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Internet of Things (IOT) Based Personal Device for Diabetes Mellitus Treatment & Management

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Abstract - *The importance of diabetes treatment in various conditions majorly included elder individuals and home patients with diabetes having very difficult conditions and the same number of variables influence blood glucose levels in a patient. Symptoms like sickness, medications, physical and mental pressure, physical movement, drugs, intravenous liquids, and dinner plan change cause unusual and conceivably hazardous variances in glucose levels. At this moment, dose related tasks are centered around methodology steps for insulin imbuement, which is given to the patients by specialists. These steps don't consider extremely compelling variables, for example the eating regimen glycemic list and by this way patients need to gauge the measurement prompting portion, which finishes in a partly scene of hyperglycemia and hypoglycemia. Thus, the estimation of the correct insulin dosage must be helped by the upcoming age of individual consideration gadgets. The glucose sugar level inside a human could be estimated by inserting IR radiations. The level of glucose focus inside the blood relies upon the power upon the frequency explicit of the radiation. For this purpose, a personal device was created to assist in the determination of insulin therapy dose and consider further factors. The arrangement proposed relies on the Internet of Things from one viewpoint also to help the particular with the board arrangement of a patient dependent on close to home RFID cards and the doctor to give worldwide network between the individual gadget made for the patient dependent on 6LoWPAN, program for attendants/doctors to screen individual wellbeing cards, the glycemic file data framework and the patient web-based interface. Along these lines, the proposed framework won't just assistance a person to oversee diabetes yet in addition to screen every single needed parameter and support forestall the difficulties that may emerge from diabetes.*

Keywords: Diabetes mellitus, CGM sensor, hypoglycemia, hyperglycemia, RFID, 6LoWPAN.

1. INTRODUCTION

DIABETES MELLITUS type 1 (DM) a severe and expensive worldwide public health issue today. Research organization figures show that there are today 180 million people suffering from diabetes globally, reaching a total of approximately 300 million through 2025. Mellitus diabetes is a condition with multiple complications. Those with diabetes, for instance, are at expanded danger of creating cardiovascular, kidney or renal disappointment, lower beheading of the appendages, and even lower future than somebody without diabetes. Such confusions may bring about death.

As per the above-mentioned evidence, people with diabetes must take some steps to minimize complications. One crucial precaution to take is to maintain the blood sugar levels as near as possible to ordinary. Productive diabetes the executives incorporates self-observing, including glucose checking, glucose levels following, utilization of drug, and self-care practices, for example, sustenance control and day by day work out. Self-checking could give information required to directing glucose levels by adjusting the eating regimen, exercise, and medication schedule. The preservation of additional health details will also help patients track any problems that may occur. And keeping track of their overall health records is essential for individuals-a systematic strategy rather than only tracking their blood sugar measurement.

A ton of diabetes treatment frameworks are accessible today, however huge numbers of these frameworks are adjustable and centre just around glucose scale or a couple of contemplations. Subsequently in this exploration, we are planning a comprehensive technique structure of the diabetes treatment framework where an individual wellbeing record would be joined with this program. The individual clinical record is a wellbeing record where people hold wellbeing records and archives identifying with all aspects of wellbeing. In addition to helping individuals control diabetes, the new program would also help track all body processes and help avoid problems that could occur from diabetes. Besides, the proposed program would use a cell phone to gather information about sugar intake, macronutrient intake, workout, and medication was taken.

2. LITERATURE SURVEY

Diabetes mellitus is projected to be one of the world's largest chronic illnesses and rising public health concerns. This condition raises the risk that a patient may suffer numerous health problems including heart and kidney failure. These suggestions can, be that as it may, be limited generously by managing blood glucose levels [1]. Factors, for example, tolerant illness, got drugs, physical and mental pressure, physical action, opiates, intravenous liquids, and supper plan (diet) can cause unconstrained, conceivably perilous changes in glucose levels, which brings about scenes of hypoglycemia and hyperglycemia. For instance, a scene of hyperglycemia (high glucose level) postpones the mending procedure and raises the danger of contamination [2, 3].

Ongoing work shows that utilizing self-administration systems for diabetes manages glycemia and the related fluid glucose level. For these purpose, programming solution [4] were indicated for blood glucose checking and displaying.

