QUEST
A Peer Reviewed Research Journal
ISSN : 2583-9748 (Online)
© Patna Women's College, Patna, India
https://www.questjournal.in

A Study on Monitoring health using Internet of Medical Things (IoMT) devices

• **Priyadarshini** • **Omisha Sidhi Prakash** • **Anushika Sinha** • **Sana Fatima**

Received : December, 2023
Accepted : January, 2024
Corresponding Author : Priyadarshini

Abstract: *Internet of medical things is part of Internet of things which with help of Artificial intelligence and continuous innovation transforming the globe with their marvellous impact. The rapid progress in this field with AI leads to expanding its market and use case filled in medical field industry to reach singularity. It increases attention that their developments will one day cover it would cover large population and grow exponentially. It is used for continuous evaluation of health and help person to discover dangerous disease at a very early stage. It also increases awareness among person regarding to various diseases. System health monitoring is a set of activities undertaken to maintain a system in operable condition and may be limited to an observation of current system states, with maintenance and repair being prompted by these observations.*

Priyadarshini
Assistant Professor, Department of Computer Applications (MCA)
Patna Women's College (Autonomous),
Bailey Road, Patna–800 001, Bihar, India
E-mail: singh.priyadarshini80@gmail.com

Omisha Sidhi Prakash
Department of Computer Applications (MCA)
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Anushika Sinha
Department of Computer Applications (MCA)
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

Sana Fatima
Department of Computer Applications (MCA)
Patna Women's College (Autonomous),
Patna University, Patna, Bihar, India

"It is Health That is Real Wealth and Not Pieces of Gold or Silver"—Mahatma Gandhi

An in-depth study that how IoMT used in medical field under this research and analysed how much IOMT influenced the society. Our study include some disease like (cancer, epilepsy) and how can be it early diagnose. A throughout analysis of data and market size of IoMT devices were done as well. The intent of this is to make awareness among people for their health for dangerous and silent disease like (Diabetes Miletus).With a thought that it will leave positive impact on large amount of population.

Keywords: *IOMT, Internet of medical things, Artificial intelligence, Diseases, IoMT wearables.*

Introduction:

Internet of medical things is a subsidiary of IOT. It is a field of medical devices and applications that can connect to health care information technology system using networking technologies. It can reduce unnecessary hospital visits and the burden on health care systems by connecting patients to their physicians and allowing the transfer of medical data over a secure network.

IoMT consists of smart devices such as wearables and vital monitors use on the body at home.

Some of its uses are:

- On-body segment: - Trackers, band, sport watches etc.
- In-home segment: - Personal emergency response system (PERS), Remote Patient monitoring (RPM), Video consultations and digital tests.

- In-clinical segment: - Point of care devices used by qualified staff.
- In-hospital segment: - Infusion pumps and wheelchairs. Patient flow management, Zoll's wearables defibrillator examines patients at risk of ventricular tachycardia etc.
- Community segment: - Passenger vehicles to track health parameters during transits, Emergency response intelligence.

Objectives:

The primary objective of IoMT is to enhance healthcare by leveraging technology to improve patient outcomes, streamline healthcare operations, and empower both patients and healthcare providers. Some specific objectives of IoMT include:

Remote Patient Monitoring: IoMT allows healthcare providers to remotely monitor patients' health conditions using various medical devices such as wearable sensors, smart medical equipment, and mobile apps. This enables early detection of health issues, continuous monitoring of chronic conditions, and timely intervention.

Data Collection and Analysis: IoMT devices gather real-time health data, such as vital signs, medication adherence, and activity levels. This data can be analysed to provide insights into patient health trends, allowing healthcare professionals to make informed decisions about treatment plans and interventions.

Personalized Healthcare: IoMT can enable personalized treatment plans based on an individual's unique health data. This approach takes into account factors such as genetics, lifestyle, and real-time health metrics to tailor interventions and optimize patient outcomes.

Efficient Healthcare Delivery: IoMT helps streamline healthcare operations by improving communication between different healthcare stakeholders, reducing administrative burdens, and enabling better resource allocation. This leads to more efficient and timely healthcare services.

Reduced Healthcare Costs: IoMT can potentially reduce healthcare costs by preventing hospital readmissions, enabling early interventions that prevent complications, and optimizing resource utilization within healthcare facilities.

