

The Emerging Trends in IoT Technologies of Health Care

DR. SRINIVASA RAO KADARI

Assist. Prof Of Computer Science, Babu Jagajeevan Ram Government Degree College, Narayanaguda, Hyderabad

Abstract- *The healthcare sector is experiencing considerable investments in digitalization, with a focus on adopting IoT technology. The Internet of Things has the potential to transform the entire industry by enhancing diagnostics and enabling personalized treatment approaches. It's not surprising that a specialized branch, known as the Internet of Medical Things (IoMT), has emerged as part of the broader digital health concept. This is an emerging modernization technology that combines the capabilities of RFID tracking and IoT technology to integrate routine hospital procedures and make them more efficient. Upon arrival, each patient will be given healthcare IoT systems like a bracelet containing an RFID tag that holds all relevant patient data. IoT sensors placed in various locations in the hospital will be able to collect and analyze this information to classify patients based on the priority of illness. This would efficiently take care of bottlenecks that occur in traditional hospital systems and make the process more methodical*

Indexed Terms- *IoT, Healthcare, Smart Hospitals, Mobile Health, Diagnosis & Drug Discovery*

I. INTRODUCTION

The Internet of Things, or IoT, is the interconnection of devices & machines to the internet and The Internet of Things (IoT) has revolutionized our interconnected society and transformed the way interact with technology. These devices can be anything from smartphones, smart TVs & smart speakers to home appliances, vehicles & wearables. IoT allows these devices to collect & share data with each other, as well as with the cloud, to provide users with improved functionality & convenience. This powerful force seamlessly integrates devices, sensors, and systems to create a vast network of connected objects that exchange data and facilitate intelligent decision-making. New realms of innovation have been

opened, paving the way for exciting opportunities in various industries.

History of IoT

IoT began in the early 1980s when a group of engineers at Carnegie Mellon University invented the first internet-connected device, a Coke vending machine. But, it wasn't until the mid-2000s that IoT began to take off with the invention of low-power wireless sensors & the emergence of cloud computing. Today, more than 10 billion devices are connected to the internet, & as per estimates, this number will grow to around 30 billion by 2030. With more devices connected to the internet & the rising future IoT projects, the IoT future is poised to revolutionize industries including healthcare, transportation & manufacturing.

Current State of IoT

IoT has become a driving force in industries like healthcare, transportation, retail & manufacturing & is transforming these industries like never before with the power that the future of Internet of Things holds.

The Major Emerging trends in Healthcare Sector:

IoT in Healthcare

The incorporation of smart technology in healthcare modernization has led to the rising popularity of the Internet of Medical Things (IoMT) in the last few years. Innovative approaches like Remote Patient Monitoring (RPM) and smart wearables collect real-time insights and allow medical professionals to deliver high-quality care by keeping track of vital signs and formulate treatment plans without being present in the same physical location as their patients. The advocacy of big data IoT in the healthcare sector has led to the rise of a host of newer innovations that will invariably make life easier for both patients and healthcare professionals. The healthcare sector is experiencing considerable investments in

digitalization, with a focus on adopting IoT technology. The Internet of Things has the potential to transform the entire industry by enhancing diagnostics and enabling personalized treatment approaches. It's not surprising that a specialized branch, known as the Internet of Medical Things (IoMT), has emerged as part of the broader digital health concept.

Some IoT use cases that have become popular in hospitals around the world include:

- medical wearables
- patient data collection and analytics
- smart diagnostic tools
- robotic surgery machines
- monitoring systems to supervise patients
- controlling systems for storage conditions in laboratories

The healthcare business model undergoes changes with the influence of IoT, bringing advantages to both patients and service providers:

- **Cost reduction.** By utilizing IoT sensors, healthcare providers ensure continuous real-time monitoring for patients who require it. This improves the quality of medical care and cuts costs, as medical professionals no longer need to regularly check patients' vital signs.
- **Enhanced disease control.** Continuous monitoring of patients and access to real-time data enable early diagnosis and preventive care. Combined with ongoing assessment of therapy effectiveness, healthcare providers can help prevent serious complications.
- **Remote consultations.** Certain population groups, such as those in remote areas, face challenges in accessing medical institutions promptly for effective treatment. These individuals can use IoT solutions along with mobile applications to collect and share health data with doctors, receiving consultations based on it.
- **Patient engagement.** IoT in healthcare shifts the focus to patients and their needs. Patients now have more control over managing their health conditions independently and only need to contact a medical specialist when necessary. This creates a new relationship model between doctor and patient, where the latter becomes a partner in preventing and treating diseases.

