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An IOT Based Non-Invasive Glucose Monitoring using Raspberry Pi

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Abstract: Patients diagnosed with diabetes mellitus must monitor their blood glucose levels in order to control the glycaemia. Consequently, they must perform a capillary test at least three times per day and, besides that, a laboratory test once or twice per month. Diabetes is an incurable disorder which produces various problems related to the body. It is a fast-growing disorder, about 500 million people in the world and 50 million people in India are the victims of diabetes. All problems related to diabetes can be reduced through physical exercise, proper and balanced diet, and medication. The current invasive technique which is painful and inconvenient because people have to prick their finger to draw the blood for the measurement of glucose concentration in the blood on a daily basis so it is not recommended for a lifetime. People living in villages do not have facilities to check their blood sugar level regularly because of unavailability of glucose measurement devices and procedural cost. To overcome the difficulties caused by invasive method we are using non-invasive method in our project. In this project we are displaying the glucose value on LCD and this data can be stored in database, and also this data sent to the doctors through web/android application so that patient can get early medications and they can take precautions.

Keywords: IoT, Raspberry Pi, Health Care, Non-Invasive Glucose level Monitoring.

I. INTRODUCTION

Diabetes mellitus is a metabolic disorder where the blood glucose swings from normal blood glucose level (90-140 mg/dl) . This chronic disease has high morbidity and it is established that the disease is incurable. The increase in sugar level is either due to inadequate production of insulin in blood cells or can be because of improper response of body cells to the insulin or can be because of both the reasons. Diabetes can lead to major complications like heart failure and blindness in the human body. Hence regular monitoring of glucose level is important. There exist three types of diabetes mellitus, which are type 1, type 2 and gestational diabetes. Type 1 comes under most serious type of diabetes mellitus. It occurs mainly when the quantity of beta cell produced in the pancreas was destroyed by the immune system due to which the body fails to produce sufficient amount of insulin. Patients who have been diagnosed with this disease were required to inject the insulin or they must wear an insulin pump. It is usually developed during childhood and adolescence. The most common type of the diabetes mellitus is Type 2.It mainly occurs when excess of insulin is produced within the body and when the insulin is not properly utilized by the body or the cell does not respond to the insulin. It mostly develops in obese and adult people. The gestational diabetes is a third type of diabetes mellitus. It mostly occurs when pregnant women with no history of the diabetes develop a high blood glucose level. The blood glucose level mainly contains three categories, they are hypoglycemia (low blood sugar level), normal blood glucose level and hyperglycemia (high blood sugar level). The normal range of blood glucose level is between 70mg/dl to 100mg/dl for children while 70mg/dl to 150mg/dl for adults.

II. PROPOSED SYSTEM

The proposed system is design and execution of the patient monitoring system. The mandatory sensors are connected with Raspberry Pi and cloud were connected by a WIFI, the below architecture. In our paper we propose the IoT based health monitoring for the diabetes patients. The common way of monitoring is not compatible for all peoples, some of peoples they are moving to a internet world. So that we done this idea for a future execution. The doctor will monitor the patients by day to day monitoring. We collect the health readings by the sensors and that data all are transmit into a Raspberry Pi. From there we upload to cloud storage. The sender side will collect the readings by the patients and transmit to the Raspberry Pi. The receiver side collects the read data by WIFI through Raspberry Pi and store into cloud storage. The glucose estimation method described in the present work consists of a non-invasive optical analysis in which a laser beam is pointed to the user’s fingertip, while for capturing the transmitted light response, an. Previous works use different body tissues (e.g., forearm, ear lobe, finger, cheek) for non-invasive glucose measurement. However, due to its high capillary density and its ease of implementation the fingertip was selected as the most convenient for the present study.

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For this reason, the proposed system was instrumented on a glove, where the Raspberry Pi Zero board was placed in an acrylic case attached to the carpal area, whereas a 3D-printed case housing the image acquisition setup was placed at the index fingertip.

