iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.37914

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

Tipping Bucket Rain Gauge Data Processing System: A Review

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Abstract: ***The tipping bucket system consists of funnel 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. By this system the high, medium or heavy rainfall character can be obtained. The rainfall character is calculated by the rainfall in 1 hour and corresponding number of pulses clicking in a period of 10 minutes. Various types of tipping bucket systems are reviewed 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. Tipping Bucket is the most useful parameter for measuring the rainfall. In this way the rainfall is measured using the Tipping Bucket Rain Gauge System.***

I. INTRODUCTION

When there is a rainfall, water falls into the funnel which is located at the top of the rain gauge. The funnel directs the water into the top of two way tipping buckets. The buckets tip against the pivot and push the screws. This activates a switch and the information about the rain is recorded electronically.

There are several different methods to calculate the rainfall measurement. One of the method is to design the Tipping Bucket Rain (TBR) Gauge System. This TBR works on the system where the rain fallen on the earth surface is measured with respect to time. This system is most commonly used in urban areas [1]. Another method to design is 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, which provides the data of water equivalently faster [2]. The behavior of the rain gauge tipping bucket in various form of rain intensities, such as from light rain to heavy rain is observed. It also described the problem that the most common tipping bucket rain gauge suffered from the calibration and how to improve the accuracy of system [3]. Another rain gauge system with tipping bucket was studied using the Internet by the Data Logger. In this, data can be collected in data loggers and further this data is forwarded to the main server. [4]. One more method to measure rainfall by tipping bucket was using Ground Rainfall Measurement. Here CMOS integrated camera in 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 [5]. Wireless Sensor was another new technology which provided real time data of field from sensors [6]. This paper showed water intensities that can be varied and measured by using a rain gauge tipping bucket [7]. 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 [8].

Figure 1. Shows the basic model of tipping bucket.

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

II. RELATED WORK

Gozali Syahrul [1] had designed the Tipping Bucket Rain Gauge System. 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 most 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] has used different method to design 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

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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.

Udom Lewlomphaisarl; Prawit Saengsatcha [3] designed behavior 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 most 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.

Tarun Karuturi Venkata Raghava [4] designed Internet Enabled Tipping Bucket Rain Gauge, whereas tipping bucket rain gauge are most 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, we can build this system 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] 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 has 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, Sensus Wijonarko, Dadang Rustandi [7] this paper showed water intensities can be varied and measured by using a rain gauge tipping bucket, this was the method to measure 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] this paper 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.

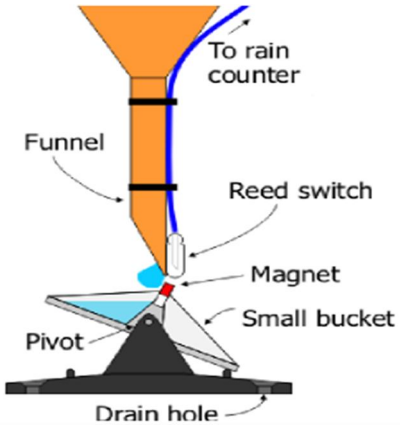

Fig. 1 Tipping Bucket

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

III. METHODOLOGY

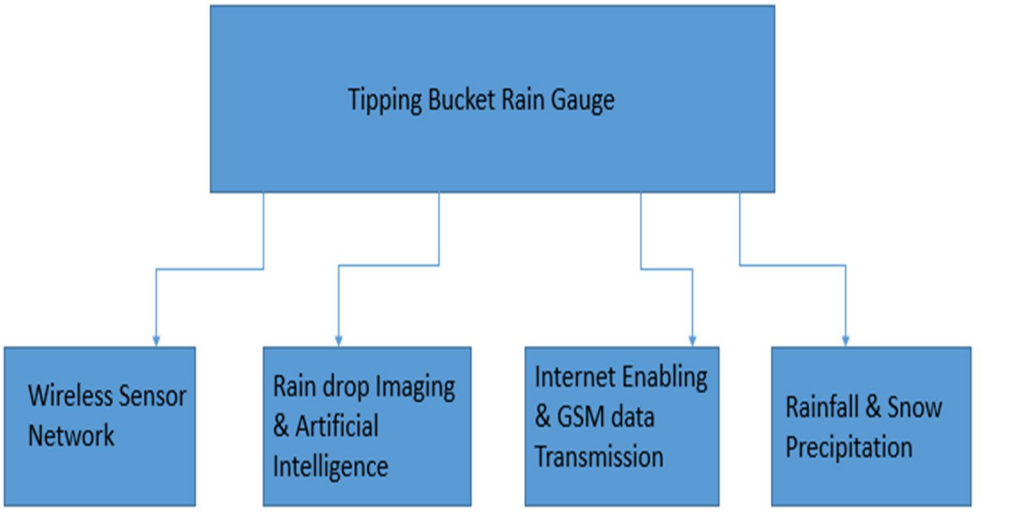

Figure 1.Taxonomy of Rain Gauge System

There are various different methods to calculate the rainfall measurement. These are stated as below:

A. Tipping-bucket Rain Gauge Implementation & Designing

In this method, the tipping bucket rain gauge system which measured the rainfall on the ground surface by calculating the time of the rainfall. The commonly used areas of this tipping bucket rain gauge (TBR) system were urban areas. The main parameters that affected the time resolution for measurement are the intensity of rain falling and the size of the bucket. This tipping bucket rain gauge was built, designed and also tested on the field as well as in the laboratory. This testing was done through micro controller connected to the rain gauge and the program done by the micro controller. This rain gauge system displayed and recorded the data of the rainfall for 24 hours. Further the result was measured by the micro-controller which was stored in the database and was displayed on the web. A tipping-bucket rain gauge had encouraging result when designed and field tested. The reed switch connected to the tipping bucket also worked effectively and sensitively. This rain gauge result was detected when the bucket tipped.