Smart Hospitals:

This is an emerging modernization technology that combines the capabilities of RFID tracking and IoT technology to integrate routine hospital procedures and make them more efficient. Upon arrival, each patient will be given healthcare IoT systems like a bracelet containing an RFID tag that holds all relevant patient data. IoT sensors placed in various locations in the hospital will be able to collect and analyze this information to classify patients based on the priority of illness. This would efficiently take care of bottlenecks that occur in traditional hospital systems and make the process more methodical

Smart Pills:

These are quite similar to regular medication in the way it is consumed. However, smart pills are equipped with ingestible monitors that send signals to sensor patches worn on the patient's body. These sensors then track the patient's vital signs and relay it to the medical professional. Another invention that is likely to gain popularity in the coming years is the cloud-based smart pill monitors that send real-time alerts when a patient has missed a dose of their medication.

The Different Iot Technologies in Healthcare

There are also plenty of traditional IoT use-cases such as hospital-room sensors that can monitor patient vitals over the course of the day to aid doctors in diagnosis and treatment. The evolution of this technology has accelerated due to the spread of COVID-19.

Data Management

AI systems can play a crucial role in addressing some healthcare challenges by automating various aspects of data management, starting with document processing, completing electronic health records (EHRs), medical imaging, genomics, and wearable device data.

Diagnosis & Drug Discovery

AI is beneficial for improving efficiency in information processing and decision-making when it comes to the drug development process. One example, predicting the 3D structures of proteins from their amino acid sequence is an extremely difficult and challenging task.

For example ; From the blog mobidev.biz Breathhh represents an AI-driven Chrome extension created to automatically provide mental health exercises tailored to an individual's web activity and online behaviors. Through continuous monitoring and analysis of user interactions, Breathhh identifies the best moments to give stress-relieving practices and strategies. This innovative approach seamlessly blends AI technology with hands-on mental health support, simplifying the integration of self-care into users' daily routines. AI can also be used to detect the symptoms of illnesses caused by chemical changes in our brains, which result in several mental symptoms

Data and Privacy

The performance of machine learning-powered software is inherently tied to the quality of its training dataset. A model's capabilities are directly proportional to the excellence and comprehensiveness of the data it is trained on

The Evolution of Remote Care

Another technological innovation in healthcare is connected with the recent pandemic. Telehealth has been on the rise since the COVID-19 pandemic. The infrastructure supporting telemedicine has seen significant improvements. The popularity of telemedicine has soared across various medical specialties, encompassing primary care, mental health, dermatology, and pediatrics. In April 2020, more than 43% of Medicare primary care visits were made using telehealth services. Although telehealth visits have dropped since the peak of the pandemic,

Mobile Health

MHealth stands as an innovative and swiftly evolving domain within healthcare, leveraging the capabilities of mobile devices to extend the reach of telemedicine solutions globally. Recent years have introduced a new category of mHealth applications that prioritize users in the health data equation, empowering them with greater control over their data. These healthcare mobile apps go a step further by focusing on user engagement in self-care, offering payments or rewards to

encourage users to actively use the mHealth app and contribute their healthcare-related data.

The Best example Rural Area Health Program:

Andhra Pradesh is going to provide a first-of-its-kind healthcare service to the rural population starting from April 6 (Thursday) with the launch of the 'Family Doctor' programme. The Department of Health and Family Welfare took up the programme on a pilot basis in October last year and ensured that the shortcomings were addressed before the full-scale launch. As of March 30, 2023, more than 69.64 lakh people availed themselves of the services under the programme,

For the 'Family Physician' programme, the department has reorganised the PHCs and sanctioned 151 new ones so that every mandal in the State has at least two PHCs covering about 30,000 people each. There are 1,293 PHCs in the State and each of it has two doctors and 12 paramedical staff. Every doctor is linked to six or seven village secretariats through which all the families are connected to their 'family doctors'. The government has appointed 2,879 doctors as 'family doctors'. Phone numbers of the 'family doctors' will be publicised widely so that people can seek help when needed. The 'family doctors' would visit the households in the villages assigned to them at least twice a month between 9 a.m. and 4 p.m. using the Mobile Medical Units equipped with medical equipment, drugs and diagnostic facilities. The government has purchased 260 MMUs for the purpose.

