Management of Diabetes in Children Based on Internet-of-Things

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ABSTRACT

This paper presents a new e-Health platform incorporating humanoid robots to support an emerging multidimensional care approach for the treatment of diabetes. The architecture of the platform extends the Internet of Things (IoT) to a web-centric paradigm through utilizing existing web standards to access and control objects of the physical layer. This incorporates capillary networks, each of which encompasses a set of medical sensors linked wirelessly to a humanoid robot linked (via the Internet) to a web-centric disease management hub (DMH). This provides a set of services for both patients and their caregivers that support the full continuum of the multidimensional care approach of diabetes. The platform's software architecture pattern enables the development of various applications without knowing low-level details of the platform. This is achieved through unifying the access interface and mechanism of handling service requests through a layered approach based on object virtualization and automatic service delivery. A fully functional prototype is developed and its end-to end functionality and acceptability are tested successfully through a clinician-led pilot study, providing evidence that both patients and caregivers are receptive to the introduction of the proposed platform.

Keyword : - *Diabetes, e-health, multidimensional care, sensors.*

1. INTRODUCTION

Prevalence OF diabetes is increasing at an alarming rate worldwide. It is estimated that 415 million people have diabetes, every 6 seconds a person dies from diabetes with the accounts for 12% of the global healthcare expenditure. Benefiting from technology advancements and cost reduction in wireless networks and web technologies, numerous electronic mobile health applications have been increasingly reported in the literature. These applications offered various levels of user interaction intensity; ranging from general information, specific information targeting specific patients, to tailored user feedback information. Authors of these studies generally agree that ICT solutions are effective in diabetes management in terms of patient monitoring and technology-based decision support applications but further studies are still needed to assess the effectiveness of technology-based solutions with respect to long-term behavior change support in self management, adherence and patient engagement with their health careers. In addition, most of these solutions are focused on the functionality, technological and mobility issues but not on behavioral changes and acceptability challenges of these applications. Continued improvement in diabetes self management and, in particular, type 1 diabetes mellitus (T1DM) in children and adolescents therefore requires a multidimensional care approach that is not only focused on routine diabetes care activities but also on psychological and social dimensions

1.1 Background And Motivation

The work presented in this paper suggests a next generation of e-Health platform driven by the requirements of the multidimensional approach of diabetes care and the IoT architectures. It suggests a technology that support diabetes care aspects, robotic coaching, wireless technologies and distributed intelligence in a single platform. Incorporation of robotics in diabetes management, which is not yet thoroughly explored in literature improves patient-caregiver interactions over a distance and allows for a more efficient and cost-effective implementation of the multidimensional care approach.
Understanding from children how they live with diabetes is not an easy task. Several attempts have been made in the past, making use of a number of different methodologies. The Diabetes Attitudes Wishes and Needs (DAWN) is a very important global programme to improve psychosocial support for people with diabetes focusing on the person behind the disease. DAWN was initiated to increase the understanding of how people perceived their diabetes in order to develop better outcomes for diabetes treatment. In the results of the study and the observation that diabetes in children has specific clinical and psychosocial characteristics, the DAWN Youth [4][5] programme was designed. Analyzing this program, Kadohiro et al. [6] reports that 35% of the 6,789 respondents reported to having poor psychological well-being. 47% missed school or school activities because of their diabetes;39% experienced a major to moderate effect on their school performance and 12-17% of them found that diabetes regularly cause them embarrassment, resulting in discrimination and limits their social relationships. In general, support received at schools was reported to be worse than from any other source(family, healthcare services, etc)

1.2 Problem Definition

Diabetes mellitus is a chronic non-communicable disease resulting in increased blood glucose levels. In diabetes there is deficiency of insulin secretion by the pancreas or ineffectiveness of secreted insulin, which can either be inherited or acquired. There are several forms of diabetes, such as:

- Type 1 diabetes mellitus or insulin dependent diabetes mellitus.
- Type 2 diabetes mellitus or non-insulin dependent diabetes mellitus (NIDDM) (other specific types include damage to pancreas by specific causes – toxins, infections etc.).
- Impaired glucose tolerance (≥200mg/dL after 2h of 75g of glucose intake) and impaired fasting glucose (≥126 mg/dL).
- Gestational diabetes mellitus (only during pregnancy).