Patient Empowerment: IoMT encourages patients to take an active role in managing their health by providing them with access to their own health data. This empowers patients to make informed decisions about their lifestyles and treatment plans.

Research and Innovation: The vast amount of data generated by IoMT devices can contribute to medical research and innovation. Researchers can use this data to gain insights into diseases, treatment effectiveness, and public health trends.

Data Security and Privacy: Ensuring the security and privacy of sensitive medical data is a crucial objective of IoMT. Robust security measures are essential to protect patient information from unauthorized access and breaches.

Preventive and Predictive Care: By analysing large datasets from IoMT devices, healthcare providers can identify patterns and trends that may indicate potential health risks. This allowsfor proactive interventions and preventive measures to be taken before serious health issues arise.

Methodology:

The implementation of these devices involves several key methodologies and steps to ensure the successful integration of medical devices, data, and systems. Here is the methodology to use these devices efficiently.

- Needs Assessment and Planning: Identify the specific healthcare needs and goals.
- Device Selection and Integration:
  - Select appropriate medical devices and sensors for data collection. These can include wearables, medical equipment, implantable devices, and more.
  - Establish connectivity protocols (e.g., Wi-Fi, Bluetooth, cellular) for seamless datatransmission.
- Data Management and Storage: Implement a secure and scalable data management infrastructure to collect, store, and process the generated data.
- Data Transmission and Communication: Utilize encryption and authentication mechanisms to protect data during transit.
- Data Processing and Analytics: Implement data processing and analytics tools to extract meaningful insights from thecollected data.
- User Interface and Experience:
  - Develop user-friendly interfaces for both healthcare professionals and patients to accessand interact with the data.

- Ensure that interfaces are accessible and intuitive, allowing for real-time monitoringand data visualization.

- Security and Privacy Measures: Encrypt sensitive data, enforce strong authentication, and regularly update security protocols.
- Regulatory Compliance: Maintain documentation and records to demonstrate compliance.
- Testing and Validation: Perform user acceptance testing (UAT) involving healthcare providers and patients to validate system usability.
- Continuous Monitoring and Maintenance:
  - Establish a system for ongoing monitoring, maintenance, and support to address issuespromptly.
  - Regularly update software and firmware to enhance security and functionality.

Method of Approach:

Analyzing data from the devices involves various methods and techniques to extract valuable insights, monitor patient health, and support healthcare decision-making. We are going to use time series analysis in our research paper.

Time-Series Analysis:

Time-series analysis focuses on patterns and trends in data that evolve over time. This isespecially relevant for monitoring chronic conditions.

Seasonal decomposition, autoregressive integrated moving average (ARIMA), and Fourier analysis are common methods used for time-series analysis.

Data Analysis:

We analyze data by given time series model of data analysis in which data is collected through client device and processed through various algorithm, detect anomaly and warn the client and produce report.

Some of devices used are as follows:-

Smart watch: Systems and methods include a cellular, Wi-Fi, and Bluetooth transceiver coupled to a processor; an accelerometer or a motion sensor coupled to the processor; and a sensor coupled to the processor to sense mood or body vital sign; and a wearable device operating wirelessly with the processor, wherein the wearable device includes at least one sensor coupled to a back of the wearable device and wherein the wearable device recognizes and executes a speech command.

Wrist wearable devices are being developed in a variety of ways with differences in shape, purpose, hardware features, etc. It is possible to classify them into two categories attending to their functionalities. there are simple devices with limited capabilities, named as smart bands, whose purpose is to quantify very specific features such as user physical activity, sleep, etc.

On the other hand, there are more advanced and general-purpose devices, known as smartwatches.

Taking into account market shares for both (quantifying) smart bands and smartwatches, nowadays, the number of smart bands is much larger than smartwatches. Also, the smart bands market is very fragmented, more than 40% of devices have a market share of less than 5%. In the smartwatch market the fragmentation is smaller. Apple leads the smartwatch market with a share of more than 45%, followed by Samsung with more than 20% and Motorola with a 10% share (Arriba-Pérez et. al., 2016).