B. Tipping Bucket Rain Gauge Design for Measurement of Rain and Snow Precipitation.

Snow water at the snow places is equal to the amount of water that is in the snow pack. One should know that the actual time of the monsoon and winter season information for the flood forecast and for agriculture. The snow depth is known if the snow density is known by the snow water equivalent database which has been the main parameter for forecasting. Here the rainfall and the snow precipitation is measured by using the tipping bucket rain gauge system. The tipping bucket rain gauge system and anti-freeze based attachment was designed to reduce the failure of the tipping bucket. This tipping bucket showed more significant data of the snow water and rainfall. The measurement of snow precipitation by the anti-freeze attachment has a good rate of measurement i.e. approximately 7 mm/hr. The reduced delays which were in the previous tipping bucket were improved faster and the timing of the precipitation recording also improved.

C. High Accuracy Tipping Bucket Rain Gauge.

Some areas considered were having land slide, flood forecast or inflow forecast. Applications were there for the rain intensity measurement and amount of rainfall or water that flows in those areas which are important for hydrologist and geologist to estimate. The rain gauge tipping bucket system was mostly used in the ground-based rainfall measurement. Here it was seen, behavior of the rain gauge tipping bucket system in different rain intensities, from low rainfall to heavy rainfall. This problem can also be described as the most common tipping bucket rain gauge suffered by calibration and for the accuracy improvement of the rain gauge of the system.

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D. Internet Enabled Tipping Bucket Rain Gauge.

The tipping bucket rain gauge was most of the important apparatus which was mostly used for rainfall measurement. The data count was kept with the data logger where the rainfall occurred, connected to rain gauge in the internal storage of that device. Internet data logger are very expensive and are limited in the real market. In this paper the setup was made which was more competent and less priced rain gauge tipping bucket connected to the internet data logger. The rainfall data collected by the data logger was followed to the SQL (structured query language) database which was connected with the micro controller and was interfaced with GSM/GPRS module. Further this data automatically found latest information and upload the server as every time the rain fallen. It also updated the data after every 24 hours either there was or no rainfall. It also posted the data of the temperature and humidity obtained from the respective sensors, interfaced with micro-controller.

E. Automatic Precipitation Measurement of rain drop Imaging and the Artificial Intelligence.

This method involved the measurement of rainfall using tipping bucket by the method that used here is ground rainfall measurement. Here an instrument called Video-based Disdrometer was used in which a camera with a low cost was having CMOS integrated for a high speed image obtaining source object with backlight for lens in presence of Planar LED used to increase the depth. The rain drop images were 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.

F. Rainfall Measurement Using Wireless Sensor Network for a Tipping Bucket Rain Gauge Mechanism.

In this method, a new technology of the distributed wireless sensor networks was used which showed the real-time field data surrounded in that field. Here the rainfall was detected as well as measured through the distributed wireless sensors. Rainfall measurement can done by various methods one of the method is tipping bucket rain fall measurement system. Here this system used a wireless transceiver which transmits measured information and also a water level sensor is connected with the rain gauge. This measured data is 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.

G. Rain Gauge of Tipping Bucket System, Measurement of Performance by Controlling Water Flow Rate.

This paper showed the test measurement performance by varying the water intensities which were especially for the measurement of the tipping bucket. The conversion of water flow was obtained by intensity of water which entered into the funnel that is connected to the rain gauge. For this study the practical experiments were done. This system showed that as the water flow rate changes the volume of the water also changes. This method can also be used for other methods of tipping bucket. This study was done to see the measurement stability which was checked by the variations in the rate of water flow of the rain gauge system. Thus the intensity of the water was obtained by controlling the rate of water flow and performance of the measurement repeated by rain gauge system.

H. GSM Data Transmission Link used for Automated Rain Gauge Stations.

This paper showed the monitoring of the rainfall in five areas form only one of the base station which was an automated rainfall gauge tipping bucket system. This rain gauge stations which were automated called as automated rain gauge station (ARGS) were developed at the 5 most remote places in Sri Lanka. These same base stations can also be installed in National Building Research Organization (NBRO) and the Department of Meteorology. This main station was connected to the GSM (Global System for Mobile communication) link. This automated rain gauge station (AGRS) system send the data of the rainfall per hour as per the threshold level it send the data depending on the intensity of the rainfall which if crosses the threshold level then the warning regarding this is given and a data is e-send at the higher rate. 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 station. As there was human being presence, this presence was captured by the LCD via IR (Infrared) proximity sensor. The main station had a GSM module with PC connected to it. The software application showed the data of the software in the tabular format. The data can also be saved in database.

