Glucose Level Monitor and Alerting System using IOT

Varuna Shree Gore, Linganna Banothu

Department of Electrical and Electronics Engineering

Sree Dattha Group of Institutions, Hyderabad, Telangana, India.

Abstract

In the process of medication, it is a common practice to treat patients with saline for dehydration and other medical ailments to improve the health condition of the patients. When fed with saline continuous observation of nurses is mandatory in monitoring the level of the saline. There are many cases where patients are being harmed due to the staff inattentiveness, as their absence does not notice the completion of saline level in the container. This arise the problem of back flow of blood immediately after the completion of saline in container. Hence to protect the patient from getting harmed an IoT based saline level monitoring system has been developed. The proposed model incorporates a sensor which continuously detects the saline drops using ultrasonic sensor. Whenever the ultrasonic sensor low level of saline it alerts the staff of the hospital with the buzzer, automatically it turn off the valve using servo motor , for the safety of the patients.

Keywords: Glucose level monitor, alerting system, IOT.

1. Introduction

This project is to enhance the current technology which eases the medical practitioner to monitor and get the update of the patient's glucose level without physically present at the patient place. The objectives are to detect and monitor the patient's glucose level, also to raise the patient's awareness of their sugar level. And when the glucose level beyond the acceptance range, the system notifies the user. This project uses blood glucose sensor to detect the glucose level, the information from the sensor will retrieve and process by the Arduino Uno which acts as a brain that will transmit the data to the Cloud by using Wi-Fi module. The data than analysing and send the information to the patient's and medical practitioner smartphone. If the glucose beyond the acceptance range, they will receive a warning notification and amount of insulin need to be taken by the patient. The project uses Iterative Waterfall Model as its supports redesign if the changes are needed in the project. By using this methodology, the phase can be looped back to the previous iteration if the process encounters any bugs or lacks any criteria when running the program. The proposed system has the potential to make the diabetic aware of their glucose level and could help them to control their glucose intake. This project is a success and capable of detecting the glucose level, and thus, the data gained used to notify the patient when the glucose level reaches the abnormal range.

This project is about is developing a heart rate monitoring which revolves around the technology of Internet of Things (IoT). Instead of using SMS (short message service) as a communication medium between the patient, nurse and doctor, there will be a system that records and keeps track of the patient’s data real time. It will also inform the doctors and nurses if there are any abnormalities instantly and inform of any emergencies that needs to be attend to. This project will be using a development kit and it will take the heart rate and temperature of the patient through sensors. Then it will send the data back to the development kit and send the data by using a Wi-FI module thus dispatching the collected data to an IoT Platform and display it for the nurses or doctors to monitor consistently.

The scope of this project is mainly focusing on diabetic patients, family and medical practitioner for clinic and hospital in Malaysia. The function of this IoT based Glucose Monitoring System for

Diabetic Patients is to make sure the medical practitioner and patients' family knows what the current glucose level of their patient or family is. The system will maintain the current device used to check glucose level which is built-in Arduino glucose sensor shield but with an upgrade of an IoT end-to-end solution that will notify the medical practitioners when the glucose level is beyond the normal reading through the smartphone. However, the limitations of this project are the system cannot continuously monitor the glucose reading as the patient need to manually check their glucose level first before the data of the sugar can be transferred and then notified to the medical practitioners. Also, the smartphone needs to be connected through the Internet, otherwise the data cannot be received. Then, the idea of pricking the blood to get the glucose data may cause the pain and high risk of infectious diseases to the patient. Health monitoring systems based on Internet-of-things (IoT) have been recently introduced to improve the quality of health care services. However, the number of advanced IoT-based continuous glucose monitoring systems is small and the existing systems have several limitations. In this paper we study feasibility of invasive and continuous glucose monitoring (CGM) system utilizing IoT based approach.