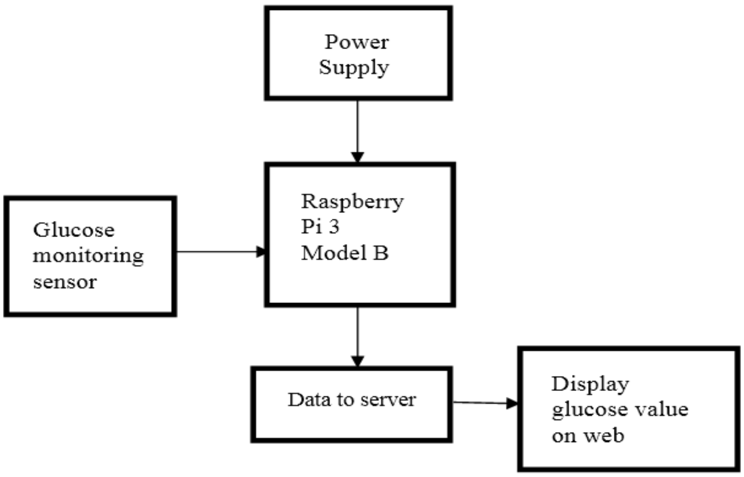

Fig.1 Block diagram of Proposed System

III. MATERIALS AND METHODS

Material and Software used in this project are Power Supply, Raspberry Pi, Glucose monitoring sensor, Web application, Keil C51, Proteus.

POWER SUPPLY: The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

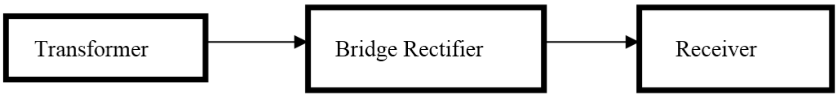

Fig.2 Power Supply Block Diagram

RASPBERRY PI: The Raspberry Pi3 is manufactured in four board configurations through licensed manufacturing agreements with Newark element14, RS Components and Egoman. These companies sell the Raspberry Pi3 online. Egoman produces a version for distribution solely in China and Taiwan, which can be distinguished from other Pis by their red coloring and lack of FCC/CE marks.

Fig.3 Raspberry Pi3 Model B

The hardware is the same across all manufacturers. In 2014, the Raspberry Pi3 Foundation launched the Compute Module, which packages a Raspberry Pi3 Model B into module for use as a part of embedded systems, to encourage their use. The Raspberry Pi3 is based on the Broadcom BCM2835 system on a chip (SoC), which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded (Model B & Model B+) to 512 MB. The system has Secure Digital (SD) or MicroSD (Model A+ and B+) sockets for boot media and persistent storage. The Foundation provides Debian and Arch Linux ARM distributions for download.

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Tools are available for Python as the main programming language, with support for BBC BASIC (via the RISC OS image or the Brandy Basic clone for Linux), C, C++, Java, Perl and Ruby.

GLUCOSE LEVEL MONITORING SENSOR: Blood glucose monitoring is the use of a glucose meter for testing the concentration of glucose in the blood (glycemia). Particularly important in diabetes management, a blood glucose test is typically performed by piercing the skin (typically, on the finger) to draw blood, then applying the blood to a chemically active disposable 'test-strip'. Different manufacturers use different technology, but most systems measure an electrical characteristic, and use this to determine the glucose level in the blood. The test is usually referred to as capillary blood glucose. Healthcare professionals advise patients with diabetes mellitus on the appropriate monitoring regimen for their condition. Most people with type 2 diabetes test at least once per day. The Mayo Clinic generally recommends that diabetics who use insulin (all type 1 diabetics and many type 2 diabetics) test their blood sugar more often (4–8 times per day for type 1 diabetics, 2 or more times per day for type 2 diabetics),[1] both to assess the effectiveness of their prior insulin dose and to help determine their next insulin dose. A blood glucose meter is an electronic device for measuring the blood glucose level. A relatively small drop of blood is placed on a disposable test strip which interfaces with a digital meter. Within several seconds, the level of blood glucose will be shown on the digital display. Needing only a small drop of blood for the meter means that the time and effort required for testing is reduced and the compliance of diabetic people to their testing regimens is improved significantly. Although the cost of using blood glucose meters seems high, it is believed to be a cost benefit relative to the avoided medical costs of the complications of diabetes.

SOFTWARE PROCESSOR

PROTEUS: Proteus PCB design electronic circuits can computer-aided design and circuit boards are designed.

ISIS (Intelligent Schematic Input System): The ISIS Intelligent Schematic Input System (Intelligent Switching input system), is the environment for the design and simulation of electronic circuits. The component library includes claims more than 10,000 circuit components with 6000 Prospice Simulations models. Own components can be created and added to the library.