Since these arrangements have a difficult that depends upon a Desktop, exclusive kinds of easy to use arranging, for example, glucometer inserted in computerizing photography [5] and mobile cell, for example cell wellbeing arranging (eHealth) [6], are being characterized. Hearty research work and program have been seen as of late tending to the structure and execution of mHealth-based diabetes the executive's systems [7, 8]. An ongoing deliberate survey checked this present methodology's suitability as far as its accomplishment in overseeing diabetes and its consequences for escalating circulatory strain management [9].

Web of Things (IoT) is among the advancements in systems administration as of late that associate the web with present day detecting and working gadgets for an all-IP structure, incorporating neighborhood and remote articles through the usage of information obtaining and correspondence usefulness. IOT design will include basic object recognition, sensor, and communication functionality as the basis for autonomous collaborative facilities and technologies creation. Extensive testing has currently been published on the use of this term in various applications [10]. But no research to date discusses this idea and proposes a framework for the pervasive control of individual diabetes.

This article introduces a specific diabetes treatment system focused on the Internet web of Things to include the young era of digital assisting servicing and understand some of the aforementioned insulin treatment causes, to minimize the amount of screen time of patient high blood sugar and hypoglycemia and thus related hazards. This personal computer supports 6LoWPAN networking to link the specific user to the built personal gateway [11], RFID distinguishing proof to initiate the victim's profile from the individual wellbeing card, remote RS232's & IRDA's interchanges to interface the glucometer within various providers, and the shading touchpad to speak within the customer. Moreover, this PC is recognized by a glycemic list the board framework (with more than 2,600 ordered things and. merchandise) that can give subtleties on the impact of dietary glucose, a product program for specialists/clinical experts to modify and check the victim's individual wellbeing card dependent on RFID, A cloud interface for remote patients and advisor the board and, at last, a product layer concentrated on man-made reasoning to distinguish practical insulin treatment for patients supplements this PC. The key objective of this methodology is to give individuals more noteworthy access, information, and cooperation in the customized treatment program of their insulin treatment consolidating the appropriate models that follow.

3. METHODOLOGY

Methodology contains hardware and software components as subsections explained as follows:

HARDWARE COMPONENT

1. Microcontroller IC ATmega328P: The Atmel 8-piece AVRs RISC's base upon microcontrollers incorporates 32 KBs of ISP's streak memory of read-compose capacity, 1 KB of EPROM, 2 KBs of SRAM's, 23 broad useful I/O tomahawks, 32 universal useful worked registers, 3 particular clock & counters with differentiate mode, inside & of outer interferes. USART sequential programmer. Byte-arranging 2 of wire sequential controller, SPI sequential info, 6 of channel & 10 of piece A to D connector (8 channel TQFP or QFN & MLF bundle, programmable inside oscillator guard dog time and five force sparing gadget chose modes. The system works in the spectrum from 1.8-5.5 volts.

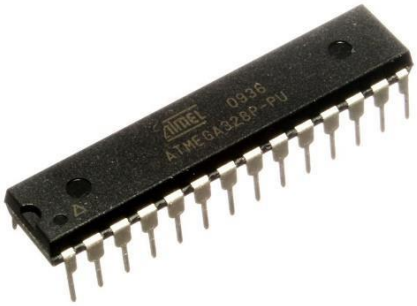

Figure 1: ATmega328P

2. CGM Sensor: Nonstop glucose observing (CGM) gadgets monitor glucose sugar contents through the stipulated time. CGM clients utilize a robotized utensil to include a small sensor wire simple below their skins. The CGM sensor placing is kept set upon by a glue fix, so the senor can screen glucose levels in interstitial liquid during the days as well as nights. A lightweight, reusable transmitting appends to the sensor wired and send the remote, constant perusing to a beneficiary, empowering the client to get to the data. A shrewd gadget good together the CGM frame worked App will filled in the showcase instrument for specific frameworks. The recipient or perfect shrewd framework shows the present degree of glucose, just as chronicled rate designs. At the point when such glucose levels are surpassed, the CGM beneficiary or potentially good brilliant gadget can likewise be arranged to send custom alerts to the client.

