International Journal of Scientific Research in Science, Engineering and Technology

Print ISSN - 2395-1990
Online ISSN : 2394-4099

OPEN ACCESS

Available Online at :www.ijsrset.com
doi : https://doi.org/10.32628/IJSRSET

IoT and Chronic Disease Management

Nithin Nanchari
Independent Researcher, USA

Article Info
Volume 8, Issue 3
Page Number : 378-381

Publication Issue :
May-June-2021

Article History
Accepted : 15 June 2021
Published: 25 June 2021

Abstract
Most of the countries with elderly populations are currently facing chronic diseases. IoT technology offers promising solutions to reduce the burden of chronic illness. Despite its promising results, the literature on IoT for chronic illness management rarely undergoes review. This study examines how IoT can manage chronic diseases in developing countries and ranks them by importance. Additionally, IoT-driven diabetes, hypertension, and asthma management systems use smart sensors, wearables, and cloud computing. This research study illustrates how Python, Django, and Flask backend frameworks offer safe data processing and EHR integration, while C, C++, and Rust embedded systems enable real-time data collecting. IoT allows more efficient, cost-effective, and data-driven chronic illness management solutions using these technologies.

Keywords: IoT, chronic disease management, diabetes, hypertension, asthma, predictive analytics, AI, machine learning, cloud computing, healthcare software, real-time monitoring.

Introduction

IoT provides a variety of technologies that may improve health care at reduced cost, enabling continuing delivery. Smart items in the IoT network enable people and things to interact at any time/place to create services. IoT revolutionizes Traditional healthcare systems by providing a continuum of care and precise prognosis, sharing effective health strategies between regions, checking patients' compliance with treatment, offering effective and customized treatment planning, and gaining insight from collected data. IoT allows for more complete health care, particularly for chronic patients. IoT-based healthcare solutions and software development also ensure that devices can talk to each other, that data is sent safely, and that data processing is better. Many IoT apps that connect with wearable devices, smart sensors, and EHR systems employ Python, Java, and C++. Therefore, this research examines IoT's technological use in diabetes, hypertension, and asthma care. It also covers IoT-based frameworks for programming healthcare software and future developments.

IoT in Diabetes Management

Diabetes management requires continuous monitoring of blood glucose levels, insulin administration, and lifestyle adjustments. According to Vettoretti et al. (2020), IoT-enabled CGMs and smart insulin pumps automate data collection and provide patients and doctors with real-time information. Embedded C or C++ microcontrollers handle sensor readings and give data to cloud platforms because Bluetooth Low Energy (BLE) and Zigbee guarantee CGM-mobile app interaction (Lin et al., 2019). Similarly, diabetes management software uses Python for backend data processing and Swift or Kotlin for developing mobile apps. Using TensorFlow and Scikit-learn, predictive modeling may identify aberrant glucose patterns and recommend personalized treatment approaches. Moreover, improved IoT biomedical devices assist individuals with diabetes in self-managing and health organizations. For example, "Figure 2 presents trends of IoT and different levels of medical healthcare in the case of diabetes."