VSM (Virtual System Modeling): The VSM Virtual System Modeling provides a graphical SPICE circuit simulation and animation directly in the ISIS environment. The SPICE simulator is based on the Berkeley SPICE3F5 model. It can microprocessor-based systems can be simulated. With the VSM engine can interact during the simulation directly with the circuit. Changes of buttons, switches or potentiometers are queried in real-time and LED indicators, LCD displays, "Hot / Cold" Wires displayed. Proteus 7.0 is a Virtual System Modeling that combines circuit simulation, animated components and microprocessor models to co-simulate the complete microcontroller based designs. This is the perfect tool for engineers to test their microcontroller designs before constructing a physical prototype in real time. This program allows users to interact with the design using on-screen indicators and/or LED and LCD displays and, if attached to the PC, switches and buttons. One of the main components of Proteus 7.0 is the Circuit Simulation -- a product that uses a SPICE3f5 analogue simulator kernel combined with an event-driven digital simulator that allow users to utilize any SPICE model by any manufacturer. Proteus VSM comes with extensive debugging features, including breakpoints, single stepping and variable display for a neat design prior to hardware prototyping. In summary, Proteus 7.0 is the program to use when you want to simulate the interaction between software running on a microcontroller & any analog or digital electronic device connected to it.

IV. RESULT AND DISCUSSION

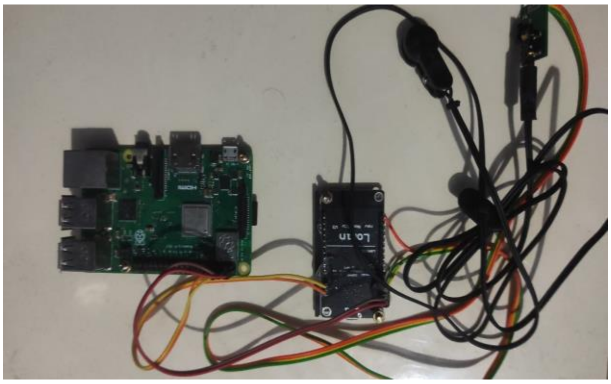

Fig.4 Glucose level monitoring using Raspberry Pi

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The non-invasive blood glucose monitor designed contains a sensor unit, processing unit and display unit. The sensor unit also acts as a transducer which detects the signal from the patients and converts it to the electrical form and transmit it to the processing stage. The processing stage sends the processed data to the output unit to display the results. The sensor used here is an optical digital sensor which is clipped with finger of the patients. The sensor contains transmitter and receiver on both the ends respectively. The glucose levels of patients are displayed on Monitor. After the results are processed, they are displayed. A processing time of about 60 seconds is required for the Monitor to display the results. The obtained results shown on Monitor after 60s can be stored and are transmitted and received using the web server module. After the design, we have to check its accuracy. For its accuracy, we measured the glucose level of the patients both invasively and non- invasively. Around 15 patients were checked for their glucose levels before meals followed by 90 minutes after meals.

V. CONCLUSION

This paper presented an IOT based health monitoring approach to diabetes self-management with the goal of multi-dimensional aspects of treatment, shifting the emphasis from a traditional clinician-centered approach to a patient centered one. The main contributions of this work are the new architecture and development of a platform to support a new multidimensional approach for diabetes care. The main contributions of this work are the new architecture and development of a platform to support anew multidimensional approach for diabetes care From the results obtained, it is concluded that the non- invasive type of glucose measurement is possible, and the output of the non-invasive type results are validated with the help of conventional invasive type glucometer's results with minimum error and tolerance. Our approach to medicine not only provides patients with cost–efficient healthcare but also is healthier (Invasive monitors penetrate the skin and Blood Glucose Measurement Based on 2-dimension Photo acoustic Spectrum have a high potential to cause blood-borne infections) than an invasive approach to detecting glucose. The accuracy of the system can be improved further by obtaining additional measurements at different excitation wavelengths. This should be coupled with improvements in signal denoising to obtain noise-free signals without the need for repeated excitation of the sample. The interfacing of the system with a mobile device and server can enable automated monitoring of blood glucose levels and can provide physicians and healthcare practitioners with an easy way of monitoring the health and well-being of patients under their care. The collected glucose measurements can be used to personalize care by helping ascertain patient response to treatment for adjusting medication dosage and dietary intake. Additional work with larger datasets is needed for implementing these functions and for standardization of the device interconnections under different conditions and system loads. This approach of combining a portable measurement system with a mobile device and IoT services will allow for the collection of detailed health information about a patient and help in delivering personalized treatments that improve their quality of life.

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