International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 513-517 www.ijaem.net ISSN: 2395-5252

IOT Based Tipping Bucket Rain Gauge Data Processing System

Sheetal Mali[1], Dr. Prof. Reena Gunjan[2], Dr. Prof. Virendra V. Shete[3], Dr. Selva Balan[4]

Department of Electronics and Communication Engineering, MIT School of Engineering, MIT ADT University, Pune, India

Scientist F and Head, Hydraulic Instrumentation and Canal Automation, Central Water and Power Research Station, Pune

Date of Submission: 10-12-2022 Date of Acceptance: 20-12-2022

ABSTRACT: Tipping Bucket is the instrument which is used to measure the rainfall. The designing of tipping bucket system consists of funnel at the top which collects the water of the rain in a container which is like a seesaw type module which tips side by side and collects the water. When the level of the water decreases below a preset level, the lever changes its side, causing the collected water to dump in a vessel and electrical signal is sent. The rainfall character is calculated by the rainfall in 1 hour and corresponding number of pulses clicking in a period of 10 seconds.By this system different levels of rainfall such as heavy, medium and low rainfall charactercan be obtained.

Various types of tipping bucket systems are by using rainfall and snow precipitation, using internet enabling, using rain drop imaging and artificial intelligence and also using wireless sensor network and GSM data transmission and many more ways are there to measure the rain. Using these types of measurements rainfall can be calculated and intensity of rainfall can be detected.

Tipping Bucket is the very useful parameter for measuring the rainfall. This system can be used in various areas which are suffering from the rainfall disasters where they can save themselves and their surroundings. In this way the rainfall is measured using the Tipping Bucket Rain Gauge System.

I. INTRODUCTION

Tipping bucket name itself depicts that it measure the rain water by tipping. This tipping helps to measure the rainfall by tipping side by side and collecting the water. There are several different methods to calculate the rainfall measurement. One of the method is to design the tipping bucket rain gauge data processing system. This project is done in collaboration with Central Water and Power Research Station (CWPRS) under the guidance of Dr. SelvaBalan, Scientist, CWPRS.

Tipping bucket is the very useful parameter for measuring the rainfall. Rainfall measurement has become a major problem in today's life as it is known that rainfall brings a major disaster sometime. The locations near the sea, river, and dam are the critical locations where they face these problems of water. To overcome such problems a project of tipping bucket data processing system has been built and can be saved from disasters.

Tipping bucket system consist of funnel which collect the water of the rain in a container, its module is like a seesaw type which tips side by side and collect the water at the bottom of the container. When the water is collected at the container below there is a tipping bucket situated on a pivot point at the end and having a buckets side by side one of which when filled tips down and the water is again collected at the second bucket and then the second bucket will tip and again the first bucket is filled, in such way the data can be collected by tips of the bucket.

When these tips are taking place the data is collected at the micro-controller through a reed switch connected at the system, it works when the reed switch comes in contact with the magnet while taking tips a pulse is generated and the data is forwarded.

There are various methods of tipping bucket, by using this method data can be collected through internet. This data collection is done through online mode where the location and rain intensities such as high, medium and low will be getting through the SMS and a link created at the cloud.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 513-517 www.ijaem.net ISSN: 2395-5252

The data transmission takes place using a GSM, GPS and Node MCU. The Global System of Mobile communication (GSM) used here is for SMS purpose where the data of location of the system and the intensities of rain measured is displayed. The location received is obtained through the Global Positioning system (GPS) and the node MCU used here is Wi-Fi for updating the data on the link created at cloud.

In addition to rainfall, the system can also detect the temperature and humidity levels which it transmits along with the rainfall data. The additional part of this system is data count with temperature and humidity is send to the link generated at cloud which is connected to node MCU.

Figure 1. Shows the basic model of tipping bucket.

Figure 2. Shows the Taxonomy of tipping bucket rain gauge system.

