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Design and Implementation of a Real-Time Cardiac and Oxygen Saturation Monitoring System

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ABSTRACT: Monitoring vital health parameters continuously is essential for early diagnosis and preventive care. This document presents a redesigned and original explanation of a system that measures heart rate and blood oxygen saturation (SpO_2) in real time using an embedded platform. The system employs non-invasive optical sensing methods to capture physiological signals, which are processed using a microcontroller and transmitted wirelessly to external devices.

The proposed solution emphasizes affordability, portability, and low power consumption. It enables users and healthcare providers to track vital parameters remotely and continuously. The system demonstrates stable performance and responsiveness, making it suitable for everyday health monitoring and early detection of abnormalities.

KEYWORDS: Real-time monitoring, cardiac monitoring, oxygen saturation, pulse oximetry, biomedical sensors, IoT healthcare, wearable devices, signal processing, patient monitoring system, health diagnostics

I. INTRODUCTION

In modern healthcare, continuous monitoring of vital signs has become increasingly important. Heart rate and oxygen saturation are two critical indicators that reflect the functioning of the cardiovascular and respiratory systems. Conventional monitoring methods often rely on clinical equipment or manual measurement, which limits their usability for continuous observation.

Advancements in embedded systems and wireless communication technologies have enabled the development of compact and intelligent health monitoring devices. This project introduces a system that integrates sensors, processing units, and communication modules into a single portable device. The system collects data in real time and transmits it wirelessly, allowing remote monitoring and analysis.

The design focuses on ease of use, portability, and efficiency, making it suitable for daily health tracking and preventive care.

II. OBJECTIVES

The primary aim of this work is to develop a reliable system for real-time monitoring of heart rate and oxygen saturation. The objectives are:

- To design a compact and user-friendly monitoring device
- To implement non-invasive sensing techniques
- To process physiological data in real time
- To enable wireless transmission of data
- To reduce power consumption for longer operation
- To provide an affordable healthcare solution

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III. LITERATURE REVIEW

Recent research in healthcare technology highlights the growing importance of IoT-based monitoring systems. Many studies have explored wearable devices capable of measuring heart rate and SpO_2 using optical sensors.

Some systems focus on integrating microcontrollers with wireless communication to transmit data to mobile applications. Others emphasize cloud-based solutions for storing and analyzing patient data remotely. These approaches improve accessibility and allow continuous monitoring outside hospital environments.

Several works also demonstrate that low-cost microcontroller-based systems can provide acceptable accuracy and reliability. These developments confirm that compact and affordable monitoring devices can play a significant role in modern healthcare.

IV. PROBLEM STATEMENT

Traditional health monitoring methods are often limited by their inability to provide continuous data. Manual devices require user interaction and do not support long-term tracking. Hospital-based systems, while accurate, are expensive and not suitable for home use.

Many wearable devices lack sufficient accuracy or real-time connectivity. Delayed identification of abnormal heart rate or oxygen levels can result in serious health complications. Therefore, there is a need for a system that is portable, cost-effective, accurate, and capable of continuous monitoring with wireless data transmission.

V. EXISTING SYSTEM

Existing systems include pulse oximeters, fitness bands, and hospital monitoring equipment. Pulse oximeters provide readings only when used manually. Fitness trackers are portable but may not meet medical accuracy standards.Hospital-grade equipment offers high precision but is expensive and not suitable for personal use. Many systems also consume significant power and lack efficient wireless connectivity. These drawbacks highlight the need for an improved solution.

VI. PROPOSED SYSTEM

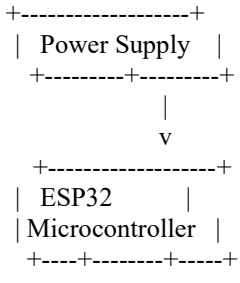
The proposed system integrates sensing, processing, and communication into a compact device. Optical sensors are used to measure heart rate and oxygen saturation without causing discomfort.

A microcontroller processes the collected signals and ensures accurate output. The processed data is displayed locally and transmitted wirelessly to mobile or web platforms. This allows real-time monitoring by users and healthcare professionals.

The system is designed to be energy-efficient, portable, and reliable. It supports continuous monitoring and helps in early detection of health issues.

