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Healthcare Using Wireless Sensor Networks in IoT

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ABSTRACT

Wireless sensor networks (WSNs) are playing a major role in revolutionizing the world through sensing technology. Wireless sensor networks (WSNs) are networks composed of small, autonomous devices called sensors. Different types of sensors include multimedia, thermal, acoustic, magnetic or electromagnetic, biological, chemical, mechanical, vehicle motion sensors, etc. WSNs find applications in various fields including environmental monitoring, military, industrial automation, health monitoring and smart cities. A health system that has nano sensors that collect real-time health status and converts it into text that transmits it to a doctor's server using a genetic algorithm. The results were tested for time complexity. Sensors used for detection must be registered with a user, and the user ID with the sensor ID is sent to the gateway to match the authentication ID. Then, after validating the data sources, the data is sent to the destination and false identity data is rejected. Future technologies may merge the healthcare system with some artificial intelligence models to make the system more efficient and intelligent.

Keywords: Genetic algorithm; Wireless sensor networks; authentication; IoT; remote patients monitoring system; Healthcare.

INTRODUCTION:

Because of its benefits and versatility, wireless sensor networks (WSNs) are now widely employed in healthcare applications. Additionally, their usage can now be made possible by a variety of creative applications thanks to developments in microelectronics and wireless communications. New strategies for healthcare organization and advances in medical treatments are required as a result of the rising frequency of chronic diseases and impairments brought on by an ageing population and longer life expectancy. A thorough overview of new IoT communication standards and technologies appropriate for smart healthcare applications is provided, with a particular emphasis on low-power wireless technologies as a critical enabler for energy-efficient IoT-based healthcare systems. Industry 4.0, or the Internet of Things, and wireless sensor networks (WSN) are aspects of the healthcare system that rely less on human intervention and more on automation. Applications for WSNs can be found in many domains, such as smart cities, industrial automation, military, environmental monitoring, and health monitoring. Nano sensors are used in healthcare systems to gather health status data in real time and send it to the doctor's server. The study proposes an authentication process for authorised users to access the data channel and a genetic-based encryption technique to secure data transferred over a wireless channel utilizing sensors in order to solve concerns about assaults and time consumption. The suggested algorithm offers increased security, is 90% faster, uses less energy, and is lightweight. in order for the healthcare system to be more intelligent and effective in the future by integrating artificial intelligence models with it. IoT integration has the potential to greatly improve intelligence, adaptability, and interoperability in healthcare systems. It also emphasises how crowd sourcing and crowd sensing may be used to quickly gather enormous amounts of medical data. It offers future directions for the Internet of Medical Things as well as open research challenges. One paradigm that facilitates effective data context extraction and decision-making in Internet of Things smart healthcare systems is the 6TiSCH architecture. Another topic of discussion regarding current trends in IoT smart healthcare frameworks is the development of sophisticated API models, such as Representational State Transfer (REST) scalable architecture.

RELATED WORKS:

E. M. Ar-Reyouchi et al.,[1] Through simulated tests, it is compared with the state-of-the-art technique (SoAT) in terms of delivery delay (DD), overall network capacity (ONC), roundtrip time (RTT), and message size. Additionally, it covers the usage of wireless mesh networks (WMNs) and narrowband Internet of things (NB-IoT) for healthcare applications including remote wellness monitoring systems and smart health. intends to examine the fundamental parameters of narrowband Internet of Things (NB-IoT) systems in wireless mesh networks (WMNs) and assess how well the suggested scheme performs in terms of message size, roundtrip time (RTT), overall network capacity (ONC), and delivery delay (DD) in comparison to the state-of-the-art technique (SoAT). The future work is to explore the reliability of the proposed protocol and apply it to different domains such as agriculture, connected clothing, suitcases connected to devices, connected vehicles, and connected houses.The proposed PEH scheme in the paper achieves significant performance enhancement over the state-of-the-art technique (SoAT) scheme, with improvements of 64% in roundtrip time (RTT), 66% in overall network capacity (ONC), and 71% in delivery delay (DD) .

