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Research Article

Developing a sustainable rain alarm sensor for agricultural land

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Background: The weather, especially rainfall, has a major impact on agricultural production. Accurate and timely rainfall monitoring is crucial for efficient farm management. Farmers may make more informed decisions about crop protection, irrigation, and general land management with the aid of a sustainable rain alarm sensor. Rain sensors are gadgets made to recognize when there is rain or other precipitation and to initiate an action, such as setting off an alarm. The rain sensor project is a small model project used to sense rainfall, and it is used to inform by sounding an alarm to store rain water for irrigation.

Methods: Rain may be consistently and precisely detected using a variety of technologies and methods, including conductive, optical, capacitive, and auditory sensors. The flow study illustrates the procedures required to operate the coconut shell rain sensor. The coconut shell is used to characterize the rain sensor. When the rain sensor detects precipitation, the motor activates, and the surface water level is utilized to remove surplus runoff and rainfall water from the farmed land's surface. This allows rainwater to be stored for use in the circuit later on. If this is the case, it is used to gauge the quantity of water in the soil and is required to gauge the field's water level. The pump will start working, and the alarm will sound if there is an excess of water detected.

Results: Rainwater flow in the field might occur after a period of intense rain, which would impact crop development and yield. The issue here is that the sensor uses sound to signal rain in order to prevent erosion and excessive water overflow *via* the channel. The sensor is used to subtract rain based on time. With the aid of the Rain Alarm Sensor, this research offers a pump to release extra water through the appropriate route. The analysis conducted with this data demonstrates how the sensor functions as a flow chart study, and the comparison of various technologies reveals that, out of the three sensors we have put up for review, Sensor A (sensitivity at 0.1 mm/hr, A has the quickest reaction time, at 100 ms, Sensor A at 95%) is the top performer. Out of all of them, sensor A displays the finest performance.

Conclusion: This experiment may be used to find out what is more helpful to farmers when it rains. It is also extremely helpful to find out the field's surface water level in case any extra water runs off and lowers the water level in the cultivated region.

Keywords: *infiltration, growth, storing water level, rain sensor, solution*

Introduction

The weather has been fluctuating a lot these days (Swain et al., 2020). These days, getting information about weather forecasts is fairly simple, through mobile phones and by using new technologies, but when individuals choose to travel for outdoor activities, they occasionally forget or simply don't comprehend the importance of seeing this information and during the working time it mainly happens due to the change in the weather period, mostly while the people moving ongoing outdoor activities they used to forget that clothes that are practically dry on a hanging rack outside the house could become wet if we are not aware that it is raining since it might rain at any moment and without warning, not only clothing things mostly in the agricultural sector also there may be a sudden change in weather one of the main reason for the crop damages. The sensor device used to check the weather and help us to schedule our outdoor pursuits for that day GSM Based Rain Fall Detector Using Arduino (Latha & Murthy, 2016) that is used to detect rain. Only the abovementioned rain detection is used to find the weather, but it is very difficult to communicate with the people so they found a rain sensor with an alarm, Design and Build of an Alarm System Integrated Rain Detector (Roy et al., 2019). Owing to the development in technology and the increase in the growth of the Smart Automation System Using Arduino (Iyen et al., 2020), the model of the rain sensor has become new and creative in Rain Drop Sensor. Then, the growth of IOT technology in the agricultural sector introduced the Environmental Monitoring System Using Arduino Uno (Zulkiflee et al., 2022). The Rain Detector Plate, which resembles an umbrella and was made out of coconut shells, LED, buzzer, and 555 Timer IC are the components that make this project work (Srikanth et al., 2022). The Rain Detector Plate, which resembles an umbrella and was made out of coconut shells, LED, buzzer, and 555 Timer IC are the components that make this project work (Taufiqurrohman & Simanjuntak, 2023). We primarily designed the rain detector plate, and it was different in size and structure from other plates. We used coconut shells to polish their surface area before using aluminium to make the sensor plate, which gave it an umbrella-like appearance. Al foil makes up the rain detector plates, which are grouped in teams on opposing sides. Mainly humans are created by nature, but we do not follow the principles and maintain nature, so it causes some climatic changes, weather changes, and so on. It affects the soil, human activity, and other daily activities of human life. Because over-rainfall in the farming area affects the farming land, the main process of this project is to control the excess run of water flow in the farming area, and the excess amount of water stored on the surface of the soil surface can be managed by using the help of motor power, which is used to control the flow of the water level in the surface of the soil or land and the flow of the water also controlled by using this sensor.

