

Brief information about the project

Name of the project	Development of an Intelligent System for Sleep Disorder Monitoring and Diagnostics Utilizing Blockchain and IoMT (Internet of Medical Things)
Relevance	This project addresses a critical challenge in modern healthcare: the diagnostic assessment and clinical management of sleep disorders. Currently, sleep disorders are significantly underdiagnosed due to the limitations of traditional approaches, which fail to provide continuous, remote, and objective evaluations of sleep duration, quality, and associated physiological parameters. These parameters include Heart Rate Variability (HRV), peripheral oxygen saturation (SpO2), and electroencephalographic (EEG) activity. The primary objective of this initiative is to design and implement an application leveraging Blockchain, IoT, and Machine Learning (ML) for the collection, processing, and analysis of sleep-related data. By integrating interdisciplinary domains such as medical informatics, big data analytics, and secure multi-party computing, the project aims to deliver personalized interventions for sleep optimization. Furthermore, the project seeks to utilize these frontier technologies to enhance the efficacy and sustainability of digital health interventions, contributing to global public health objectives in sleep diagnostics and therapeutics.
Purpose	The goal of this research is to establish a secure environment for data storage and sharing via Blockchain technology, perform real-time data acquisition through IoMT, and execute advanced data interpretation using ML algorithms. The solutions developed within this platform will provide clinical-grade recommendations to improve sleep hygiene based on the analysis of HRV, SpO2, and EEG metrics. The expected outcome is a comprehensive system for real-time monitoring, diagnostics, and health management that will facilitate the global decoding and treatment of sleep pathologies.
Objectives	Objective 1: To develop an integrated health monitoring platform that utilizes sensor fusion to detect and analyze key physiological indicators, including Heart Rate, SpO2, HRV, and EEG. Objective 2: To design Graph Attention Networks (GAT) and Denoising Diffusion Probabilistic Models (DDPMs) to investigate complex correlations between multi-modal physiological signals. Objective 3: To architect a Blockchain-based framework to ensure decentralized, secure, and immutable storage of longitudinal sleep data. Objective 4: To develop predictive models based on Temporal Graph Networks (TGNs) and Neural Ordinary Differential Equations (Neural ODEs) for forecasting sleep disorder onset and generating personalized clinical recommendations. Objective 5: To engineer a high-precision diagnostic instrument utilizing Capsule Networks and HyperNetworks. Objective 6: To implement an interactive platform providing users with personalized health management strategies and real-time actionable insights to improve sleep quality.
Expected and achieved results	– Successful deployment of a comprehensive IoT sensor array for the continuous, real-time acquisition of sleep metrics (HRV, SpO2, and EEG). – Implementation of GAT to model longitudinal physiological signals by capturing both local and global dependencies. Deployment of DDPMs for signal reconstruction and denoising to enhance the precision of correlation studies. – A robust Blockchain system that ensures data provenance, transparency, and resistance to unauthorized tampering, thereby upholding stringent patient confidentiality standards.

	– Development of forecasting models using TGNs and Neural ODEs capable of triggering timely therapeutic interventions and mitigating the long-term adverse effects of sleep deprivation. – A specialized diagnostic tool powered by Capsule Networks and HyperNetworks for the automated detection of sleep-related pathologies with high sensitivity and specificity. – An interactive interface that translates real-time data analysis into personalized health interventions.
Research team members with their identifiers (Scopus Author ID, Researcher ID, ORCID, if available) and links to relevant profiles	1. Imanbek Baglan Talgatkyzy, Scopus Author ID: 56664379200, https://www.scopus.com/authid/detail.uri?authorId=56664379200. Researcher ID: JNT-6011-2023, https://www.webofscience.com/wos/author/record/JNT-6011-2023. ORCID: https://orcid.org/0000-0001-7249-380X 2. Baigaraeva Zhanel Ermashkyzy, Scopus Author ID: 57848704300, https://www.scopus.com/authid/detail.uri?authorId=57848704300. Researcher ID: LTA-1193-2024, https://www.webofscience.com/wos/author/record/LTA-1193-2024. ORCID: https://orcid.org/0000-0003-1919-3570 3. Boltaboeva Asiya Kublandy kyzi, Scopus Author ID: 59337046400, https://www.scopus.com/authid/detail.uri?authorId=59337046400. Researcher ID: LSU-7759-2024, https://www.webofscience.com/wos/author/record/LSU-7759-2024. ORCID: https://orcid.org/0000-0002-7279-9910. ORCID: https://orcid.org/0009-0005-3612-5678. 4. Amangeldy Bibars Sapargaliuly, Scopus Author ID: 57239012100, https://www.scopus.com/authid/detail.uri?authorId=57239012100&origin=AuthorProfile Researcher ID: IWE-2434-2023, https://www.webofscience.com/wos/author/record/47102006 https://orcid.org/0000-0002-4089-6337 5. Tasmurzaev Nurdaulet Musakhanuly, Scopus Author ID: 57238311800, https://www.scopus.com/authid/detail.uri?authorId=57238311800 ResearcherID: KHW-3566-2024 https://www.webofscience.com/wos/author/record/56358474 6. Zholdybaeva Zhanel Kairatkyzy, ORCID: https://orcid.org/0009-0004-8388-6747 7. Turmakhan Maksat Serikuly 8. Turmakhan Sandugash Serikkyzy, ORCID: https://orcid.org/0009-0007-8211-5723 9. Zhadraeva Akmaral Erezhepovna 10. Amangeldi Inzhu Sapargalykzy, Scopus Author ID: 59407808800, https://www.scopus.com/authid/detail.uri?authorId=59407808800&origin=recordpage. ORCID: https://orcid.org/0009-0003-7129-2936.

