Internet of Thing Based Approach for Glucose Monitoring in Healthcare

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Abstract- *Diabetes is a major health disease in both industrial and developing countries, and it increasing day by day. It is a disease in which the body does not produce or properly use insulin. Diabetes is a metabolic disease in which they occurs high blood sugar levels over a long period of time. Long-term diabetes care requires involvement from patients as well as doctors and family caregivers. With rapid advancements in wireless and web technologies, a number of applications based on Internet of Things have been proposed for management of diabetes. Most of these applications focus on patient monitoring and technology-based decision making. We consider that the survey which directly calculates the Glucose level and robotize with an Alert message with the help of Internet of Things used in diabetes management. The result of the study was compared with the result of previous study on Diabetes.*

Keywords- Diabetes, Glucose, Internet of Things.

I. INTRODUCTION

Diabetes is a chronic disorder of carbohydrate, fat and protein metabolism which is characterized by increased fasting and post prandial blood sugar levels. This is the third leading cause of death in many developed countries The estimation in 2010 is that there were globally 285 million people (approximately 6.4% of the adult population) suffering from this disease. The number is estimated to increase to 430 million in the absence of better cure or control. NIDDM (Non-Insulin Dependent Diabetes Mellitus) occurs in adults (usually above 35 years) and is less severe than IDDM (Insulin-Dependent Diabetes Mellitus) [1]. Diabetes mellitus is a complex metabolic disorder resulting from either insulin inefficiency or insulin dysfunction. It is most common endocrine disease. This disease is characterized by metabolic abnormalities and by long-term complications involving the eyes, kidneys, nerves, and blood vessels. The diagnosis of symptomatic diabetes is not difficult. When a patient presents with signs and symptoms attributable to an osmotic dieresis and is found to have hyperglycemia essentially all physicians agree that diabetes is present. There are two major types of diabetes Type I diabetes and Type II diabetes. Type I diabetes usually diagnosed in children and young adults, and was previously known as juvenile diabetes [2]. Type 2 Diabetes Mellitus is basically due to behavior part and heredity. A number of behavior part are best-known to be important for the development of type 2 Diabetes Mellitus. These are physical inactivity, sedentary lifestyle, cigarette smoking and generous consumption of alcohol. Obesity has been found to contribute to approximately 55% of cases of type 2 Diabetes Mellitus. The increased rate of childhood obesity between the 1960s and 2000s is believed to have led to the increase in type 2 Diabetes Mellitus in children and adolescents. Environmental toxins may contribute to the recent increases in the rate of type 2 Diabetes Mellitus. A weak positive correlation has been found between the concentration in the urine of bisphenol A, a constituent of some plastics, and the incidence of type 2 Diabetes Mellitus [3]. Internet of Things (IoT) is an emerging concept of an ecosystem that consists of automated devices further attached to either a private or public cloud. The cloud helps in capturing/monitoring data for quick decision making process. IoT has tremendous uses in healthcare ranging from medical device unification to remotely monitoring of patients and smart devices. It has the potential to keep patients healthy, safe, and improve the medication provided by physician. IoT in healthcare can also increase patient commitment and satisfaction as it allows patients to interact with their doctors at the click of a button. The system also helps healthcare professionals to monitor patients more effectively and use this data to determine patient care plan and prioritize treatment for the patient accordingly. Comprehensive diabetes management at patient's home is an asserting task as many issues may impact a patient's blood sugar level. The main aim in healthcare would be to retrieve data and further reduce the margin of error. IoT enabled ecosystem are automated and have the capacity to intelligently create alerts and detect the onset of a wide range of health issues, from high blood pressure to early signs of problems from diabetes. The emergency admissions in hospitals can be minimized with proper health systems in place to consider the problem before it becomes uncontrollable. [4].

The architectural elements generally needed in healthcare IoT systems (Health-IoT) are illustrated in Figure 1.