J. J. Kang et al., [2] The development and implementation of a Multilayer Inference System (MIS) to reduce data size while maintaining accuracy in a military mobile health system.While the paper presents results showing a data reduction of 97.9% and satisfactory accuracy.It utilizes a Multilayer Inference System (MIS) to conserve battery power in ad-hoc network devices, such as wearables and sensor devices, by reducing data size for transfer .Further research can explore the integration of additional biometrics and health data information to enhance authentication accuracy in the military mobile health system .Investigating the use of other emerging technologies, such as Low Power Wide Area Networks (LPWAN) and Wireless Body Area Networks (WBAN), for health monitoring and user location tracking in emergency settings can be a focus for future studies.

P. Chanak et al., [3] Is to address the challenge of congestion control during physiological data routing in Healthcare Wireless Sensor Networks (HWSNs) and propose a congestion avoidance scheme known as Relaxation Theory with Max-Min Fairness (RT-MMF) to avoid congestion in wireless body sensor networks .It proposes a congestion control algorithm for IoT networks,theoretical analysis is conducted to examine the complexity of the proposed congestion control algorithm.The congestion control mechanism for IoT-based healthcare aware network was evaluated and compared with existing schemes in terms of percentage of successfully received packets, average throughput, and average hop-by-hop delay .It achieves a 98.3 accuracy rate and 97.9 savings rate.The future work should focus on studying new functions and further integration to complete the proposed system.

X. Li, J. Peng et al., [4] A secure three-factor user authentication protocol with forward secrecy for Wireless Medical Sensor Network Systems (WMSNs) to enhance data security and information privacy.Utilize an ECC-based approach and Incorporate fuzzy verifier and honey_list techniques to solve the contradiction of local password verification and mobile device lost attack.Further research can be conducted to explore the application of the proposed three-factor authentication protocol in other wireless sensor network systems beyond medical applications. The paper highlights the limitations of existing authentication mechanisms for WSN and WMSN, such as the inability to achieve local password verification while defending against stolen smart card attack and mobile device lost attack.

N. Pathak et al., [5] To implement a framework called healthcare device interoperability (HeDI) for in-home remote health monitoring. The integration of wearable sensors into the system without any predefined information poses a challenge, which is addressed using an IP-based mapping scheme .It is a system that utilizes a set of wireless adapters denoted by A1, A2, A3, ..., An, each assigned a different data rate denoted by set R1, R2, R3, ...Further research can be conducted to enhance the scalability, performance, and functionality of the proposed system .It can focus on improving the data transmission efficiency and reducing information loss in the network. Compares the error in data transmission between different network configurations, highlighting the excess packets in the mesh configuration. It also evaluates the packet delivery ratio (PDRCPH) for different sensors and network topologies, showing the minimum and maximum PDRCPH values.

Y. Yang et al., [6] To analyze studies on smart health monitoring systems and the types of sensor components utilized within the Internet of Things (IoT) for applications such as activity recognition, fitness assistance, vital signs monitoring, daily dietary tracking, and sleep monitoring. Accuracy and usability of activity recognition systems depend on the granularity of sensor data, which is determined by the number of sensors used .Different types of sensors and hardware, such as accelerometers, mmWave-based methods, and RFID-based methods, are discussed in the paper.Signal processing and classification techniques, including time-domain methods and supervised learning methods like random forests and neural networks, are explored in the paper.One area for future work is improving the environmental robustness of these systems, addressing challenges such as interference, noise, and varying environmental conditions .Their work achieves an accuracy of around 90%.

