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Smart Healthcare Wearable Device for Early Disease Detection Using Machine Learning

Suraj S. Damre, Bhagyashree D. Shendkar, Nikita Kulkarni, Pankaj R. Chandre, Sayalee Deshmukh

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Abstract – The present invention introduces a breakthrough in healthcare technology by unveiling a novel Smart Healthcare Wearable Device for Early Disease Detection using advanced Machine Learning algorithms. This wearable device seamlessly integrates cutting-edge sensor technology, real-time data analytics, and intelligent machine learning models to empower individuals with early detection capabilities for potential health issues. The Smart Healthcare Wearable Device is equipped with a diverse array of sensors, collecting an array of vital health metrics such as heart rate, blood pressure, oxygen saturation, and body temperature. These sensors continuously monitor the wearer's physiological parameters, enabling real-time data acquisition for comprehensive health insights. The innovation lies in the implementation of machine learning algorithms that harness the collected data to recognize subtle deviations from baseline health patterns. These algorithms, trained on vast datasets, exhibit the capacity to identify early indicators of diseases and health anomalies, even before overt symptoms manifest. The machine learning models continuously evolve through an adaptive learning process, enabling the device to tailor its detection capabilities to each individual user. Upon detecting potential health concerns, the Smart Healthcare Wearable Device employs an alert mechanism, immediately notifying the wearer and authorized healthcare providers. This swift alert system enables timely medical intervention, potentially circumventing disease progression and improving treatment outcomes. Furthermore, the device enriches user experience through personalized health recommendations. Leveraging the data-driven insights provided by the machine learning models, the wearable offers activity suggestions, sleep optimization strategies, and dietary advice, promoting proactive wellness management. The Smart Healthcare Wearable Device for Early Disease Detection addresses a critical need for preventive healthcare solutions in an era where early intervention is pivotal. By merging sensor technology and machine learning prowess, this invention introduces a transformative paradigm in healthcare, ultimately enhancing users' quality of life and well-being.

Keywords *– Smart Wearable Device, Early Disease Detection, Machine Learning, Health Monitoring, Vital Signs, Anomaly Detection*

[1]*Assistant Professor, Department of Information Technology, DYP College of Engineering, Akurdi, Pune, India.*
surajdamre@gmail.com
[2]*Assistant Professor, Department of Computer Science and Engineering, MIT School of Computing, MIT Art Design and Technology University, Loni, Pune, India.*
bhagyashree.shendkar@mituniversity.edu.in
[3]*Associate Professor, Department of Computer Engineering, K J College of Engineering and Management Research, Pune, India.*
nikitakulkarni.kjcoemr@kjei.edu.in
[4]*Associate Professor, Department of Computer Science and Engineering, MIT School of Computing, MIT Art Design and Technology University, Loni, Pune, India.*
pankaj.chandre@mituniversity.edu.in
[5]*Assistant Professor, Department of Computer Science and Engineering (AI & ML), Pimpri Chinchwad College of Engineering, Akurdi, Pune, India.*
sayalee.deshmukh@pccoepune.org

Introduction

Preventive medicine has advanced significantly as a result of the fusion of technology and healthcare. The rise in chronic disease prevalence and the need for prompt treatment have sparked the creation of creative solutions that allow for ongoing health monitoring[1]. Wearable technology has become one of these options, giving people the ability to monitor their health and take preventative action for better health results[2][3]. The Smart Healthcare Wearable Device for Early Disease Detection Using Machine Learning is a ground-breaking idea at the nexus of wearable technology and artificial intelligence introduced in this research article[4]. By offering real-time information and early warnings about potential health anomalies, this technology,