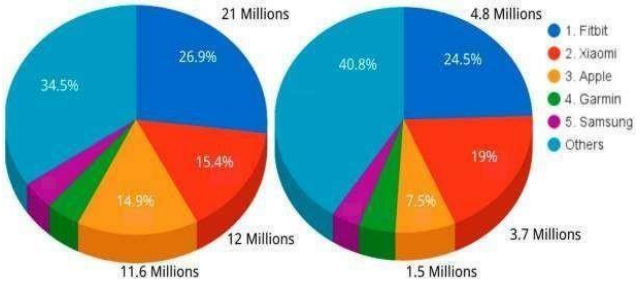


Fig. 1. Wrist wearable devices' 2015 market share on the left side, 1Q 2016 market share on the right side, both by IDC Research Inc. (Framingham, MA, USA)

In addition to the variety of devices, OSs and platforms, there is also a great variety in sensors included in wearables. Its shows the percentage of sensors available in the more than 140 wristwearables analyzed in our piece of research.

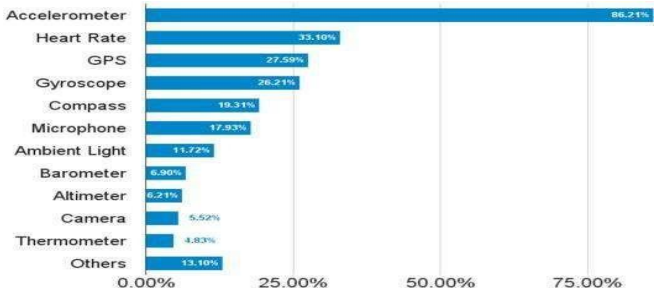


Fig. 2. Sensors data available in wearables

Process of analyzing raw data and transform it into a meaningful are described with help of diagram:

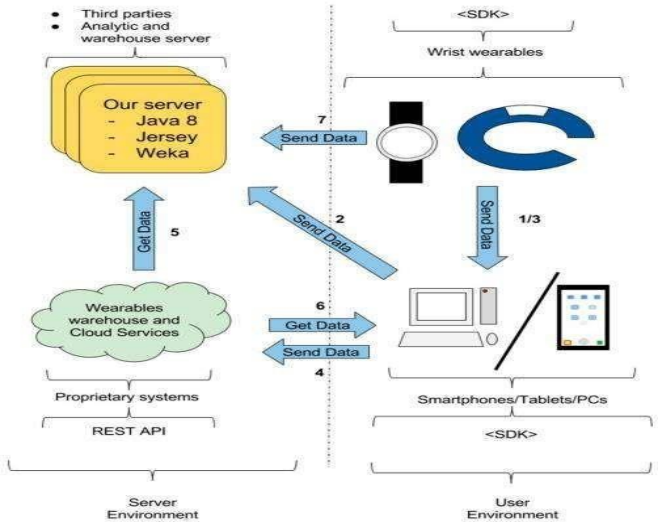


Fig. 3. Systems involved in the smartwatch data collection scenario

Every data of user is identified and transfer to app which is connected to smart watch. Some examples are in form of figure in which sleep of user is analyzed: -

Fig. 4. Sleep analysis by Fitbit based on data from the Fitbit Surge

As a final reflection, it is important to note that current wearables feature quite limited capabilities that restrict their performance.