The following are the study's aims: water during the rainy season and the creation of a control measure for it, which is stored in the farming area. During periods of heavy rain, agricultural farming lands and other land surfaces are fully covered by water bodies to drain the excess water that this rain detector can use. During the planning duration of the trip for the moving outing, we used to dry our clothes outside. Some people dry seeds, vegetables, and other agriculturally harvested products in the sourced area to remove moisture from the materials. Therefore, it is mainly used to determine the operating system for the automatic and make basic instruments that are widely applicable across all societal levels and operate automatically. Due to heavy soil erosion in the soil, agricultural lands are mostly affected by more runoff at the time of the flow of rainwater in the agricultural land, which mostly affects the soil nutrient content. At the time of runoff, it is very difficult to control this problem; therefore, we used this sensor. Eight of the ten largest producers are in the Asia Pacific region. The three main producers, Indonesia, the Philippines and India, account for 75% of world production. 90% of India's coconut output is centered in the southern region. So, it is a huge production in India. The usage of the coconut shell is more applicable, but it is very difficult to implement in the field because the material used for the sensor detector is a biomaterial, so it is not applicable to implement in the field. Coconut shells are abundant, long-lasting, and biodegradable. Effective application is ensured by processing them into appropriate shapes, such as ground bits or shaped plates. The longevity and water resistance of the plates can be increased by coating them with natural, biodegradable compounds without endangering the environment. Use moisture sensors to track rainfall and provide information to a central system for in-the-moment monitoring and action.

A rain alarm system is used (Xia et al., 2023) and proper channels are constructed to use the rainwater effectively (Zheng et al., 2023). Buzzer alarm is used to find the weather factors of the zone level (Lv et al., 2022). Rainwater or the excess flow of water can be stored and used for the irrigation method effectively (Eisfeld et al., 2023). This rain sensor is used to reduce or control soil erosion (Costabile et al., 2024). It is not only used to remove the excess amount of water from the field but also to control soil erosion, improve soil fertility and conserve soil and water. Plates made from coconut shells are eco-friendly since they break down without producing any hazardous leftovers. Their use lessens the need for synthetic materials, supporting sustainable agriculture. Using coconut shells—a waste product from other industries—helps conserve resources and cut down on waste. The concepts of sustainable resource management and the circular economy are in line with this approach and so in the technical level.

Objective of the work

The agriculture industry has developed as a result of technological improvements. These days, it is difficult to get by without food or food supplies. When crops are being grown, it is difficult to identify the specific weather factors that lead to the former. Technologies like Internet of Things sensors and mechanical systems are very helpful for assessing weather conditions, soil composition, water quality, quantity, soil nutrition, and water requirements for plant consumption. One of the best technologies for conserving water and soil is this one. By storing water in buildings like agricultural ponds, we can make efficient use of water with the help of this rain alert sensor. It reduces soil erosion and increases soil fertility.

The onion is one of the most widely produced crops in almost all parts of India. It is vital to the economic and financial sectors of India. Usually, onions are growing subsurfacely (as a root crop). Due to the excessive amount of rain that falls in a short period of time, the formers are unable to release the water from the field during the heavy rainy season, which could result in significant losses for the farmers (Deekshath et al., 2018). This research conducts a survey of the literature on drones with a focus on applications for remote sensing in smart farming. Global assessments indicate that employing drones and remote sensing technology to increase agricultural yields and productivity is both desirable and necessary (Kulbacki et al., 2018). This article addresses the current issues and potential paths for future study while providing a review of the uses and developments in SSA. Furthermore, we have included an explanation and examples of taxonomy for exactly that. Additionally, the taxonomy covers new futuristic approaches and various communication protocols. We have now covered the challenges associated with developing CE devices as well as the areas of future research that will be looked into to increase the devices' acceptability for usage in SSA (Gunasekaran et al., 2011).

