A Review on IoT based m-Health Systems for Diabetes

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ABSTRACT: ***This paper provides an overview of the most recent mobile health applications for diabetes management that are based on the Internet of Things. Diabetes is a metabolic disease characterized by persistently high blood sugar levels. Long-term diabetes management necessitates the participation of patients, doctors, and family caregivers. With remarkable progress in connectivity and web technologies, an amount of Internet of Things-based diabetes management applications have been proposed. The majority of these apps are concerned with patient monitoring and technology-assisted decision-making. Diabetes is a metabolic disease characterised by high blood glucose levels and inadequate or inefficient insulin. Blindness, renal failure, amputation, heart attacks, and stroke are among diabetic consequences. It is the leading cause of death in many developed countries. These new applications work and the underlying architecture, as well as the major challenges and issues they face. The main goal of this paper is to assist researchers in developing advanced diabetes management applications.***

KEYWORDS: Challenges, Diabetes, IoT, Medical Applications, Problems.

1. INTRODUCTION

Diabetes is a metabolic disorder increased blood glucose levels and insulin that is either insufficient or ineffective. Diabetic complications include blindness, kidney failure, amputation, heart attacks, and stroke. In many developed countries, it is the number one killer. In 2010, it was estimated that this disease affected 285 million people worldwide. In the absence of better control or cure, this number is expected to rise to 430 million. The rise can be attributed to two factors: an aging population and obesity. Furthermore, nearly half of all putative diabetics are not diagnosed until ten years after the onset of the disease, implying that the true global diabetes prevalence must be enormous. Insulin-dependent diabetes mellitus (IDDM), also known as Type I diabetes, and non-insulin-dependent diabetes mellitus (NIDDM), also known as Type II diabetes, are the two types of diabetes. Type I diabetes is most common in children, especially between the ages of 12 and 15. Type II diabetes is the most common type, accounting for 80 to 90 percent of diabetics. NIDDM is a type of diabetes that affects adults (usually over the age of 35) and is less severe than IDDM [1]–[4].

Diabetes is curable if caught early enough before it progresses to the danger zone; otherwise, it becomes a serious problem. To keep this disease at bay, blood glucose levels must be monitored on a regular basis. The disease will be under control if you meditate every day and eat a healthy diet. According to new study, adopting diabetic self-management tools may assist regulate glycaemia and blood glucose levels. As a result, software solutions for blood glucose monitoring and modelling have been developed. Because these solutions are limited by their reliance on a PC, new types of solutions that are closer to the user are being developed, such as glucometers integrated into digital photography and cellular phones, i.e., mobile Health solutions (m-Health). In recent years, there has been a lot of research and system development addressing the design and development of health-based diabetes management systems [5].

The Internet of Things (IoT) is a recent communication advancement that connects the internet with everyday sensors and working devices for an all-IP-based architecture that connects physical and virtual objects using data capture and communication capabilities. It is an Internet-connected network of ubiquitous devices or things capable of computation and communication. As the foundation for the creation of autonomous cooperative services and applications, the Internet of Things architecture will provide particular item identification, sensing, and connection capabilities. IoT is reshaping contemporary health care with exciting technical, economic, and social possibilities by leveraging the power of wireless ad hoc and sensor networks, as well as cutting-edge technologies like fog computing and smart devices [6], [7]. Several IoT-based healthcare apps for diabetes control have been suggested in recent years. This

study examines the newest IoT-based diabetes management apps and their functioning and underlying structures. The article addresses the main problems and obstacles they confront, such as technical issues, safety and security, privacy, and trust, and offers fresh insights and research paths in the IoT. The primary goal of this paper is to assist researchers in creating much more sophisticated and efficient IoT-based systems.

1.1 Diabetes M-Health Systems Based On The Internet Of Things:

1.1.1 Sensors and Web-based Services:

A online service that offers low-cost worldwide connection between the patient's personal device and the patient's web portal and updates personal information, medication remaining, and blood sugar level is one approach suggested to manage diabetes remotely. When there is an increase, an automated update is provided to the personal doctor by phone call or SMS.

