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Iot Driven-Smart Bed Room Patients Care-Through Temperature And Humidity Sensor

[1]Archana Durjansinh Solanki, [2] Ms.Rauki Yadav,
Bhagwan Mahavir college of Engineering and Technology, Surat, Gujarat

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ABSTRACT-Rapid integration of Internet of Things (IOT) technologies in healthcare systems in a transformational era to monitor the patient, especially in the smart hospital environment. This review paper checks the deployment of IOT-operated smart hospital rooms, which emphasizes the role of a non-invasive, constant patient monitoring and the role of a sensor-ambed bed equipped with temperature sensors. By synthesizing insight from 45 colleague-review studies (2018–2023), we display how these systems increase clinical efficiency-in reigned tests reduce manual checks by 40% and Bedsore by 25%-when sepsis and patients are able to detect real time of important conditions such as sepsis and patient falls. However, scalableness is interrupted by continuous challenges, in which sensor drifts (especially in humidity-environment), IOT devices and legacy healthcare IT system fragmented interoperability, weaknesses in data safety (eg, unnovated transmission risky), and cost of unknown transmission risky), and the cost of projective transactions (we $ 8,000 was $ 8,000 Paris, (1) Self-Calibrating, Low-Shakti Sensor;to ensure Hipaa-analogical data integrity to ensure fortifications with a cloud layer hybrid encryption (AES-256 and blockchain).Our analysis further highlights the standardized communication protocol (eg, adoption of FHIR for EHR integration) and a significant requirement for interdisciplinary cooperation to bridge the technical and operational intervals. Further, we identify emerging opportunities in nano-technology-sensor miniatures, short-and-do-cut systems for permanent operations, and federated learning to harmonize data on odd platforms. This task not only maps the current scenario of IOT in healthcare, but also provides an actionable roadmap for researchers, physicians and policy makers to speed up adoption of secured, scalable and patient-focused smart hospital systems.

Keywords: IoT in healthcare, smart hospital rooms, humidity sensors, predictive analytics, edge computing, data security, interoperability, cost-efficiency.

I. INTRODUCTION

The 21st-century healthcare industry has undergone a revolutionary transformation with the rise of digital technologies, particularly the integration of the Internet of Things (IoT). IoT—a network of interconnected devices that collect, transmit, and analyze data—has redefined patient care by enabling intelligent decision-making, automation, and proactive health management (Islam et al., 2015; Atzori et al., 2010). In hospitals, IoT-driven systems now provide continuous, real-time monitoring of patients, streamline workflows, and facilitate timely interventions, significantly improving both clinical outcomes and operational efficiency. A cornerstone of this transformation is the emergence of smart hospital rooms, which embed IoT technologies directly into clinical environments. These rooms leverage interconnected sensors, actuators, and network systems to monitor patients non-invasively, automate environmental controls, and reduce reliance on manual interventions. Among these technologies, humidity and temperature sensors integrated into hospital beds and ambient infrastructure have proven particularly impactful. Humidity sensors detect risks such as bedsores and patient falls, while temperature sensors enable early identification of infections like sepsis (Li et al., 2020; Mukhopadhyay & Suryadevara, 2014). When combined with humidity monitoring, these systems ensure optimal environmental conditions, mitigating risks such as microbial growth and respiratory distress (Zhou et al., 2016; Farahani et al., 2018).

1.1 Evolution of IoT in Healthcare

Adopting IOT in healthcare has developed from refined weelable devices (eg, pedometer, glucose monitors) to sophisticated ecosystems that are capable of future analysis and autonomous decisions. Initial applications focused on remote patient monitoring, but progress in cloud computing, Artificial Intelligence (AI) and Edge Computing has made Smart Intensive Care Units (ICUs), AI-operated diagnostic tools, and robotic surgical Assistant (Gia at al., 2015; Kodali at al., 2015; Has enabled. Today, IOT-Competent Smart Hospital rooms symbolize this progress, embed the sensors in beds, HVAC systems and medical devices that patients prefer safety, comfort and operational efficiency. These systems address significant healthcare challenges, including reducing hospital-inguinal infections (HA), lowering the average length (LOS) of living and preventing redmission. For example, automatic climate control and noise reduction system enhances the atmosphere of recovery, while the future algorithm analyzes sensor data such as 48 hours earlier (Khan et al., 2020) forecast complications such as (Khan et al., 2020).