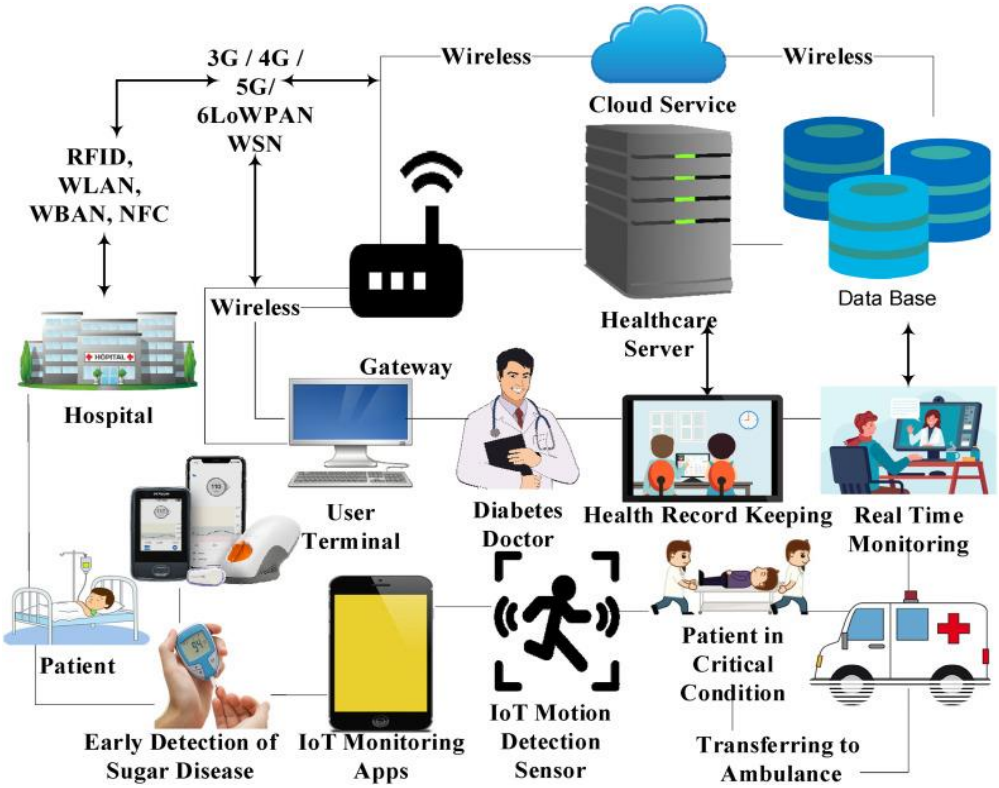

***Figure 2**: IoT-enabled diabetes trends.*

IoT in Hypertension Management

Hypertension, or high blood pressure, requires continuous monitoring and lifestyle modifications to prevent severe complications such as heart disease and stroke. IoT-enabled solutions for monitoring blood pressure let users watch their readings as they happen and share them with doctors for prompt treatment (Kario, 2020). Embedded C-programmed ARM Cortex-M microcontrollers gather and process blood pressure measurements in these devices. Wi-Fi and NB-IoT modules let devices send data to cloud services without wires (Shahidul Islam et al., 2019). Integrating individual time-series data with environmental component data is also becoming more significant for holistic BP monitoring (Figure 2). Researchers have repeatedly linked cold temperatures to higher BP, BPV, and cardiovascular disease risk due to sympathetic nervous system activation, vasoconstriction, and reduced endothelial function.