We designed an IoT-based system architecture from a sensor device to a back-end system for presenting real-time glucose, body temperature and contextual data (i.e., environmental temperature) in graphical and human-readable forms to end-users such as patients and doctors. In addition, nRF communication protocol is customized for suiting to the glucose monitoring system and achieving a high level of energy efficiency. Furthermore, we investigate energy consumption of the sensor device and design energy harvesting units for the device. Finally, the work provides many advanced services at a gateway level such as a push notification service for notifying patient and doctors in case of abnormal situations (i.e. too low or too high glucose level). The results show that our system is able to achieve continuous glucose monitoring remotely in real-time. In addition, the results reveal that a high level of energy efficiency can be achieved by applying the customized nRF component, the power management unit and the energy harvesting unit altogether in the sensor device. Number of advanced IoT-based continuous glucose monitoring systems is small and the existing systems have several limitations. In this paper we study feasibility of invasive and continuous glucose monitoring (CGM) system utilizing IoT based approach. We designed an IoT-based system architecture from a sensor device to a back-end system for presenting real-time glucose, body temperature and contextual data (i.e., environmental temperature) in graphical and human-readable forms to end-users such as patients and doctors. In addition, nRF communication protocol is customized for suiting to the glucose monitoring system and achieving a high level of energy efficiency. Furthermore, we investigate energy consumption of the sensor device and design energy harvesting units for the device. Finally, the work provides many advanced services at a gateway level such as a push notification service for notifying patient and doctors in case of abnormal situations (i.e. too low or too high glucose level). The results show that our system is able to achieve continuous glucose monitoring remotely in real-time. In addition, the results reveal that a high level of energy efficiency can be achieved by app.

2. Literature survey

Number of advanced IoT-based continuous glucose monitoring systems is small and the existing systems have several limitations. In this paper we study feasibility of invasive and continuous glucose monitoring (CGM) system utilizing IoT based approach. We designed an IoT-based system architecture from a sensor device to a back-end system for presenting real-time glucose, body temperature and contextual data (i.e., environmental temperature) in graphical and human-readable forms to end-users such as patients and doctors. In addition, nRF communication protocol is customized for suiting to the glucose monitoring system and achieving a high level of energy efficiency. Furthermore, we investigate energy consumption of the sensor device and design energy

harvesting units for the device. Finally, the work provides many advanced services at a gateway level such as a push notification service for notifying patient and doctors in case of abnormal situations (i.e., too low or too high glucose level). The results show that our system is able to achieve continuous glucose monitoring remotely in real-time. In addition, the results reveal that a high level of energy efficiency can be achieved by app rated into monitoring and decision processes. There are potential benefits to ageing population, where elderly people could be monitored and treated at the comfort of their own homes. Fully autonomous health monitoring wireless systems can have many useful applications. Among those applications is glucose level measurement for diabetics. Diabetes is a major health concern. According to a WHO report, the number of people with diabetes has exceeded 422 million and in 2012, over 1.5 million people died because of diabetes. The WHO classified diabetes as a top ten causes of mortality. Diabetes has serious effects on the well-being of a person and the society. Unfortunately, there is still no known permanent cure for diabetes 3. However, one solution to this problem is to continuously measure blood glucose levels and close the loop with appropriate insulin delivery. Statistics published by the UK Prospective Diabetes Group demonstrate that CGM can reduce the long-term complications between 40 % and 75 %. 4. Hence, CGM equipped with alarm systems can help patients to take corrective action(s) such as decisions on their diet, physical exercise and when to take medication. Energy harvesters incorporated into wearable devices allow powering wireless sensor operated applications, thereby making them autonomously operated. This regime has many useful implications on patients and health-care providers, especially for implanted sensors where battery changing could cause pain and discomfort. Cautious design of both low-power electronic circuitry and efficient energy harvesting scheme is pivotal to fully autonomous wearable systems. In this paper, the presented work aims to study the feasibility of invasive and secure CGMS using IoT. The work is to design an IoT-based system architecture from a sensor device to a back-end system for presenting real-time glucose, body temperature and contextual data (i.e., environmental temperature) in graphical and text forms to end-users such as patient and doctor. Moreover, the work customizes the nRF communication protocol for suiting to the glucose monitoring system and achieving a high level of energy efficiency. Furthermore, we investigate energy consumption of a sensor device and design energy harvesting units for the device.