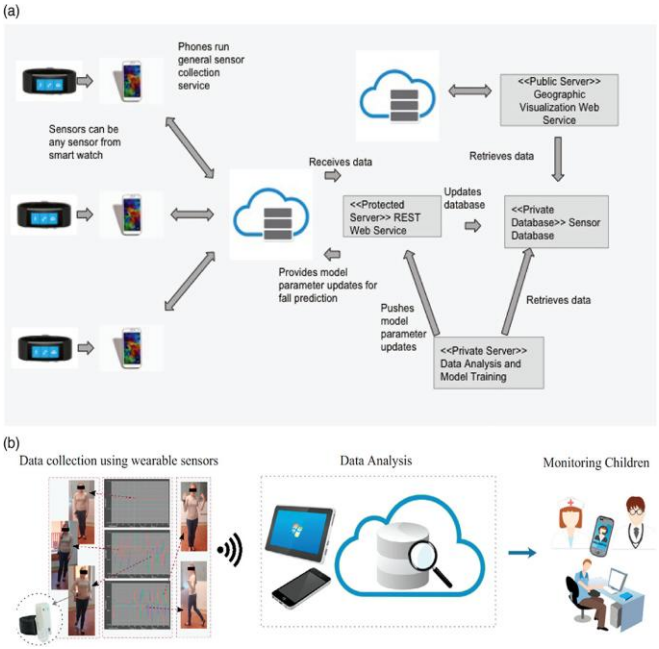


Fig. 5. Describes the sensor by which smart-phone collect and analyze data

It is critical that data can be stored locally to preserve privacy and is in close proximity to the program thatprocesses and analyses the data in real-time. However, the smartphone has a limited storage capacity and there is thus a need to periodically remove the sensed data or transfer the sensor data (with consent from user) to a cloud server securely for continuous refinement of the fall detection model and for the long term archival.

Case study of monitoring health using IoMT device which solve major disease are as follows: A Smart Solution for Cancer Patient Monitoring Based on Internet of Medical Things Using Machine Learning Approach Fuzzy brain-storm optimization algorithm. This algorithm was designed and classified the MRI scan images based on the brain tumour. Its improved various methods accurately calculated the location and shape of tumours based on brain function and its measurements. Its accuracy is 94.21% (Arram et. al., 2022).

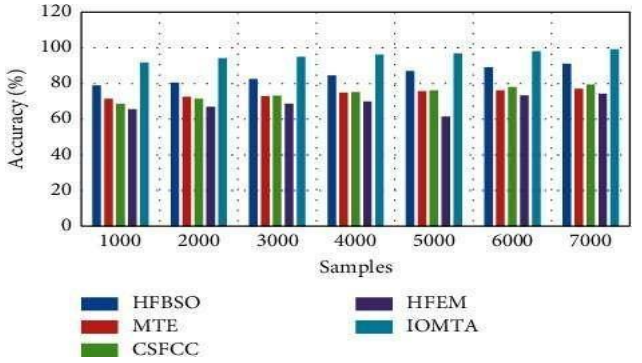
Calculated the number of patients with tumours in the USA-based population. That means that a total of more than 7 lakh people is reported to be living everyday life with different types of tumours, and they estimate that 80% of them are benign malignant tumours and the other 20% are malignant tumours.

According to the latest estimates, 80,000 people are affected by brain tumours. 55,000 of them are classified as belonging to types 1 and 2. A further 25,000 people are reported to be affected by type 3 and type 4 tumours.

Chances of tumor probabilities:

Chances of tumor probability	Level of result
Above 81%	Tumor confirmation: type 4
60% ≤ probability chance ≥ 80%	Tumor confirmation: type 3
40% ≤ probability chance ≥ 79%	Tumor confirmation: type 2
Below 40%	Tumor confirmation: type 1

Measure of tumor accuracy



Measurement of tumour precision

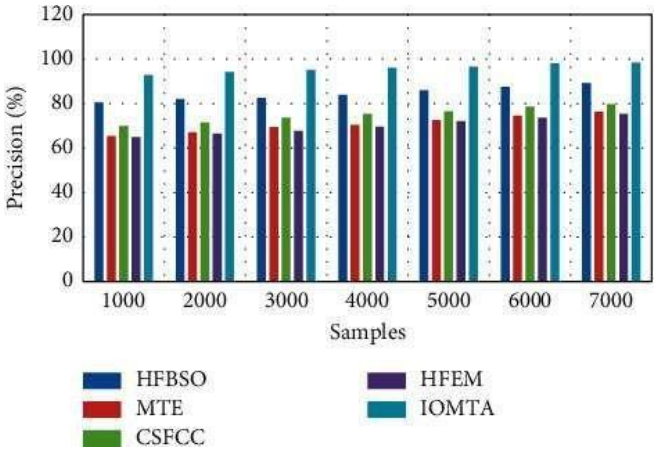


Fig. 6 and 7. Measure of tumor accuracy and precision

The tumor accuracy is the parameter which describes the ratio between perfectly predicted tumor input images from the given samples to the total number of collected image samples.When the rate of tumor accuracy is high, then the given output image sample gets the high- quality rate.

IoMT-Based Seizure Detection System Leveraging Edge Machine Learning: Epilepsy is one of the major lifelong diseases which can be occur any time that's why it is very difficult to monitor. For it we can use IoMT based seizure detection system in which data is analyse with help of algorithm in machine learning (Wenshan Zhao et. al., 2023).