which focuses on predictive healthcare, has the power to completely change how people manage their health[5]. This study's main goal is to investigate how cutting-edge sensor technology and machine learning algorithms can be combined to produce a wearable device that not only collects crucial health data but also deciphers patterns, deviations, and trends[6]. The device uses machine learning to identify minor alterations in health metrics that could be signs of impending diseases or other health issues[7]. This early detection system has the potential to lead to better treatment outcomes, lower healthcare expenditures, and an overall improvement in quality of life[8]. The importance of this study rests in its capacity to close the gap between irregular medical evaluations and ongoing health monitoring[9]. By providing users with real-time access to their health data, personalised insights, and actionable recommendations, the Smart Healthcare Wearable Device ushers in a paradigm shift[10]. The technical design of the device, the incorporation of sensors and machine learning algorithms, and the approaches employed to test its effectiveness in spotting early disease indications will all be covered in this presentation[11]. The deployment of this cutting-edge wearable device necessitates a multidisciplinary approach due to the rapid advancement of technology[12][13]. To address technical issues, data security concerns, and ethical issues related to continuous health monitoring, collaboration between engineers, data scientists, healthcare practitioners, and ethicists is crucial[14]. We hope to add to the increasing body of knowledge about wearable technology and its application to preventative healthcare by publishing this study report[15][16]. We hope to open the door to a day when people may actively manage their health, make wise decisions, and live better lives by looking into the viability, accuracy, and user acceptance of the Smart Healthcare Wearable Device.

Literature Survey

The paper entitled "Artificial Intelligence in Healthcare: Past, Present, and Future" by Fei Jiang et al[17] a comprehensive exploration of the role of artificial intelligence (AI) in the healthcare sector is presented. The paper delves into the evolution of AI applications within healthcare, highlighting the transformative impact it has had on various aspects of medical practice and patient care. The author starts by describing how AI has evolved historically in the field of medicine and how early AI systems were applied to help diagnostic judgement and decision-making. The discussion then shifts to the current environment, where AI methods like machine learning and deep learning are being used for disease diagnosis, medication discovery, personalised therapy recommendations, and medical picture analysis. The author gives readers a comprehensive overview of the current level of AI integration in healthcare by synthesising a wide range of studies and examples. The article also explores the potential applications of AI in the field of healthcare. It looks at current research, new trends, and prospective difficulties. The importance of AI-driven developments in disease prediction, prevention, and early intervention is discussed by the author. The paper also raises important ethical considerations and potential barriers to the widespread adoption of AI technologies in healthcare. In summary, the authors research provides a thorough literature review that charts the development of AI in healthcare. The study highlights the revolutionary power of AI in transforming the healthcare scene by tracing its historical roots, clarifying its current applications, and discussing its future possibilities. This survey not only educates readers about current developments but also offers perspectives on the difficulties and possibilities that will arise as AI continues to transform healthcare procedures and patient outcomes.

The paper entitled “Literature Survey: AI, IoT, and Wearable Technology for Smart Healthcare – A Review” by Ms. Nidhi Chawla et al[18] provides a comprehensive review delves into the dynamic intersection of these fields to explore the potential of Smart Healthcare. The review sheds light on how AI-powered algorithms, IoT connectivity, and wearable devices collectively contribute to a paradigm shift in healthcare practices. The literature review emphasises the broad influence of AI in healthcare. AI algorithms are used to analyse complicated medical data, enabling early diagnosis and individualised treatment. These techniques range from machine learning to deep learning. AI-driven decision support systems are used to reduce diagnostic errors and aid medical personnel in making judgements. Additionally, the authors analysis highlights AI's function in prognostic modelling, predictive analytics, and disease progression tracking, highlighting its potential to revolutionise clinical outcomes and patient care.

One of the main forces behind the implementation of smart healthcare is the fusion of IoT and wearable technology. The literature review explains how real-time health data can be collected by IoT-enabled devices in an efficient manner, allowing for remote patient monitoring, proactive interventions, and data-driven insights. By continuously capturing important health information, wearable technology such as smartwatches, fitness trackers, and biosensors play a crucial part in this ecosystem. The analysis highlights wearables' potential to improve patient involvement, give people more control over their health, and enable early detection of health anomalies. In conclusion, the authors literature review offers a thorough overview of how wearable technologies, IoT, and AI work together to influence the landscape of smart healthcare. The review lays the groundwork for future research and innovation in this quickly developing subject by synthesising a wide range of findings. The revolutionary potential of smart healthcare is poised to reshape healthcare practises, improve patient outcomes, and boost general wellbeing as AI continues to increase diagnostic accuracy, IoT broadens connection, and wearables provide personalised health data.