IV. CONSLUSION

In this paper, different means and different methods of rainfall measurement in any area over the world were reviewed by the Rain gauge Tipping Bucket method. The standard tipping bucket rain gauge system measured the rainfall by calculating the time of the rainfall. Here, the drawback was that the rainfall count was for 24 hours only. So it could not be used for long term period as the data of long period was required.

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In another method, the tipping bucket could collect the data of that particular area through internet instead of visiting that place. Different sensors like temperature sensor & humidity sensor were used to detect the weather condition. The data collected by the data logger was transferred to the micro controller which was interfaced with these modules. But the data received here was displayed on the LCD. This could be enhanced by setting the information on the cloud where everyone could see the information. The rainfall was also measured by an instrument called video based disdrometer but it had an integrated CMOS camera which could be an issue for the water based circuit. Many rainfall measurement system used the capacitive proximity sensor. Instead it was seen that reed switched could be used which gave the accurate measurement value of the tips. By using this tipping bucket rain gauge system it was easier to get the weather condition as well as measure the rainfall in that particular area.

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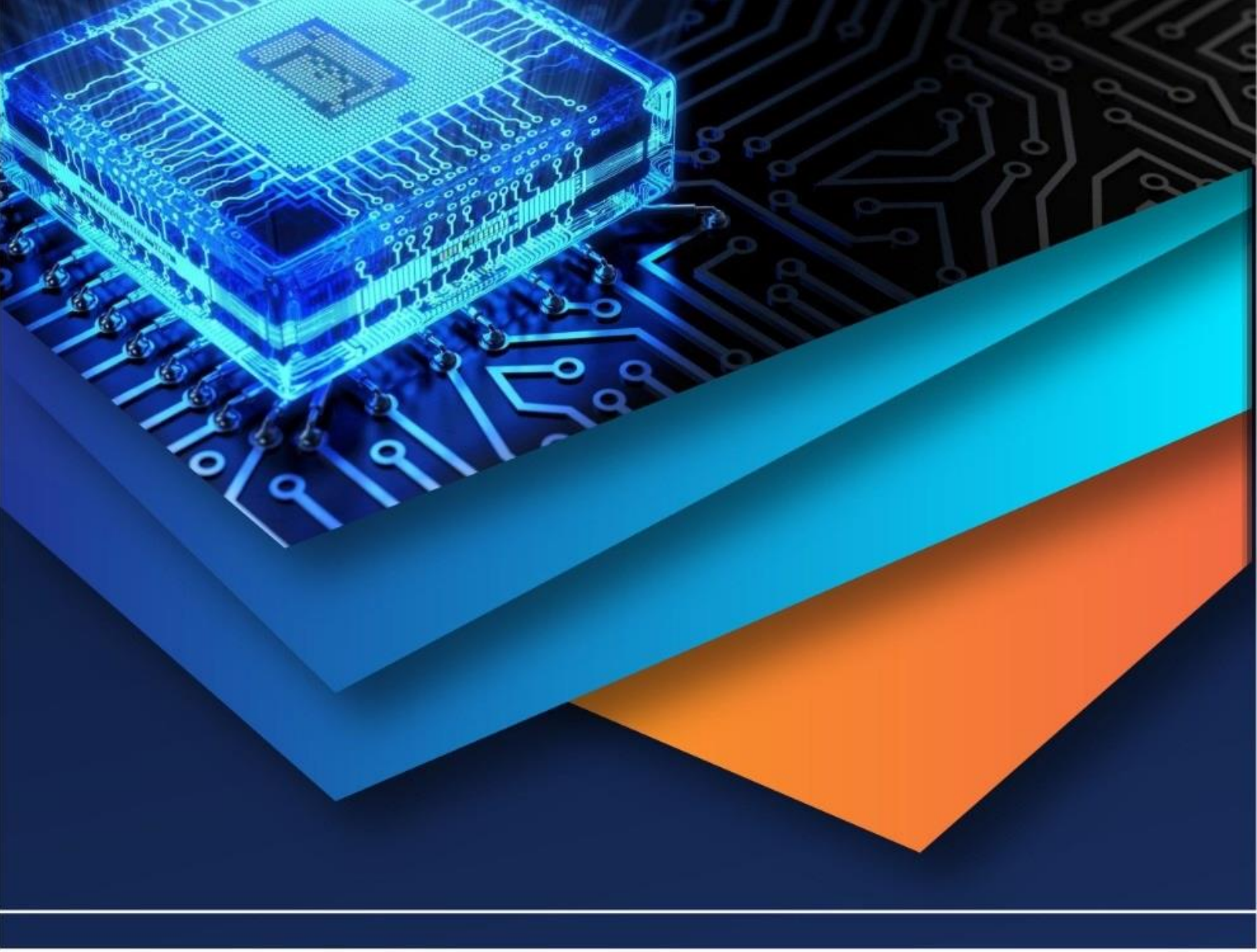

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