As the fast growth of mHealth industry, seizure detection system (SDS) based on electroencephalography (EEG) has become a research hotspot. Cloud-based approach for EEG-based SDS has several shortcomings introduced by the wireless transmission of large amounts of EEG data. In this context, this article proposes an implementation method for EEG- based SDS leveraging edge machine learning. The hardware-friendly seizure detection algorithm (SDA) is presented to meet the requirement of edge devices with limited hardware resources. The feature extractor based on exponential moving average and generalized Hurst exponent (EMA– GHE) is proposed, and the random forest (RF) is employed as a classifier, in which the synthetic minority oversampling technique (SMOTE) is used to address the problem of imbalanced classification. Meanwhile, a field-programmable gate array (FPGA) is used as an edge device, and the software–hardware co-design method is employed to decrease hardware resource utilization. Experimental results show that the proposed method achieves excellent seizure detection performance, with the sensitivity (SE) of 95.2%, specificity (SP) of 99.9%, F1 score of 0.963, and area under the curve (AUC) of 0.976. The power consumption for the core logic module of the designed SDS is 316 mw with a low response latency of 112 m/s. The applicability of designed edge-based SDS in the Internet of Medical Things (IoMT) framework is demonstrated by the constructed validation platform.

Epilepsy is a nervous system disorder, affecting almost 50 million people worldwide. Despite the development of epilepsy therapeutics, 30% of patients continue to suffer from recurrent and unprovoked seizures, which greatly reduce their

quality of life. With the emergence of smart healthcare, a seizure detection system (SDS) has been proposed as a promising tool for the health management of intractable epilepsy. By employing a seizure detection algorithm (SDA), SDS can recognize epileptic seizures timely using smart sensors, and provide patients and caregivers with real-time warning calling for help. Also, SDS can record seizure times automatically, and generate accurate seizure diaries to replace unreliable self-report by patients, which can improve therapeutic decision-making and the quality of drug trials.

We can conclude that we can solve many serious and severe problem using consumer wearable IoMT device which help to early diagnose of disease and patient can easily monitor their symptom and takes further step. IoMT device is cost effective if we apply on large scale and also increase GDP of our country which also make country developed economically and physically also.

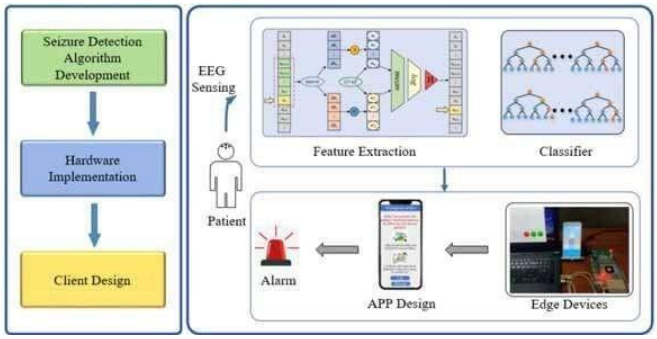


Fig. 8. Represent Epilepsy detection using machine learning

Future Scope:

The global market size of IoMT is valued at 65.72 billion in 2022 and predicted to reach 357.35 billion by 2031 (Internet-of-medical-things-market).

The innovation of IoMT is already taking place in INDIA. The IIT Kanpur and Ansys created a startup that is developing a modular, power-efficient and low-cost ventilator (CSR Agreement signed to help fight COVID-19 with Nocca V110 April 09, 2020).

The startup Nocca Robotics pt. ltd. plans to design these ventilators with an IoMT functional design (Nocca-robotics).

India has begun to integrate IoMT sensors into ambulances. These sensors provide a patient's vitals in real-time to healthcare cloud ecosystem.

The future scope of the Internet of Medical Things (IoMT) in India is promising, and it holds significant potential for transforming healthcare in the country. Several factors contribute to the positive outlook for IoMT in India:

Rising Healthcare needs: India has a large and diverse population with varying healthcare needs, IoMT can help address challenges related to access to healthcare services, chronic disease management, and preventive care.