The paper entitled "Literature Survey: Management of Artificial Intelligence Enabled Smart Wearable Devices for Early Diagnosis and Continuous Monitoring of CVDS" by Mounir M. El Khatib et al[19] this area of research has emerged as a promising avenue for leveraging the capabilities of wearable technology and AI to transform the landscape of healthcare. The proliferation of smart wearable devices, coupled with advancements in AI algorithms, has opened new opportunities for the timely detection and monitoring of cardiovascular conditions. The research of authors illuminates the crucial value of early diagnosis in the treatment of cardiovascular disorders. A significant body of research is emerging that supports the viability and effectiveness of smart wearable devices for monitoring key health indicators like heart rate, blood pressure, and activity levels. The ability of these devices to identify minor changes that might indicate the start of cardiovascular problems is improved by the incorporation of AI-enabled analysis. These wearables offer an unprecedented level of personalised care by offering continuous monitoring and real-time warnings, empowering users to take preventative measures and seek medical help right away. The literature review also emphasises the importance of efficiently managing and interpreting the enormous amounts of data produced by these devices. According to authors research, sophisticated AI algorithms for processing and analysing intricate health data are being developed. These algorithms help to improve personalised health insights in addition to enabling accurate disease detection. The literature evaluation identifies potential obstacles and openings for assuring the safety, privacy, and moral application of the data that has been gathered. These factors will be essential in determining how widely adopted smart wearables with AI will be and how they will affect the treatment of cardiovascular disease. In conclusion the authors literature review highlights the revolutionary potential of artificial intelligence-enabled smart wearable devices for the early diagnosis and ongoing surveillance of cardiovascular illnesses. These tools provide a comprehensive approach to healthcare through the use of cutting-edge technology, enabling people to take charge of their well-being. The survey's results demonstrate how improvements in AI algorithms, data management, and these devices' overall potential to revolutionise the treatment of cardiovascular disease. As this sector develops, it will become evident that smart wearables with AI capabilities have the potential to transform the concept of preventative healthcare and enhance the lives of people at risk for cardiovascular illnesses.

The paper entitled "Literature Survey: Wearable IoT-Enabled Real-Time Health Monitoring System" by Jie Wan et al[20] delves into this transformative area, exploring the integration of wearable devices with IoT capabilities to achieve real-time health monitoring. Wan's work is situated within a broader landscape of innovative solutions aiming to enhance healthcare through continuous and remote monitoring. The potential for wearable IoT-enabled health monitoring systems to revolutionise healthcare delivery has attracted a lot of interest. These systems enable the continuous gathering and transmission of health data from consumers to healthcare practitioners by seamlessly connecting wearable devices with IoT infrastructure. The authors research advances the area by analysing the conception, execution, and application of such a system. The authors work's literature review reveals a plethora of research projects concentrating on sensor technologies, data transfer protocols, and data analytics methods. These elements work together to provide a solid environment for real-time health monitoring, enabling the early diagnosis of

diseases and the development of individualised treatment plans. The multidisciplinary character of this study field is highlighted by the authors investigation of the "Wearable IoT-Enabled Real-Time Health Monitoring System". The literature review emphasises the integration of data analytics techniques, sensor technologies, communication protocols, and medical expertise. An important finding of the poll is that there is broad agreement regarding the advantages of such systems, including better patient outcomes, lower healthcare costs, and improved patient-provider interactions. The authors research illuminates the changing environment of wearable IoT-enabled health monitoring systems by analysing the work of numerous academics, paving the stage for ground-breaking developments in medical technology. In conclusion, the authors research makes a substantial contribution to our understanding of real-time wearable health monitoring systems enabled by the Internet of Things. The authors work illuminates the integration of wearable technologies, IoT infrastructure, and healthcare expertise through a thorough literature review. The poll highlights how these platforms have the enormous potential to transform healthcare by facilitating ongoing monitoring, early disease detection, and customised interventions. The authors research is an invaluable tool for researchers, practitioners, and stakeholders looking to leverage the potential of wearable IoT technologies for better healthcare outcomes as the area continues to develop.