VII. BLOCK DIAGRAM

The overall working of the system can be represented using the following block diagram:



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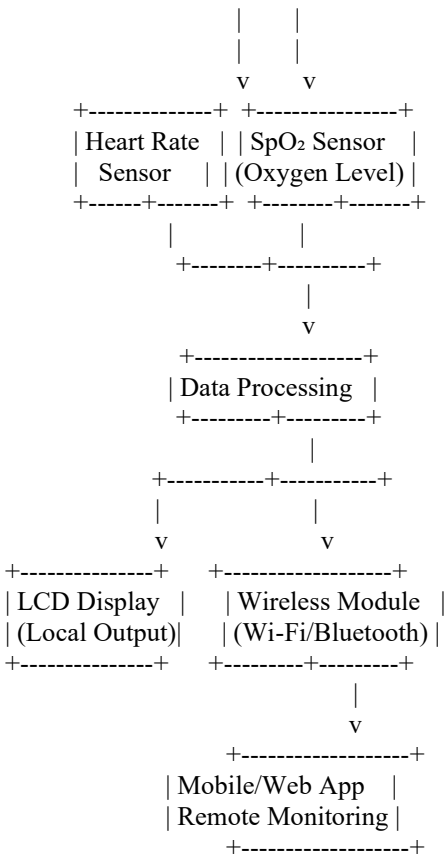

VIII. HARDWARE COMPONENTS

Power Supply Unit
The power supply unit delivers stable voltage to all components. It includes regulators and filters to ensure safe and efficient operation. The design is optimized for portability and energy efficiency.

Microcontroller
The microcontroller acts as the brain of the system. It collects sensor data, processes signals, and manages communication between components. It supports multiple interfaces for easy integration.

Heart Rate Sensor
This sensor detects pulse rate using optical methods. It measures variations in blood flow and converts them into electrical signals for processing. SpO_2 Sensor
The SpO_2 sensor measures oxygen levels in the blood by analyzing light absorption. It provides essential data for respiratory monitoring.

Display Module
The display unit shows real-time readings, allowing users to instantly view their health status.

Wireless Communication Module
This module enables data transmission to smartphones or web applications. It supports remote monitoring and data analysis.

IX. SOFTWARE REQUIREMENTS

The system is developed using embedded programming tools. The software handles data acquisition, signal processing, and wireless communication. Simulation tools can be used to verify system performance before implementation.

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Future improvements may include:

- Integration with cloud platforms
- Advanced data analytics
- Improved sensor accuracy
- Mobile application development
- AI-based health prediction

X. CONCLUSION

The system provides an efficient and practical solution for monitoring heart rate and oxygen saturation in real time. It combines embedded technology with wireless communication to deliver a user-friendly healthcare device.

The design is affordable, portable, and suitable for daily use. It enables early detection of abnormalities and supports preventive healthcare. Future enhancements may include improved accuracy, cloud integration, and advanced analytics.

REFERENCES

1. Research studies on IoT-based health monitoring systems
2. Publications on optical sensing techniques
3. Embedded system design manuals
4. Journals on wireless healthcare technologies
5. Technical resources on microcontroller applications
6. Level," *Proceedings of the International Conference on Information Technology, Advanced Mechanical and Electrical Engineering (ICITAMEE)*, 2020.
7. R. K. Parate, K. M. Dhole, and S. J. Sharma, "Design of a NodeMCU-Based Web Server for Heart Rate and SpO_2 Monitoring," *International Journal of Engineering Research & Technology (IJERT)*, vol. 12, no. 01, 2023.
8. M. I. Putra, L. H. Pramono, and A. K. Saputro, "Design and Evaluation of an IoT-Enabled ESP32 Photoplethysmography Monitor for Heart Rate and SpO_2," *Journal of Electrical Engineering and Computer Systems*, 2025.
9. Khushi Singh, Pradheep Thiyagarajan, and Sasikumar P, "Design and Implementation of IoT Enabled Low-Cost SpO_2 and Heart Rate Monitoring System," *IEEE Delhi Section Conference (DELCON)*, 2022.
10. A. T. Ayance, H. S. Ramirez, J. M. R. Perez, and C. G. T. Palacios, "Low-Cost Microcontroller-Based Wireless Heart Rate and Oxygen Saturation Monitor," *International Conference on Electronics, Communications and Computers*, IEEE, 2022.
11. ESP32 Technical Reference Manual, Espressif Systems.
12. Arduino IDE Documentation, Arduino Official Website.
13. C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor &Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011. DOI: 10.1080/15325008.2010.541746
14. C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of Electrical Engineering, Vol.63 (6), pp.365-372, Dec.2012. DOI: 10.2478/v10187-012-0054-2
15. C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011. DOI 10.1007/s00202-011-0203-9
16. S.Tamilselvi, R.Prakash, C.Nagarajan,"Solar System Integrated Smart Grid Utilizing Hybrid Coot-Genetic Algorithm Optimized ANN Controller" Iranian Journal Of Science And Technology-Transactions Of Electrical Engineering, DOI10.1007/s40998-025-00917-z,2025
17. S.Tamilselvi, R.Prakash, C.Nagarajan," Adaptive sliding mode control of multilevel grid-connected inverters using reinforcement learning for enhanced LVRT performance" Electric Power Systems Research 253 (2026) 112428, doi.org/10.1016/j.epsr.2025.112428
18. S.Thirunavukkarasu, C. Nagarajan, 2024, "Performance Investigation on OCF and SCF study in BLDC machine using FTANN Controller," Journal of Electrical Engineering And Technology, Volume 20, pages 2675–2688, (2025), doi.org/10.1007/s42835-024-02126-w