II. RELATED WORK

The method of calculating rain using tipping bucket was proposed by GozaliSyahrul [1]. He had designed the Tipping Bucket Rain Gauge System (TBR). This TBR works on the system where it measured the amount of rainfall on the earth surface with respect to time, as it was measured by units in mm per time. It was used in the urban areas where there was heavy amount of rainfall. For measuring intensity of the rainfall the tipping bucket was very commonly used and was easier way. The tipping bucket has been designed and tested in the laboratories and field areas. These testing were done by using the micro-controller. The system displayed the measurement record of the rainfall in between every 24 hours as well as system had detected the rainfall when the bucket was tipped in the funnel of rain gauge.

Rajiv Kumar Das, Neelam Rup Prakash [2]. Had designed different method of an anti-freeze attachment system along with tipping bucket rain gauge to measure rainfall and snow precipitation. This system was designed to measure the rainfall as well as the snow information, which provided the data of water equivalently faster. The operation of this system was to count the number of tips which was taken by the tipping instrument in the catch tube and convert it into the liquid, as this liquid filled, it made a tip. There are various tubes followed in tipping instruments such as antifreeze reservoir, overflow tube and catch tube. The snow caught in the tube gets melted into anti-freeze liquid and prevents water from freezing. Again the snow melts & antifreeze reservoir rises. The measurement of snow precipitation by the anti-freeze attachment has a good rate of measurement by approximately 7 mm/hr.

UdomLewlomphaisarl; PrawitSaengsatcha [3]. Had designed thebehaviour of the rain gauge tipping bucket in various form of rain intensities, such as from low rainfall to heavy rainfall. It can also describe the problem that the very common tipping bucket rain gauge suffered from the calibration and improving the accuracy of system. It was used because it has compact size, highly reliable requires less components and is simple for measuring rainfall.

TarunKaruturiVenkataRaghava [4]. Had designed Internet Enabled Tipping Bucket Rain Gauge, whereas tipping bucket rain gauge are very commonly used apparatus for the measurement of rainfall. In this system, the data logger keeps the count of rainfall in the internal memory received by the rain gauge. As it was required, this system can be built anywhere in the remote areas as well as in the rural areas. Here the data transmission takes place through internet by using GSM/GPRS modules and the sensors used in this system are temperature sensor and the humidity sensor which are connected to the microcontroller.

Chi-Wen Hsieh, Chih-Yen Chen, Lijuan Wang [5]. Had designed one more method to measure rainfall using tipping bucket was by using ground rainfall measurement. Here an instrument called Video-based Disdrometer was used to obtain a high speed image of source. It had a backlight for lens to increase the depth in the presence of Planar LED. The rain drop images are used for result. Here the ANN Artificial Neural Network was used for further features i.e. from rain drop detection to the identification of measurement process of rainfall. Finally the rainfall rate as well as the accumulated rate can be obtained.

Adeyinka A. Adewale, Kennedy O. Okokpujie [6] Wireless Sensor was another new technology which had designed and provided a real time information of area or ground by using the sensors which were available at field. In this paper the study of wireless sensor network was given which shows accurate rainfall detection and measurements. Rainfall can be measured by different techniques one of the technique used was tipping bucket rain fall measurement system. A wireless transceiver which transmitted measured information and water level sensor was connected with the rain gauge. This data was transmitted to the receiver. The receiver was connected to the base station. Finally the data was displayed through the graphical user interface (GUI) at the base station. The result of this paper showed the accurate rainfall measurement.

Jalu.A. Prakosa, SensusWijonarko, DadangRustandi [7] had designed and showed water intensities can be varied and measured by using a rain gauge tipping bucket, this was the method to measure

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 513-517 www.ijaem.net ISSN: 2395-5252

the rainfall repeatedly. For this the volume of water was converted to gain the intensity of water or water flow rate which were collected through the funnel of tipping bucket. Various experiments were done for this system. This system showed that as the rate of water flow changed the volume of the water also changed. This method can also be used for other methods of tipping bucket.

