*Tipping Bucket Rain Gauge Data Processing System: A Review*

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Abstract: The tipping bucket system consist of funnel which collects the water of the rain in a container which is like a seesaw type modules which tips side by side & 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 vessel & electrical signal is sent. By this system the High, Medium or Heavy Rainfall character is obtained. The Rainfall character is calculated by the Rainfall in 1 Hour and corresponding no. of pulses clicking in a period of 10 minutes. Types of tipping bucket are using Rainfall & snow precipitation, using internet enabling, using rain drop imaging & artificial Intelligence & also using wireless sensor network & GSM data transmission. Tipping Bucket is the most useful parameter for measuring the rainfall. So in this way we can measure the rain fall using the Tipping Bucket Rain Gauge System.

# INTRODUCTION

There are several different methods to calculate the rainfall measurement. One of the method is to Design the Tipping Bucket Rain Gauge System which can also be mentioned as TBR. This TBR works on the system where the rainfall fallen on the earth surface 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 & snow precipitation. This system is designed to measure the rainfall as well as the snow, which provides the data of water equivalent faster. [2]. the behavior of the rain gauge tipping bucket in various form of rain intensities, such as from light rain to heavy rain. It can also describe the problem that the most common tipping bucket rain gauge suffers from, the calibration & how to improve the accuracy of system [3]. Another Rain Gauge System with tipping bucket can be done 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 using tipping bucket is using Ground Rainfall Measurement. Here an instrument called Video-based Disdrometer is used which a less-cost camera is having CMOS integrated for a High Speed image obtaining asset, for a backlight source and a specific lens for increasing the depth in presence of Planar LED. [5]. Wireless Sensor is another new technology which provides a Real Time Field data from sensors which are available in the field area. [6]. This paper shows water intensities can be varied and measured by using a tipping bucket rain gauge, this is the method to measure the rainfall repeatedly [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 Taxonomy of tipping bucket rain gauge system.

# Related work

Gozali Syahrul [1] has designed the Tipping Bucket Rain Gauge System which can also be mentioned as TBR. This TBR works on the system where the rainfall fallen on the earth surface with respect to time, this system is most commonly used in urban areas. For measuring intensity of the rainfall the tipping bucket is most commonly used and easier way. The Tipping bucket has been designed & tested in the laboratories & field areas. These testing is done by using the micro-controller. This system displays the information of the rainfall in between every 24 hours. This system had detected the rainfall when the bucket is 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 & snow precipitation. This system is designed to measure the rainfall as well as the snow, which provides the data of water equivalent faster. The Operation of this system is counting the no. of tips which was taken by the tipping instrument in the catch tube and convert it into the liquid, as this liquid fills and it can make a tip. There are various tubes such as Antifreeze reservoir, Overflow tube and Catch tube. The snow catched in the tube gets melted into anti-freeze liquid & 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 approx 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 light rain to heavy rain. It can also describe the problem that the most common tipping bucket rain gauge suffers from, the calibration & how to improve the accuracy of system.

Tarun Karuturi Venkata Raghava [4] designed Internet Enabled Tipping Bucket Rain Gauge, whereas Tipping bucket rain gauges are most commonly used apparatus for the measurement of rainfall. For this internet enabled system the data loggers keeps the count of the rainfall data in the internal memory received by the rain gauge. As it is 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 whereas the sensors are used such as temperature sensor & the humidity sensors, which are connected to the microcontroller.

Chi-Wen Hsieh, Chih-Yen Chen, Lijuan Wang [5] One more method to measure rainfall using tipping bucket is using Ground Rainfall Measurement. Here an instrument called Video-based Disdrometer is used which a less-cost camera is having CMOS integrated for a High Speed image obtaining asset, for a backlight source and a specific lens for increasing the depth in 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 is another new technology which provides a Real Time Field data from sensors which are available in the field area. In this paper the study of wireless sensor network is given which shows accurate rainfall detection & measurements. Rainfall can be measured by different techniques one of the technique is here we used is tipping bucket rain fall measurement system. A wireless transceiver which transmits measured information and water level sensor is connected with the rain gauge. This data is transmitted to the receiver. The receiver is connected to the base station. Finally the data is displayed through the graphical user interface (GUI) at the base station. The result of this paper shows the accurate rainfall measurement.

Jalu.A. Prakosa, Sensus Wijonarko, Dadang Rustandi [7] This paper shows water intensities can be varied and measured by using a tipping bucket rain gauge, this is the method to measure the rainfall repeatedly. For this the water intensities were obtained by converting the volume of water or water flow rate which were collected through the funnel of tipping bucket. Experiments were done for this system. This system shows 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.

Indunil, B. A., & Hettiarachchi, H. A. P. K. [8] This paper about the rain gauge system was used in Sri Lanka to detect and monitor the rainfall in that area/field. The Global System for Mobile communication (GSM) link was used here to connect with the base station and automated rain gauge system (ARGS). 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 ARGS. As there was Human Being Presence, this presence was captured by the LCD via IR (Infrared) proximity sensor. The base station had a GSM modem with PC connected to it. The software application shows the data of the software in the tabular format. The data can also be saved in database.