The 'family doctors' would follow up on general OP, non-communicable diseases, antenatal and post-natal cases, anaemia and other cases during their visits to the villages and also make home visits to check on bed-ridden patients. In addition, the 'family doctors' would also visit Anganwadi centres and ensure proper food was served to children, pregnant women and lactating mothers. The Auxiliary Nurse and Midwives (ANMs) are provided with ANM App to direct patients in need to the Aarogyasri network hospitals and collect feedback on services provided at private hospitals. Meanwhile, the government has increased the number of Dr. YSR Rural Health Clinics (Health sub-centres) to 10,032 from 7,458 and each sub-centre is headed by Community Health Officer, a

B.Sc. nursing graduate. Every clinic is provided with 67 types of drugs for three months and 14 diagnostics, tele-consultation facility to reach out to doctors at PHCs and specialists and district hospitals in case of emergency.

II. MOBILE MEDICAL UNIT (MMUS)

Support to Mobile Medical Units (MMUs) under NHM, now encompassing both NRHM and NUHM is a key strategy to facilitate access to public health care particularly to people living in remote, difficult, under-served and unreached areas. The objective of this strategy is to take healthcare to the doorstep of populations, particularly rural, vulnerable and under-served areas. This is not meant to transfer patients.

MMU services are envisaged to meet the technical and service quality standards for a Primary health Centre through provision of a suggested package of services under 12 thematic areas- Maternal Health, Neonatal and Infant Health, Child and Adolescent health, Reproductive Health and Contraceptive Services, Management of Chronic Communicable Diseases, Management of Common Communicable Diseases & basic OPD care (acute simple illnesses), management of Common Non-Communicable Diseases, Management of mental illness, Dental Care, Eye Care/ENT Care, Geriatric Care and Emergency Medicine. These services are provided free of cost through MMUs, besides enabling referrals.



There is usually one vehicle per MMU, however, in case of more than one vehicle:

- One vehicle is used for transport of medical and para-medical personnel.
- Second vehicle is used for carrying equipment/ accessories and basic laboratory facilities.
- Third vehicle carries diagnostic equipments such as X-Ray, ultrasound, ECG machine and generator.

Deployment of MMUs is based on a population norm with 1 MMU per 10 lakh population subject to a cap of 5 MMUs per district. However, further relaxation of norms is available on a case to case basis, where patients served through existing MMUs exceeds 60 patients per day in plain areas and 30 patients per day in hilly areas, based on the appraisal of proposals submitted by the respective states in this regard. Support to the states/UTS for MMUs is provided both for capital cost as well as operational cost within the ceiling of specified financial norms. The approved operational cost/ recurring cost with a diagnostic van is Rs.24 lakhs, while it is Rs. 28 lakhs for North Eastern states, Jammu & Kashmir and Himachal Pradesh. The recommended human resource per MMU is one medical officer, one nurse, one lab technician, one pharmacist cum administrative assistant and one driver cum support staff. The growing usage of mobile devices and mobile application development services will definitely continue to encourage the growth of mHealth applications in the coming years.

III. CLOUD HOSTING AND DATA STORAGE

Storing data in many cloud storage services offers a reasonable level of security, but it may not align

with government regulations concerning protected health information. The implementation of HIPAA-compliant cloud hosting solutions is crucial to ensure the functionality and efficiency of any healthcare operation that deals with electronic health records (EHR).

Nevertheless, teleconferencing and data hosting represent only a part of the features that could be beneficial for your organization. Additional functionalities such as security mechanisms, location services, appointment management, secure messaging, healthcare provider reviews, visit history, and integration with wearables are all potentially beneficial features.

Certain applications might also require the storage of fitness data from consumer devices like Google Fit and Apple HealthKit. The ability to maintain these integrations securely and efficiently can greatly benefit both the patient and the healthcare provider.

Augmented Reality and mixed reality in Healthcare

in rehabilitation and physical therapy settings, augmented reality (AR) finds application in crafting interactive and captivating exercises. Through the overlay of digital elements onto real-world environments, AR has the potential to inspire and guide patients throughout their rehabilitation journey, enhancing both their engagement and overall outcomes.

