



A SMART ROBOT IoT BASED HEALTH SYSTEM FOR DIABETES

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ABSTRACT: This paper presents an IoT based new eHealth platform incorporating with ARM11 processor to support an emerging multi- dimensional 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 en-compasses a set of medical sensors linked wirelessly to a ARM11 processor 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 multi-dimensional care approach of diabetes.

Index Terms— Diabetes, eHealth, Internet of things, Multidimensional care, DMH, Glucometer, Rasberry PI3

I. 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. As a result, there has been an increased pressure on the available healthcare resources, and patients diagnosed with diabetes require a more efficient and individualized disease management plan to prevent (or delay) progression and treatment costs of the short- and long-term complications of the disease. 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 carers. 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.

The multidimensional care approach of diabetes has emerged in 2010, when a multidisciplinary team combined psychological and social aspects with the traditional primary care of diabetes. Preliminary findings from a clinical trial showed a significant improvement in the blood sugar control in those who engaged in this care approach. However, the requirement of engaging additional physicians is likely to be financially unsustainable in the current frugal economic climate in light of NHS staffing constraints. This is where the incorporation of eHealth technologies to facilitate the seamless and asynchronous interaction between the patients and their caregivers could potentially add a significant value by improving both efficiency and productivity of the care process, while providing a personalized and patient-centered experience.

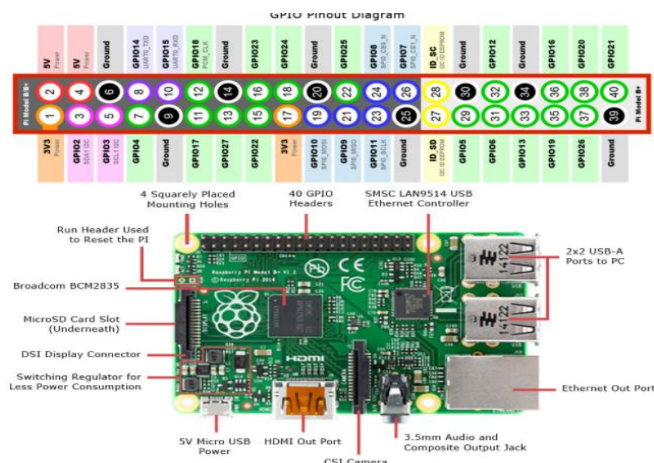


Fig 1: GPIO pinout diagram

II. DISTRIBUTED ARCHITECTURE

The scenario adopted in this paper is an eHealth platform with remote accessibility and manageability of variety of POs. Network architecture of the platform encompasses two main components; capillary networks of the POs and a web-centric disease management hub (DMH) for patients monitoring and disease management. The long-range connectivity between these components is performed through a wireless local area network (Wi-Fi) linked to an existing network infrastructure (the Internet) as illustrated in Fig. 1. Each capillary network comprises a set of medical sensors (blood glucose monitor, blood pressure & pulse rate monitor, and weight scale).

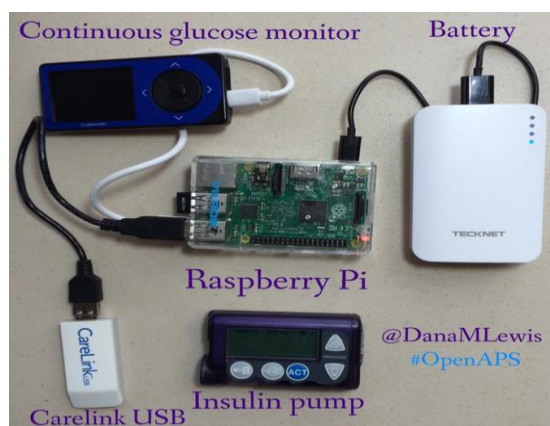


Fig 2: Abstract view of proposed architecture

The medical sensors are linked to an ARM11 processor through a personal area network in which the processor acts as a master Bluetooth device, as illustrated. The ARM11 processor at each capillary network also acts as a conduit between the patient and his/her medical sensors from one side and the DMH and caregivers from the other side. The DMH provides a set of services that cover the full continuum of diabetes management for the patients and their caregivers. Virtual objects (VOs) of the DMH are capable of interpreting events and activities with respect to predefined healthcare policies/guidelines in terms of awareness, representation and interaction. For instance, these objects understand to what extent the patient's activities comply with the treatment plan/guidelines, apply rules on patient's data streams to extract useful summaries, and use accumulated data to create appropriate warning messages and advices to the corresponding objects at the physical layer.