Murakami et al. 5 present a CGM system in critical cardiac patients in the intensive care unit. The system is built by a disposable subcutaneous glucose sensor, a glucose client, and a server. The system collects glucose data four times per day and stores in a hospital information system. Doctors can use the bedside monitor to monitor the glucose data. Ali et al. 6 propose a Bluetooth low energy (BLE) implantable glucose monitoring system. Glucose data collected from the system is transmitted via BLE to a PDA (smart-phone, or Ipad) which represents the received data in text forms for visualization. The system shows some achievements in reducing power consumption of an external power unit and an implantable unit. Lucisano et al. 7 present a glucose monitoring in individuals with diabetes using long-term implanted sensor system and model. Glucose data is sent every two minutes to external receivers. The system shows its capability of continuous long-term glucose monitoring. In addition, the system proves that implanted sensors can be placed inside a human body for a long period time (i.e. 180 days) for managing diabetes and other diseases. Menon et al. 8 propose a non-invasive blood glucose monitoring system using near-infrared (NIR). Glucose in blood is predicted based on the analysis of the variation in the received signal intensity obtained from a NIR sensor. The predicted glucose data is sent wirelessly to a remote computer for visualization. Recently, some IoT-based applications for glucose monitoring have been built. However, those systems do not attentively consider energy efficiency of sensor nodes and the communication between sensor devices and a gateway. Rasyid et al. 9 propose a blood glucose level monitoring system based on wireless body area network for detecting diabetes. The system is built by using a glucometer sensor, Arduino Uno, and a

Zigbee module. Doctor and caregiver can access to a web-page to monitor glucose levels of a patient remotely. However, the system is not energy efficient due to high power consumption of the Arduino Uno board and the Zigbee module. Wang et al. 10 introduce a monitoring system for types 2 diabetes mellitus. The system is able to make decision on the statues of diabetes control and predict future glucose of an individual. Obtained glucose data can be monitored remotely by medical staffs via wide area networks.

Mansi G. Chidgopkar, Aruna P. Phatale "Automatic and Low-Cost Saline Level Monitoring System Using Wireless Bluetooth Module and Cc2500 Transreceiver " International Journal of Research in Engineering and Technology; Volume:04 Issue: 09 |September-2015 Traditional methods used for health care are becoming obsolete due to increase in population. Current health care system requires manual care takers and their heavy duties which is very time-consuming job. Innovative health monitoring systems are required with less human intervention which will be available at low cost in rural as well as urban areas. Engineering technologies are getting coupled with medical field to solve this problem. So phisticated health monitoring systems are getting developed with the help of electronic components such as sensors, PLC, microcontrollers etc. with easy interfacing. This paper mainly focuses on providing advanced saline level monitoring system. [1] 2. C.C. Gavimath, Krishnamurthy Bhat, C.L. Chayalakshmi, R. S. Hooli and B.E.Ravishankera "Design And Development Of Versatile Saline Flow Rate Measuring System And Gsm Based Remote Monitoring Device " International Journal of Pharmaceutical Applications Vol 3, Issue 1, 2012. As the world population grows, the need for health care increases. In recent years, progress in medical care has been rapid due to the advancements in the field of sensors, microcontrollers and computers. A major reason for this is the combination of the two important disciplines namely medicine and engineering. This paper describes the development of an automatic saline monitoring system using a low-cost indigenous sly developed sensor and GSM (Global system for mobile communication) modem. This enables the doctor or nurse on duty to monitor the saline flow rate from a distance. The 8051 microcontroller is used for providing coordination action. An IR sensor is used at the neck of the saline bottle to know the flow rate of the liquid. The detection of saline drop rate is quite faithful. The output obtained from the sensor is processed to check whether the flow rate is slow, medium or fast and the same is transmitted through GSM technology to a distant mobile cell for future actions.[2] 3. Pattarakamon Rangsee, Paweena Suebsombut, Phakphoom Boonyanant "Low-Cost Saline Droplet