Virtual reality in Healthcare

VR has proven to be exceptionally beneficial in healthcare, particularly in the realm of training. The creation of virtual training scenarios for doctors enhances their skills and readiness for medical procedures. Beyond training, VR is also applied in certain contexts for treatment

Wearables become more widespread in Healthcare

With wearables and IoT technologies becoming a common part of our lives, their potential in the healthcare industry has grown enormously. In 2020, Internet of Medical Things (IoMT) solutions accounted for about 30% of the total IoT market.

Wearables

The ability to remotely monitor a patient's status throughout the day with wearables or enable patients to track their own health is immensely valuable. According to the latest GWI data, 3 out of 10 working-age internet users possess a "smart wrist" device, such as a fitness tracker or smartwatch.

Among the fundamental health metrics that a smartwatch can provide, heart rate monitoring is crucial. Yet, the capabilities extend beyond this basic function. Smartwatches can also track physical health using features like pedometers and blood oxygen saturation measurements. Detecting low blood oxygen saturation, a potentially life-threatening condition, becomes possible with specialized sensors on these devices, potentially contributing to life-saving interventions.

Furthermore, smartwatches are enhancing their capability to measure users' blood vitals. Optical technology like Photoplethysmography (PPG) can measure variations in blood volume and composition. As this technology is miniaturized for smartwatch use, it furnishes users with more comprehensive data on their blood vitals. Healthcare providers can leverage this information to offer valuable advice to patients and facilitate accurate diagnoses.

Other IOT Solutions

The integration of IoT can revolutionize hospital operations by connecting various devices and systems. A prime example is the usage of IoT-enabled asset tracking systems, which monitor the location and status of medical equipment. This optimization enhances inventory management, reducing the time spent searching for resources. Additionally, IoT can automate temperature and humidity monitoring in healthcare facilities, ensuring optimal storage conditions for medications and specimens.

Wearable devices and smart hospital beds, equipped with sensors, offer another facet of IoT application. These devices can detect falls or unusual patient movements, promptly triggering alerts to healthcare providers. In emergencies, IoT-

enabled response systems play a crucial role in locating and tracking patients, ensuring swift assistance. Take, for instance, the IntelliVue Guardian solution, which employs wearable biosensors and IoT connectivity to continuously monitor patients' vital signs. It alerts healthcare providers to any abnormalities or signs of deterioration. Furthermore, IoT-enabled solutions extend to remote patient monitoring, telehealth, and connected home care.

Accuracy Challenge

It's essential to remember that wearable technology comes with inherent limitations and may not offer 100% precise data. However, it proves valuable as a tool for tracking trends and monitoring progress over time.

IV. FUTURE TRENDS IN HEALTHCARE TECHNOLOGY

1. The pace of technological advancements is swift, making it challenging to anticipate what the upcoming years will hold. While security measures are expected to enhance throughout the industry, the evolving landscape of threats necessitates a proactive approach to prevention, rather than a reactive response.
2. Advancements in technologies like artificial intelligence, machine learning, and extended reality will stay with us, contributing to ongoing improvement in the quality and efficiency of healthcare. While it might sound like science fiction, the reality of 3D-printed body parts is emerging and has already entered clinical testing. Organs such as ears, corneas, bones, and skin are undergoing trials for 3D bioprinting.
3. Another noteworthy innovation is smart pills, which not only function as pharmaceuticals but also offer care providers valuable insights into patient health. While the first smart pill approved by the FDA emerged in 2017, its common usage is still in progress.
4. When deciding to bring promising healthcare trends to your product, you should team up with the right team of software engineers who understand your needs and goals

CONCLUSION

The transformative possibilities of IoT are nearly limitless in future. With emerging trends such as edge computing, AI and ML, smart agriculture, smart cities, blockchain and digital twins; countless industries have been revolutionized and health care by this technology's growth. Despite its massive potential for changing our world so thoroughly, security precautions must be taken to ensure success when adopting these innovative technologies. By staying agile and welcoming productive collaboration, we can unlock the incredible benefits of implementing IoT-creating new levels of convenience & efficiency while working towards a smarter future overall. Over the past few years, the healthcare sector has faced numerous challenges arising from worldwide digital transformation, the pandemic, significant demographic shifts, and growing patient demands. As we enter the age of evidence-based medicine, individualized healthcare, and digital customer service, it becomes crucial for healthcare practitioners, startups, and entrepreneurs to stay informed about the current trends changing the industry.

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