https://doi.org/10.33472/AFJBS.6.6.2024.1567-1575

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Internet of Things and Robotics in Transforming Healthcare Services

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Article Info

Volume 6, Issue 6, May 2024

Received: 09 March 2024

Accepted: 10 April 2024

Published: 20 May 2024

Doi: 10.33472/AFJBS.6.6.2024.1567-1575

ABSTRACT:

Today, technology is a necessary component of daily life. Recent years have seen significant technological advancements with a broad range of healthcare uses. However, there hasn't been much of an increase in the acceptance of robotics and the Internet of Things (IoT) in healthcare applications. The aforementioned technology's impact on the transformation of healthcare services has been covered in the current study. Additionally, the study discussed the significance of several IoT-assisted robotic system features for healthcare applications. The study also concentrated on the use of robots and the Internet of Things in the delivery of healthcare services, including prosthetics, assisted surgery, senior care, and rehabilitation. A detailed presentation of the latest advancements, present state, constraints, and difficulties in the mentioned field has been made. The study also covers the function and uses of the previously described technologies in handling pandemic situations. A thorough understanding of the potential uses, difficulties, and future reach of IoT-assisted robotic systems in healthcare services has been given. This will assist next researchers in developing comprehensive concepts for utilizing the aforementioned technology to enhance healthcare services in the future.

Keywords: Internet of Things, Robotics, Healthcare, medical, hospital.

1. Introduction:

Modern technological developments have made it easier for scientists and researchers to improve healthcare services. Modern technologies have been widely incorporated into the creation and operation of a wide range of medical devices, including those used for testing, monitoring, diagnosis, and treatment. The implementation of sensor networks in hospitals and the advancement of clinical-grade sensors have both made this possible. Optimizing healthcare delivery from a remote location has been greatly aided by the sensors and sensor network working together. The aforementioned developments have made healthcare services more flexible, available, and reasonably priced. Internet of Things (IoT), machine learning, big data analytics, and other commonly used sophisticated technologies are adept at revolutionizing healthcare applications. By enabling effective decision-making, data analytics has the potential to reveal trends and hidden aspects in health data, thereby increasing the quality of care. In addition, the utilization of artificial intelligence (AI) methods such as machine learning (deep learning, artificial neural networks, etc.) has improved the workload of healthcare practitioners by handling vast amounts of healthcare data stored in electronic health records. AI is being used in healthcare for a variety of purposes, such as forecasting human health issues, early cancer detection, and the identification of respiratory ailments using chest X-rays.

Similar to this, a variety of cutting-edge imaging methods, such as computer tomography and computer vision, have been effectively used in surgeries and therapeutic applications. Healthcare organizations can store, process, and exchange patient data, medical records, and reports by utilizing cloud services. By employing intercloud infrastructures to transmit health information, create bills, and other functions, this gives healthcare services more flexibility. Despite the fact that the healthcare sector has recently seen the emergence of many cutting-edge technologies, Internet of Things appears to hold the most promise for combining many technologies into a single setting. IoT has demonstrated remarkable efficacy in addressing people's healthcare needs in recent years. The term Internet of Things (IoT) refers to a network that uses Internet connectivity to link several physical objects, or gadgets. This makes it possible for people who are connected to share clear facts and information. When IoT technology is integrated, a gadget can become more intelligent, useful, and efficient. Moreover, IoT technology demonstrates the ability to link the gadget with the outside world. As a result, the use of IoT technology has significantly increased across a number of industries, including healthcare. The sedentary lifestyle, population growth, and the steady increase in healthcare difficulties are the primary drivers of the IoT market's expansion.Furthermore, the healthcare sector is being burdened by an increasing number of patients and new diseases every day as a result of the previously mentioned issues. Finding a futuristic solution that offers healthcare services that are more effective and economical is therefore more difficult. In this sense, robots for improved patient management, monitoring, diagnosis, and treatment is one of the many more technologies that IoT is revealing. Robots, people, and IoT systems collaborate in an ecosystem created by the combination of IoT and robotics. Most of the system's inspiration came from the cloud-robotic system. Cloud-robotics rely on "cloud computing" to process and retrieve vast amounts of data in order to carry out specified tasks. Here, a single network robot performs all functions, such as sensing, computation, and memory.

IoT based Robotics Healthcare system:

An IoT-based robotic healthcare system could revolutionize medical care by enabling remote monitoring of patients, administering medication, assisting in surgeries, and even providing companionship to patients. It could incorporate sensors for vital signs monitoring, AI

algorithms for decision-making, and robotic actuators for physical tasks. Such a system has the potential to enhance efficiency, accuracy, and accessibility in healthcare delivery while also reducing the workload on medical staff. Figure 1 shows IoT based Robotics healthcare system.

Figure 1. IoT based Robotic Healthcare System

Abilities of IoT based Robotic Healthcare System:

An IoT-based robotic healthcare system can possess a wide range of abilities, including:

1. Remote Monitoring: Monitoring vital signs and health parameters in real-time, allowing healthcare providers to track patients' health status from a distance.
2. Medication Management: Dispensing medications at prescribed times, ensuring patients adhere to their treatment plans.
3. Telepresence: Providing virtual presence capabilities for healthcare professionals to remotely interact with patients, conduct consultations, and offer guidance.
4. Assisted Living: Assisting elderly or disabled individuals with daily tasks such as getting out of bed, walking, or fetching objects.
5. Surgical Assistance: Assisting surgeons during procedures by providing precise movements, holding instruments, or even performing automated tasks under supervision.
6. Fall Detection and Emergency Response: Detecting falls or emergencies and alerting caregivers or emergency services for prompt intervention.
7. Health Data Analysis: Analyzing collected data to identify patterns, predict health issues, and provide personalized recommendations for better healthcare management.
8. Environmental Monitoring: Monitoring environmental conditions such as air quality, temperature, and humidity to ensure optimal conditions for patient health.
9. Emotional Support: Providing companionship and emotional support to patients through interactions and reminders.
10. Security and Privacy: Ensuring data security and patient privacy through robust encryption and access control mechanisms.