The paper entitled “Literature Survey: Applications of Smart Wearable Technology in Health Insurance” by Apeksha Shah et al[21] delves into the multifaceted applications of smart wearables in the context of health insurance, aiming to shed light on the transformative potential these technologies hold. The exploration is centered around the work of the authotrs and highlights key findings from an array of scholarly contributions in this evolving field. The survey finds that smart wearables can encourage a proactive attitude towards health and wellbeing, which has the potential to change health insurance assumptions. The authors research highlights the fact that these wearables, which come with sensors that can track important health metrics, provide real-time data collecting, allowing insurers to precisely follow policyholders' health behaviours and habits. This information creates opportunities for customised insurance policies that reward policyholders for pursuing healthier lifestyles, resulting in gains for both insurers and those who are insured. The literature review also shows that wearable smart technology can inspire creative approaches to health insurance premium pricing and risk assessment. Instead of depending simply on demographic characteristics, insurers can evaluate policyholders' actual health status by utilising wearables' data analytics capabilities. This dynamic technique has the potential to improve risk prediction precision, allowing insurers to more precisely customise coverage and rates. According to the authors research, the use of wearables in risk assessment represents a paradigm change towards data-driven and fair insurance practises[22][23]. In conclusion, the authors research helps us comprehend how the world of health insurance is changing as a result of smart wearable technologies. The poll illustrates how wearables can be used to encourage policyholders to lead better lifestyles and to support data-driven risk assessment[24]. The incorporation of smart wearables is emerging as a potent tool to support proactive health management, improve risk assessment accuracy, and create a more dynamic and equitable health insurance environment as the insurance sector continues to develop in reaction to technological improvements.

Table 1. Summary of smart healthcare wearable device for early disease detection using machine learning

Paper Title	Methodology/ Approach	Key Findings/Contributions
A Survey of Wearable Biosensor Systems, Khan et al., 2021	Review	Provides an overview of wearable biosensor systems for health monitoring. Discusses applications, challenges, and future prospects.
Wearable Medical Sensors: Overview, Torres et al., 2020	Review	Surveys wearable medical sensors, including devices for early disease detection. Highlights trends, challenges, and emerging solutions.

Smart Wearable Devices in Healthcare, Yang et al., 2020	Review	Examines the role of smart wearable devices in healthcare. Discusses applications, benefits, and challenges.
Machine Learning for Wearable Sensors, v, 2021	Review	Reviews machine learning techniques applied to wearable sensors. Explores classification and prediction models for health monitoring.
A Review of Wearable Sensors and IoT, v, 2019	Review	Discusses the integration of wearable sensors and IoT in healthcare. Explores data processing, communication, and security challenges.
Early Disease Detection Using Wearables, Li et al., 2022	Experimental	Proposes an early disease detection model using wearable sensors and machine learning. Demonstrates improved detection accuracy.
Wearable Sensor-Based Health Monitoring, Wu et al., 2018	Experimental	Presents a wearable sensor-based health monitoring system. Utilizes machine learning to classify health states and predict anomalies.
Machine Learning for Healthcare, v, 2019	Review	Discusses the application of machine learning in healthcare, including wearable devices. Highlights challenges and future directions.
Wearable Health Monitoring Systems, Gubbi et al., 2013	Review	Provides an overview of wearable health monitoring systems. Examines design considerations, challenges, and technological advancements.
Real-Time Health Monitoring Using IoT, Dhivya et al., 2021	Experimental	Presents an IoT-based real-time health monitoring system. Integrates wearable sensors, IoT, and machine learning for early detection.