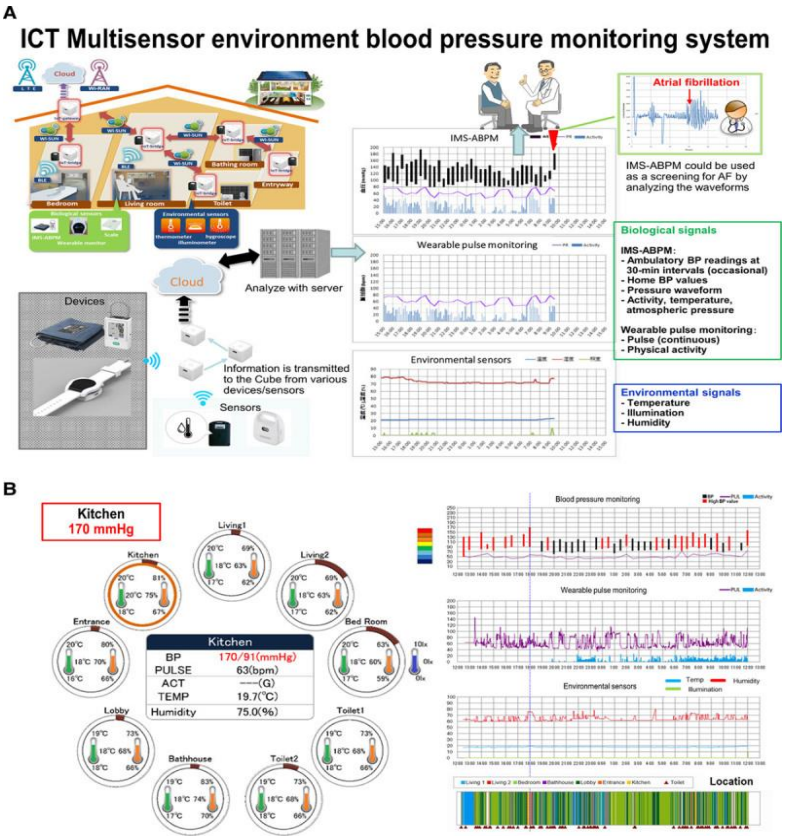

Figure 2: *Digital Hypertension Management*

Hypertension software analyzes blood pressure changes and predicts hazards using machine learning. LaFreniere et al. (2016) state that RESTful APIs allow IoT devices and medical databases to communicate, while Pandas and NumPy handle huge datasets. Using Flutter or React Native mobile apps, patients can easily monitor their blood pressure trends and get alerts when readings go above safe levels. AI improves IoT-based hypertension therapy by finding patterns in patient data and suggesting changes to the patient's lifestyle or prescription. AI-powered chatbots using NLP libraries like spaCy may give real-time advice on what to eat and how to exercise based on blood pressure (Kario, 2020). Cloud-based technologies keep patient data safe and provide remote access, boosting telemedicine and lowering hospital visits.

IoT in Asthma Management

To keep asthma attacks from worsening, asthma management includes monitoring environmental triggers, medication compliance, and lung function. Smart inhalers and air quality sensors based on the Internet of Things can instantly pick up on asthma symptoms and dangerous environmental conditions. These devices transmit sensor data to cloud-based analytics platforms through embedded systems that use C++ or Rust microcontrollers (Valero-Ramon et al., 2020). In asthma management software, AI and machine learning analyze respiratory data to anticipate asthma exacerbations. Patient data is processed via Django or Flask backend services and React frontend apps. JavaScript or Angular provides patients and physicians with dynamic dashboards (Valero-Ramon et al., 2020). Wearables like smart spirometers also use LoRaWAN and BLE to send data about lung function to cloud servers, where algorithms use that data to predict asthma attacks.

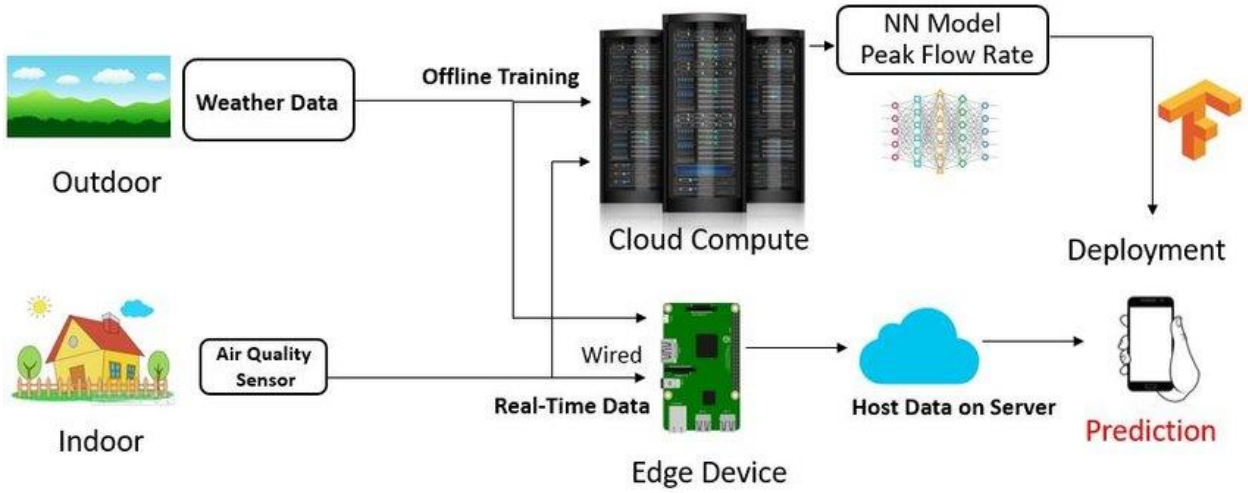

Figure 3: *Block schematic of the machine learning-based IoT asthma risk prediction.*

Conclusion and Future Scope

IoT has enabled real-time monitoring of people with chronic illnesses, using predictive analytics and creating personalized treatment plans. Embedded systems, wireless communication protocols, cloud computing, and sophisticated software programming allow data-driven healthcare management in IoT-enabled diabetes, hypertension, and asthma solutions. However, future IoT-based healthcare advances will concentrate on device interoperability, AI-driven diagnostics, and cybersecurity. Edge computing will cut down on latency and let devices process data in real-time, making them less reliant on the cloud. Blockchain technology will improve data security and patient privacy, boosting confidence in IoT-enabled health.

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