Approximately 177 million people worldwide are diabetic. This number is likely to double by 2030. Diabetes is responsible for every 1 in 20 deaths from all causes and approximately four million annual deaths are because of complications of diabetes i.e. six deaths every minute or one death every 10 seconds. More than 80 per cent of diabetes deaths occur in low- and middle-income countries. The problem of diabetes is not homogenous in India. Currently, 4.0-11.6 per cent of India's urban population and three per cent of the rural population above the age of 15 has diabetes. India has been called "the diabetes capital of the world," and it is estimated that 41 million Indians have the disease and "every fifth diabetic in the world is an Indian". The prevalence of impaired glucose tolerance test (GTT) ranges from 3.6–9.1 per cent, which indicates a potential of further increase in the prevalence. It is projected to increase to 70 million by 2025. Due to these sheer numbers, the socio-economic burden due to diabetes in India is among the highest in the world. The overall direct healthcare costs of diabetes mellitus ranges from 2.5–15 per cent of annual health care budgets. This burden is likely to only increase with the projected increase in the numbers of people with diabetes. In low income families the cost of care of a diabetic adult is up to 25 per cent of the family income.

Usually, the importance of diabetes prevention is not realized by patients until they suffer from it. The main problem with diabetes is that it cannot be cured, it can only be managed. In India, the Chennai-based Diabetes Research Centre says that over 50 per cent of diabetes cases in rural India and about 30 per cent in urban areas go undiagnosed. In another study, screening has shown that the unknown to- known diabetes ratio is about 1.8:1 in urban areas, whilst it is as high as 3.3:1 in rural places.

1.3 Objective

Diabetes is treatable when it is analyzed before achieving the peril zone, else it turns into a significant issue. There is a need to consistently screen the blood glucose level of patients to keep this sickness under control. Every day contemplation and standard eating regimen will monitor the sickness. Late research shows that utilizing diabetes self-administration frameworks help to control blood glucose levels. Hence, programming arrangements have been characterized for observing and demonstrating of blood glucose. Since these arrangements have the confinement of reliance on a PC, various types of arrangements nearer to the client are being characterized, for example, glucometers coordinated in advanced photography and in phones, i.e., portable Health arrangements (m-Health). As of late, broad research work and framework tending to the outline and advancement of portable Health based diabetes administration frameworks have been seen. Web of-things is one of the real correspondence progresses lately that connections the web with ordinary sensors and working gadgets for an all IP-based design, connecting physical and virtual protests through the abuse of information catch and correspondence capacities. It is a system of omnipresent gadgets or things that are equipped for calculation and correspondence over the Internet. In this paper we intend to overview the most recent IoT based social insurance applications for diabetes administration and survey their working and fundamental structures. This paper will likewise audit the issues or constraints looked by these most recent applications. The primary target of this paper is to help specialists in planning propelled applications for diabetes administration.

2.SYSTEM ARCHITECTURE

A personalized healthcare monitoring system was developed to help diabetic patients to better self-manage their chronic condition. The proposed system records various health-related activities of the users. Moreover, it can be considered as a healthcare information platform that achieves interaction between patients, medical institutions, and medical devices over a wireless network. The main idea behind the system is to collect users' vital signs data using sensors and then transfer the data over a wireless network to a remote service platform. After this, with the help of machine-learning methods, it can help patients to review their ongoing health patterns and predict future changes in health status.

As can be seen in Figure , the BLE-based sensors collect the user's vital signs data and then transfer the data via Bluetooth to the smartphone. A BLE-based device such as a smart band, a blood pressure monitor, weight scales, and a glucometer sensor are utilized to collect user data such as heart rate, blood pressure, weight, and BG level. A prototype android app was developed to receive the user's vital signs data from the sensors as well as user personal input (gender, height, age, and other information). The sensor and personal data are transmitted wirelessly to a secure remote server where the real-time data processing is installed. Two machine learning–based solutions for diabetes classification and forecasting of BG are utilized to analyze and predict future changes in health status given current user personal sensor data. MLP is utilized to predict the presence or possibility of diabetes in the future, while LSTM is utilized to predict the future level of BG. The results of the analysis are then presented to the medical team via a web-based healthcare monitoring system. The results are combined with standard medical care from a doctor and the final personal healthcare treatment is delivered to the patient.