Figure 2: CGM Sensor

3. RFID: RFID is abbreviated as for "radio recurrence frequencies identity distinguishing proof" and alluded to an innovative utilizing which a pre use catches advanced information encoded in RFID labels or little names through radio signals. RFID is like barcoded format, within that information is recovered from tags or imprint by a PC that put away info as data in a database. The more important is that information from the RFID labels can be perusing past the view, while standard tags must coordinate having an optical scanner.

Figure 3: RFID

SOFTWARE COMPONENT

1. Proteus Design Suite: The Proteus Programmed Suite is an exclusive set-up of programming apparatuses for the most part utilized for computerizing electronic programming.
2. MATLAB: MATLAB (grid research facility) is a multi-worldview numerical registering condition and Math Works created restrictive programming language.
3. Things Speak: Thing Speak is an open-source (IoT) program and an API for putting away and recovering information from objects over the Internet or through a neighborhood utilizing the HTTP and MQTT conventions.

4. ARCHITECTURE

Architecture of the project involves proposed design model structure, flow diagram and comparison tables having vital information.

PROPOSED DESIGN

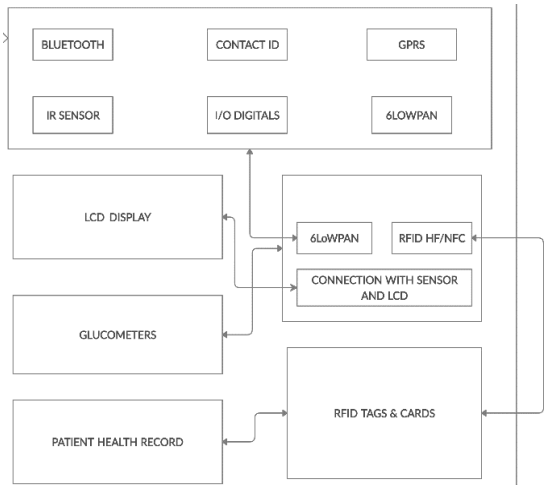

Figure 4: Proposed Architecture

FLOW DIAGRAM

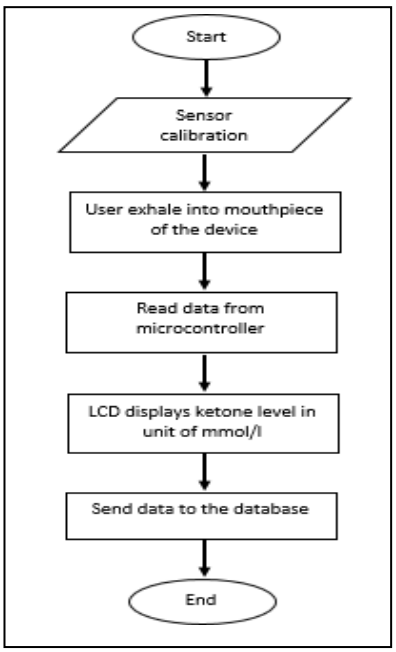

Figure 5: Flow Diagram

TABLES

Glucose levels (mg/dl)	*Rate (mg/dl)*
Abnormal (low sugar)	Less than 65 (mg/dl)

Normal	65 to 120 (mg/dl)
Abnormal (high sugar)	Greater than120 (mg/dl)

Figure 6: Glucose level table

TEST CASES	SCENARIO	OUTCOME
Hyperglycemia	Blood glucose level above 125 mg/dL	Display the high sugar level using CGM sensor
Hypoglycemia	Blood glucose level below 60 mg/dL	Display the low sugar level using CGM sensor
Insulin therapy	Blood sugar level maintains at 90mg/dL	A regular dose of insulin to get a normal blood sugar level display
High-Risk detection	Blood glucose level is 110 mg/dL with family history	Prediabetes levels of blood sugar