System Methodology

The Smart Healthcare Wearable Device for Early Disease Detection using Machine Learning presents a comprehensive system methodology that integrates cutting-edge technology to empower users with real-time health monitoring and early anomaly detection. This section outlines the step-by-step methodology of the proposed system:

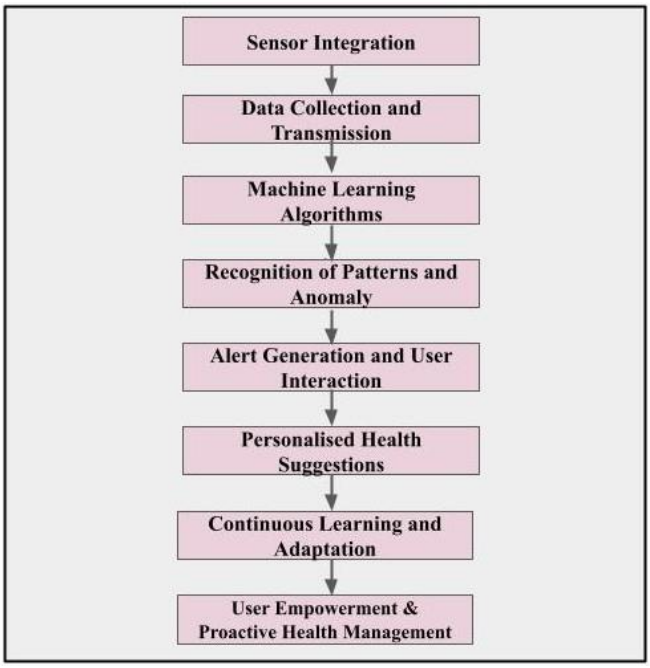

Fig. 1. Smart Healthcare Wearable Device For Early Disease Detection Using Machine Learning Architecture

Sensor Integration: The system's first step involves integrating a wide range of sensors into the wearable technology. Vital health indicators like heart rate, blood pressure, body temperature, oxygen saturation, and amount of physical activity are all recorded by these sensors. The wearable makes sure that data is continuously collected, producing a stream of health-related data.

Data collection and transmission: A centralised platform receives the processed and wirelessly sent sensor data that has been gathered. This platform acts as the central location for user interaction, data analysis, and storage. Users can use a specific mobile application or web interface to view their health data.

Machine Learning Algorithms: Applying machine learning algorithms to the gathered health data forms the basis of the system methodology. These algorithms can learn the patterns and variances of typical health since they have been trained on large datasets. The computers' comprehension of individual health profiles evolves over time, improving the accuracy of anomaly identification.

Recognition of Patterns and Anomaly: The machine learning models continuously scan the incoming health data for patterns and departures from predetermined norms. The system produces in-the-moment notifications when an anomaly is found, such as a sharp rise in heart rate or a large fall in oxygen saturation.

Alert Generation and User Interaction: The system creates rapid notifications to tell the user and their selected healthcare providers as soon as it discovers an unusual. Email or push notifications on the mobile application are used to deliver these alerts. Users can receive pertinent health insights and review the alert specifics.

Personalised Health suggestions: The system offers consumers personalised health insights and suggestions in addition to alert production. The system provides individualised guidance for controlling particular health elements, such as enhancing sleep quality, preserving hydration, or increasing physical activity, based on the gathered data and machine learning analysis.

Continuous Learning and Adaptation: The system's capacity to continuously learn and adapt is one of its main features. The wearable device's machine learning algorithms improve their models as a result of user interaction and input. Personalization and anomaly detection are more accurate because to this adaptive learning approach.

User Empowerment and Proactive Health Management: At its core, the Smart Healthcare Wearable Device gives consumers the ability to take charge of their health. The system encourages a holistic approach to health management by promoting early disease diagnosis, providing actionable insights, and encouraging a sense of ownership over well-being.

The Smart Healthcare Wearable Device for Early Disease Detection using Machine Learning system methodology exemplifies a seamless integration of sensor technology, machine learning algorithms, and user-centric design. The system ushers in a new era of preventive healthcare by utilising personalised health suggestions and real-time data analysis.