Telemedicine and Remote monitoring: IoMT can support the growth of telemedicine and remote monitoring in India, especially in rural and underserved areas. It helps patients to consult with healthcare providers and receive continuous care remotely.

Chronic disease and management: India is facing a growing burden of chronic diseases like diabetes, cardiovascular diseases, and respiratory disorders. IoMT assist in monitoring patients with chronic conditions, providing timely interventions, and reducethe overall healthcare costs.

Public health initiative: The government of India is actively promoting public health initiatives. IoMT plays a crucial role in disease surveillance, early detection of outbreaks, and improving the healthcare programs efficiency.

Healthcare and Infrastructure development: Investments in healthcare infrastructure, including the expansion of digital health records and health information exchange systems, are ongoing in India. IoMT can complement these efforts by providing real-timepatient data.

Health Insurance and wellness program: IoMT devices are increasingly incorporated by various health insurance companies and wellness programs to encourage healthy behaviours and reduce claim costs.

Research and Innovation: India has a growing ecosystem of healthcare startups and technology innovators. IoMT provides opportunities for research and innovation in areas such as wearable health technologies, AI-driven diagnostics, and personalized medicine.

Data Analytics and AI: The large volume of healthcare data generated by IoMT devices can be harnessed for data analytics and AI-driven insights can aid in disease prediction, drug discovery, and treatment optimization.

Medical Education: Medical education and training can be enhanced by IoMT by providing access to real-time patient data and virtual simulations, improving the quality of medical professionals in the country.

Government Initiatives: The government of India has shown interest in promoting digital health solutions initiatives, like the National Digital Health Mission (NDHM) and Ayushman Bharat health account(ABHA)aim to create a digital health ecosystem offering opportunities for IoMT implementation.[7, ABHA - Ayushman Bharat Health Account or Health ID Card Approved by NDHM.GOV.IN]

However, several challenges need to be addressed for IoMT to reach its full potential in India:

Infrastructure and Connectivity: Steady internet connectivity and development of infrastructure are essential, especially in rural areas, to make sure widespread access to IoMT services.

Data Privacy and Security: Protecting data of patient from security breaches and ensuring data privacy will be crucial for IoMT adoption.

Regulatory Framework: Development and implementation of clear regulations and standards for IoMT devices and services to ensure patient safety and data integrity.

Affordability: Making IoMT devices and services affordable to a broad range of population, including low-income groups, will be crucial for widespread adoption.

Healthcare Provider Training: Healthcare providers need training and education to effectively use IoMT tools and integrate them into their clinical practice.

Conclusion:

The potential of IoMT in India and world healthcare system are vast, but it also raises some financial and management challenges. Addressing these challenges will be crucial to realizing the full potential of IoMT in healthcare system and to ensure that all segments of the population enjoy the benefits of these technologies.

References:

Arriba-Pérez, F. d., M. C.-R., & J. M.-G. (2016). Collection and Processing of Data from Wrist Wearable Devices in Heterogeneous and Multiple-User Scenarios. *Sensors (Basel)*, 16.

Arram Sriram, G. Shekhar Reddy & Prashant B. (2022). A Smart Solution for Cancer Patient Monitoring Based on Internet of Medical Things Using Machine Learning Approach. *Evidence-based Complementary and Alternative Medicine, 2022*, 6. Retrieved from https://doi.org/10.1155/2022/2056807

Wenshan Zhao, Yiyuan Wang, Xuejiao Sun, & Siyu Zhang. (2023). IoMT-Based Seizure Detection System Leveraging Edge Machine Learning. *IEEE Sensors Journal PP(99)*, 2. doi:10.1109/JSEN.2023.3300743

https://www.insightaceanalytic.com/report/internet-of-medical-things-market/1559#:~:text=The%20Global%20Internet%20Of%20Medical,forecast%20period%20for%202023%2D2031. [Retrieved: Dec 2023]

Press Release for immediate publication: Ansys supports IIT Kanpur incubated Start-up to develop ventilators CSR Agreement signed to help fight COVID-19 with Nocca V110 April 09, 2020, Kanpur

Web-links:

https://www.forbes.com/profile/nocca-robotics/?sh=e797d524f1e8 [Retrieved: Dec 2023]

https://www.eka.care/ayushman-bharat/create-abha-abdm-ndhm-health-id [Retrieved: Dec 2023]