Figure 7: Test cases table

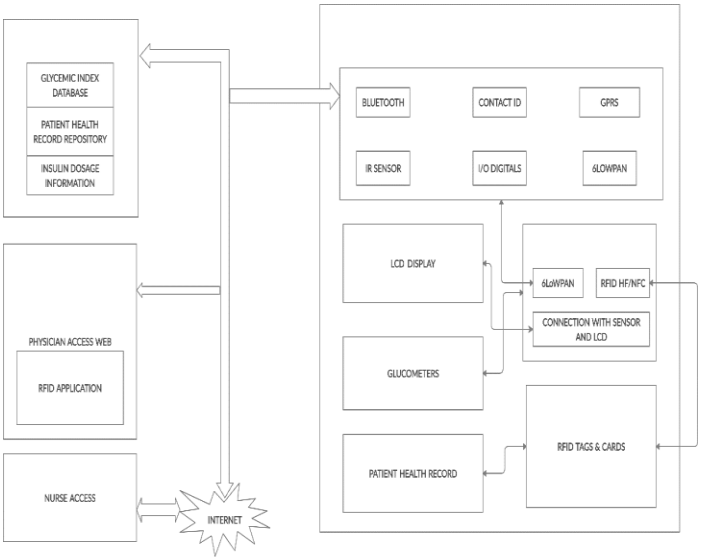

Figure 8 : Architecture diagram For Personal Device

5. WORKING OF DEVICE

The idea of this gadget is principally centered around furnishing a diabetes understanding with an advanced individual convenient gadget that can record fluids glucose measurement and give direction to the patients in regards to next dinner and insulin(liquid) imbuement. The set up structure is centered around the web of things that gives a worldwide system availability and overseeing framework for sensors, instruments, clients and information. This proposition along these lines acquaints a design with make worldwide correspondence to the diabetes care data framework, to accelerate the administration instrument and to upgrade its patients, sensors, and everything around it. This architecture involves many innovative Internet networking technologies such as RFID and 6LoWPAN technologies, which form the foundation of a future generation of internet- based personal services. The key justification for considering issues in our proposal on the Web was that 6LoWPAN access enables staff to be directly connected to the Internet and other information technology, including the definite diabetes control system and RFID offers simple and fast paint identifying and loading the patient's healthcare as a device. The IOT was considered for our proposal. 6LoWPAN is an IETF prototype that expands the wireless network sensor (WSN) over the Internet and then adds a layer supporting IPv6 to IEEE 802.15.4. This defines a wireless link to low latency (LoWPANs) networks. These networks have a much smaller scale, a low bandwidth rate, a low throughput and a low transmission power than other WPAN (e.g. Bluetooth and Wi-Fi). All of this in order to manufacture less power and less-priced sensors.

RFID's is the barcode evolutions that makes it easy to recognize physicians, nurses and patients. It also helps to improve barcode-based approaches by allowing certain data to be stored with RFID cards and tags while barcode enables the storing of an ID code. The additional memory capacity is valuable for preserving patient medical profile information, i.e. in the electronic medical record. It is significant as it enables the patient health record to be reviewed locally even if the device doesn't have Access to the internet.

GLYCEMIC INDEX AND WEBPORTAL DATABASE

There are two angles to the strategy for diabetes the board. At the one side, this decides the information base of the Glycemia's Indexes things database, which is the Diabetic Information Systems. The Mo vital will use the internet to view the GI readings through the glucose information system. At the other hand, this information can also be obtained from the web site created, offering registered users a convenient way to search and receive a list of food items as per their insulin treatment guidelines. The patient can search for the items that match his glycemic index by type or category, select the products they want and sustain the items checklist for the future.

MANAGEMENT OF PATIENT INFORMATION USING RFID

The framework is used and/or reviewed by the physician and nurse for the patient profile and the prescribed dosage as per guidelines of board for insulin. Such documents are kept on individual health card for the patient.

User Data: This segment contains recognizing data for the client, similar to name, address, age, tallness, weight and national or private protection approach numbers. Coming up next is the framework structure.

Info on dosage: This is the doctor's approved insulin therapy sheet. The column data are determined by the glucometer mgs /dl of glucose sugar in fluid blood. Such fields are then filled out in accordance with the patient's profile as per the doctor's advice. All of this is used for multiple main meals every day: dinner, breakfast.