Materials and Methods

LED Light, 100pF ceramic Capacitor (code 101), Small Rain sensor, 555 timer IC, 2N2222 NPN Transistor, Connecting wire, 1N4007 PN Junction diode, 220 k Resistor, 330 k Resistor, 10 k Resistor, 470k Resistor, 3.3k Resistor, 68k Resistor, 22F Capacitor, 100F Capacitor, 10nF ceramic Capacitor (code 103), Buzzer, Breadboard, Motor, BC548 NPN Transistor, 12v power supply, Connecting pipes. These are the major components used to detect rain using the rain sensor plate and to control the flow rate and surface level of water. The structure of the rain sensor board is made of coconut shells. The following diagram shows the coconut shells (Figure 1).

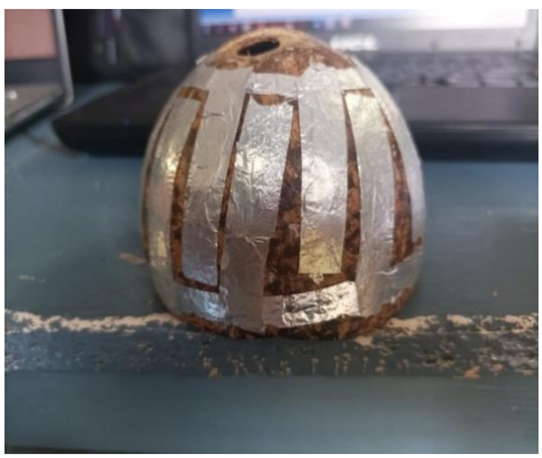

Figure 1. Side view of the coconut shells in the rain sensor

Flow chart

The flow chart shows the steps involved in operating the coconut shell rain sensor. First, the rain sensor is described in the context of the coconut shell. The rain sensor detects rain, and when it detects it, the motor starts to turn on, the rain LED begins to blow and sound an alarm, and the surface water level is used to remove excess runoff and rainfall water from the surface of the farming land in order to store rainwater for later use in the circuit. The picture below explains how the sensor began to operate technically during a rainy period. If there is no rain or no alert, it means that there isn't any rain; if there is rain, it means that the sensor may have sensed the rainfall. If so, it is used to measure the amount of water in the soil and necessary to measure the water level in the field; if there is an excess of water, the alarm indicator will sound and the pump will start to run (Figure 3).

Circuit diagram

The graphic below displays the Rain Alarm Project's circuit schematic (Figure 2).