A. Rathnayaka et al., [7] The paper aims to address the challenges posed by the COVID-19 pandemic in healthcare settings, particularly in terms of transmission to healthcare workers (HCWs) and the need for effective contact tracing. It focuses on the use of real-time location systems (RTLSs) and Bluetooth low energy (BLE) technology for indoor contact tracing in healthcare environments .It describes the comprehensive system architecture of an autonomous contact tracing platform for infectious disease wards, which includes BLE wearable tags, hybrid transceivers, IoT edge gateway, and a remote server .The hybrid transceivers installed in patient rooms and common areas record close contacts between healthcare workers (HCWs) and patients, and send staff IDs and room access information to the edge gateways via LoRa .This presents the results of a two-week data collection trial using a real-time location system (RTLS) and Bluetooth low energy (BLE) technology for contact tracing in a healthcare setting .The future work should focus on improving the system by extending the battery life, reducing the size, and lowering the cost of the contact tracing platform.

M. Kamarei et al., [8] This aims to address the challenge of real-time functionality in Medical IoT (MIoT) systems caused by the variability of wireless channels, which can lead to delays due to natural or malicious congestion. It also aims to enable APs to dynamically readjust their coverage range based on the overall traffic load, detect and mitigate congested areas, and prevent both benign congestion and intentional congestion (traffic injection attacks) in MIoT systems. The proposed algorithm aims to improve network delay variation, network energy consumption, and network delay in MIoT systems. Further research can explore the integration of machine learning techniques to enhance the algorithm's ability to detect and mitigate malicious traffic injection attacks in real-time. The detection rate approaches to 100%, the fast countermeasure jumps sharply and shows more sensitivity to even having few malicious nodes.

Li, Xr., Jiang et al., [9] It focuses on the importance of smart healthcare systems in an IoT environment, specifically in wireless body region networks (WBANs) where biomedical sensors are placed on patients' bodies to gather their condition. To address the energy consumption issue in wireless body region networks (WBANs) in emergency situations in an IoT environment. To propose a solution using sensor node clustering methods and the whale optimization algorithm (WOA) to improve the network lifespan and energy efficiency in WBANs. To use the WOA for selecting cluster heads, which is a crucial factor in increasing the network lifespan. The proposed method was superior to the SEP algorithm in terms of not adding overhead from nodes in the middle region and having advanced nodes lose their energy later, resulting in a wider network lifespan. Future works should focus on providing an algorithm that can express the best balance between energy ratio and the number of advanced nodes.

Gavrilovic et al., [10] It focuses on the analysis of software architecture in the context of the Internet of Things (IoT) for smart cities, healthcare, and agriculture. It also aims to propose a software architecture that is most relevant to the IoT system of a particular area, considering the specific requirements and needs of smart cities, healthcare, and agriculture. Additionally, the paper aims to analyze the processing, analysis, and selection of data in IoT systems, particularly in healthcare, to generate patient status reports and improve service delivery. Future research should focus on optimizing software architectures and resources processed through IoT systems .Further investigation is needed to explore the possibilities of upgrading the identified software architectures in the domains of smart cities, healthcare, and agriculture.

Onasanya et al., [11] It discusses the implementation of a Smart Integrated IoT Healthcare System for Cancer Care, focusing on the use of IoT technology and business analytics/cloud services to enhance cancer treatments and improve the quality of life for patients.The reliability of the network system is crucial in the healthcare environment, and the proposed mesh topology aims to ensure high availability and minimal equipment failure. The paper also addresses security issues and operational challenges associated with the IoT-enabled healthcare system, emphasizing device-level authentication and link encryption as security strategies. The authors mention that they will be considering and integrating more services in their future research work in the same research domain. Therefore, further research and practical implementation are needed to evaluate the feasibility and impact of the IoT-based healthcare system for cancer care services.

