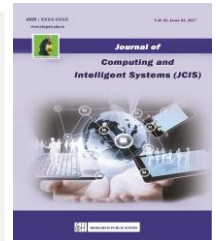




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## An Extensive Survey on the implementation of Internet of Things (IoT) in Continuous Glucose Monitoring System

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**Abstract** — *The Continuous glucose checking System (CGMS) more than once is used to tracks blood glucose levels, and glucose for the length of the day and night. The patients/Human can see their glucose level at whatever point and wherever through the CGMS. Also, moreover they can study how the glucose level changes over several hours or days. Seeing glucose level consistently the CGMS can help the human with settling on more decisions for the length of the day and night about how to alter the consistently sustenance, physical development, and remedies. In this paper we review how the human glucose Monitoring Systems capacities with IoT Technology.*

Keywords - Internet-of-Things, Health Monitoring, Glucose sensors, continuous glucose monitoring

### 1. INTRODUCTION

The Continuous glucose checking System (CGMS) more than once is used to tracks blood glucose levels, and glucose for the term of the day and night. The patients/Human can see their glucose level at whatever point and wherever through the CGMS. What's more, besides they can study how the glucose level changes over two or three hours or days. Seeing glucose level ceaselessly the CGMS can help the human with settling on more decisions for the length of the day and night about how to alter the consistently sustenance, physical development, and solutions. In this paper we review how the human glucose Monitoring Systems capacities with IoT Technology. Even more typically known as hemoglobin A1C (HbA1c). Nevertheless, afresh, HbA1c does not describe to the whole story as while it gives information about Glucose presentation it can't pursue glycemic variance. HbA1c is a profitable test to distinguish how well glucose is controlled in the course of recent months. In any case, since HbA1c demonstrates the typical glucose, it doesn't give a correct picture of how much changes happen [1]. Believe it or not, if a patient has ceaseless low glucose, it could result in low HbA1c (in light of the fact that HbA1c shows a typical regard) and a misinformed impression that everything is great and great to the patient and master, despite when the glucose is often high and is very controlled.

### 2. WHAT IS CONTINUOUS GLUCOSE MONITORING

During the 1970s, blood glucose meters wound up accessible and changed the idea of diabetes self-checking [1]. Be that as it may, occasional blood glucose estimations by means of blood glucose meters just demonstrate a depiction of blood glucose at some random test time. As the outline delineates, blood glucose meter tests (reflected by blue square shapes) give just immediate previews of glucose action; occasional blood glucose estimations may not genuinely portray the profile of a patient's glucose control [1].

### 3. SENSOR TECHNOLOGIES

As of late Glucose detecting components for non-obtrusive, or if nothing else insignificantly intrusive, CGM have been tried, trying to coordinate every essential prerequisite for a reached out in vivo use, e.g., affectability, explicitness, linearity inside organic pertinent range, biocompatibility, and lifetime. Among all the proposed strategies, i.e., electrochemical, optical, and piezoelectric, the one that is today misused by a large portion of the popularized CGM frameworks is the glucose-oxidase electrochemical guideline [2]. The gadgets dependent on this guideline utilize an insignificantly obtrusive needle sensor, more often than not embedded in the subcutaneous tissue, in the midriff or on the arm, which estimates an electrical flow sign created by the glucose-oxidase response. This sign is relative to the glucose fixation accessible in the interstitial liquid, which is then changed over into a glucose focus by an alignment technique more often than not performed two times every day [2].

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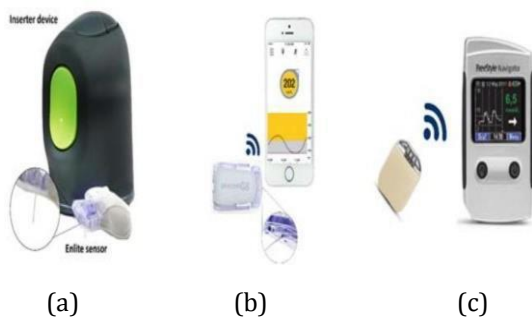


Figure 1(a) Medtronic Enlite sensor with dedicated inserter; (b) Dexcom G5 Mobile with Share technology; (c) Abbott FreeStyle Navigator II[2].

#### 4. IoT Enabled CGMS

The existing methods for measuring blood glucose are categorized into two types namely Invasive and Non-Invasive[3].

