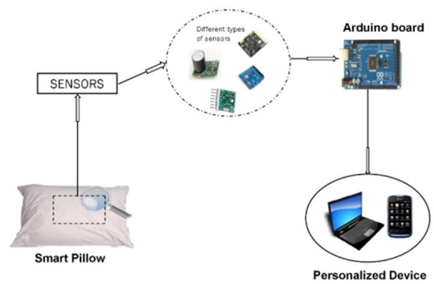

Figure 1. Smart Sleep System

The Smart sleep system as shown in figure 1. is built in order to help people to have good sleep and to reduce their stress level. It is designed in a such a way that it is easy for the user to use it as well as it is easy to collect data and process it. Data collection is done mainly by two factors. First by proposed smart pillow and second by any smart watch of the user. This system is built and the transfer of data from the sensors to the user device is done by cloud storage. The output of this is given as input for the machine learning algorithm for stress prediction.

IV. PHASES OF IMPLEMENTATION

PHASE 1

In the first phase we have collected the necessary data that is required for the prediction of the stress. This includes many attributes as follows:

- Snoring rate (45-100) – Depending on the observed sound and calculated frequency noise can be classified as snoring and a range can be given.
- Respiration rate (15- 30)-It is the observes rate of respiration of a person.
- Body temperature (90-98)-It is the temperature range of the user.
- Body movement (5-20)- It is the calculated from the sensors and a range is given.
- Blood oxygen (85-95)- It is the blood oxygen level of the user collected from smart device.
- Eye movement (80-100)-It is the eye movement during sleep of the user, collected from smart device.
- Sleeping hours (0-15)-It is the observed hours of sleeping of the person, collected from the smart pillow.
- Heart rate (60-80)- It is the Heart rate of the user during sleep collected from smart device.

In collection of all these data there is a proposed model of using Arduino based edge device in order to record the hours of sleeping, body movement and snoring. After collecting all these data from the sensors and edge devices a data set is prepared which is used as the input for machine learning algorithms. The process predicts the stress level.
Some other attributes values like heart rate, respiration rate can be easily gained through smart watches which are available in the market vastly. And even this eye movement can be detected through image processing technology.

PHASE 2
In the second phase the collected data is used as the input for the machine learning algorithm to predict the level of stress of the user. Prediction of stress is done by implementing different types of machine learning algorithms.

V. ALGORITHM USED

A. KNN model

KNN an algorithm which uses the Euclidean distance formula to find the points getting classified into same group. It can also be used in regression problems. Here a set of k number of neighbors are selected, and their Euclidean distance is calculated. Then later k number of neighbors with the nearest values are grouped together. A new data point is assigned to a category to which the number of neighbors is maximum. This method is used as it is easy to implement and out data contains several categories of input constraints.

B. Random Forest

Random forest is a supervised learning algorithm which is similar to decision trees. It is a collection of multiple random decision trees hence called as random forest. They are less sensitive to training dataset. Only few trees are considered for training the model. When a new data point is to be tested and results must be given, it is passed through each tree and results are noted down and majority class is given as the results.

C. Support Vector Machine (SVM)

It is a supervised algorithm which is the extended part of the linear regression where decision boundary is given to fit in the data. It finds a hyperplane in N dimensional space where data points are classified distinctly. It is effective and uses support vectors for memory efficiency.

D. Decision Tree Classification

It is a Supervised learning technique that can be used whenever the dataset cannot be classified linearly. It is used for problems of both classification and regression. With the aid of binary called as decision tree this algorithm splits the dataset recursively until the leaf node i.e., the node with same class is obtained. Here in the tree all the internal nodes represent features of the dataset and branches represent decision rules and all the leaf nodes represents the class to which the dataset belong. In this problem level of stress is based on the extremity of the input constraint and decisions are taken based on the features of the tree.

E. Linear regression

It is an algorithm that shows relation between one or more variable which are classified based on the linear equation value. The relation between a dependent on an axis and the constraints in another axis can be found easily. It shows us how the value of a variable depends on the other.

VI. RESULTS

After successfully applying machine learning algorithm we can get the result i.e. the stress level of the user. Here is the accuracy obtained by using different methods of algorithm on the input data set.

TABLE II: ACCURACY OF MACHINE LEARNING ALGORITHMS

Sl. no	Algorithm	Accuracy
1	K Nearest Neighbor’s	99.1
2	Random Forest	97.5
3	Support Vector Machine	96.3
4	Linear Regression	95

Further prediction for obtaining the accurate stress level with respect to the various models is shown in Figure 1 and Figure 2.