Type of insulin: Two kinds of insulin are present here: bolus (fast) and basal (slow). Slowly insulin is consumed one a day. The tables completed in the dosage information's area covers Bolus insulin, showing the length, peak effect time and start time for each glucose active ingredient chosen, in order to measure the effect of insulin. Index of body mass: this aspect is recognized here as BMI.

RFID read settings: The end segment is the config connections wherein IP addresses & ports are selected. These applications were linked with an RFID card reader to the lib NFC-based software. This is linked by a socket because the USB reader is C-based in interaction and Java Program is the diabetes control program. In parallel, the RFID reading includes in the networks may be used in post aspect via the IPv6 network. Presents how lib NFC and USB readers bind to the program. Touch tag's RFID module is ACS 122.

6. RESULT

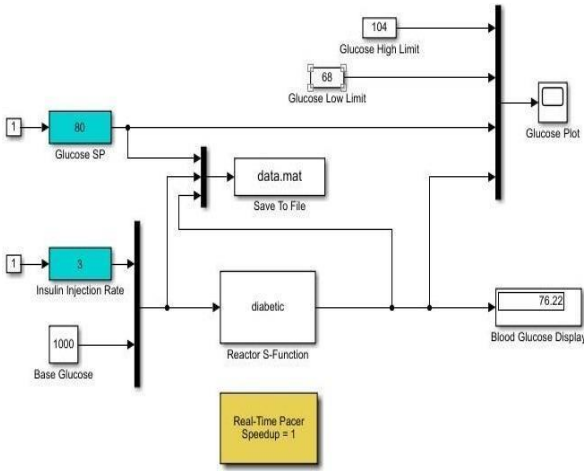

Figure 9: Simulation using MATLAB

Matlab Sensors Simulation Sample code

```
function xdot = blood_glucose(t,x)
global u A
% Input (1)
% Insulin infusion rate (mU/min)
U = 3;
% States (3)
% Plasma Glucose Conc. (mmol/L)
G = x(1,1);
% Plasma Insulin Conc. (mU/L) in remote compartment
X = x(2,1);
% Plasma Insulin Conc. (mU/L)
I = x(3,1);
% Disturbances (1):
% Meal glucose disturbance (mmol/L-min)
% Disturbance from the large meal
D = 3 * exp(-0.05 * t);
% Parameters
% Basal values of glucose and insulin conc.
G_basal = 4.5; % mmol/L
X_basal = 15; % mU/L
I_basal = 15; % mU/L
% For a type-I diabetic
P1 = 0.028735; % min-1
P2 = 0.028344; % min-1
P3 = 5.035e-5; % mU/L
V1 = 12; % L
n = 5/54; % min
Gdot = -P1 * (G - G_basal) - (X - X_basal) * G + D;
Xdot = -P2 * (X - X_basal) + P3 * (I - I_basal);
Idot = -n * I + U / V1;
% Vector to return
xdot = [Gdot; Xdot; Idot];
```