##### 4.1. Intrusive Method

The intrusive strategy includes the estimation of blood glucose by the glucometer and blood. There is much ongoing progression in the intrusive blood glucose checking [3]. They are:

1. Alternative Measure - This strategy includes the utilization of test strips and permits blood examining without torment.
2. Multi-test Systems - This sort of frameworks uses tape or circle which contains various test strips.
3. Uncoded Systems - The test strips require coding in the more established frameworks which contains a danger of mistakes in coding and furthermore the qualities estimated. This can be abstained from utilizing two methodologies in particular "auto coding" and "single coding". In auto coding, the coding is accomplished for each test strip though in single coding, all the test strips contain a similar code to dodge mistakes.
4. Recordable Parameters - This framework is gone with the product which empowers the client to store the deliberate outcomes to the PC.

##### 4.2. Non-Invasive Method Non-Invasive Methods inspected by

Stavroulaet. Al. (2010) required with putting of sensors in the human focused on territory, for example, skin, ear projection and so forth. The different methodologies are: [3]

**1. Near IR (NIR) Spectroscopy** - This strategy included the use of infrared scope of electro-attractive range running from 800mm to 2500 mm. The real favorable position is the NIR enters a lot further in tests.

**2. Ultrasound Technology** - Ultrasound is characterized as the sound weight wave that has recurrence of 20 kHz which is more prominent than human hearing[3]. It can reveal the nitty gritty structure of the article under scrutiny.



Figure 2: IoT enabled CGMS

**3. Dielectric Spectroscopy** - This technique is utilized for estimating the dielectric properties of an item concerning recurrence.

**4. Metabolic heat Confirmation (MHC) [3]** - It is primarily based on the amount of heat dissipated and the degree of oxygenation of the blood. The existing gadget become a time consuming system wherein the affected person has to in my opinion meet the doctor irrespective of their busy schedules. The instant facts concerning the food diet, exercising manipulate became now not viable in this machine.

#### 5. IoT Enabled Exist System

##### 5.1 Glucose Monitoring Kit

The generally speaking Continuous Glucose Monitoring procedure is delineated in figure 3. The CGMS framework is associated with the PC server utilizing the Micro USB link. The glucose levels are estimated utilizing the unit and the qualities are moved to the server utilizing the sequential port correspondence [2]. The system designed for the glucose monitoring purpose consists of the following components: Arduino Nano Microcontroller, 2G GPRS Arduino, Display Unit, Testing Strips, and Micro USB Cable.



Figure 3: Continuous Glucose Monitoring System

### 5.2 Arduino Nano Microcontroller

Arduino Nano is a surface mount breadboard inserted adaptation with incorporated USB as appeared in Figure 4. It is a littlest, complete, and breadboard well disposed. It has pretty much a similar usefulness of the Arduino Duemilanove, yet in an alternate bundle. It needs just a DC power jack, and works with a Mini-B USB link rather than a standard one.

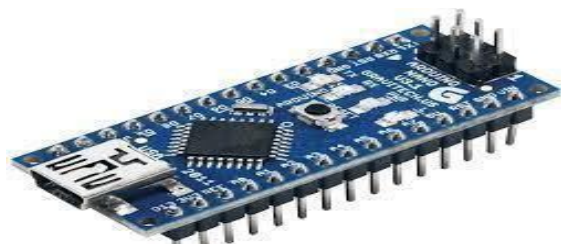


Figure 4: Arduino Nano Microcontroller

### 5.3 GPRS Arduino

The Arduino GSM Shield V2 associates your Arduino to the web utilizing the GPRS remote system as appeared in Figure 5. In this framework, it is utilized to send and get messages from and to the patients.



Figure 5: 2g GPRS Arduino

### 5.4 Display Unit

The presentation unit utilized in this pack is 20x4 LCD (Liquid Crystal Display), implies 20 characters showed per push and there are 4 pushes in the showcase unit. The showcase unit is utilized to print the deliberate glucose level from the pack as appeared in Figure 6.



Figure 6: Display Unit

### 5.5 Testing Strips

A test strip is a band/piece/portion of paper or other material utilized for organic testing. The test strip is utilized to test the glucose level for a patient. A spot of blood is put on the test strip to quantify the glucose level as appeared in Figure 7.



Figure 7: Testing Strips

### 5.6 Micro USB Cable

The Micro USB link is a gadget which is utilized to associate the microcontroller and the framework. The adjustments in the coding should be possible and it is sustained to the microcontroller utilizing the USB link as appeared in Figure 8.



