Digital Rain Gauge With Enhanced Features

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Abstract-*The paper describes the digital rain gauge. Rainfall is usually unpredictable. Various fields which are dependent or affected by varied rainfall have very limited means, by which accurate data of rainfall can be obtained. The digital rain gauge is designed after considering these requirements. Features are included to comply as many of these as possible, technically and commercially. Use of efficient low power microcontroller and data storing feature ensures that, minimum human interference is required for considerable time span. The objective of the paper is to give precisely measured data of rainfall as well as temperature at any instant of time.*

Keywords-Rainfall measurement, programmable scaling, tipping bucket, data storage

I. INTRODUCTION

In past few years it has been noticed, that the rainfall has become very irregular, which not only affects farming but also industries viz. agriculture, aviation, shipping, fisheries, tourism etc. These fields have very limited means, by which reliable measurement of rainfall can be obtained at any given instance. Most of the presently available rain gauges use the methods that are either highly fallible or do not include favorable features for accessing the measured data[1]. Thus, it is important to measure the rainfall accurately and get the data in time for further analysis. Human interference in such cases can be errable, affecting the accuracy of the measurement of rainfall. As the data stored or being measured can be lost due to various causes, the alternate storing facility is always beneficial in the case of rainfall measurement where lost data can affect the overall evaluation. To overcome the mentioned shortcomings, the Digital Rain Gauge is included with various auxiliary feature and facilities to accomplish the objective with minimum errors.

II. SYSTEM DESIGN AND IMPLEMENTATION

System can be explained in three segments, as represented in figure 1.

Input section

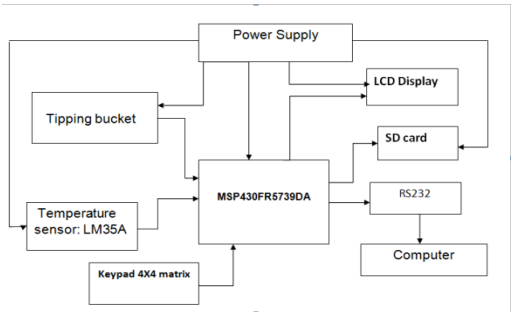

Figure 1

1. Data storage and programming,
2. Output section.

Following input devices are used in instrument:

Tipping bucket:

Tipping bucket type rain sensor is used as it is suited for the purpose of minimum human interference and precise measurement of rain. The construction is shown in the figure 2. As rainfall fills the tiny bucket, which holds an exact amount of precipitation, it becomes overbalanced and tips down. While emptying itself the other bucket pivots into place for the next reading. The action of each tipping event triggers a small switch that activates the electronic circuitry to transmit the count to MCU, recording the event as 0.5 mm of rainfall[1] .

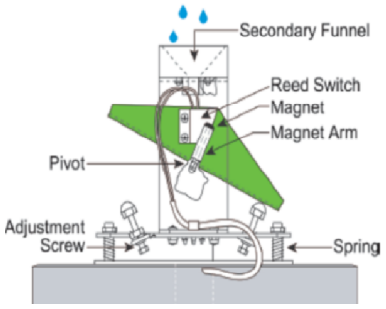

Figure 2 [4]

LM35, temperature sensor:

Temperature measurement is included as an enhanced feature, which is used to analyze the effect of rainfall on surrounding atmosphere. LM35 is used as

temperature sensor, as it has suitable range and ease of interfacing with microcontroller.

4x4 matrix keypad:

Keypad is used to enter the date or month of which rainfall is to be displayed on LCD display. Also, it is used for the giving input to microcontroller when needed.

Data storage and programming:

Data storage:

Data storage is the most crucial aspect of the instrument. The array is programmed such that it will store the data every 15 min i.e. 4 times in an hour this makes it 96 times a day. This process is executed throughout for one complete year from the installation; thus two dimensional array of 365x96 is programmed for data to be stored in RAM.

When switched ON, instrument is needed to know whether it is first time installation, if yes, all memory locations are cleared for future data storage.

If no, the blank memory locations of the time instrument was switched OFF are saved as invalid data and further data is stored according to the time it was measured.

Operation and programming:

The output of the tipping bucket is given to MCU as highest priority maskable interrupt, to ensure every pulse is counted for accurate measuring of rainfall.

RTC is used in calendar-mode according to which the data is stored with time and date[1]

Inbuilt ADC is used in single-channel-repeat mode, to convert LM35 output voltage in temperature (°C)[2]

As an alternate arrangement for data storage, SD card is provided; which acts as a data logger. Also the same data can be collected by computer or laptop using RS232 protocol whenever required.

Programming is done such that while transferring the data; rainfall measurement is not interrupted[3]

Cal Mode:

The Rain gauge also consists of Cal Mode, which is initiated when manual switch is in ON position. It is mode in which tipping bucket is calibrated by pouring fixed amount of water in it, and getting output pulse at the right amount.

Microcontroller specifications:

It was mandatory to choose efficient microcontroller, so that the operation described is carried out smoothly for long period of time.

Thus, microcontroller of Texas Instruments MSP430FR5739DA is used. It consumes considerably less power (Ultra-Low-Power) and is consist of special purpose high speed FLASH memory called FRAM. Also due to inbuilt RTC, ADC, and other features made MSP430FR5739DA obvious choice for the Rain gauge[2]

Output section:

Output section has LCD, 20x4 display for viewing current measurement of rainfall and temperature along with date and time. Also, to display the data of any particular day/month entered by using keypad.

SD card is used to keep backup of the data in case of the malfunction of instrument.

RS232 is the protocol used for connecting Rain gauge to laptop for acquiring the data whenever needed.

III. RESULT

Expected result is to get accurate measurement of rainfall and temperature, also data being stored in both MCU memory and SD card. As well as the smoothly running operation with instant data being displayed on LCD display.

IV. CONCLUSION

The Digital Rain gauge is more efficient and accurate than currently available manual methods to measure the rain. Due to enhanced features and the programmed operation, the human errors and possibility of losing data is eliminated. Its ultra-low power consumption makes it more cost-effective. Considering the the design and implementation the Digital rain gauge is more user friendly.

Modifications are easily possible in the aspect of communication with remote control rooms or station using various wireless protocols e.g SDI-12.

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