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19. C. Nagarajan, M.Madheswaran and D.Ramasubramanian- 'Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model'- *Acta Electrotechnica et Informatica Journal* , Vol.13 (2), pp.18-31,April-June.2013, DOI: 10.2478/aeei-2013-0025.
20. C.Nagarajan and M.Madheswaran - 'DSP Based Fuzzy Controller for Series Parallel Resonant converter'- *Springer, Frontiers of Electrical and Electronic Engineering*, Vol. 7(4), pp. 438-446, Dec.12. DOI 10.1007/s11460-012-0212-0.
21. C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- *Iranian Journal of Electrical & Electronic Engineering*, Vol.8 (3), pp.259-267, September 2012.
22. C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007
23. Suganthi Mullainathan, Ramesh Natarajan, "An SPSS and CNN modelling based quality assessment using ceramic materials and membrane filtration techniques", Revista Materia (Rio J.) Vol. 30, 2025, DOI: https://doi.org/10.1590/1517-7076-RMAT-2024-0721
24. M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", Journal of Environmental Protection and Ecology, Volume 23, Issue 2, pp: 520-530,2022
25. Photoplethysmography Principles and Applications in Healthcare Monitoring – Various Research Journals.Embedded Systems Design: A Unified Hardware/Software Introduction by Frank Vahid and Tony Givargis.Wireless Sensor Networks and IoT in Healthcare – Recent Survey Papers.
26. **Kiran, A., Rubini, P., & Kumar, S. S. (2025).** Comprehensive review of privacy, utility and fairness offered by synthetic data. *IEEE Access.*
27. **Gopinathan, V. R. (2024).** Real-Time Financial Risk Intelligence Using Secure-by-Design AI in SAP-Enabled Cloud Digital Banking. *International Journal of Computer Technology and Electronics Communication, 7(6), 9837-9845.*
28. **Udayakumar, R., Elankavi, R., Vimal, R., & Sugumar, R. (2023).** Improved Particle Swarm Optimization with Deep Learning-Based Municipal Solid Waste Management in Smart Cities. *Environmental & Social Management Journal, 17(4).*
29. **Anand, L. (2023).** An Intelligent AI and ML–Driven Cloud Security Framework for Financial Workflows and Wastewater Analytics. *International Journal of Humanities and Information Technology, 5(02), 87-94.*
30. **Soundappan, S. J. (2020).** Big Data Analytics in Healthcare: Applications for Pandemic Forecasting. *International Journal of Advanced Research in Computer Science & Technology, 3(1), 2248-2253.*
31. **Rajasekar, M. (2024).** Real-Time Predictive DevOps Intelligence for Risk-Aware Digital Business Processes in Cloud and SAP Ecosystems. *International Journal of Advanced Research in Computer Science & Technology, 7(4), 10713-10718.*
32. **Poornima, G., & Anand, L. (2024, May). Novel AI Multimodal Approach for Combating Against Pulmonary Carcinoma. In 2024 5th International Conference for Emerging Technology (INCET) (pp. 1-6). IEEE.**
33. **Prabha, P. S., & Rengarajan, A. (2025).** Adaptive Cloud Resource Allocation Using Attention-Driven Deep Reinforcement Learning. *Engineering, Technology & Applied Science Research, 15(6), 29334-29340.*
34. **Jagadeesh, S., & Sugumar, R. (2017).** A Comparative study on Artificial Bee Colony with modified ABC algorithm. *European Journal of Applied Sciences, 9(5), 243-248.*
35. **Varma, K. K., & Anand, L. (2025, March). Deep Learning Driven Proactive Auto Scaler for High-Quality Cloud Services. In International Conference on Computing and Communication Systems for Industrial Applications (pp. 329-338). Singapore: Springer Nature Singapore.**
36. **Kumar, S. A., & Anand, L. (2025). A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS, 19(11), 3841-3855.**
37. **Poornima, G., & Anand, L. (2025). Medical image fusion model using CT and MRI images based on dual scale weighted fusion based residual attention network with encoder-decoder architecture. Biomedical Signal Processing and Control, 108, 107932.**
38. **Archana, R., & Anand, L. (2025). Residual u-net with Self-Attention based deep convolutional adaptive capsule network for liver cancer segmentation and classification. Biomedical Signal Processing and Control, 105, 107665.Kumar, S. A., & Anand, L. (2025).** A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. *KSII Transactions on Internet and Information Systems, 19(11), 3841-3855.*