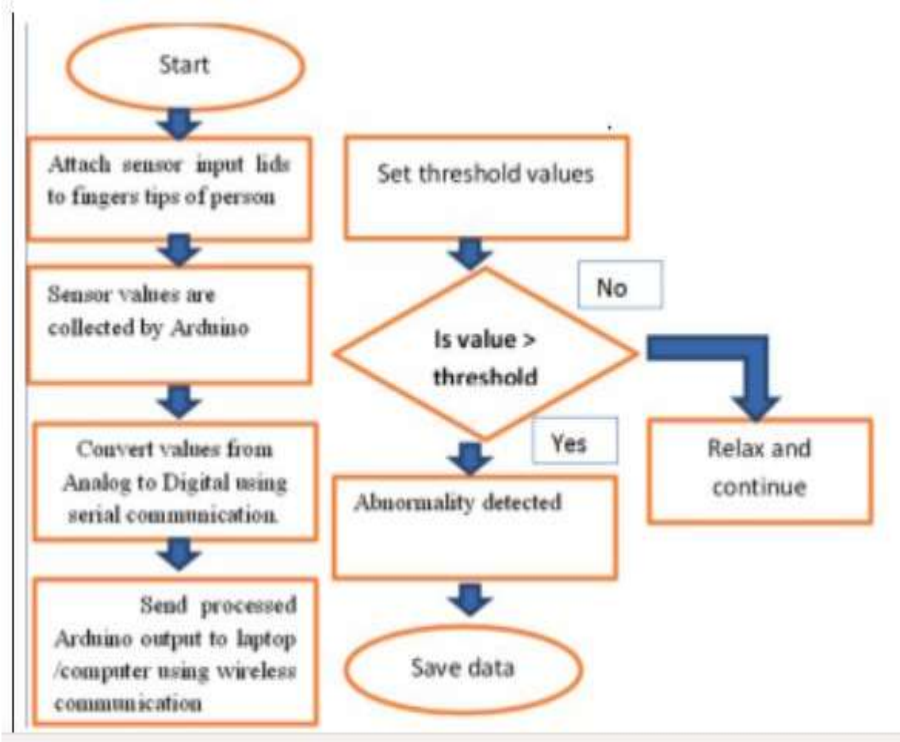
Sikandar Ali et al., [12] The healthcare system relies on technology and network-oriented devices, such as Internet-of-Medical-Things (IoMT), for remote patient monitoring and diagnosis. The proposed authentication scheme in the paper is lightweight and robust, addressing the identified weaknesses in the recent literature regarding the security of patient monitoring and information transmission in the healthcare system.The security of the proposed authentication scheme has been analyzed formally using BAN logic and ProVerif2.02, as well as informally using pragmatic illustration.Conducting further research on the security aspects of wireless medical sensor networks (WMSN) and developing more robust authentication protocols to ensure the integrity and confidentiality of patient data.Exploring the integration of Internet-of-Medical-Things (IoMT) with other emerging technologies to enhance the overall functionality and efficiency of the healthcare system.

Kashyap et al., [13] The focus of the paper is on the applications of Wireless Sensor Networks (WSNs) in healthcare and the advancements in wireless networks and electronics that have led to the emergence of WSNs in healthcare. To discuss the potential benefits of WSNs in providing real-time information relevant to all stakeholders in the healthcare system, regardless of their location. Further research can be conducted to explore the potential of Wireless Sensor Networks (WSNs) in addressing specific healthcare challenges, such as remote patient monitoring, chronic disease management, and emergency response systems. There is a need for research on the development of cost-effective WSN solutions that can meet the general patient needs and overcome the high operational and development costs associated with healthcare delivery. The use of WSNs in healthcare can improve monitoring consistency, enhance data quality and precision for decision support, and lead to better titration of therapeutic interventions.

Upreti, Kamal et al., [14] aims to discuss and propose a congestion control routing protocol for Healthcare Internet of Things (HIoT) enabled Wireless Sensor Networks (WSN) to increase the efficiency of healthcare sector with low cost. The objective is to solve the congestion issue in HIoT by predicting packet forwarding window size using machine learning algorithm and classifying data packets into priority and normal packets for efficient transmission. A theoretical comparison of the proposed congestion control routing protocol shows an increase in system efficiency. The proposed algorithm can be extended to handle dynamic network conditions and adapt to changing traffic patterns in healthcare IoT WSN networks. Future studies may explore the integration of other machine learning techniques or algorithms to enhance the congestion control capabilities of routing protocols.