Indunil, B. A., &Hettiarachchi, H. A. P. K. [8] had designed and showed the information about the rain gauge system used in Sri Lanka to detect and monitor the rainfall in that area/field. The GSM (Global System for Mobile communication) link was used here to connect with the main local station and automated rain gauge system (ARG'S). The rainfall can be measured using a Real time Clock (RTC) by measuring the rainfall along with the date and time of the tipping bucket data and sending per hour information through SMS to the base station. The Liquid Crystal Display (LCD) were used to see or observe the current rainfall which were attached to automated rain gauge system (ARG'S). As there was human being presence, this presence was captured by the LCD via IR (Infrared) proximity sensor. The main local station had a GSM module with computer connected to it. The software application showed the data of the software in the tabular format. The data can also be saved in database.

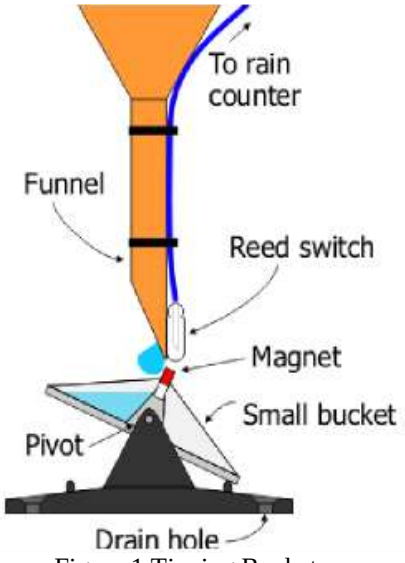

Figure 1 Tipping Bucket

III. METHODOLOGY

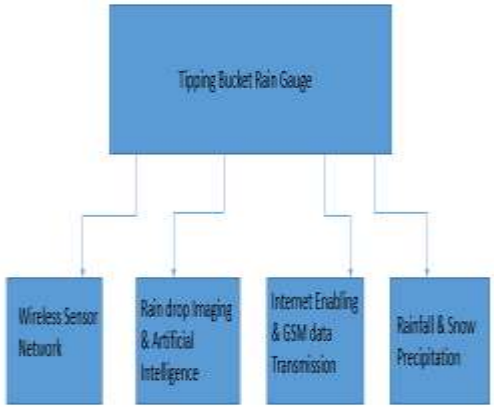

Figure 2.Taxonomy of Rain Gauge System

A. Description

When the rain falls it enters the funnel through the top and then the water flows downwards through funnel till it falls on the tipping bucket at the bottom.

This bucket is balanced on a pivot point. When the water comes at the bottom it falls on one side of the tipping bucket, when one of the buckets receives a certain amount of rainfall, it tips causing a change in the state of the reed switch momentarily due to the movement of the magnet attached to the buckets. The fig 1. Shows the basic diagrammatic view of tipping bucket.

The reed switch gets closed when it comes in contact with magnet, this closing of the switch sends out a pulse for one tip which can be detected by the circuitry i.e. the micro-controller.

As the tips are detected by micro-controller the data of rain intensity is reflected in the form of tips as for low rainfall less than two tips are detected, for medium rainfall less than or equal five tips are detected, for high rainfall more than five tips are detected. So in this way rain intensities can be detected and can be measured to know whether it is heavy, medium or low.

The GSM module connected to the micro-controller will receive the data of tipping count and will send a SMS of rain intensity and the location of that area will be known from the GPS system. After SMS is send to the user the relay switch is switched to node MCU and the data of rain intensity, temperature and humidity is shared to the link.

There is a LCD screen where the rainfall intensity along with the tipping count is displayed. The temperature and humidity of the surrounding atmosphere is also calculated and displayed on LCD screen.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 513-517 www.ijaem.net ISSN: 2395-5252

B. Hardware Description

The hardware used in this project are Atmega 328P AVR micro-controller, RHT03 temperature and humidity sensor, esp 8266 node MCU, 28 M GPS module and SIM800L GSM module and relay switch is used to switch between GSM and node MCU.