	11. Sharipova Symbat Seytkhasymkyzy, Scopus Author ID: 59407828400, https://www.scopus.com/authid/detail.uri?authorId=59407828400&origin=recordpage. 12. Kenesbay Alnur Erikuly 13. Baltabaeva Marina Kubladi kyzi 14. Aliya Gemal Getahun, Scopus Author ID: 59961109300 https://www.scopus.com/authid/detail.uri?authorId=59961109300&origin=AuthorProfile ORCID: https://orcid.org/0009-0002-2141-925X 15. Mohebi Mirwais, ORCID: https://orcid.org/0009-0009-3216-8709
Usage	The system is designed for the precise diagnostics and longitudinal monitoring of sleep pathologies, including obstructive sleep apnea (OSA), insomnia, and other sleep-related disorders. It enables clinicians to access real-time patient data, significantly reducing the time-to-treatment. Optimized for home-based use via wearable devices, the platform facilitates continuous observation without the need for clinical hospitalization, thereby improving patient comfort and reducing healthcare costs. The system can be seamlessly integrated into digital health platforms for remote consultations, utilizing cloud services for secure data transmission between patients and healthcare providers. The platform serves as a robust tool for aggregating large-scale physiological datasets, essential for training high-fidelity machine learning models and conducting advanced clinical trials in Sleep Medicine and IoMT. The technology is scalable for integration into smart wearables, fitness trackers, and mobile applications, promoting sleep hygiene and the primary prevention of sleep-associated chronic conditions.
Priority compared to real-world alternatives	The project focuses on the engineering of an intelligent, real-time sleep monitoring system utilizing IoMT (Internet of Medical Things) devices equipped with HRV, SpO2, and EEG sensors. The architecture ensures high-frequency data acquisition, seamless transmission, and automated physiological analysis for the early detection of sleep disturbances. To enhance diagnostic precision, the system employs hybrid deep learning architectures, specifically: Graph Attention Networks (GAT) and Temporal Graph Networks (TGN) for modeling complex spatiotemporal dependencies in physiological signals. Denoising Diffusion Probabilistic Models (DDPMs) for signal purification and artifact removal. Furthermore, the system generates personalized therapeutic recommendations to optimize sleep quality. The integration of Blockchain technology and Edge Computing ensures data decentralization, robust cybersecurity, and compliance with medical privacy standards, providing a secure and immutable framework for sensitive health information.
List of publications with links to them	1. Tasmurzayev, N.; Amangeldy, B.; Baigarayeva, Z.; Boltaboyeva, A.; Imanbek, B.; Maeda-Nishino, N.; Zhussupbekov, S.; Baidaletova, A. Enhancing Cardiovascular Disease Classification with Routine Blood Tests Using an Explainable AI Approach. Algorithms 2025, 18, 708. https://doi.org/10.3390/a18110708 (Q1, percentile 78%) 2. Tasmurzayev, N.; Amangeldy, B.; Imankulov, T.; Imanbek, B.; Postolache, O.A.; Konysbekova, A. A Wearable IoT-Based Measurement System for Real-Time Cardiovascular Risk Prediction Using Heart Rate Variability. Eng 2025, 6(10), 259. https://doi.org/10.3390/eng6100259 (Q2, percentile 58%)

	3. Tasmurzayev, N.; Amangeldy, B.; Imanbek, B.; Baigarayeva, Z.; Imankulov, T.; Dikhanbayeva, G.; Amangeldi, I.; Sharipova, S. Digital Cardiovascular Twins, AI Agents, and Sensor Data: A Narrative Review from System Architecture to Proactive Heart Health. <i>Sensors</i> 2025, 25(17), 5272. https://doi.org/10.3390/s25175272 (Q1, percentile 88%)
Patents	For utility model No. 11377 dated November 7, 2025. System for monitoring sleep and physiological indicators. Authors: Baygaraeva Z. E., Boltaboeva A. K., Imanbek B. T., Ibrasheva Z. S., Maulenbekov M. A., Zhusupbekov S. S., Saresenbaev N. S., Karymsakova N. T., Kurmanbek Sh.Θ., Bekturganova A. B., Tergeusizova A. S.