The system architecture for the Diabetes Management System presented in Figure 1 is the conceptual model that defines the structure, behavioral interactions, and multiple system views that underpins the system development. It presents the formal descriptions of the systems captured graphically that supports reasoning, and the sub modules developed as well as the dataflow between the developed modules shows following figure 1

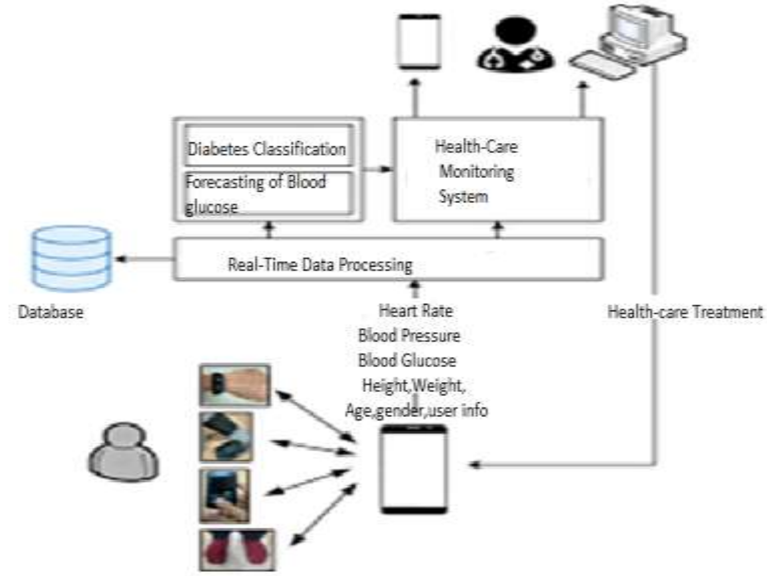

Fig -1: The architecture of the personalized healthcare monitoring system for diabetic patients.

3.CONCLUSIONS

It is understand that diabetes is a noteworthy endless sickness issue worldwide with major monetary and social effect. Profiting from innovation headways and cost lessening in remote systems and web advancements, various electronic/versatile wellbeing applications have been proposed over these years. As of late, more complex applications have been proposed and effectively actualized, profiting by late progressions and cost decreases in remote systems and web innovations. We introduced the working and hidden engineering of the most recent social insurance applications in view of Internet of Things utilized as a part of diabetes administration. We investigated the issues and difficulties looked by these most recent applications. At last we recommended conceivable arrangements and future research headings in Internet of Things.

4. FUTURE SCOPE

The system can be further improved further by adding artificial intelligence system components to facilitate the doctors and the patients. The data, consisting medical history of many patients' parameters and corresponding results, can be explored using data mining, in search of consistent patterns and systematic relationships in the disease. For instance, if a patient's health parameters are changing in the same pattern as those of a previous patient in the database, the consequences can also be estimated. If the similar patterns are found repeatedly, it would be easier for the doctors and medical researchers to find a remedy for the problem.

The clinical experience of families of young children with Type-1Diabetes coupled with the limited research focusing on this age group suggest that there are unique challenges to managing T1D in young children. A more in-depth understanding of the impact of early-onset type 1 diabetes on children as they age, as well as the impact on family members, is needed to better ascertain specific intervention targets. In addition, consideration of other caregivers, including in schools and day care settings, is deserving of future research. Encouraging parent-child problem solving and communication, promoting healthy parent-child interaction around diabetes-related tasks, and allowing young children opportunities to participate in their own care, as appropriate, may also be worthwhile intervention goals.

In terms of clinical care, health care providers working with young children with T1D and their families should take into consideration the many challenges of managing diabetes in this age group. During routine clinics providers may learn a great deal by asking parents about their own level of stress, impact of diabetes on sleep, and parenting concerns. Young child-specific clinics may benefit both families as well as providers, and potentially allow parents to connect with others experiencing similar challenges. From providers, parents may need guidance about child development, and best practices for negotiating picking eating, or managing diabetes in a very active toddler/preschooler. Further, parents would likely benefit from clinical programs that support them in their employment and school/daycare decisions. With the changing health care system and discussion of mental health being incorporated into care with medical providers, perhaps it will become routine for families to meet with a psychologist or social worker as part of a young child's diabetes clinic appointment.

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