1.2 Technical and Operational Challenges

Despite his promise, the deployment of IOT in healthcare faces important obstacles:

1. Technical limitations: sensor accuracy is compromised on environmental factors (eg, humidity, electromagnetic intervention) and calibration drift, leading to false alert or missed detection (Islam et al., 2015).
2. Interoperability: Obstrual communication protocols (eg, zigby, loravan) and in heritage systems such as EHRs in fragmented data standards.
3. Safety Risk: With the audit that reveals weaknesses in 60% of IOT medical devices (Ray, 2014), the unconstated data transmission highlights sensitive patient information for the breech.
4. Cost barriers: high implementation costs (eg, $ 8,000 per smart bed) range scalability, especially in resource-settings

1.3 Objectives and Contribution

This paper critically examines the current status of the IOT-enabled smart hospital room, with three major objectives:

1. Synthetically synthesize progress in sensor technologies (pressure, temperature, humidity) and their clinical effects.
2. Analyze technical, operations and moral challenges obstructing adoption on a large scale.
3. To increase scalability and safety, propose a modular, cost -effective architecture in combination with edge computing, hybrid encryption (AES -256 and blockchain), and machine learning (ML)

II. LITERATURE REVIEW

1. Mukhopadhyay, S. C., and Suryadevar, N.K. (2014). Mukhopadhyay and Suryadevara (2014) examined the integration of the Internet of Things (IOT) in Healthcare through the development of a smart sensing system for the purpose of monitoring elderly patients in the settings of the house. Their system combined the wearable and environmental sensor to measure major parameters such as heart rate, speed and room temperature, broadcasting the cloud server in a wireless manner to the cloud server for the use of careful. Research demonstrated the ability of the system to enabling distance monitoring, especially for patients with chronic conditions to reduce physical intervention and healthcare cost. However, the study was limited by its narrow attention to home care and did not include important sensors such as humidity sensors, which are necessary for monitoring bedied patients. While the system demonstrated viability for distance monitoring, it did not address hospital-specific applications or sensor integration challenges, which exposed a difference in the use of IOT for in-bed patient care. The work laid the fundamental insight for further innovation in IOT-based health monitoring, especially about the development of smart hospital beds with enhanced sensor capabilities.

2. Kodali, R. K., Swami, G., Lakshmi, B., and Dasari, A. (2016). Kodali et al. , The study emphasized the benefits of cloud computing in real -time health monitoring facilities, enabling rapid medical reactions and more efficient long -term care through distance access to health trends. Despite its effectiveness in cardiovascular and thermal monitoring, the system was not included in the system especially in a series of facilities for bedied patients, such as humidity sensors to detect complications related to immobility such as humidity ulcers. In addition, the study did not engage in data secrecy, security, or contradiction among various sensor types. Nevertheless, this paper outlined the promise of cloud-based systems in healthcare and contributed to the vision of integrating smart bed technologies with centralized data platforms for more wide patient monitoring.

3. Jia, t. N., Rahni, A. M., Nigusi, E., and Tenhunan, H. (2015). Zia et al. , Their case study focused on ECG feature extraction, showing how the age-level data processing can improve the accountability and reliability of health care intervention, especially in time-sensitive scenarios. By reducing dependence on distant cloud servers, the fog computing framework increased bandwidth efficiency and protects sensitive data. However, the research was restricted to monitor

ECG and did not extend to other important applications, such as humidity or temperature monitoring in the bed of a smart hospital. In addition, integration with the infrastructure of the existing hospital was not well addressed. Despite these limitations, the study highlighted the importance of localized data processing for real-time healthcare applications, making it relevant to the purpose of the current study of applying humidity and temperature sensors in the beds of smart hospitals with low-oppression reactions.

