A VIABLE APPROACH FOR RAINFALL MEASUREMENT TO IMPROVE WEATHER INFORMATION GATHERING ACROSS AFRICA

by

ODETOYINBO Abdulhafeez Olaide

OKUNOLA Abdullah Akolade

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SUMMARY

The sustainability of Africa hinges on its ability to adequately provide water to cater for all its needs. Africa is presently severely lacking in this capability.

Therefore, all stakeholders must collaborate to deploy as much available resources the continent has as possible in order to solve the problem.

As stakeholders, members of the group realize the need to participate actively in efforts aimed at addressing the water scarcity problem.

For agriculture and indeed the human existence to be sustained, effective water management is essential.

Although existing conventional weather stations measure hydrological variables, they are often expensive, inaccessible or not robust.

Consequently, the group decided to undertake the measurement of rainfall which is an important weather / hydrological parameter by employing strategies that are cost-effective and robust, with the Hall Effect as well as mass of rainwater collected as the physical principles to use, along with basic knowledge and concepts derived from science and mathematics.

OBJECTIVES

With this project, the following will be achieved:

(i) design and implement a cost-effective weather station; and

(ii) design and implement a robust weather station measuring a weather (hydrological) variable, as desired.

Rain can be described as liquid water in the form of drops or droplets which have condensed and precipitated from the water vapour that is in the atmosphere, thereby falling under gravity to the earth. It is imperative to measure the amount of rainfall when such precipitation occurs in the atmosphere.

Water is life, and forms the basis of growth and development of living organisms and is central in man-made processes. Rain is therefore important for plants and animals as it is a major means by which water enters into the water cycle.

The methodology of approach to measure the amount of rain when it is precipitated is presented in the following sections.

METHODOLOGY

A. Theory

In the water cycle, a lot of processes are involved, and one of such important processes is the evapotranspiration of water molecules from plants, earth surface and water bodies into the atmosphere. Precipitation results ultimately from another important process which is the condensation of the vaporised water molecules. One of the important results of the precipitation action is rain, which adds water to the earth once again. Along with other processes, the water cycle continues infinitely.

Conventionally, rainfall amounts are measured using rain gauges. A rain gauge is often a cylindrical container with uniform cross-sectional area graduated often in millimetres to take the length or height to which rainwater collected in it gets to.

For the process here, a neat and empty cylindrical container with uniform cross-section with a light mass that passes for a rain gauge is selected. Its mass would be determined and noted from its label or by means of a mass/chemical balance. The UK Met Office uses a **5-inch** (diameter) rain gauge, according to a Met Office expert (Ralph James) (2010).

When rain falls, some rainwater is collected into the container. This results into a new mass for the system due to the addition of the rainwater. The difference between the new mass and the mass of the empty container can be determined. The cross-sectional area of the container is determined mathematically using a mensuration formula, once its diameter is known. The density of water has been found to be **1.0g/cm^3**.

The Hall sensor interacts with the field of a magnet and induces a voltage as a result. It is attached to the base of the cylindrical container, and the entire container is positioned in such a way as to enable the sensor interact with a magnetic field in an enclosure. Therefore, with the new masses due to water being collected, voltages are induced in the sensor. The induced voltage, which is fed into a microprocessor, then has to be calibrated experimentally according to the changes in mass due to water.

Figure 1: Rain gauge/Cylindrical container

Figure 2: Hall Sensor

Figure 3: Magnetic Coil

With the calibration done, cross-sectional area of the container and density of water known, a combination of these parameters will be used to determine the amount of rainfall in **mm**.

B. Design

In carrying out the design of the weather station, the stages identified are as shown in the flow chart in Figure 4 below and expatiated on, subsequently.

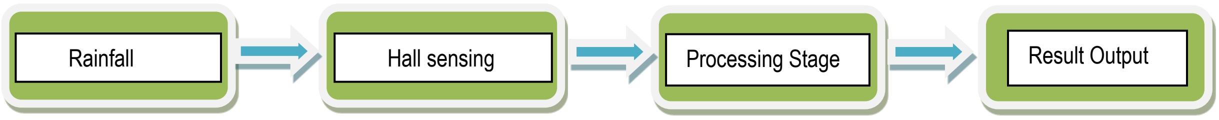

Figure 4: The Design Stages

Input:

During rainfall, rainwater is continually collected into the light-mass container. The mass of the system continues to increase as more rainwater enters into the container. The increase in the mass of the system impacts on the Hall sensor as it cuts more into the magnetic field of the magnet enclosed beneath the container system. Voltage is induced as a consequence of the cutting of the field of the magnet by the Hall sensor.

Processing

The induced voltage is fed into a microprocessor. A calibration is done to determine the relationship between the change in mass of the system due to water and the voltage that is induced in the Hall sensor as a result.

The density of water is known (**1.0g/cm^3**), the cross-sectional area of the container of diameter **5-in** (**12.7cm)** is **126.68cm^2** and with the calibration done as stated for the sensor voltage and water mass, the amount of rainfall can be determined in **cm**, and then converted to **mm**.

Output

The amount of rainfall, in mm, which is the result as processed by the microprocessor, is then displayed on a liquid crystal display board and can be easily read off.

CIRCUITRY

The following are needed in designing and implementing the relevant circuits making up the project:

i. The Arduino Kit

ii. Hall sensor

iii. Connecting wires

iv. Coils from loudspeakers

A source of power is required to energise the Arduino.

CONCLUSION

This proposal has presented information about the design and implementation of a cost-effective and robust weather station that measures the amount of rain that falls when it is precipitated. A lot of information will be derived from the active implementation and use of the sensor. Common materials are required for its implementation.

With information obtained from here, it would be a lot easier to monitor and distribute water much more effectively across the African continent.

REFERENCE

The UK Met Office. (2010). “Measuring Rainfall”. In: Met Office Video Channel on YouTube. < http://bit.ly/1qscU6t >. Retrieved 21st June, 2014.