Figure 8: Micro USB

## 6. Architectural diagram of the Overall CGM System

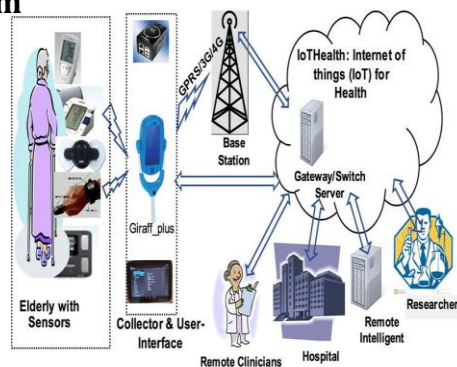


Figure 9: Architecture of CGMS

## 7. Related Works

The significance of nonstop glucose observing in different applications is introduced by the creators [4]. The continuous calculations can make CGM more astute by improving the precision and their capacity to offer alarm messages during uncommon conditions. The creators focused on shrewd CGM sensor thought which comprises of attractive CGM sensor. The yield of the sensor is given to the three programming modules. These modules are equipped for working progressively for gauge, improvement and de-noising. The consequences of these modules were a) forecast module predicts hypo and hyperglycemic occasions b) improvement module delivered the decrease of mean outright relative contrast and c) the de-noising module that improved the smoothness of CGM time. The a fore mentioned modules improved the exhibition of CGM applications.

The algorithmic difficulties of CGM utilized at various times have been looked into by the creators in this work [5]. This work demonstrated the acknowledgment of likely future patterns in the CGM. The real difficulties were connected with the quality improvement in the information got from CGM gadgets through sign preparing techniques previously. This issue has been overwhelmed by utilizing "Savvy" CGM sensors. Another test is being looked during the season of their exploration, i.e.) the presentation of CGM sensors to the non-adjunctive utilize that guarantees productivity and wellbeing. The goals to handle the previously mentioned test is by the utilization of In Silico Clinical Trials (ISCT). Two significant research points are straightforwardly associated with the Non adjunctive utilization of CGM sensors.

The creators [6] have expressed that the advances are having the forthcoming to help the social insurance experts and patients. It is an administration situated design stage dependent on individual administrations. These models are utilized to do an assortment of capacities like patient observing and clinical criticism arrangement.

This prompts the ability to hold up diabetes the executives in differing human services association and this additionally prompted the ascent of the development of the Glucose Management System. It had the ability to check the parameters from differing sources that contains glucose levels, drugs, healthful eating routine admissions and patients insulin affectability. The principle advantage of this task is that there is a better authority over diabetes by conquering the risk and wellbeing entanglements of the patients.

The creators [7] anticipated a work in the improvement of Artificial Pancreas (AP) for the patients with Type-1 diabetes. In this work, a novel device was built up that enabled numerous parameters to screen the counterfeit pancreas of different patients utilizing the home condition. DiAs Web Monitoring (DWM) is the name of the apparatus which was displayed in this work.

The work [8] concentrated on the task titled REACTION that depends on a versatile and cloud stages. This undertaking was made to beat two principle challenges to be specific Health care data conveyance and Cost. The creator likewise had a diagram in regards to the administrations that were offered by the REACTION venture. The REACTION based applications are created by focusing on the sort 1 DM patients. The REACTION stage is connected to the sensors in a remote way. This plan was likewise utilized in the clinical field preliminaries to be specific Safe Glycemic Control in medical clinics and Automatic Glycemic Control.

The work [9] explored on assortment of plans that are utilized for blood glucose checking frameworks. The creators for the most part managed the Non-intrusive methodologies of blood glucose observing framework. They checked on a scope of obtrusive strategies that are utilized for as far back as years for blood glucose estimations. In the obtrusive methodology of strategies, a drop of blood test is taken by utilizing needles and the blood is moved to the glucose measurement device to quantify the glucose level in the blood. The substitute method for estimating glucose is the somewhat intrusive technique which uses the strategy for embeddings a sensor into the skin to gauge the glucose this technique is executed by putting sensors straightforwardly to the human body without considering the blood tests. Transdermal and Optical are the strategies received for non-obtrusive blood glucose estimation.

The work [10] concentrated on the advancement of AI calculations, for example, diabetes finding instruments. These administered and unsupervised plans are utilized in location and analysis of diabetes at different stages. The creators have given an extraordinary focus to the calculations that improve diabetes determination. The creators focused on the diverse investigation strategies like information examination through calculated relapse, grouping procedures, bolster vector machines, neural systems, and Expert frameworks.

## CONCLUSION

The Continues Glucose Monitoring System (CGMS) is measure the Human/Patients Glucose Level with assistance of IoT Sensor Technology. The advantage of Continues Glucose Monitoring System (CGMS) is they can utilize the gadget anyplace on the planet. And furthermore the time will put something aside for human to not go emergency clinic to check their Glucose Level. The Continuous glucose Monitoring System (CGMS) more than once is utilized to tracks blood glucose levels, and glucose for the length of the day and night.

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