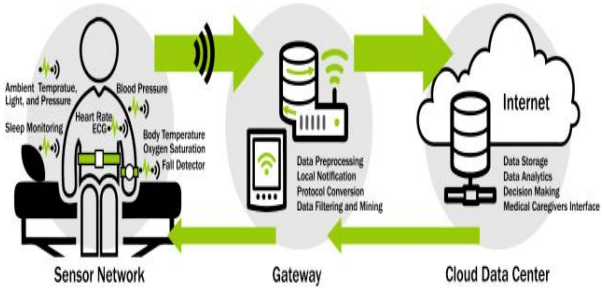

Figure1: General IoT-based health monitoring system [5].

This structure incorporates three principal accessories are; i) the body subject sensor network, ii) internet-linked gateways, and iii) cloud and massive data help. Information generated from sensor connected to customers is made on hand to caregiver, household members and authorized events giving them the potential to examine the topics vital signs from at any place each time. Gateways on the whole act as a hub between a sensor layer and cloud offerings [5].

The below paper is divided into 3 sections:-

- The IInd section is covered by Glucose sensor Monitoring
- The IIIrd section is covered by Literature Survey
- The IVth section is covered by Conclusion & Future Work

Table 2. Survey on Patent of Glucose Monitoring system

Manufacture Name	Patent ID	Date	Description
I. BLOOD GLUCOSE MONITORING SYSTEM	**II. US6110522A**	1995-06-07	It relates to noninvasive systems for monitoring blood glucose and other blood constituent concentrations [6].
III. CONTINUOUS GLUCOSE MONITORING SYSTEM AND METHODS OF USE	**IV. US20040186365A1**	2002-12-31	The invention relates to an in-vivo continuous glucose monitoring system which detects glucose levels continuously and transfers the detected glucose level information at predetermined time intervals to data processing devices for monitoring, diagnosis and analysis [7].
V. BLOOD SUGAR MEASURING DEVICE	**VI. EP2186480A1**	2007-09-07	It is used to provide a safe blood glucose measuring device capable of ruling out the risk of misidentification and misprescription among the patients [8].
VII. GLUCOSE DETECTOR AND METHOD FOR DIAGNOSING DIABETES	**VIII. WO2000064334A1**	1999-04-23	It provides a method of monitoring blood glucose by stimulating salivary gland secretions of saliva into oral fluid, collecting a sample of the oral fluid, detecting an amount of glucose in the sample, and finally quantitating blood glucose level based on the amount of glucose detected [9].
IX. NON-INVASIVE GLUCOSE MONITOR	**X. US6181957B1**	1998-07-13	It concerns methods and apparatus for the non-invasive monitoring of blood glucose levels by spectrographic analysis of the aqueous humor in the anterior chamber of the eye [10].

II. GULUCOSE MONITORING SENSORS

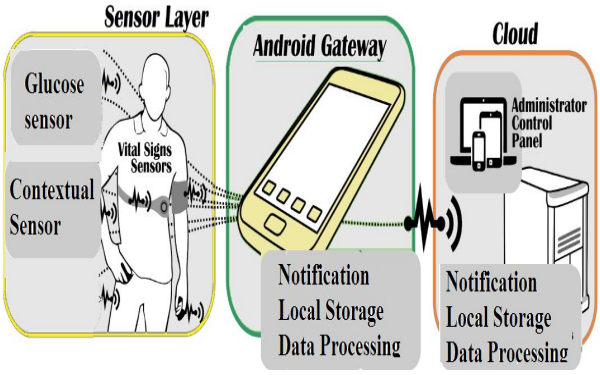

Figure 2: Continuous Glucose Monitoring using IoT [11].

This determine 2 is headquartered on an IoT structure. The system includes three essential accessories equivalent to a transportable sensor device, a gateway and a back-finish method.