Figure 10: MATLAB simulation pseudocode

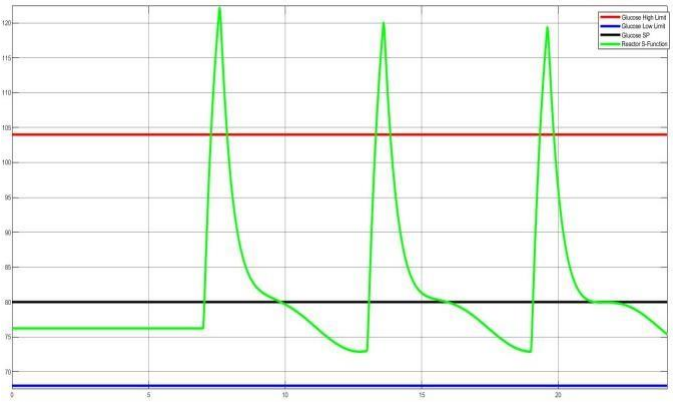

Figure 11: MATLAB Plot 1 Insulin Level

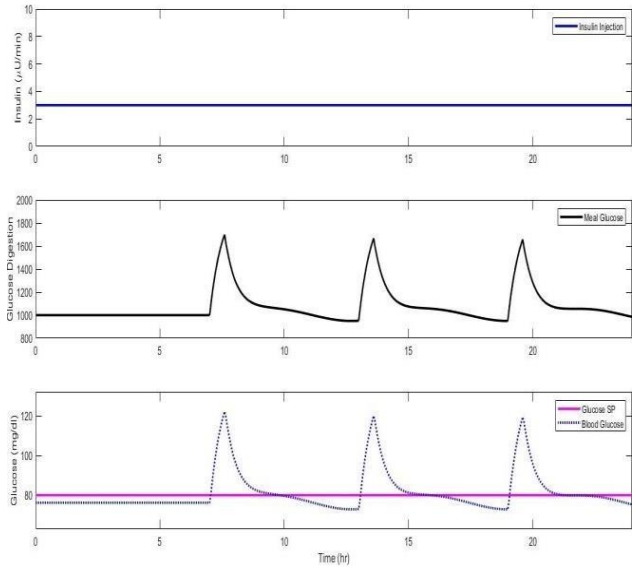

Figure 12: MATLAB Plot 2 Insulin Variation

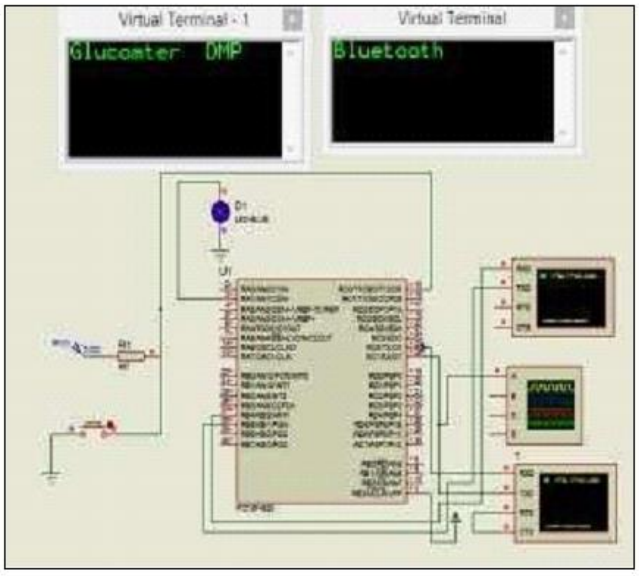

Figure 13: Proteus simulation

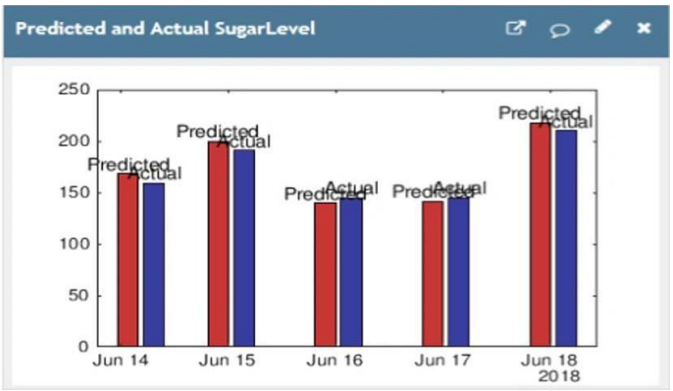

Figure 14: Predicted Sugar levels in ThingSpeak

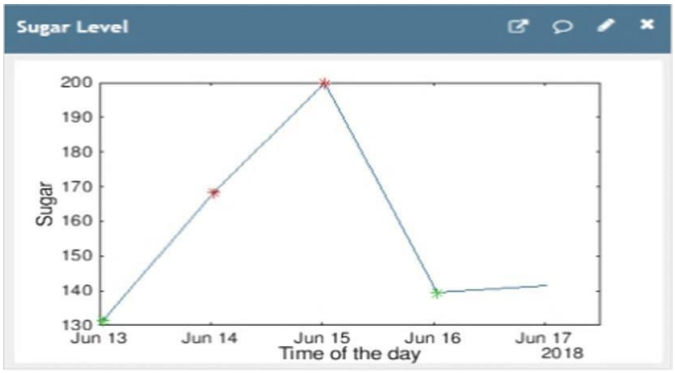

Figure 14: Day wise Sugar levels in ThingSpeak

7. CONCLUSION

Thus, we have implemented the simulation of IOT based personal device for diabetic treatment management on explicit simulation software's which are MATLAB and Proteus 8 Professional. The graphs showed up in MATLAB demonstrated the fluctuating glucose levels i.e. hyperglycemia (Up-level sugar) and hypoglycemia (down-level sugar) with respect to a glycemic index containing pre-defined glucose levels. The Proteus included the schematic representation of the circuit implemented which acts as an interface between the virtual hardware and the mobile device. The data collected from the patient get transmitted to the doctors as well as nurses using RFID tags so that the patient gets a good treatment. The 6LoWPAN protocol has been used for retrieving the data of a particular patient through wireless communication. Thus, the history of the patient could be saved on the cloud database to further access whenever required. The Internet of Things (IoT) feature allows for the significant-time management system of diabetes. Thus, the efficiency of the web-based personal diabetes monitoring device has been shown and implemented successfully.

8. REFERENCES

1. Dr. K. Lakshmi, Darsini, S. Subbaiahs, R. Vasanthakumar, "IoT for monitoring diabetic patients", Internation Journals of Advanced Research, Idea and Innovative in Technologies © 2018, ISSN: 2454-132X.
2. Jongtae Rhee, M. Alex Syaekhoni, Ganjar Alfian, "A Personalized Healthcare Monitoring System for Diabetic Patients by Utilizing BLE-Based Sensors and Real-Time Data Processing", Sensors 2017, 18, 2183; doi:10.33.90/s180/721/83.