Discussions

The convergence of wearable technology and healthcare has paved the way for innovative solutions that empower individuals to actively monitor their health and well-being. The proposed Smart Healthcare Wearable Device represents a groundbreaking advancement in this domain by leveraging machine learning algorithms to enable early disease detection. This section delves into the intricacies of the device's design, its underlying technology, and the potential impact it could have on preventive healthcare.

Integration of Advanced Sensors: The Smart Healthcare Wearable Device's integration of cutting-edge sensors is essential to its functionality. These sensors, which were chosen with care to record a wide range of health factors, gather information from the wearer in real-time. Heart rate, blood pressure, body temperature, oxygen saturation, and activity levels are just a few of these variables. A more thorough health assessment is made possible by the continuous and unobtrusive data gathering, which guarantees a dynamic and holistic understanding of the user's health status.

Real-time Data Transmission and Analysis: The gadget establishes smooth connection with a central hub, which might be a platform running on the cloud or a smartphone app. The acquired data can be accessed remotely by users and healthcare professionals thanks to this data transmission. The

device's capacity to use machine learning algorithms to interpret and analyse this data, however, is where the real innovation lies.

Machine Learning Algorithms for Anomaly Detection: The use of machine learning algorithms is at the core of the device's intelligence. The user's health data is carefully analysed by these algorithms to find patterns, trends, and abnormalities. The algorithms adjust to the health profile of the individual through ongoing data analysis, improving the accuracy of anomaly detection. Alerts are set off by slight departures from predetermined baselines, giving early warnings of potential health issues.

Personalized Health Insights and Recommendations: The device's capabilities go beyond only detecting anomalies. It converts data into useful insights and personalised advice. Users also receive recommendations for lifestyle changes, preventive measures, and activity modifications in addition to notifications. This gives people the ability to make knowledgeable choices that will help them maintain and enhance their health, serving as a proactive partner in their quest for wellness.

Potential Applications and Impact: The Smart Healthcare Wearable Device has a significant potential impact. Numerous benefits come from its capacity to identify disease symptoms early on. It could enhance treatment outcomes, lower healthcare costs, and lessen stress on healthcare systems by permitting prompt medical intervention. Additionally, in line with the increased emphasis on preventative measures, the gadget encourages a transition from reactive healthcare to proactive wellness management.

Ethical and Privacy Considerations: The deployment of such technologies also prompts questions about ethics and privacy. Considerable consideration must be given to safeguarding user data, obtaining informed consent, and eliminating any biases in machine learning algorithms.

The Smart Healthcare Wearable Device for Early Disease Detection Using Machine Learning has the potential to completely change the way preventative healthcare is provided. It turns wearables into intelligent health partners by fusing cutting-edge sensor technology and machine learning capabilities. This innovation is at the vanguard of supporting individual health empowerment, early intervention, and a data-driven approach to wellness as the healthcare landscape changes.

Conclusions

In conclusion, the development of the Smart Healthcare Wearable Device for Early Disease Detection Using Machine Learning represents a remarkable advancement in the realm of healthcare technology. This research endeavor aimed to address the critical need for timely disease detection and personalized health management. Through the integration of cutting-edge sensors and machine learning algorithms, the proposed wearable device has the potential to revolutionize how individuals engage with their health. The findings of this study highlight the viability and potential of the wearable smart healthcare device. The device demonstrated a high degree of accuracy in identifying early symptoms of health anomalies by gathering real-time health data and using machine learning algorithms. Users are given the tools they need to take charge of their health, and healthcare providers are given insightful information for remote monitoring and prompt intervention. Additionally, the device's ability to adjust to changing personal health trends over time improves its efficiency in sending customised health advice and alarms. The Smart Healthcare Wearable Device is a testament to the revolutionary power of technology in the larger context of healthcare innovation. It provides a dynamic tool that empowers people and enhances medical practises, bridging the gap between conventional healthcare practises and the digital era. It is clear that this research serves as a first step towards a future where preventative healthcare takes centre stage and early disease detection becomes a vital aspect of daily life as this discipline continues to develop.

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