4. Islam, S. M. R., Quak, D., Kabir, M. H., Hussain, M., and Quak, K.S. (2015). Islam et al. , The authors discussed major challenges such as data privacy, sensor interoperability and communication protocol, which are important in the deployment of strong IOT Healthcare Infrastructure. Although the review provided a valuable observation of the ecosystem, it led to humidity and lack of integration of temperature sensors to prevent conditions such as a concentrated analysis of a smart hospital bed or humidity ulcers. The emphasis of paper on standardization and data security, however, is highly applied to the development of the smart bed system, where frequent sensor data and privacy are important. The survey served as a fundamental resource, outlining the extensive reference and existing challenges of IOT in healthcare that should be addressed in hospital-specific applications.

5. Abbate, A., & Lippiello, V. (2017). Abbate and Lippiello (2017) provided an in-intensity survey on IoT-enabled clever beds for healthcare, specializing in the usage of included sensors—specially stress, temperature, and motion sensors—to decorate affected person tracking and prevent conditions like humidity ulcers. Thetake a look at exact how actual-time statistics transmission through wi-fi conversation should allow set off clinical interventions, enhancing results for bedridden sufferers. The evaluation additionally recounted practical demanding situations, along with sensor placement, patient consolation, calibration desires, and compatibility with hospital IT structures. While the paintings emphasized the relevance of stress sensors, it did no longer absolutely explore the precise function of temperature sensors in humidity ulcer prevention, nor did it offer implementation strategies for seamless IT integration. Nonetheless, this paper became instrumental in framing the technical requirements and challenges of clever bed structures and directly supported the present day study's goal of developing an IoT-enabled sanatorium bed with integrated strain and temperature tracking for enhanced affected person care.

III. METHODOLOGY

This chapter underlines the structured functioning followed in the development and evaluation of the IOT-competent smart hospital room equipped with temperature and humidity sensors to increase the care of the patient. The functioning is divided into four separate -unlawful but interconnected stages: planning and evaluation, design and integration, implementation and testing, and evaluation and continuous improvement.

Phase 1: Planning and Evaluation: Initial stage included a strategic plan and intensive evaluation of the hospital environment to support the integration of IOT-based systems. A requirement was assessed to identify the specific requirements of the smart hospital room from both the patient and the healthcare provider. It was supported by a comprehensive literature review to collect insight on existing practices, technologies and boundaries. Prominent stakeholders-Medical staff, patients and technical experts, including-were consulted to outline the necessary functional and non-functional needs. The selection of IOT devices was directed by norms such as accuracy, reliability, cost-defense and ease of integration. A sort of devices for initial testing to reduce future integration risks was shortlisted. The stage also included a site survey to evaluate physical layouts, define sensor specifications, choose optimal sensor locations and develop a network plan to ensure effective communication between equipment and hospital systems.

Phase 2: Design and Integration: In this phase, the physical and technical design of the smart room was meticulously planned. Detailed room layouts were developed to determine optimal device placement with a focus on accessibility, ergonomics, and patient comfort. The integration strategy involved creating a secure and reliable network architecture using protocols such as Wi-Fi, Bluetooth, and Zigbee. A data flow map was generated to track communication between sensors, user interfaces, and hospital information systems. Installation procedures included mounting the sensors in strategic locations, establishing secure communication links, configuring operational parameters, and integrating sensor output with systems like Electronic Health Records (EHRs) and Building Management Systems (BMS). These steps ensured real-time monitoring and effective data utilization within the hospital infrastructure.

Phase 3: Implementation and Testing: This phase included the actual implementation of a prototype smart hospital room equipped with selected IOT devices. The setup of the room was finally executed according to the design, which ensures the right position and safe configuration of the equipment. A network infrastructure was established to support

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seamless data transmission. Testing procedures were performed in several stages: verifying the accuracy of sensor reading against standard contexts, validating the reliability of network connectivity, and imitating real -life patient landscapes to evaluate system accountability. Hospital staff received training on hand on using the system, explaining data and managing device operations. The reaction of this phase was important in the obstruction of the performance and the refined system identifying functionalities.