Measurement System using for Common Patient oom in Rural Public Hospital " The 4th Joint International Conference on Information and Communication Technology, Electronic and Electrical Engineering (JICTEE) 978-1-4799-3855-1/14 2014 The system can be used to check saline droplet of patients in each patient's bed in rural public hospital. By installing the measuring modules in all patients' beds, the system will show saline droplet status of each patient. So, nurses can accurately check saline droplet status of their patients on a computer including saline droplet statuses, saline droplet rate (drops per minute), and remaining time. The saline droplet statuses include four statuses that are Normal status (the system is working, the green light is shown on monitor), Warning status (sensor at critical point cannot detect saline, the yellow light is shown on monitor), Error status (droplet sensor cannot detect saline droplet, the red light is shown on monitor), and Chang New Bag (the blue light is shown on monitor). So, nurses do not need to go to patient's bed every time because they can check saline drop let status of each patient via this system. This system is a low-cost system and comfortable for a nurse. Therefore, in rural public hospital can use this system in common patient's room.[3] 4. P. Kalaivani, T.Thamaraiselvi, P.Sindhuja and G.Vegha "Saline Level Monitoring System Using Arduino UNO Processor " Asian Journal of Applied Science and Technology (AJAST) Volume 1,March 2017 . The epidemic growth of wireless technology and mobile services in this epoch is creating a great impact on our life style. Some early efforts have been

taken to utilize these technologies in medical industry. In this field, ECG sensor based advanced wireless patient monitoring system concept is a new innovative idea. This system aims to provide health care to the patient. We have sensed the patient's ECG through 3 lead electrode system via AD8232 which amplifies minor and small bio-signals to the arduino which processes them, along with saline level. Saline level is detected through IR sensors. The output of the electrical pulse is shown with the serial monitor. The saline level is indicated by LCD. The major output ECG analog signal is displayed on serial plotter. The outputs are displayed through mobile application.[4] 5. Priyadharshini. R, Mithuna.S, Vasanth Kumar.U, Kalpana Devi.S, Dr. SuthanthiraVanitha.N. "Automatic Intravenous Fluid Level Indication System for Hospitals" International Journal for Research in Applied Science & Engineering Technology ; Volume 3 Issue VIII, August 2015. During recent years due to the technological advancements many sophisticated techniques has been evolved for assuring fast recovery of the patients in hospitals. For good patient care in hospitals, assessment and management of patient's fluid and electrolyte need is the most fundamental thing required. All most in all hospital, an assist/nurse is responsible for monitoring the fluid level continuously. But unfortunately, during most of the time, the observer may forget to change the saline bottle at correct time due to their busy schedule. This may lead to several problems to the patients such as backflow of blood, blood loss etc. To overcome this critical situation, a low-cost RF based automatic alerting and indicating device is proposed. Where IR sensor is used as a level sensor. It is based on the principle that the IR sensor output voltage level changes when intravenous fluid level is below certain limit. [5]

3. Proposed system

In this proposes system which can automatically monitor the saline flow rate by using microcontroller. It can wirelessly send the data to nurses or doctors' computer and display the results in the form of saline., as their absence does not notice the completion of saline level in the container. This arises the problem of back flow of blood immediately after the completion of saline in container. Hence to protect the patient from getting harmed an IoT based saline level monitoring system has been developed. The proposed model incorporates a sensor which continuously detects the saline drops using ultrasonic sensor. Whenever the ultrasonic sensor low level of saline it alerts the staff of the hospital with the buzzer, automatically it turns off the valve using servo motor, for the safety of the patients.