Ahmed, Hamsa M et al., [15] aims to explore the potential benefits of integrating RFID and wireless network technologies into a single platform for healthcare monitoring including patient location, status and tracking. To identify the complexities and barriers associated with RFID implementation in healthcare, such as high adoption costs, security and privacy concerns, and human security risks. It emphasizes the need for RFID integration with back-end systems and data synchronization networks to fully exploit its potential in healthcare settings. The overall cost of RFID adoption is still high despite declining tagging costs, and an uncertain return on investment may hinder its implementation. Further research is needed to address the complexities of RFID implementation in healthcare and ensure patient safety.

METHODOLOGY:

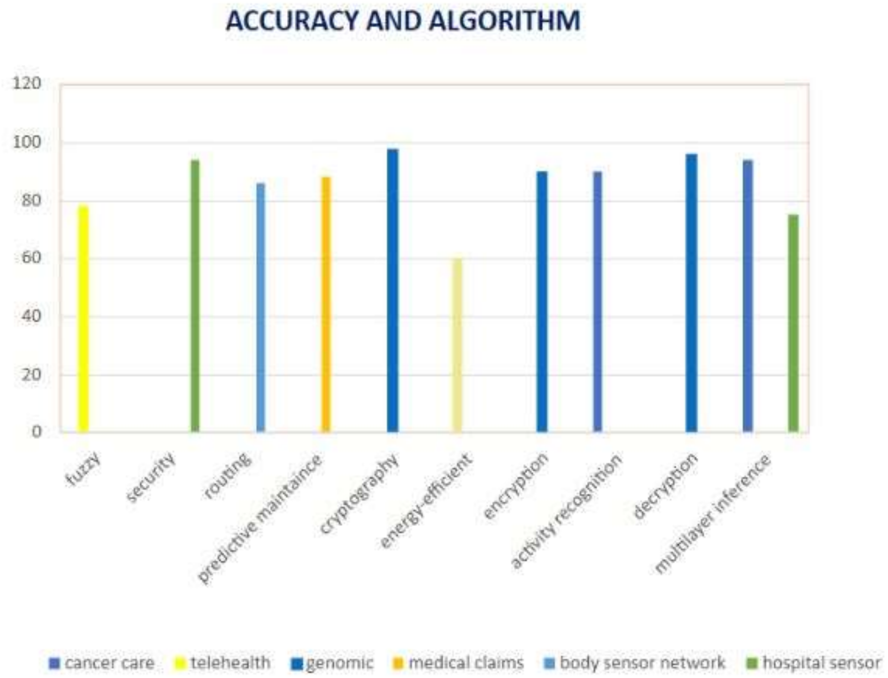


1. **Attach sensor input to a person's fingers:** In this case study, a wireless sensor network will be used to collect fingerprint data from people. The sensors will be attached to a person's fingers and collect data such as fingerprint pressure and temperature.
2. **Set threshold values:** Threshold values are used to determine whether a fingerprint is a match or not. For example, the threshold value for fingerprint pressure may be set to 100 kilopascals. If the pressure of the fingerprint is greater than 100 kilopascals, it will be considered a match.
3. **Sensor values are collected by Arduino:** Arduino is a microcontroller used to collect and process data from sensors. It converts the analog data from the sensor into digital data that can be sent to a laptop or computer.
4. **Convert values from analog to digital using serial communication:** Arduino converts analog data from sensors into digital data using serial communication protocols such as UART or SPI.
5. **Is value greater than threshold:** Arduino compares each sensor's value to the corresponding threshold value. If the value is greater than the threshold value, the Arduino sends a signal to the laptop or computer.
6. **Rest and continue:** If the fingerprint matches, the Arduino sends a signal to the laptop or computer to rest and continue.
7. **Abnormality detected:** If the fingerprint does not match, the Arduino sends a signal to the laptop or computer that an abnormality has been detected.
8. **Send Processed Arduino Output to Laptop/Computer Using Wireless Communication:** Arduino sends processed data to laptop or computer using wireless communication protocol such as Wi-Fi or ZigBee.
9. **Save data:** The laptop or computer saves the data from the Arduino to a database for future analysis.