A Sensor Support System for Diabetes Patient Monitoring is one of the most widely utilized technologies. This tool makes it easier for new members, diabetics, their family members, and anybody else interested in the illness to register. The user must fill out the registration form with their personal information and choose a username and password for their account. Once the information is correct and the registration is complete, the user may log in and take use of the various services available. It is necessary to manage the user profile created upon registration. It is critical to automatically enrol their sensor readings. The sensors must be affixed to the diabetic patient, as well as the RFID tag, which must be linked to the patient's hand. The patient must be at home or at a hospital where the IoT can monitor them remotely. This technique makes use of a variety of sensors. Arduino is an open source microcontroller that allows you to create multidisciplinary projects by making things more flexible and accessible. E-health Sensor Platform—allows Arduino to conduct biometric and medical applications requiring body monitoring by using various sensors as required; Body Temperature Sensor—Used to determine the body's current temperature; Glucometer sensor- It is a medical device for detecting the approximate concentration of glucose in the blood. Pulse and Oxygen in Blood Sensor (SPO2) - It is used to measure the pulse level and quantity of oxygen content available in blood. A tiny drop of blood is put on a disposable test strip by pricking the skin with a lancet, which the meter reads and utilizes to determine the blood glucose level [8]–[11].

The blood pressure sensor, glucose sensor, pulse and oxygen sensor, and body temperature sensor must all be attached to the patient's body, and the related values must be monitored using the Arduino and E-Health Sensor shield. Every time a user connects into a website, the login id and password must be verified using an RFID tag. The measurements are then updated automatically. Sensors attached to the body that interact with each other through IoT technology take the readings. The sensors are installed in the diabetes patient using the Arduino and E-health sensor shield, the measurements are taken from the patient and compared to the database, and finally the observed reading is analyzed; normal, then update; above the normal level, it will automatically send a message and make a phone call to the patient's personal doctor. After that, the data is entered into a website for diabetes patient monitoring. Figure 1 shows the Sensors deployed for diabetes management and Figure 2 shows the Architecture of Sensor support for diabetes management.

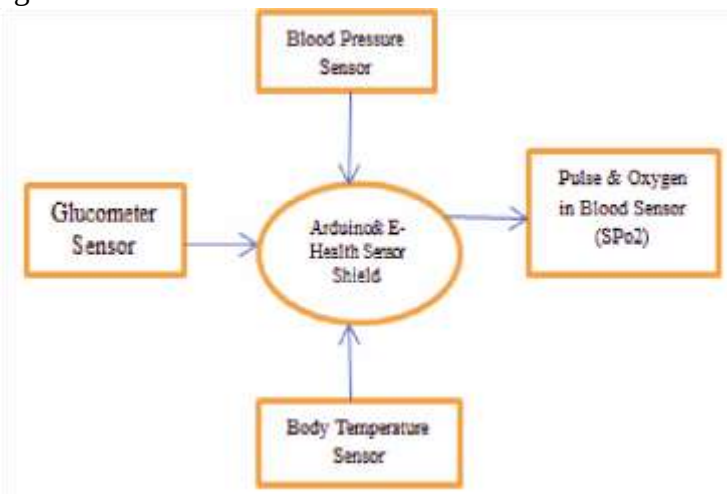

Figure 1: The above figure shows the Sensors deployed for diabetes management.

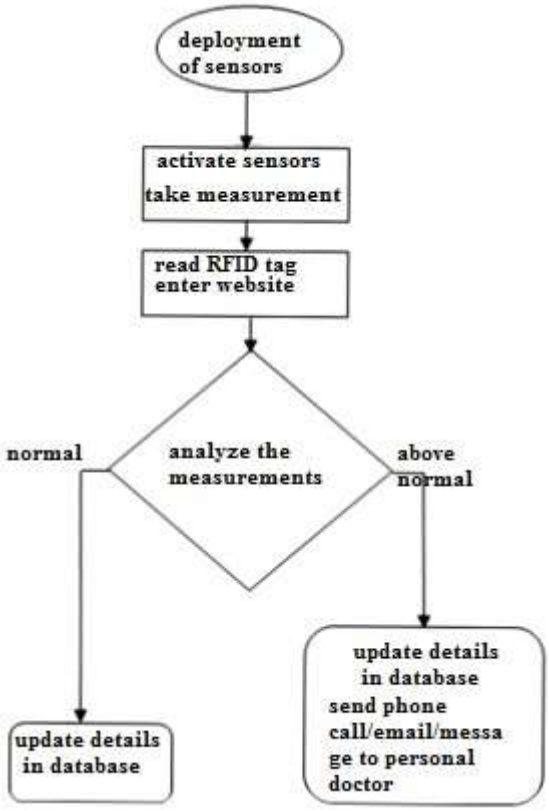

Figure 2: The above figure shows the Architecture of Sensor support for diabetes management.