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39. **Rengarajan, A. (2025).** Cloud-Based AI-Driven Threat Detection Framework for Smart Grid Cybersecurity. *International Journal of Future Innovative Science and Technology, 8(6), 16065.*
40. **Murugeshwari, B., Sudharson, K., Panimalar, S. P., Shanmugapriya, M., & Abinaya, M. (2020).** SAFE–Secure Authentication in Federated Environment using CEG Key code.
41. **Raj A. A., & Sugumar, R. (2023).** Early Detection of COVID-19 with Impact on Cardiovascular Complications using CNN Utilising Pre-Processed Chest X-Ray Images. *2023 International Conference on Applied Intelligence and Sustainable Computing (ICAISC), IEEE.*
42. **Jagadeesh, S., & Sugumar, R. (2017). A Comparative study on Artificial Bee Colony with modified ABC algorithm. European Journal of Applied Sciences, 9(5), 243-248.**
43. **Selvi, G. V., Anbarasan, A. B., Murthy, B. A., & Prabavathy, S. (2023).** An Application Oriented Integrated Unequal Clustering Algorithm for Wireless Sensor Network. In *Underwater Vehicle Control and Communication Systems Based on Machine Learning Techniques* (pp. 140-154). CRC Press.
44. **Sruthi, R. S., Ananya, S., & Murugeshwari, B. (2010).** Web Based Virtual Control System Laboratory and On-Line Temperature Control of Electrophoresis Equipment using LabVIEW. *International Journal of Computer Applications, 975, 8887.*
45. **Vimal Raja, G. (2021).** Mining Customer Sentiments from Financial Feedback and Reviews using Data Mining Algorithms. *International Journal of Innovative Research in Computer and Communication Engineering, 9(12), 14705-14710.*
46. MATHEW, A. R. (2025). Neurosecurity and Brain-Computer Interfaces.
47. Soundappan, S. J. (2024). AI-Driven Customer Intelligence in Enterprise Lakehouse Systems Sentiment Mining Governance-Aware Analytics and Real-Time Data Synchronization. International Journal of Advanced Engineering Science and Information Technology (IJAESIT), 7(5), 14905.
48. Mathew, A. (2025). Human–AI Collaboration in Security Operations: Measuring Alert Trust, Automation Bias, and Analyst Upskilling in AI-Augmented SOC Environments. International Journal of Computer Technology and Electronics Communication, 8(5), 11375-11380.
49. Soundappan, S. J. (2022). AI-Based Fault Detection and Isolation for Reliability in Modern Power Systems. International Journal of Research Publications in Engineering, Technology and Management (IJRPETM), 5(4), 7106-7110.
50. **Poornima, G., & Anand, L. (2024, April). Effective Machine Learning Methods for the Detection of Pulmonary Carcinoma. In 2024 Ninth International Conference on Science Technology Engineering and Mathematics (ICONSTEM) (pp. 1-7). IEEE.Garg, V. K., Soundappan, S. J., & Kaur, E. M. (2020).** Enhancement in intrusion detection system for WLAN using genetic algorithms. *South Asian Research Journal of Engineering and Technology, 2(6), 62–64.*
51. Rengarajan, A., Jayakumar, C., & Sugumar, R. (2012). Optimization Of Recent Attacks Using Internet Protocol. National Journal of System and Information Technology, 5(1), 8.
52. Mathew, A. (2024). AI TRiSM: Trust, Risk, and Security Management in Cybersecurity. Cybersecurity, 4(3), 84-90.
53. Mathew, A. (2025). Deep seek vs. ChatGPT: A deep dive into AI Language mastery. Int J Multidisciplinary Res, 7(1), 1-5.