# METHODOLOGY

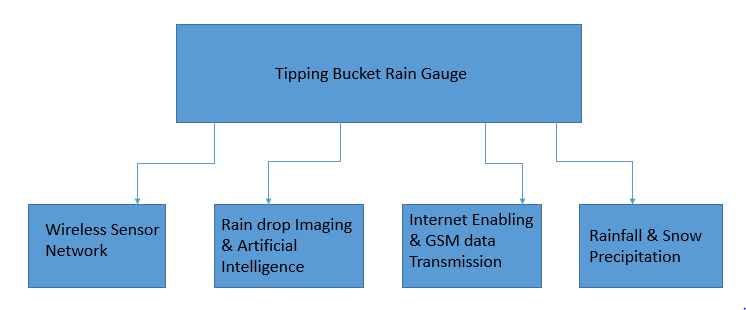


Figure 1.Taxonomy of Rain Gauge System

## Design and implementation of tipping-bucket rain gauge.

This paper has designed the Tipping Bucket Rain Gauge System which can also be mentioned as TBR. This TBR works on the system where the rainfall fallen on the earth surface with respect to time. This TBR system is most commonly used in urban areas. The main parameters that affects the Time resolution for measurement are the intensity of rain falling & the size of the bucket. Tipping Bucket rain gauge is built & designed & also tested on the field as well as in the laboratory. This testing is done through micro controller connected to this rain gauge, & the program done by the micro controller. This rain gauge system it displays the data & recorded data of the rainfall till 24 hours. This result is measured by the micro-controller stored in the database further it is displayed on the WEB. A tipping-bucket rain gauge had encouraging results when designed and field tested. The Reed switch connected to the tipping bucket also work effectively and sensitively. This rain gauge result is detected when the bucket is tipped.

## Design of an improvised tipping bucket rain gauge 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 forecasting and for agriculture. We can know the snow depth if the snow density is known to us by the snow water equivalent database which had been the main parameter for forecasting. Here we measure the rainfall and the snow precipitation by using the tipping bucket rain gauge system. Here the tipping bucket rain gauge system and anti-freeze based attachment is designed to reduce the failure of the tipping bucket. This tipping bucket gives 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 by approx 7 mm/hr. The delays for the reduction which were in the previous tipping bucket were improved faster and the timing of the precipitation recording also.

## High accuracy tipping bucket rain gauge.

In this System the land slide, flood forecast or inflow forecast these applications are there for the rain intensity measurement & amount of rainfall & water that flows in those areas are important for hydrologist & geologist to estimate. The rain gauge tipping bucket system is mostly used in the ground-based rainfall measurement. Here we see the behavior of the rain gauge tipping bucket system in different rain intensities, from light rain to heavy rain. It can also describe the problem that the most common tipping bucket rain gauge suffers from, the calibration & how to improve the accuracy of system.

## Internet Enabled Tipping Bucket Rain Gauge.

The tipping bucket rain gauge is one of the important apparatus which is mostly used for rainfall measurement. The data count is kept with the data loggers where the rainfall occurs, connected to rain gauge in the internal storage of that device. Internet data loggers are very expensive and are limited in the real market. In this paper here the setup is made which is more competent and less priced rain gauge tipping bucket connected to the internet data logger. The rainfall data collected by the data logger is followed to the SQL database which is connected with the micro controller which is interfaced with GSM/GPRS module. Further this data is automatically finds latest information and upload the server as every time the rainfalls. It also updates either there is no rainfall, the data after every 24 hours. It also posts the data of the temperature & humidity obtained from the respective sensors, interfaced with micro-controller.

## Automatic Precipitation Measurement Based on rain drop Imaging and Artificial Intelligence.

This paper has proposed the measurement of rainfall using tipping bucket is using Ground Rainfall Measurement. Here an instrument called Video-based Disdrometer is used which a less-cost camera is having CMOS integrated for a High Speed image obtaining asset, for a backlight source and a specific lens for increasing the depth in 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.

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

This paper proposed the new technology of the Distributed wireless sensor networks which shows the real-time field Data which are surrounded in that field. Here the Rainfall is 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 they had 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 is connected to the base station. Finally the data is displayed through the graphical user interface (GUI) at the base station. The result of this paper shows the accurate rainfall measurement.

## The Performance Measurement Test on Rain Gauge of Tipping Bucket due to Controlling of the Water Flow Rate.

This paper shows the test measurement performance by varying the water intensities which is especially for the measurement of the tipping bucket. This water intensities are obtained by converting the flow of water which entered into the funnel that is connected to the Rain gauge. For this study the practical experiments were done. This system shows 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 if the water flow rate varied to check the measurement stability of the rain gauge system. By controlling the water flow rate the performance of the measurement repeatability of rain gauge system the intensities of the water can be obtained.

## Automated Rain Gauge Stations with A GSM Data Transmission Link.

This paper shows the monitoring of the rainfall in five remote areas form only one base station which is an automated rainfall gauge tipping bucket system. This automated rain gauge stations (ARGS) were developed at the 5 most remote places in Sri Lanka. These same base stations can also be installed in Department of Meteorology, and National Building Research Organization (NBRO). This base stations are connected to the Global System for Mobile communication (GSM) link. This AGRS System sends the data of the rainfall per hour as per the threshold level it sends 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 ARGS. As there was Human Being Presence, this presence was captured by the LCD via IR (Infrared) proximity sensor. The base station had a GSM modem with PC connected to it. The software application shows the data of the software in the tabular format. The data can also be saved in database.

# CONSLUSION

In this paper describing the Rain gauge Tipping Bucket, by which rainfall can be calculated fallen in any area over the world. This paper tells us that how the tipping bucket rain gauge can help us to measure the rainfall which has become the important factor of today’s life by different means and different methods. Here we can collect the data of that particular area through internet instead of visiting that place. We can also use different sensors like Temperature sensor & Humidity sensor to detect the weather condition. As the data collected by the data logger can be transfer to the micro controller which are interfaced with these modules. By using this tipping bucket rain gauge system it is easier to get the weather condition as well as we can measure the rainfall in that particular area.

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