E-health sensor shield, the measurements taken from the diabetes patient and then compared with the database and finally the observed reading is analyzed; normal, then update; above the normal level, it will automatically send a message and the phone call to the personal doctor to the patient. Then the collected information is updated into the website for Diabetes patient management.

1.1.2 An Internet of Things-based robot assistant for diabetes management:

This system introduces a novel e-Health platform that incorporates humanoid robots to assist a developing multidimensional diabetes care strategy. This technology's design transforms the Internet of Things (IoT) into a web-centric paradigm by using current web standards to access and manage physical layer devices. The policy-aware IoT devices that make up this technological platform have the following design dimensions: Awareness - determines if the patients' actions are in accordance with their unique treatment goals. Representation - applies a set of rules to patients' data streams to extract relevant summaries and health indicators such as blood glucose (BG) trends, insulin bolus calculation, and patients' classification based on health condition characteristics; When self-management outcomes vary from pre-specified goals, interaction utilizes collected data from the patient's electronic medical record to provide reminders, warning messages, and relevant health advice.

Capillary networks and a web-centric disease management hub (DMH) for patient monitoring and illness management are the two major components of this e-Health platform. A wireless local area network (Wi-Fi) connected to an existing network backbone provides long-range communication between these components (the Internet). A set of medical sensors (blood glucose meter, blood pressure & pulse rate monitor, and weight scale) and an existing humanoid robot are included in each capillary network. The medical sensors are connected to the robot through a personal area network (PAN), with the robot serving as the master Bluetooth device. Each capillary network's robot also serves as a link between the patient and his or her medical sensors on the one hand, and the DMH and caregivers on the other.

The software's architecture is divided into three parts:

- System
- Database
- Applications

The basic classes, settings, and service libraries that form a skeleton are referred to as the system. For the robots of the capillary networks and the DMH, the database represents both local and centralized storage. Modules that manage different functions, including human objects, are referred to as applications. The

robot's application modules are responsible for all day-to-day interactions with the patient and his or her medical sensors on the one hand, and the DMH on the other. Data collection, dialogue handler, event handler, network handler, security handler, and database are among the modules. The platform was created to meet the technological requirements of a developing multimodal diabetes care strategy. This platform provides the resources needed to meet this demand via the internet, eliminating the location and time constraints of face-to-face clinic appointments. A DMH dashboard is used for patient monitoring, which offers a single-page overview of the patient's health profile. It also includes connections to all of the platform's major applications, including the treatment plan, conversation wizard, diabetes diary, BG patterns, and others. Patient robot conversations help patients feel empowered and motivated to have a healthier lifestyle and improve their blood sugar management. Specialist clinicians create these dialogues, which are saved in a dialogue library at the DMH and made available to all caregivers. The conversations in this collection may be allocated to patients as needed to assist the illness management process, based on their unique requirements. The robot may interact with the DMH server during the conversation execution to exchange data/messages between the local and distant databases.

1.1.3 An m-Health System Based on Smartphones:

This system demonstrates a new Internet of Things (IoT)-based platform for diabetes self-management. By remotely collecting and monitoring patient data and providing tailored and customized feedback on a smart phone platform, this mobile health (m-Health) method enables for various diabetic treatment aspects. Such diabetic self-management assistance allows for real-time clinician engagement and feedback customized to the patient's specific requirements, based on current and previous patient data. The platform determines whether the patient's actions are in accordance with their unique treatment plans, producing rule-based health indicators and providing relevant warnings and feedback guidance. The platform's physical layer includes wireless nodes, each of which has a collection of medical sensors connected wirelessly to a mobile device. An existing telecommunication infrastructure connects the physical layer nodes to a Web-based application layer.

The Physical Objects Layer handles communications between people and device objects, as well as between objects. It consists of a mobile device and various medical sensors (blood glucose meter, blood pressure, pulse rate monitor, and weight scale) (e.g., smart phone). Bluetooth is used to connect all of these devices. The smart phone, which serves as a master Bluetooth node for a picante of medical sensors, serves as a vital interface between this layer and the health portal applications. It also serves as an interface for patients to interact with the platform. The Network Layer represents long-distance connectivity between the physical layer and the Web health portal. It is based on an existing GSM (3G/LTE) network and/or a Wi-Fi network that is connected to the Internet. The Health Portal layer represents the application layer of the platform built on top of the Internet. It connects the physical layer's various objects to other objects (e.g. health care professionals, hospitals, and other systems). It is also in charge of remote data collection, storage, processing, and monitoring, as well as making decisions based on the limitations imposed by individual patient treatment plans.