The sensor gadget whose constitution is shown in figure 2 includes predominant component blocks such as sensors, a microcontroller, a wi-fi communique block, vigor harvesting and administration add-ons. To power the glucose sensor node a blend of ambient and human powered sources is selected. Because of its ubiquitous availability RF power is an adequate supply for this utility. The proposed gateway collects data from wireless sensor instruments and transmits the data to Cloud servers. The gateway performs its duties through making use of a nRF transceiver and a wi-fi IP-based transceiver (i.E. Wifi, GPRS or 3G) [11].

III. RELATED WORK

Samreen Riaz, (2009) represents [12] Diabetes is a life-lengthy ailment marked by improved stages of sugar in the blood. It's the 2nd leading rationale of blindness and renal sickness worldwide. Diabetes mellitus is a continual disorder brought on by means of inherited and/or received deficiency in production of insulin through the pancreas, or through ineffectiveness of the insulin produced. It is a silent killer sickness and influences millions of peoples in the world. This text generally specializes in the factors, forms, reasons affecting DM, incidences, preventive measures and remedy of the acute and persistent problems of diabetes as opposed to those immediately associated with hypoglycemia and severe metabolic disturbances.

Shankaracharya et.Al. (2010) The author [13] excited about the traits in desktop finding out algorithms as diabetes diagnosis tools. The supervised and unsupervised approaches are used in detection and diagnosis of diabetes at the foremost and its developed phases. On this work, a particular attention is given to the algorithms which make stronger diabetes prognosis. The review paper presents a greater resource for analysts who are concerned with computational intelligence based diabetes analysis approaches. The authors curious about quite a lot of analysis procedures reminiscent of information analysis by way of logistic regression, clustering techniques, support vector machines, Neural networks, and trained methods. The logistic regression is used when the info involves a collection of explanatory variables and a binary response. The clustering techniques make use of okay-means, combination of Gaussians, self-organizing map (SOM) and neural gas (NG) used for diagnosis. The aid vector machines (SVM) is operated via discovering a linear hyper aircraft which separates confident and bad examples with maximum interclass distance. The neural community is of 5 forms namely 1) Multi-layer neural networks 2) again propagation neural networks 3) Radial groundwork perform (RBF) 4) normal regression neural network (GRNN) 5) Neuro-fuzzy inference systems (NFIS). The informed approach making use of combination of gurus and modified blend of specialists has been implemented to overcome the predicament of diabetes analysis prediction. The expertise is that it reduces the healthcare charges by way of early prediction and diagnosis of diabetes.

M.N. Piero et.Al (2015) in this the writer represents [14] Diabetes mellitus is an endocrinological and/or metabolic ailment with an growing global occurrence and incidence. Excessive blood glucose levels are symptomatic of diabetes mellitus as a consequence of inadequate pancreatic insulin secretion or negative insulin-directed mobilization of glucose by way of target cells. Diabetes mellitus is aggravated through and related to metabolic problems that can subsequently lead to premature death. This text explores diabetes mellitus in terms of its historical viewpoint, biochemical groundwork, financial burden, administration interventions along with the long run perspectives.

Nurul Akmal Binti Abd Salam et.Al.(2016). The writer [15] reviewed on the more than a few methods used for blood glucose detection procedure and the development of blood glucose monitoring techniques. The authors dealt most of the time with the Non-invasive blood glucose monitoring approach. The writer reviewed on more than a few invasive ways which might be used over years for blood glucose measurements. In the invasive ways, a pinch of blood sample from the finger by using utilizing needles and the blood is transferred to the glucose dimension gadget for measuring the glucose. The other way of measuring glucose is the in part invasive system wherein it makes use of the method of inserting a sensor into the dermis at the same time measuring the glucose awareness. This paper also proposed a system of non-invasive manner