Figure 1: KNN Model Prediction

Figure 2: Random Forest Model Prediction

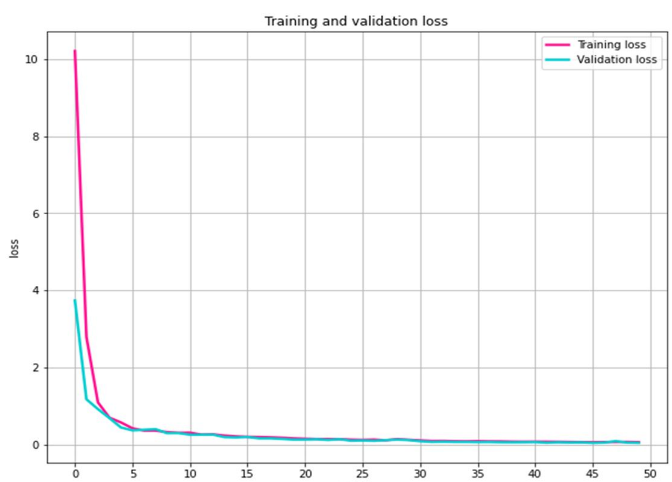

Figure 3: Graph showing the Validation vs Training Accuracy

The predicted outcome is almost the equal to the actual value which can be rounded off to the higher value. The accuracy which we are getting is almost equal to 100%. The data in the excel is given and the predicted output is obtained in the output shown in Figure 3 and Figure 4.
The training loss vs validation loss that we have got it shows that it is a good fit as the training loss are almost the same as validation loss.

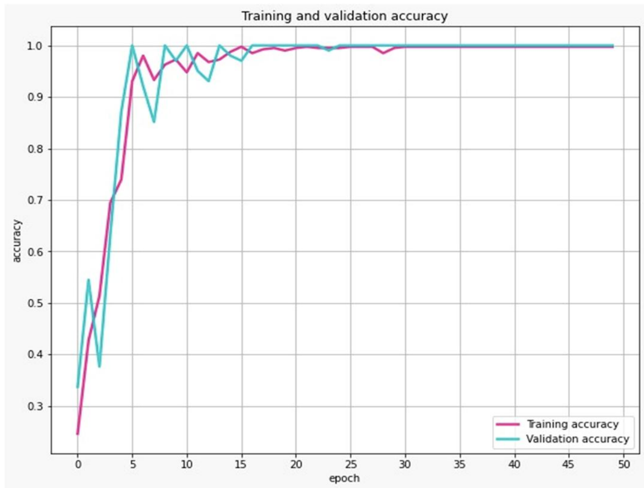

Figure 4: Graph showing the Validation vs Training loss Accuracy

Figure 4, here is a graph that gives how the validation accuracy and testing accuracy varies and both the curves are almost the same at all the points so we can conclude that it is giving a good fit for the data set.

VII. Conclusion

Everyone knows that it is very important for every human being to have enough sleep or rest in order work at their efficient level. Lack of sleep can cause an immense damage to a person's physical as well as mental health. So, it is important for us to have a trace of our sleep cycle to have stress free life routine.
Sleep quality can be considered as one of the main factors to determine human health and well-being. This project helps the user in knowing the importance of quality sleep and how it can effect on the stress level of the person. Overcoming the problem of stress by monitoring his sleeping habits at the right time before it gets out of our hands. Taking precautionary measures to avoid major illness caused due to stress. In this way this project while taking the advantage of modern technology and tools like IoT and IoMT can help us to tackle this modern day's problem giving us the stress management strategy with good visual design.

References

[1] N. Schneiderman, G. Ironson, and S. Siegel, "Stress and Health: Psy- chological, Behavioral, and Biological Determinants." Annu Rev Clin Psychol, vol. 1, p. 607628, 2005.
[2] L. Rachakonda, S. P. Mohanty, and E. Kougianos, "iLog: An intelligent device for automatic food intake monitoring and stress detection in the IoMT," IEEE Trans. Conum. Electron., vol. 2, no. 66, pp. 115–124, May 2020.
[3] R. K. Nath, H. Thapliyal, A. Caban-Holt, and S. P. Mohanty, "Machine Learning based Solutions for Real-Time Stress Monitoring," IEEE Consum. Electron. Mag., pp. 1–1, 2020.
[4] K. S. Han, L. Kim, and I. Shim, "Stress and Sleep Disorder," Exp. Neu., vol. 21, no. 4, pp. 141–150, 2012.
[5] V. C. Magaa and M. Muoz-Organero, "Reducing Stress on Habitual Journeys," in Proc. 5th IEEE Int. Conf. Consum. Electron. - Berlin (ICCE-Berlin), 2015, pp. 153–157.
[6] F. Sannholm, J. Paalasmaa, and L. Leppakorpi, "System for Determining the Quality of Sleep," US Patent 20 160 213 309A1, 2015.
[7] E.-J. Kim and J. E. Dimsdale, "The Effect of Psychosocial Stress on Sleep: A Review of Polysomnographic Evidence," Beh. sleep med., 2007.
[8] H. Scofield, T. Roth, and C. Drake, "Periodic Limb Movements during Sleep: Population Prevalence, Clinical Correlates, and Racial Differences. ," Sleep., vol. 31, no. 9, p. 12211227, 2008.
[9] S. KP, "Overview of obstructive sleep apnea in adults." webpage, Nov. 2015. [Online]. Available: http://www.uptodate.com/home

[10] L. Rachakonda, A. K. Bapatla, S. P. Mohanty, and E. Kougianos, "SaYoPillow: Blockchain-Enabled Privacy-Assured Framework for Stress Detection, Prediction and Control Considering Sleeping Habits in the IoMT," arXiv Computer Science, no. arXiv:2007.07377, July 2020.
[11] Dataset available on the Kaggle for the implementation EDA and Feature analysis | Kaggle https://www.kaggle.com/code/yadhua/eda-and-feature-analysis/notebook