1.1.4 An IoT-based Personal Device in Ambient Assisted Living for Diabetes Therapy Management:

Because many factors affect a patient's blood sugar levels, diabetes therapy management in AAL environments, such as old people's homes and diabetes patients' homes, is a difficult task. Unpredictable and possibly hazardous variations in blood sugar levels are caused by factors such as sickness, treatments, physical and psychological stress, physical exercise, medications, intravenous fluids, and changes in the meal plan. As a result, the next generation of personal-care devices must enable accurate insulin infusion calculations. As a result, a personal gadget has been created to help and consider additional variables in the calculation of insulin treatment dose. The system is built on the Internet of Things to support a patient's profile management architecture based on personal RFID cards on the one hand, and to provide global connectivity between the developed patient's personal device based on 6LoWPAN, nurses/physicians desktop application to manage personal health cards, glycaemic index information system, and patient's web portal on the other.

This system presents a personal diabetes management device based on the Internet of Things, in order to provide a new generation of mobile assistance services and take into account more of the factors mentioned for insulin therapy, in order to reduce the number of patient hyperglycemia and hypoglycemia episodes, and thus their risks. This personal device includes 6LoWPAN connectivity to connect to the developed home gateway, RFID identification to load the patient's profile from the personal health card, serial communication via RS232 and IrDA to connect glucometers from various vendors, and a colour touch screen to interact with the patient. Additionally, this personal device includes a glycaemic index information system (with over 2,600 indexed products and growing) to provide information about the impact of the diet on glucose levels, a desktop application for nurses/physicians to configure and review the patient's personal health card based on RFID, a web portal for online patient and specialist management, and finally,

1.2 Context-aware mobile health system:

Diabetes is an incurable illness that requires long-term therapy and care from the patient and his caregivers. Using Internet of Things technology, this innovative system allows for two-way communication between patients and health providers. This technology allows patients to submit their blood glucose readings to the system database, where health experts and caregivers may monitor any anomalies. The system consists of a glucometer that uses the General Packet Radio Service (GPRS), a Blood-Glucose Monitor (BGM) that takes readings from the patient, a telecare android and iOS app for caregivers that allows communication between the patient, health professional, and caregiver, and a cloud server that keeps track of all of these readings. The cloud server, which maintains patient data and permissions from approved caregivers, is at the heart of the system. Abnormal Blood-Glucose Level Detection (ABLD) and a Proactive Notification Engine are also included (PNE). The GPRS BGM is a two-way communication device that runs on Android. Blood-glucose readings are taken using GPRS BGM at various times (before/after meals, in the morning, etc.) and sent to the cloud server using the GPRS protocol and XML format. Patients may get help from afar using the Telecare application.

2. DISCUSSION

The author had discussed about the impact of diabetes on health, Diabetes is a metabolic disorder characterized by high blood sugar levels that do not go down. Patients, physicians, and family caregivers must all be involved in long-term diabetes treatment. A number of Internet of Things-based diabetes management apps have been suggested because of significant development in connection and online technology. The bulk of these applications are focused on patient monitoring and decision-making with the use of technology. Diabetes is a metabolic disorder marked by excessive blood glucose levels and insufficient or ineffective insulin production. Diabetic complications include blindness, kidney failure, amputation, heart attacks, and stroke. In many industrialized nations, it is the leading cause of death. These novel applications, as well as the underlying architecture and significant difficulties and concerns they confront, are discussed.

3. CONCLUSION

Diabetes is a well-known chronic illness that has significant economic and social consequences throughout the globe. Numerous electronic/mobile health (e/mHealth) applications have been suggested in recent years because of technological advances and cost reductions in wireless networks and online technologies. More complex eHealth applications have been proposed and effectively deployed in recent years, taking use of recent advances and cost reductions in wireless networks and online technology. We demonstrated the functionality and underlying architecture of the most recent Internet of Things-based healthcare apps for diabetes control. We looked at the problems and obstacles that these new apps confront. Finally, we proposed potential Internet of Things solutions and future research paths.

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