

Documents

Hamza, M.A.^{a b}, Abdalla Hashim, A.H.^a, Alsolai, H.^c, Gaddah, A.^d, Othman, M.^e, Yaseen, I.^b, Rizwanullah, M.^b, Zamani, A.S.^b

Wearables-Assisted Smart Health Monitoring for Sleep Quality Prediction Using Optimal Deep Learning
(2023) *Sustainability (Switzerland)*, 15 (2), art. no. 1084, . Cited 9 times.

DOI: 10.3390/su15021084

^a Department of Electrical and Computer Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia

^b Department of Computer and Self Development, Preparatory Year Deanship, Prince Sattam bin Abdulaziz University, AlKharj, 16278, Saudi Arabia

^c Department of Information Systems, College of Computer and Information Sciences, Princess Nourah bint Abdulrahman University, P.O. Box 84428, Riyadh, 11671, Saudi Arabia

^d Department of Computer Sciences, College of Computing and Information System, Umm Al-Qura University, Makkah, 24211, Saudi Arabia

^e Department of Computer Science, Faculty of Computers and Information Technology, Future University in Egypt, New Cairo, 11835, Egypt

Abstract

Wearable devices such as smartwatches, wristbands, and GPS shoes are commonly employed for fitness and wellness as they enable people to observe their day-to-day health status. These gadgets encompass sensors to accumulate data related to user activities. Clinical act graph devices come under the class of wearables worn on the wrist to compute the sleep parameters by storing sleep movements. Sleep is very important for a healthy lifestyle. Inadequate sleep can obstruct physical, emotional, and mental health, and could result in several illnesses such as insulin resistance, high blood pressure, heart disease, stress, etc. Recently, deep learning (DL) models have been employed for predicting sleep quality depending upon the wearables data from the period of being awake. In this aspect, this study develops a new wearables-assisted smart health monitoring for sleep quality prediction using optimal deep learning (WSHMSQP-ODL) model. The presented WSHMSQP-ODL technique initially enables the wearables to gather sleep-activity-related data. Next, data pre-processing is performed to transform the data into a uniform format. For sleep quality prediction, the WSHMSQP-ODL model uses the deep belief network (DBN) model. To enhance the sleep quality prediction performance of the DBN model, the enhanced seagull optimization (ESGO) algorithm is used for hyperparameter tuning. The experimental results of the WSHMSQP-ODL method are examined under different measures. An extensive comparison study shows the significant performance of the WSHMSQP-ODL model over other models. © 2023 by the authors.

Author Keywords

deep learning; healthcare; Internet of Things; sleep quality prediction; sustainability; wearables

Index Keywords

health monitoring, Internet, machine learning, prediction, sleep, sustainability

References

- Pardamean, B., Budiarto, A., Mahesworo, B., Hidayat, A.A., Sudigyo, D.
(2022) *Sleep Stage Classification for Medical Purposes: Machine Learning Evaluation for Imbalanced Data*,
Research Square, Durham, NC, USA
- Phan, D.V., Chan, C.L., Nguyen, D.K.
Applying Deep Learning for Prediction Sleep Quality from Wearable Data
(2020) *Proceedings of the 4th International Conference on Medical and Health Informatics*, pp. 51-55.
Association for Computing Machinery, New York, NY, USA
- Sadeghi, R., Banerjee, T., Hughes, J.C., Lawhorne, L.W.
Sleep quality prediction in caregivers using physiological signals
(2019) *Comput. Biol. Med.*, 110, pp. 276-288.
31252369