3. Ruhani Ab. Rahman, Mat Ikram Yusof, Nur Shima Abdul Aziz, Murizah Kassim, "IoT-based Personal Health Care Monitoring Device for Diabetic Patients", ©2017 IEEE.
4. Kalaiarasi Sonai Muthu Anbananthen, Muhammad Syaifuddin, "Framework: Diabetes Management System", IMPACT-2013 IEEE.
5. Rahul Chauhan, Shreejay Mall, Mansi Gupta, "Diet Monitoring and Management of Diabetic Patient using

Robot Assistant based on Internet of Things", ICEECCOT 2017.
6. Salem Alelyani, Abdelrahman Ibrahim, "Internet- of-Things in Telemedicine for Diabetes Management", IEEE @2018.
7. Dr. B. Sargunam, S. Anusha, "IoT Based Mobile Medical Application for Smart Insulin Regulation", 978-1-5386-8158-9 ©2019 IEEE.
8. M. J. Duncan, M. Kirwan, A. Fenning, and, "Diabetes self-management smartphone application for adults with type 1 diabetes - Randomized controlled trial", 2013, J-Med Internet Res.2013.
9. V. R. Reddy, P. Deshpande, A. D. Choudhury, S. Jayaraman, N. K. Thokala, "A non-invasive Diabetes Mellitus Classification System using Photoplethysmogram signal", Pervasive Computing and Communications Workshops, IEEE International Conference, 2017.
10. A. Thati, T. K. Sau, S. R. Chowdhury, A. Biswas, "BREATH ACETONE-BASED NON-INVASIVE DETECTION OF BLOOD GLUCOSE LEVELS," vol. 8, IEEE 1244–1260, 2015.
11. K. B. Haskard, L. R. Martin, M. R. DiMatteo, "Health Behavior Change and Treatment Adherence: Evidence-Based Guidelines for Improving Healthcare", New York, Oxford University Press, 2010.
12. M. Usha Rani, P. Anupa Elizabeth, J. Goutham, S. Monicka, "Web Based Service for Diabetes Patient Monitoring Sensors", Vol. 3, No. 2, International Journal of Computer Science and Informatics, 2013.
13. N. Laplante, P. A. Laplante, "The Internet of Things in Healthcare-Potential Applications and Challenges", IT Professional, vol. 18 - no. 3, June - 2016.

BIOGRAPHY

Anurup Atul Salokhe received his Bachelor of Technology in Biomedical Engineering from Mumbai University, Maharashtra. He is currently pursuing Master in Technology in Computer Science Engineering. His research interest includes IOT, Wireless Sensor Networks, Robotics, Artificial Intelligence and Machine Learning.