G.Sharmila, et.Al (2017) presented on this paper [16] a literature survey concerning the various approaches used in self-monitoring of blood glucose levels pervasively. The contraptions used for self-monitoring of glucose degree are additionally discussed in this survey. These devices are very valuable within the gift busy existence state of affairs. The predominant disadvantage of those gadgets is that they're high-priced and can't have enough money by usingall diabetic patients. An inspiration can proposed which includes the coaching of the kit which straightcalculates the glucose stage and automates with an alert message that entails the weight loss program manipulate, pastime manipulate and medicine control. Many of those programs support most effective in self-monitoring of glucose levels. The writer additionally steered that a process can also be proposed that isn't only used for self-monitoring but additionally to know the general information concerning the weight loss plan ,undertaking ,remedy to be taken for that specific blood glucose level. Moreover, the equal understanding can be intimated to their private health practitioner for further reference. The expertise of that system is that the patients don't need to meet their surgeon individually for their check-ups, no need of prior appointments. This method might be of larger significance and usable one day.

Tuan Nguyen Gia, et.Al (2017) offered in this paper [11] the feasibility study of invasive and steady glucose monitoring (CGM) approach using IoT centered process. The author designed an IoT-centered method structure from a sensor device to a back-finish method for imparting actual-time glucose, body temperature and contextual data (i.E. Environmental temperature) in graphical and human-readable forms to finish-customers such as sufferers and medical professionals. In addition, nRF verbal exchange protocol is custom-made for suiting to the glucose monitoring process and attaining a excessive degree of vigour efficiency. Moreover, it examine vigour consumption of the sensor device and design vigour harvesting units for the gadget. In the end, the work supplies many evolved services at a gateway level similar to a push notification service for notifying patient and doctors in case of abnormal instances (i.E. Too low or too high glucose stage). The outcome show that our system is capable to attain steady glucose monitoring remotely in actual-time. Moreover, the results reveal that a excessive degree of energy e_ciency can be executed through making use of the customized nRF component, the vigor management unit and the energy harvesting unit altogether within the sensor gadget.

Ruhani Ab. Rahman , et.Al, (2017) This research offers a procedure of monitoring ketone stage [17] via using breath dimension. Major objective of this research is to present an convenient handheld wellbeing care on monitoring diabetic level with breath. System includes development of hardware connection with web of matters (IoT) procedure to facilitate the procedure of sufferers prognosis and individual monitoring. In this system, Arduino board is used to learn the sensor with sense the breath. Breath value degree is log to method making use of wi-fi communique. Information assortment is interfaced to web web page. Ketone level is measured as the quantity of breath acetone is accrued when patients exhale into a mouthpiece that consists of gasoline sensor. The studying from Arduino is shared to the database through ESP 8266 Wi-Fi Module and can also be accessed via the patients or registered doctors. This research is gigantic where sufferers can independently display their diabetic wellness and the IoT approach can be alerted directly to medial officers in the hospitals.

Arun Chaudhury, et.Al (2017) in this paper the writer represents that [18] Diabetes mellitus is a power, modern, incompletely understood metabolic condition notably characterized via hyperglycemia. Impaired insulin secretion, resistance to tissue moves of insulin, or a combo of each are idea to be the most typical explanations contributing to the pathophysiology of T2DM, a spectrum of sickness in the beginning coming up from tissue insulin resistance and step by step progressing to a state characterized through entire lack of secretory activity of the beta cells of the pancreas. T2DM is a major contributor to the very enormous upward push within the expense of non-communicable ailments affecting developed as good as establishing countries. In this mini assessment, it exercise to stipulate the current administration standards, including the spectrum of drugs which might be currently used for pharmacologic administration, for decreasing the accelerated blood glucose in T2DM.