- Shen, Q., Yang, X., Zou, L., Wei, K., Wang, C., Liu, G.
Multi-Task Multi-Attention Residual Shrinkage Convolutional Neural Network for Sleep Apnea Detection Based on Wearable Bracelet Photoplethysmography
(2022) *IEEE Internet Things J*, 9, pp. 25207-25222.
- Ramachandran, A., Karuppiah, A.
A survey on recent advances in machine learning based sleep apnea detection systems
(2021) *Healthcare*, 9, 34356293
- Palotti, J., Mall, R., Aupetit, M., Rueschman, M., Singh, M., Sathyanarayana, A., Taheri, S., Fernandez-Luque, L.
Benchmark on a large cohort for sleep-wake classification with machine learning techniques
(2019) *NPJ Digit. Med*, 2, p. 50. 31304396
- Liang, Z., Chapa-Martell, M.A.
A multi-Level classification approach for sleep stage prediction with processed data derived from consumer wearable activity trackers
(2021) *Front. Digit. Health*, 3, p. 665946. 34713139
- Gashi, S., Alecci, L., Di Lascio, E., Debus, M.E., Gasparini, F., Santini, S.
The Role of Model Personalization for Sleep Stage and Sleep Quality Recognition Using Wearables
(2022) *IEEE Pervasive Comput*, 21, pp. 69-77.
- Sadeghi, R., Banerjee, T., Hughes, J.
Predicting sleep quality in osteoporosis patients using electronic health records and heart rate variability
Proceedings of the 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC), pp. 5571-5574.
Montreal, QC, Canada, 20–24 July 2020
- Bahrami, M., Forouzanfar, M.
Deep Learning Forecasts the Occurrence of Sleep Apnea from Single-Lead ECG
(2022) *Cardiovasc. Eng. Technol*, 13, pp. 809-815. 35301676
- Arora, A., Chakraborty, P., Bhatia, M.P.S.
Analysis of Data from Wearable Sensors for Sleep Quality Estimation and Prediction Using Deep Learning
(2020) *Arab. J. Sci. Eng*, 45, pp. 10793-10812.
- Zhang, Y., Yang, Z., Lan, K., Liu, X., Zhang, Z., Li, P., Cao, D., Pan, J.
Sleep stage classification using bidirectional lstm in wearable multi-sensor systems
Proceedings of the IEEE INFOCOM 2019-IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), pp. 443-448.
Paris, France, 29 April–2 May 2019
- John, A., Cardiff, B., John, D.
A 1D-CNN based deep learning technique for sleep apnea detection in iot sensors
Proceedings of the 2021 IEEE International Symposium on Circuits and Systems (ISCAS), pp. 1-5.
Daegu, Korea, 22–28 May 2021
- Hidayat, W., Tambunan, T.D., Budiawan, R.
Empowering wearable sensor generated data to predict changes in individual's sleep quality

Proceedings of the 2018 6th International Conference on Information and Communication Technology (ICoICT), pp. 447-452.

Bandung, Indonesia, 3–5 May 2018

- Khoa, T.A., Nguyen, D.V., Nguyen Thi, P.V., Zettsu, K.
FedMCRNN: Federated Learning using Multiple Convolutional Recurrent Neural Networks for Sleep Quality Prediction
(2022) *Proceedings of the 3rd ACM Workshop on Intelligent Cross-Data Analysis and Retrieval*, pp. 63-69.
Association for Computing Machinery, New York, NY, USA
- Arora, A., Chakraborty, P., Bhatia, M.P.S.
Intervention of wearables and smartphones in real time monitoring of sleep and behavioral health: An assessment using adaptive neuro-fuzzy technique
(2022) *Arab. J. Sci. Eng.*, 47, pp. 1999-2024.
- Cho, T., Sunarya, U., Yeo, M., Hwang, B., Koo, Y.S., Park, C.
Deep-ACTINet: End-to-end deep learning architecture for automatic sleep-wake detection using wrist actigraphy
(2019) *Electronics*, 8.
- Almanaseer, W., Alshraideh, M., Alkadi, O.
A deep belief network classification approach for automatic diacritization of arabic text
(2021) *Appl. Sci.*, 11.
- Dhiman, G., Kumar, V.
Seagull optimization algorithm: Theory and its applications for large-scale industrial engineering problems
(2019) *Knowl.-Based Syst.*, 165, pp. 169-196.
- Asiri, Y., Halawani, H.T., Alghamdi, H.M., Abdalaha Hamza, S.H., Abdel-Khalek, S., Mansour, R.F.
Enhanced Seagull Optimization with Natural Language Processing Based Hate Speech Detection and Classification
(2022) *Appl. Sci.*, 12.
- Sathyanarayana, A., Joty, S., Fernandez-Luque, L., Ofli, F., Srivastava, J., Elmagarmid, A., Arora, T., Taheri, S.
Sleep quality prediction from wearable data using deep learning
(2016) *JMIR mHealth uHealth*, 4, p. e6562.

Correspondence Address

Hamza M.A.; Department of Electrical and Computer Engineering, Malaysia; email: ma.hamza@psau.edu.sa

Publisher: Multidisciplinary Digital Publishing Institute (MDPI)

ISSN: 20711050

Language of Original Document: English

Abbreviated Source Title: Sustainability

2-s2.0-85152677077

Document Type: Article

Publication Stage: Final

Source: Scopus