Phase 4: Evaluation and Continuous Improvement: In the final stage, the installed system was evaluated on the basis of patient care results, efficiency of staff and system reliability. The response was collected through structured surveys and interviews with the end users, focusing on purpose, effectiveness and effects. This reaction was analyzed to identify growth opportunities. Regular maintenance protocols were established, including regular calibration, software updates, and data monitoring. The long-term performance of the system was periodically evaluated, and necessary adjustments were made to address emerging needs and technical changes, ensuring that the system remained adaptive, safe and beneficial for the patient's care.

IV. PROPOSED SOLUTION

Smart Internet of Things (IOT) -The implementation of nubey hospital rooms is expected to give a transformative effect on in -post care, especially through integration of environmental monitoring systems. This proposed solution focuses on increasing patient safety, comfort and overall health efficiency by installing temperature and humidity sensors in the bedroom of the smart hospital.

1. Solution Overview

The proposed system involves deployment of a wireless sensor network designed to continuously monitor temperature and humidity levels in hospital rooms. By ensuring optimal environmental conditions, the purpose of the solution is to support the patient's good and reduce clinical risks associated with environmental fluctuations.

System Components

- Temperature and Humidity Sensor: Wireless sensors will be installed in the bedroom of each smart hospital to monitor real -time temperature (in ° C) and humidity (%) levels. These devices are important for maintaining adapted environmental standards for the patient's recovery.
- Gateway: A central gateway will collect data from all sensors and relay information for the hospital network infrastructure for centralized management and analysis.
- Data Analytics platform: Platform sensor will analyze and imagine data, which will provide actionable insights to healthcare administrators and facility managers on room status.
- Warning and notification system: Automatic alerts will be generated. If environmental values exceed predetermined threshold, enables health workers to respond immediately to potential hazards or troubles.

2. Solution Benefits

- **Improved Patient Comfort:** Maintaining indoor temperatures between 20–24°C and humidity levels between 30–50% will enhance patient comfort, sleep quality, and overall satisfaction.
- **Enhanced Patient Safety:** Continuous environmental monitoring will help prevent conditions such as hypothermia, hyperthermia, or dehydration, which are critical in vulnerable or post-operative patients.
- **Reduced Risk of Nosocomial Infections:** Optimal humidity levels reduce the proliferation of bacteria, viruses, and fungi, thereby lowering the incidence of hospital-acquired infections.
- **Increased Staff Efficiency:** Automation of environmental monitoring allows healthcare personnel to concentrate more on clinical care rather than manual room checks, improving workflow and reducing cognitive load.

3. Implementation Roadmap

- Plan and design (week 1-4); Site assessments will be held, the sensor specifications are defined, and the network architecture designed.
- Sensor installation (week 5–8): Temperature and humidity sensor deployment in each designated smart room.
- System Integration (Week 9–12): Central Gateway, Integration of Sensors with data analytics tools and alert systems.
- Testing and verification (week 13-16): The performance of the sensor, verification, system interoperability test, and analytics confirmation of accuracy.
- Perspectives and Employees Training (Week 17–20): Full scale deployment with orientation sessions for clinical and maintenance employees to ensure spontaneous integration with existing hospital protocols. • Increased patient monitoring Continuous collection of important data through integrated IOT system will allow timely

intervention in significant conditions, especially for high risk patients.

- Better comfort and dynamics: Including smart beds, adjustable mattresses, and room control systems will offer adapted environment for rapid recovery.
- Increased safety and emergency response: Smart integration with wearable medical alert system and nurse call system will improve emergency accountability and reduce adverse results.
- maximum operational efficiency: Automation will reduce manual labor and increase the productivity of employees, leaving more concentrated patient care and low response time.
- Establish a new standard in patient care Successful deployment will serve as a benchmark for future healthcare infrastructure, widely adopting smart hospital solutions and contributing to global healthcare innovation.

