DIABETES PATIENT MONITORING SYSTEM BASED ON INTERNET OF THINGS

[1]Aswathi M, [2]Kalyani K N, [3]Saranya T V

[1, 2]Student, [3]Assistant Professor
Electronics and Communication Engineering
PSVP Engineering College, Chennai, India

Abstract- **This paper presents a new eHealth platform 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.**

*Index Terms-***Diabetes, DMH, ehealth, Haar cascade.**

I. Introduction

Patients living with diabetes are not constantly watched, like in a clinic or a hospital, but are managing their disease largely by themselves. Therefore, patients need to make the best-individualized care decisions about daily management of their diabetes.Every 6 seconds a person dies from diabetes with the accounts for 12% of the global healthcare expenditure [1].

Diabetes mellitus is characterized by abnormal high levels of sugar (glucose) in the blood.Generaly, after a meal,the amount of glucose in the blood increases, it triggers the release of the hormone insulin from the pancreas. Insulin stimulates muscle and fat cells to remove glucose from the blood and stimulates the liver to metabolize glucose, causing the blood sugar level to decrease to normal levels.But in case of people with diabetes, blood sugar levels remain high. This is because insulin is not being produced at sufficient levels, or not produced at all or not as effective. The most common forms of diabetes are type 1 diabetes (5%), and type 2 diabetes (95%). Gestational diabetes occurs in pregnancy, and other forms of diabetes are very rare and are caused by a single gene mutation.

For many years, scientists have been searching for clues in our genetic makeup that may explain why some people are more likely to get diabetes than others are. "The Genetic Landscape of Diabetes" introduces some of the genes that have been suggested to play a role in the development of diabetes.

Benefiting from technology advancements and cost reduction in wireless networks and web technologies, numerous electronic /mobile health (e/m Health) applications[2]-[4] 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. 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.

The multidimensional care approach of diabetes has emerged in 2010 [5], 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[6]. 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.

This paper proposes the Internet of Things communication framework as the main enabler for distributed worldwide health care applications. Starting from the recent availability of wireless medical sensor prototypes and the growing diffusion of electronic health care record databases, we analyze the requirements of a unified communication framework. Our investigation takes the move by decomposing the storyline of a day in Robert's life, our unlucky character in the not so far future, into simple processes and their interactions. Subsequently, we devise the main communication requirements for those processes and for their integration in the Internet as web services. Finally, we present the Internet of Things protocol stack and the advantages it brings to health care scenarios in terms of the identified requirements.

The Internet of things (IoT) is a new concept associated with the future architecture of applications development in which the physical objects (POs) and virtual (or digital) objects (VOs) are interconnected through various means to enable new application and services[7]-[9] . The VOs tend to be smarter representations of the POs through enriching their digital models by cognitive management functions and user information[10]. They also can have several attributes in common[11]. However, based on practical experimentation and prototyping, these objects can be categorized into three types; activity-aware, policy-aware, process-aware objects.The key differences between these object-types can be identified in terms of awareness, representation, and interaction [11]-[13].The work presented in this paper suggests a next generation of eHealth platform driven by the requirements of the multidimensional approach of diabetes care and the IoT architectures.In Existing system checking blood glucose levels by using a blood glucose meter or blood glucose test strips that change color when touched by a blood sample in order to manage diabetes. This meter is only having high class people, but low class peoples are not having this meter. Diabetic patients are to check the sugar level in government hospital some man power is needed, so time taken is high to the doctor suggession. This is the drawback of existing system. And Robot assistant is only personal assistant, this is costvice high. So low class peoples are not buying this robot.

Figure 1. Abstract view of the existing eHealth system

II. Proposed System

This paper helps to implementing the system for the purpose of cheking the sugar level for diabetic patients. The ARM11(fig 1) 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 suggession will be provided from DMH. Then microprocessor will convey the suggestion through audio or visual message.

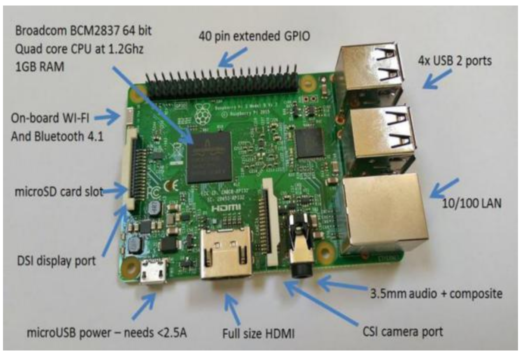


Figure 2. Rapsberry pi 3

The haar cascade algorithm and local binary pattern algorithm are used for the face detection of patient.

Figure 3.Blood Pressure sensor

Blood pressure sensor(Fig 2) is used to measure the pressure values of the patient.And also it measures the pulse values.It is connected with the rapsberry pi through the UART pins.The output of the bp sensor will be the serial data.