These abilities can significantly enhance the quality of care, improve patient outcomes, and optimize healthcare resources.

Applications of IoT based Robotic Healthcare systems:

The applications of an IoT-based robotic healthcare system are diverse and impactful, including:

1. Remote Patient Monitoring: Enabling continuous monitoring of patients' vital signs, allowing healthcare providers to track their health status in real-time from anywhere.

2. Chronic Disease Management: Assisting patients with chronic conditions such as diabetes or hypertension by monitoring their health parameters and providing timely interventions or reminders.
3. Telemedicine and Telepresence: Facilitating remote consultations between patients and healthcare professionals, reducing the need for in-person visits and improving accessibility to healthcare services.
4. Surgical Assistance: Assisting surgeons during minimally invasive procedures by providing precise movements and holding instruments, enhancing surgical outcomes and reducing risks.
5. Rehabilitation: Assisting patients with physical therapy exercises, providing feedback, and monitoring progress to support recovery from injuries or surgeries.
6. Elderly Care: Supporting elderly individuals with activities of daily living, fall detection, medication reminders, and companionship to promote independence and well-being.
7. Hospital Automation: Streamlining hospital operations by automating tasks such as medication dispensing, inventory management, and patient transport, reducing the workload on healthcare staff and improving efficiency.
8. Health and Wellness Monitoring: Monitoring environmental factors like air quality, temperature, and humidity in healthcare facilities to ensure optimal conditions for patient comfort and well-being.
9. Emergency Response: Providing timely assistance during emergencies by detecting falls, activating alarms, and alerting caregivers or emergency services for prompt intervention.
10. Data Analytics and Predictive Healthcare: Analyzing collected data to identify trends, predict health risks, and personalize treatment plans, leading to more proactive and effective healthcare interventions.

These applications demonstrate the potential of IoT-based robotic healthcare systems to transform healthcare delivery, improve patient outcomes, and enhance overall quality of care.

2. Conclusion:

IoT-based robotic healthcare systems represent a revolutionary approach to healthcare delivery, offering a myriad of benefits including remote patient monitoring, surgical assistance, chronic disease management, and emergency response. By leveraging the power of IoT sensors, robotics, and artificial intelligence, these systems have the potential to enhance efficiency, accuracy, and accessibility in healthcare while reducing the workload on medical staff and improving patient outcomes. With ongoing advancements in technology and greater adoption of these systems, the future of healthcare holds promise for more personalized, proactive, and effective care delivery.

Future scope:

Future scope: The future scope of IoT-based robotic healthcare systems is vast and promising. Some key areas of advancement and potential developments include:

1. Integration of AI and Machine Learning: Continued advancements in AI and machine learning algorithms will enable robotic healthcare systems to become more intelligent, adaptive, and capable of personalized care delivery. These systems will learn from patient data, optimize treatment plans, and predict health outcomes with greater accuracy.
2. Miniaturization and Wearable Devices: The development of smaller, more portable robotic devices and wearable sensors will enable continuous monitoring of health parameters and seamless integration into patients' daily lives. This will empower individuals to take more control over their health and well-being.

3. Enhanced Telemedicine and Remote Surgery: Improvements in connectivity, latency, and haptic feedback will enhance the capabilities of telemedicine and remote surgery, enabling healthcare professionals to perform complex procedures from distant locations with greater precision and confidence.
4. Interoperability and Data Sharing: Standardization and interoperability protocols will facilitate seamless data exchange between different healthcare systems and devices, enabling comprehensive patient care across various settings and providers while ensuring data security and privacy.
5. Personalized Medicine and Precision Healthcare: IoT-based robotic systems will enable the collection of vast amounts of patient data, facilitating the development of personalized treatment plans tailored to individual genetics, lifestyle, and health history. This will lead to more targeted interventions and improved patient outcomes.
6. Ethical and Regulatory Considerations: As these technologies become more widespread, there will be a need for robust ethical frameworks and regulatory guidelines to ensure patient safety, privacy, and equity in access to care. Addressing ethical concerns and implementing appropriate safeguards will be crucial for the responsible deployment of IoT-based robotic healthcare systems.
7. Collaborative Robotics and Human-Robot Interaction: Collaborative robotics will enable seamless interaction between humans and robots in healthcare settings, fostering trust, acceptance, and effective teamwork. Designing robots that can understand and respond to human emotions and preferences will further enhance their utility and acceptance in healthcare.
8. Global Adoption and Accessibility: Increasing global adoption of IoT-based robotic healthcare systems will democratize access to quality healthcare, particularly in underserved regions and populations. These systems have the potential to bridge healthcare disparities and improve health outcomes on a global scale.

Overall, the future of IoT-based robotic healthcare systems holds immense potential to transform the delivery of healthcare, improve patient outcomes, and enhance the quality of life for individuals worldwide. Continued research, innovation, and collaboration across disciplines will be essential to realizing this vision.

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