Atmega 328P AVR micro-controller is a single-chip micro-controller created by Atmel in mega AVR family. It has a 8 bit RISC processor core which combines 32 KB ISP flash memory with read-while-write capabilities. It has 1 KB EEPROM, 2 KB SRAM, 23 general purpose input/output lines, 32 general purpose working registers, 3 flexible timer/counters with compare modes.

RHT03 temperature and humidity sensor require a power supply of 3.3 to 6 V DC, output signal is digital signal via MaxDetect with 1 wire-bus, its sensing element is polymer humidity capacitor, operating range for humidity 0-100%RH and for temperature -40~80Celsius, Accuracy for humidity +-2%RH(Max +-5%RH) and for temperature +-0.5Celsius.

Node MCU used here is esp 8266 which is a low-cost Wi-Fi microchip, with built-in TCP/IP networking software, and microcontroller capability. This small module allows micro-controllers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. It is a low price module which can be used in the projects.

GPS system 28 M is the module used in this system. This SIMCom presents a small, high performance and reliable assisted GPS module-SIM28ML. For SMS generation the module used is SIM800L, which is a quad-band GSM/GPRS module, that works on frequencies GSM850MHz, EGSM900MHz, DSC1800Mhz and PCS1900MHz. SIM800L features GPRS multi-slot class 12 / class 10 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.

C. Software Description

C is a procedural programming language. It was initially developed by Dennis Ritchie in the year 1972. It was mainly developed as a system programming language to write an operating system. The main features of the C language include low-level memory access, a simple set of keywords, and a clean style, these features make C language suitable for system programming like an operating system or compiler development.

Many later languages have borrowed syntax/features directly or indirectly from the C language. Like syntax of Java, PHP, JavaScript, and many other languages are mainly based on the C language. C++ is nearly a superset of C language (Few programs may compile in C, but not in C++).

In order to execute the above program, compiler is needed to compile and run the programs.There are many compilers available freely for the compilation of C programs like Code Blocks.

C is a powerful general-purpose programming language. It can be used to develop software like operating systems, databases, compilers, and so on. C programming is an excellent language to learn to program for beginners.

IV. RESULT

When the tips are taken by the tipping bucket the tipping count and the rain intensity is displayed on the LCD screen, the result displayed on LCD screen is as follows –

>= 2 for LOW, <= 3 &>=5 for MEDIUM, <5 for HIGH rainfall.

Along with the tipping count and rain intensity LCD screen also displays the temperature and humidity range. As the GSM and GPS system is connected to the circuit it shares the location with the message of rain intensity. SMS received are for medium & heavy rainfall.

Via node MCU the Wi-Fi is connected to the net and the data of rain, temperature, humidity and rainfall count is reflected on the URL link created at the cloud by Think speak software. Whenever the link is clicked the recent data is updated on that link when it is connected to Wi-Fi system.

Link created at cloud is,

https://6yvamjg6i5ugfpbnzhdpeg-on.drv.tw/info/WeatherInfo.html

Figure 3. Medium rainfall displayed on LCD screen

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 12 Dec. 2022, pp: 513-517 www.ijaem.net ISSN: 2395-5252