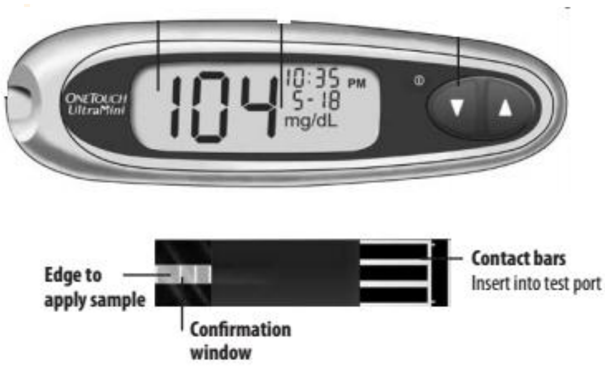
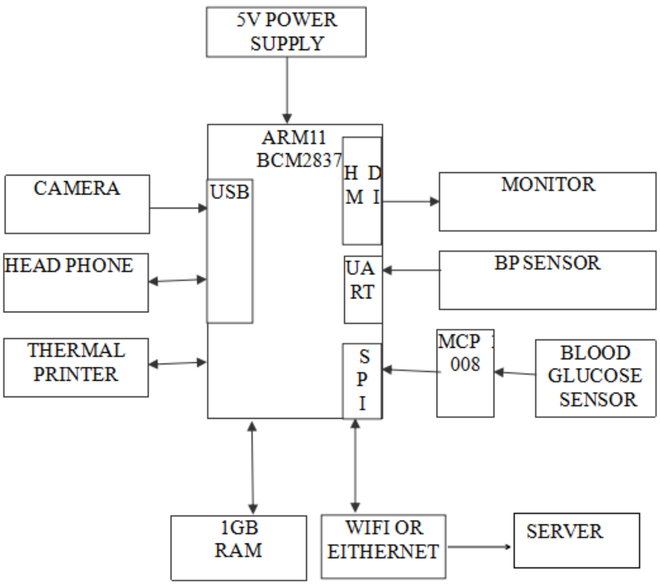


Figure 4.Blood glucose sensor

Blood glucose sensor is used to measure the blood glucose values.It is connected to the MCP 3008 analog to digital convertor.The BG values from the sensor taken as a electrical signal and it converted as a digital signal using MCP 3008 and it is given to the kit through the extended GPIO pins.

III. Block Diagram



IV. User Classes and Characteristics

1. DMH (Disease Management Hub).
2. Creation and Allocation of Virtual Objects.
3. Monitoring the patient status.

4.1 DMH (Disease Management Hub):

The Patient profile creation is used to add the patient information to a server and then add the respective kit id. The server maintains the patient information and updates the status of a patient. The kit is used to sense the patient's pulse and blood Pressure. It provides access links to all key platform applications such as treatment plan, BG patterns, and other applications. For the patient, it summarizes the health profile through monitoring patient's vitals and trends of bio-data, pediatric summary and medical summary. For the caregivers, it displays patient's icons that are hyperlinked to the corresponding patient dashboard. This saves time and helps the caregivers prioritizing their efforts accordingly.

4.2 Creation and Allocation of Virtual Objects:

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.

4.3 Monitoring the patient status:

The medical sensors are linked to the system. The system 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.

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). Each capillary network comprises a set of medical sensors (blood pressure,blood glucose & pulse rate monitor) with system

V. Haar cascade algorithm

Viola and Jones[16] introduced a method for accurate and rapid face detection within an image. This technique accurately detects facial features, because the area of the image being analysed for a facial feature needs to be regionalized to the location with the highest probability of containing the feature. For example eyes can detected at the upper part of the face, mouth is at bottom, nose is at the centre of face. By regionalizing the detection area, false positives are eliminated and the speed of detection is increased due to the reduction of the area examined. Many different algorithms exist to perform face detection; each has some strengths and limitations. Most of them are based on analysis of pixels. These algorithms suffer from the same problem; they are slow and expensive. Any image is only a collection of colour and/or light intensity values. Analysing these pixels for face detection is lengthy process and also difficult to an algorithm, called HAAR Classifiers, to rapidly detect any object, including human faces, using AdaBoost classifier cascades that are based on HAAR-like features and not pixels.

VI. Local binary Pattern Algorithm

To create an LBP representation of an input texture image, it must first be converted to grey-scale before this operator is applied to each individual pixel within the image.