TABLE 1: The Summary of the survey

Author's Name	**Year**	**Description**	**Outcomes**

Samreen Riaz	2009	It is the second leading cause of blindness and renal disease worldwide. Diabetes mellitus is a chronic disease caused by inherited and/or acquired deficiency in production of insulin by the pancreas, or by ineffectiveness of the insulin produced.	In this the author mainly focuses on the causes, types, factors affecting DM, incidences, preventive measures and treatment of the acute and chronic complications of diabetes other than those directly associated with hypoglycemia and severe metabolic disturbances.
Shankaracharya. et.al,	2010	In this the author presents and explains the most accurate algorithms, and discusses advantages and pitfalls of methodologies.	As per the experiments conducted and results is based on the promising outcomes of studies applying computational algorithms to the problem of diabetes diagnosis, it is clear that a more sophisticated risk score could be developed. This would significantly decrease healthcare costs via early prediction and diagnosis of type 2 diabetes.
M.N. Piero, G.M. Nzaro, J.M. Njagi	2015	The author explores diabetes mellitus in terms of its historical perspective, biochemical basis, economic burden, management interventions along with the future perspectives.	As per the experiments conducted and results achieved that the High blood glucose levels are symptomatic of diabetes mellitus as a consequence of inadequate pancreatic insulin secretion or poor insulin-directed mobilization of glucose by target cells.
Nurul Akmal Binti Abd Salam et.al.	2016	A non-invasive blood glucose monitoring system has been developed by integrating an Ion Sensitive FET**(ISFET)** based biosnsor technology and a suction effusion fluid **(SEF)** collection technology.	As per the experiments conducted of non-invasive blood glucose monitoring system was achieved by combining two technologies (i) the ISFET biosensor technology and (ii) the SEF collection technology.
G.Sharmila, R.Sushmitha, R.Geetha	2017	The devices used for self-monitoring of glucose level. These devices are very useful in the present busy life scenario./ Diabetes Mellitus (DM), Glucose level, self monitoring, Devices, Internet of Things (IoT).	As per the experiments conducted and results achieved that a system can be proposed that is not only used for self-monitoring but also to know the general information about the diet ,exercise ,medication to be taken for that particular blood glucose level.
Tuan Nguyen Gia, et.al.	2017	This system is able to achieve continuous glucose monitoring remotely in real-time. This result reveal that a high level of energy efficiency can be achieved by applying the customize RnF Component	As per the experiments conducted and result achieved thata real-time remote IoT-based continuous glucose monitoring system. The implemented IoT-based architecture is complete system starting from sensor node to a back-end server. The result showed that it is feasible to remote monitor glucose continuously in real-time and the system can be made energy efficient.
Ruhani Ab. Rahman, et.al.	2017	The author presents a method of monitoring ketone level by using breath measurement. Main objective of this research is to present an easy handheld health care on monitoring diabetic level with breath.	As per the experiments conducted and results show that it is possible to monitor the ketone levels by measuring the amount breath acetone. The accuracy of the system can be improved by having a better algorithm in calibrating the sensor.
Arun Chaudhury	2017	It endeavor to outline the current management principles, including the spectrum of medications that are currently used for pharmacologic management, for lowering the elevated blood glucose in T2DM.	As per the experiments conducted and results achieved that the Treatment options may be individualized and medication(s) chosen based on a patient's risk

			factors, current HbA1C level, medication efficacy, ease of use, patient's financial situation/insurance/costs, and risk of side effects such as hypoglycemia and weight gain. Effectiveness of therapy must be evaluated as frequent as possible using diagnostic blood tests (HbA1C), as well as monitoring for development of diabetic complications.

IV. CONCLUSION

It is well understand that diabetes is likely one of the metabolic ailment where a patient has excessive blood sugar level which is induced both by the body failure to provide adequate insulin and the cells failure to reply to the produce insulin. It is likely one of the principal continual disease hindrance global with principal economic and social iinfluence. We offer the working and underlying architecture of the trendy healthcare based on web of matters used in diabetes adminitration. In this paper various systems are used for glucose monitoring. In future we can calculate the sugar stage by utilizing Arduino to share database via ESP 8266 WiFi Module and readings can be measured through utilizing: Pulse cost-SEN11574, ECG-AD8232, Glucose stage-Freestyle libre sensor and BMO19. It helps in calculating the sugar degree. In the end, we suggested the viable options and future research reccomendations in Internet of Things.

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