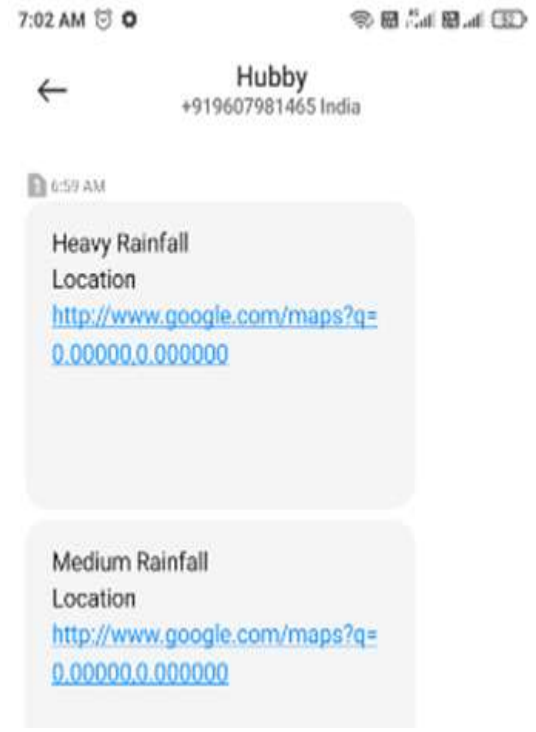

Figure 4. SMS send on mobile of Medium & heavy ra infall

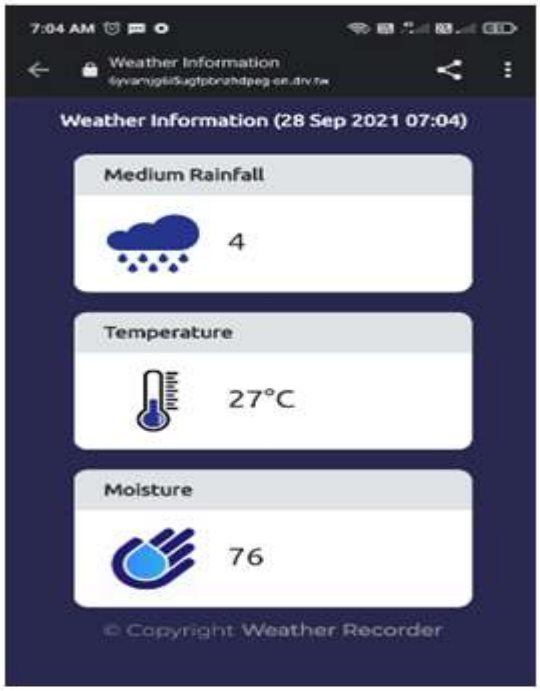

Figure 5. Medium rainfall displayed on cloud link

V. CONCLUSION

It is concluded that the rainfall can be measured using the tipping bucket system by sending the data to the microcontroller by the reed switch which sends a signal when it comes in contact with magnet. The microcontroller further forward the tipping information to GSM module and then it sends SMS and the location as well. As the SMS is send the relay switch connected between the GSM & node MCU switches to node MCU and then the data is reflected on URL link.

REFERENCES

[1]. M. Ghozalishyarul; Design and implementation of tipping-bucket rain gauge; Semarang, Indonesia 15-16 Nov. 2017

[2]. Rajiv Kumar Das, Neelam Rup Prakash, Design of an improvised tipping bucket rain gauge for measurement of rain and snow precipitation, January 2011 International Journal of Instrumentation Technology 1(1):44 – 59 DOI: 10.1504/IJIT.2011.043597.

[3]. UdomLewlomphaisarl; PrawitSaengsatcha, High Accuracy Tipping Bucket Rain Gauge, 20-23 Aug. 2012.

[4]. TarunKaruturiVenkataRaghava, Internet Enabled Tipping Bucket Rain Gauge, 2014 International Conference on Computer Communication and Informatics (ICCCI - 2014), and Jan. 03 – 05, 2014

[5]. Chi- Wen Hsieh, Po- Wei Chi, Volume: 57 Issue: 12, Automatic Precipitation Measurement Based on rain drop Imaging and Artificial Intelligence, 26 August 2019.

[6]. OsemwegieOmoruyi, Samuel N. John, Wireless Sensor Network for Rainfall Measurement Using a Tipping Bucket Rain Gauge Mechanism, 2017 International Conference on Computational Science and Computational Intelligence.

[7]. Jalu.A. Prakosa, SensusWijonarko, DadangRustandi, The Performance Measurement Test on Rain Gauge of Tipping Bucket due to Controlling of the Water Flow Rate; 978-1-5386-4340-2/18/$31.00 ©2018 IEEE

[8]. B. A. Indunil , H. A. P. K. Hettiarachchi, Automated Rain Gauge Stations with A GSM Data Transmission Link; Second International Conference on Industrial and Information Systems, ICIIS 2007, 8 – 11 August 2007, Sri Lanka