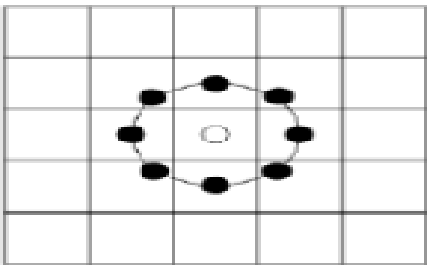


Figure 5.The circular(8,1) neighbourhood LBP operator

The diagram illustrates the algorithm of the basic LBP operator, by producing an LBP code for very pixel.

example			thresholded			weights		
6	4	2	1	0	0	1	2	4
1	6	1	0		0	128		8
8	3	7	1	0	1	64	32	16

Pattern = 01010001 LBP label = 1 + 16 + 64 = 81

Figure 6.Sample calculation for LBP

As was mentioned before, the neighbourhood surrounding a pixel consists of eight pixels, giving a total of 256 different possible labels depending on the relative gray values of that center pixel and the pixels in the neighbourhood. The contrast measure is obtained by subtracting the average gray level below the center pixel from that of above or equal to the center pixel's gray level value. If all eight thresholded neighbours of the center pixel have the same value (0 or 1), the value of contrast is set to zero. The distributions of the LBP codes can be represented as a histogram to be used as features in classification or segmentation.

VI. Results and Discussions

Patient Status

Figure 7 represents the status of patient. This can be viewed by patient after the measurement of BP and BG values.

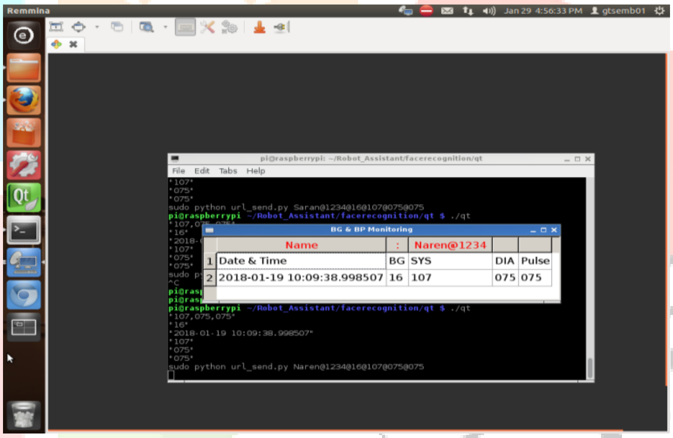


Figure 7.Sample screenshot of patient status

Doctor's Registration Page

Figure 8 represents the doctor's registration page. Here doctor can register with their details with login id and name.

Figure 8.Sample screenshot of doctor's registration page

Doctor's Login Page

Figure 6.3 represents doctor's login page. Here doctor can login and see the patient details.

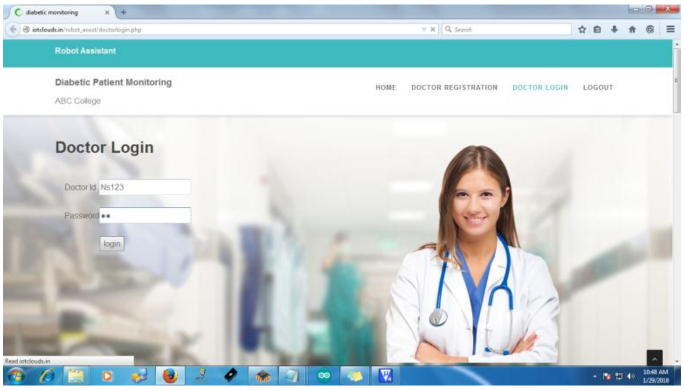


Figure 9.Sample screenshot of doctor's login page

Diabetic Patient Details

Figure 6.4 represents the patient details which is shown in the server. Here doctor can analyse the patient status and can send the prescription to the patient.

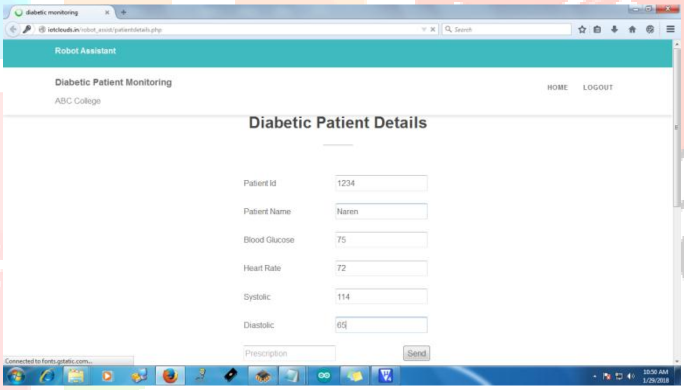


Figure 9.Sample screenshot of diabetic patient details page

CONCLUSION

The fully functional IOT based ehealth platform that helps in the treatment process of diabetes has been designed successfully.This paper presents a system which can measure the sugar level and blood pressure level of the patient by using blood pressure sensor and blood glucose sensor.And this system will give the prescription from the doctor through the server.So this paper presents a single system can measure both bg and bp values.This system is based on the internet of things.The main functionality of the DMH is performed by application, each of which has a specific authorization level. It minimizes the time.This system can be adopted to realize a more flexible patient-robot dialogues.

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