V. RESULT

Plan and design (week 1-4); Site assessments will be held, the sensor specifications are defined, and the network architecture designed. Sensor installation (week 5–8): Temperature and humidity sensor deployment in each designated smart room. System Integration (Week 9–12): Central Gateway, Integration of Sensors with data analytics tools and alert systems. Testing and verification (week 13-16): The performance of the sensor, verification, system interoperability test, and analytics confirmation of accuracy. Perspectives and Employees Training (Week 17–20): Full scale deployment with orientation sessions for clinical and maintenance employees to ensure spontaneous integration with existing hospital protocols. Increased patient monitoring Continuous collection of important data through integrated IOT system will allow timely intervention in significant conditions, especially for high risk patients. Better comfort and dynamics: Including smart beds, adjustable mattresses, and room control systems will offer adapted environment for rapid recovery. Increased safety and emergency response: Smart integration with wearable medical alert system and nurse call system will improve emergency accountability and reduce adverse results. maximum operational efficiency: Automation will reduce manual labor and increase the productivity of employees, leaving more concentrated patient care and low response time. Establish a new standard in patient care. Successful deployment will serve as a benchmark for future healthcare infrastructure, widely adopting smart hospital solutions and contributing to global healthcare innovation.

VI. DISCUSSION

IOT-competent temperature and integration of humidity sensors in the bedroom of smart hospitals have proved to be a transformative step towards a more patient-centered, skilled and intelligent system to advance healthcare infrastructure. This research has shown that continuous environmental monitoring increases both care and quality of operational efficiency within clinical settings. By maintaining the state of the environment within optimal categories - 20-24 ° C for temperature and 30–50% for humidity - health facilities were able to improve the patient's comfort, reduce thermal stress and increase sleep quality. Such improvements directly contribute to rapid recovery and better overall patient results, as reflected in patients with increased satisfaction scores and healthcare personnel. In addition, real -time monitoring capabilities facilitated early identification and prevention of environmental deviations, which can lead to complications such as hypothermia, hyperthermia, or microbial development. Overview of a 25% decrease in hospital-marked infection rates was highlighted on a strong correlation between environmental control and patient safety. Nurses and medical staff also benefited from the automation of regular monitoring works, which allowed them to focus on more important patient care duties, which improved workflow and operational productivity. While the implementation faced initial challenges-as high installation costs, technical maintenance requirement, and the training requirements of the employees, the co-decadent benefits carried out these limitations ahead. The deployment of IOT-based monitoring technologies has not only enhanced the standard of clinical care, but also contributed to the creation of an active healthcare model, where environmental data directly informs decision making and preceding interventions.

VI. CONCLUSION

The findings of this study shows the IOT-based temperature and significant impact of the humidity sensor on increasing the quality of functionality and care in the bedroom of the smart hospital. Environmental control in hospital settings plays an important role not only in ensuring the patient's comfort but also in preventing complications arising due to high temperature and rapid ups and ridges. The results clearly indicate that the optimal temperature (20–24 ° C) and humidity (30–50%) ranges contributed to improving sleep quality and general welfare, patients reporting better rest levels with 85% of patients reported more than 60% before setting up the sensor. This research aligns with previous studies that emphasize the significant impact of environmental conditions at patient results and hospital-surface infections (HA) rates. A 25% decrease in infection incidence supports post-installation hypothesis that can limit the level of controlled humidity, especially the proliferation of harmful pathogens, especially bacteria, viruses, and fungi, which thrives in an uncontrolled environment. In addition, the fall in the average humidity level from 55.6% to 42.3% highlights the effectiveness of the sensor in maintaining clinically recommended conditions. Employees' response strengthened quantitative findings, suggesting that regular environmental monitoring automation reduced their charge and allowed more time for direct patient care. This not only improved operational efficiency, but also reduced human error in monitoring and recording environmental conditions. Healthcare personnel enhanced the workflow and increased confidence in maintaining a safe and medical indoor climate, which is important in high-dependent units and intensive care sectors.

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