This is just one example of how wireless sensor networks can be used in IoT applications. Wireless sensor networks can be used to collect data from various sensors, such as temperature sensors, humidity sensors, and motion sensors. This data can then be used to monitor and control various systems such as smart homes, smart cities and industrial systems.

RESULTS:

S no	Author	Dataset	Sensitivity	Accuracy	Precision	Recall	F1-score
1	Sikandar Ali	Telehealth	----	94.81	99.3	96.4	97.00
2	M. Youni	Genomic	90.3	91.13	90.4	92.6	90.71
3	P. Chanak	Smart healthcare dataset	----	98.3	97.3	99.5	98.00
4	Y. Yang	Medical claims dataset	98.91	97	100	----	97.9



DISCUSSION:

The future of healthcare with wireless sensors in IoT faces challenges that require immediate attention. Standardization of communication protocols between different wireless sensors is essential for seamless integration. Data security and privacy concerns demand constant innovation to protect the growing volume of health data. Scalability issues, both in hardware and data processing capabilities, must be addressed to accommodate the growing number of connected devices and maintain efficient real-time applications. Energy efficiency and battery life are critical to the sustainability of healthcare IoT devices, emphasizing the need for advances in power management. Integration of sensor data with existing electronic health records requires standardized methods for effective healthcare management. Ensuring the reliability and accuracy of sensor data, with clear rules and ethical frameworks, is paramount to informed decision-making and patient trust. Affordability and accessibility are key considerations requiring strategies for widespread adoption, cost-effective solutions, and equitable access. Human-centered design principles should guide interface development to enhance user experience. Finally, it is important to foster cross-disciplinary collaboration to bridge the gap between technology developers, healthcare professionals and regulators, to ensure future healthcare IoT solutions align with real-world needs.

CONCLUSION:

In conclusion, the integration of Wireless Sensor Networks (WSNs) in healthcare within the Internet of Things (IoT) framework holds immense promise for revolutionizing the way healthcare is delivered and managed. The application of WSNs in healthcare IoT brings about numerous benefits that contribute to enhanced patient care, improved efficiency, and better overall healthcare outcomes.

The ability to remotely monitor patients in real-time through WSNs allows for timely intervention and personalized care. Patients with chronic conditions can receive continuous monitoring, leading to early detection of anomalies and the potential prevention of complications. This not only improves patient outcomes but also reduces the burden on healthcare facilities by minimizing hospital readmissions.

The use of WSNs in healthcare extends beyond patient monitoring to include asset tracking within hospitals, ensuring optimal utilization of medical equipment and streamlining operational workflows. Additionally, the deployment of WSNs in elderly care and fall detection addresses the growing challenges associated with an aging population, promoting independent living while ensuring rapid response in case of emergencies. Furthermore, the data generated by WSNs contributes to a wealth of information that can be leveraged for predictive analytics, enabling healthcare professionals to make informed decisions and implement preventive measures. However, it is crucial to address concerns related to data security and privacy to safeguard sensitive healthcare information. As healthcare continues to evolve, the implementation of WSNs in IoT presents opportunities to create a more patient-centric, efficient, and technology-driven healthcare ecosystem. Collaboration between healthcare providers, technology developers, and regulatory bodies is essential to overcome challenges and ensure the successful integration of WSNs in healthcare IoT applications. In essence, the convergence of wireless sensor networks and IoT in healthcare not only transforms the delivery of medical services but also empowers individuals to actively participate in their own health management, fostering a more proactive and preventive approach to healthcare. With ongoing advancements in technology and a commitment to addressing ethical and regulatory considerations, the future of healthcare with WSNs in IoT looks promising and poised to make significant contributions to the well-being of individuals and the efficiency of healthcare systems.

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