III. METHODOLOGY

In this proposed method a new ehealth platform is implemented for government hospital to check the sugar level for diabetic patients. The ARM11 processor identifies the patient either through a face recognition facility in the processor. Upon successful identification, the microprocessor starts interacting with the patient and how to use the medical devices using video demo. Similarly, the microprocessor attempts to establish a connection with the remote Disease Management Hub(DMH) using the same key subject to its pre-registration at the patient's profile. If successful, the DMH server returns a unique identifier for the microprocessor that is used in all future communications across the platform layers. This ensures that the patients' profiles match the patients, so that suggestion will be provided from DMH. Then microprocessor will convey the suggestion through audio or visual message.

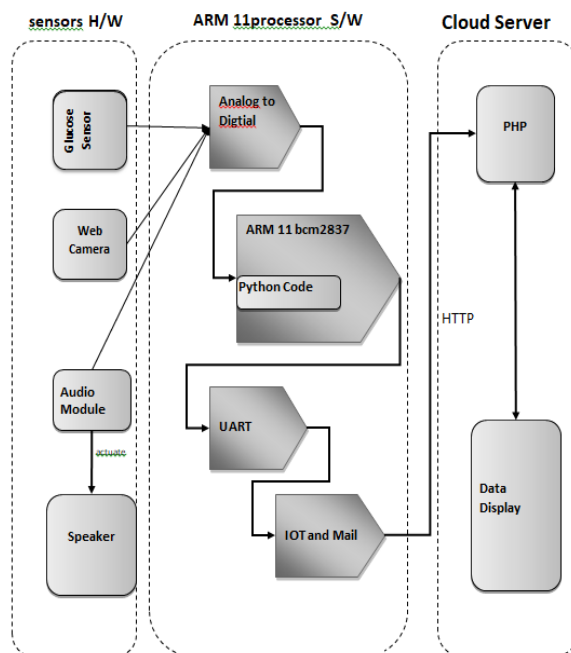


Fig 3:Software Architecture

3.1 RASPBERRY PI3:

The Raspberry Pi 3 is the third generation Raspberry Pi. This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B.

While maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processor, 10x faster than the first generation Raspberry Pi. Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs.



Fig 4:View of Raspberry Pi pin

3.2 GLUCOMETER:

It's a non-invasive type glucometer. Glucometer ear clip kit contains a ear clip and a receiver module. Glucometer measure kit can be used to monitor glucose level of patient and athlete. The result can be displayed on a screen via the serial port and analysis can be saved. The entire system has high sensitivity, low power consumption and very portable.



Fig 5:View of Glucomter

3.3 WEBCAM:

The term webcam is a combination of a web and video camera. The purpose of webcam is to broadcast video on the Web. Webcams are typically small cameras that either attach to a user's monitor or sit on a desk. Most webcams are connected to the computer via USB, though some use a Firewire connection. Webcams typically come with software that allows the user to record video or stream the video on the Web. If the user has a website that supports streaming video, other users can watch the video stream from their Web browsers.



Fig 6:View of WebCam

IV. RESULTS AND DISCUSSION

Numerous test scenarios have been carried out to assess data quality and end-to-end functionality and a seamless, secure and accurate data exchange has been demonstrated between different layers of the platform. In this section, some key aspects of the developed eHealth platform are presented and discussed.

Patient Monitoring:

A sample screenshot for the DMH dashboard that provides a single-page summary for patient's health profile is depicted in Fig. 7. It also provides access links to all key platform applications such as treatment plan, dialogue wizard, diabetes diary, BG patterns, and other applications, as illustrated. The primary design goals, which included the automaticity of remote data collection, monitoring of patients data, and maintaining continuous interactivity between the patients and their health carers have been accomplished. It was also demonstrated that the platform understands to what extent the patients comply with their individual treatment plans. DMH's ability to extract various BG patterns and generate appropriate feedback to patients when their health conditions deviate from specified targets has also been demonstrated successfully.



Fig 7: Sample screenshot of the DMH dashboard

V. CONCLUSION

This paper focuses on fully functional IoT based ehealth platform that incorporates ARM11 processor in diabetes management in children. This method facilitate a continuous loosely coupled connectivity between patient and their caregivers over a distance and thus, improving patient's engagement with their caregivers and minimize the cost, time and effort of the traditional periodic clinic visits. This system contribute to long-term behavioral change from unhealthy to healthy lifestyles.

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