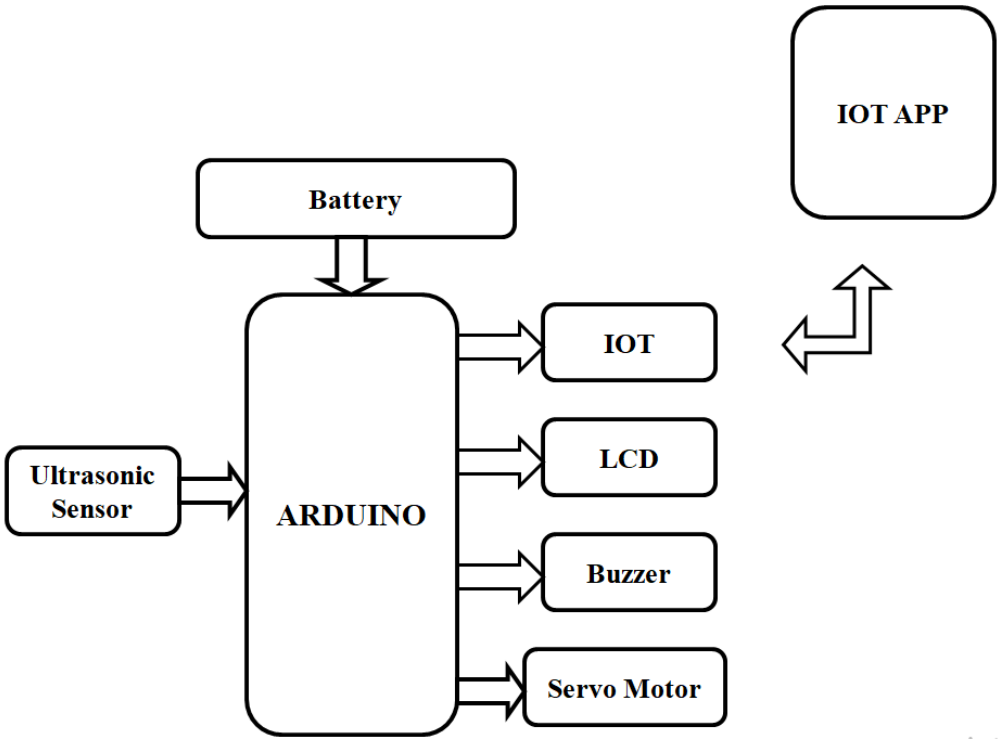

Fig. 1: Block diagram of proposed system.

3.1 Arduino IDE

What is Arduino IDE?

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

A program for Arduino hardware may be written in any programming language with compilers that produce binary machine code for the target processor. Atmel provides a development environment for their 8-bit AVR and 32-bit ARM Cortex-M based microcontrollers: AVR Studio (older) and Atmel Studio (newer).

3.2 Schematic diagram

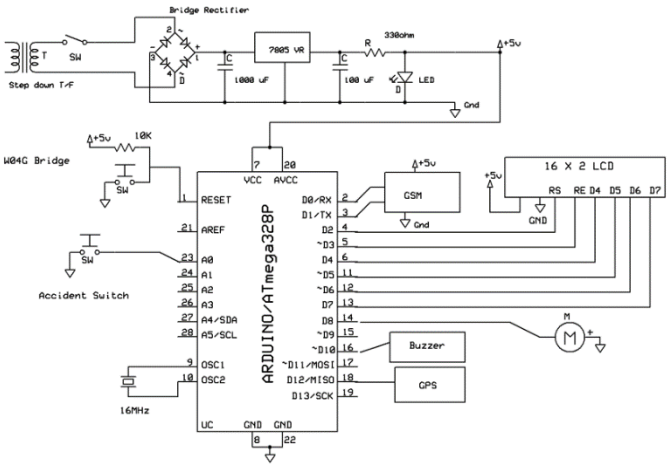

Fig. 2: Schematic diagram of proposed system.

4. Results

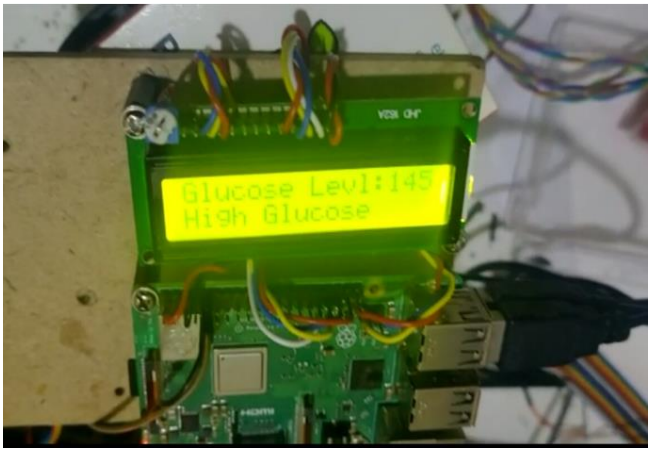

Fig. 3: Result displayed on LCD display.

Fig. 4: Result displayed as not diabetic.

5. Conclusion

In this paper, we presented a 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. Through the system, doctors and caregivers can easily monitor their patient anytime, anywhere via a browser or a smart-phone application. Ultrasonic Sensor measures the level of the glucose, alert and transmit the data wirelessly to the gateway efficiently in term of energy consumption. In addition, the gateway with its application provides advanced services to users, such as a notification service. The result showed that it is feasible to remote monitor glucose continuously in real-time and the system can be made energy efficient.

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