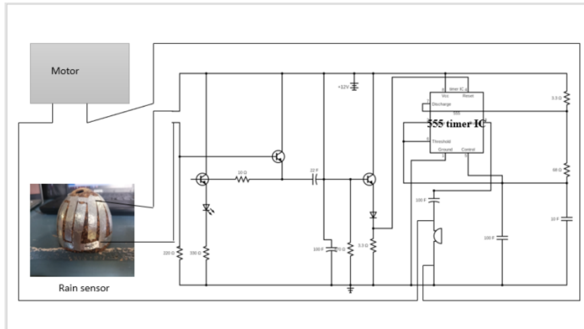

Figure 2. Circuit diagram

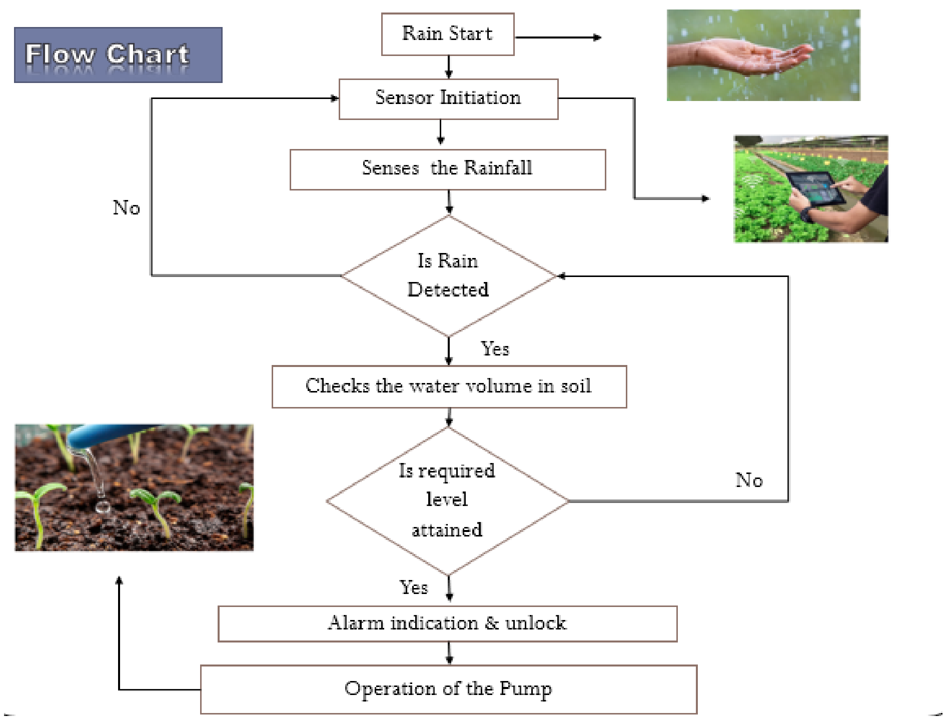

Figure 3. Methods in flow chart

Block diagram

The precipitation alert experiment block graph is displayed in the following diagram. The three primary parts of the project are the rainwater sensor, the 555 clock IC, and the buzzer (Figure 4). When precipitation is detected, the rainfall water sensor sends a signal to the 555 Clock. After that, the 555 Clock IC's constant mode will activate the buzzer.

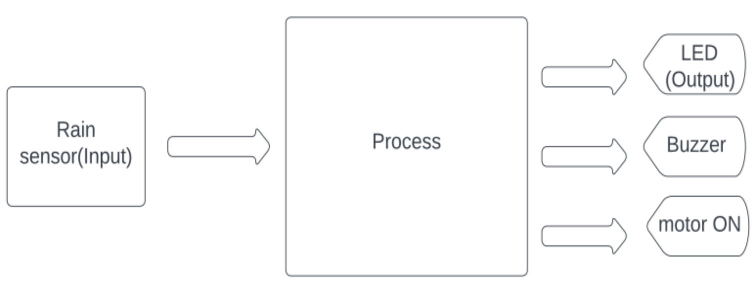

Figure 4. Block diagram.

Results and Discussion

Rain sensors ought to be stored outside, at a height of zero degrees. Rainwater won't be on the detector for a very long period as a result. After a while, this circuit will automatically turn off the alarm, and the LED will continue to light until the rain stops.

Working of circuit

Now, let's look at how the fundamental Downpour Sensor Alert Circuit Venture works (Dittmann et al., 2004). The aluminium wires on the Sensor Board will start to lead and close the path between the inventory and the semiconductor Q2 base at the moment when precipitation falls on the sensor(Tymochko & Olikh, 2007). Accordingly, Semiconductor Q2 will activate, causing Semiconductor Q1 to activate as well. This will activate the Dazzling White Drive connected to Semiconductor Q1's manufacturer. Semiconductor Q3 will switch on when capacitor C1 is shorted at the point where semiconductor Q2 is wet. R4 will act as a resistor to charge C1. Semiconductor Q3's reset pin on the 555 Clock IC, which is connected to Q3's manufacturer, will turn positive when it reaches the immersion mode. The astable mode is used to organize the 555 clock. A heartbeat signal will appear at the 555 clock IC's result pin 3 as soon as the reset pin receives a positive voltage, making the IC dynamic. This will activate the alarm and turn on the bell. If you are using a speaker, only the variations in the sign that cause the speaker to sound will be allowed to pass through Capacitor C4, which is located in the centre of Pin 3 of the 555 clocks and the speaker. Any current that runs counter to the clock is prohibited by the diode D1. At some point, when the capacitor becomes fully charged, semiconductor Q3 will go into the cut-off state because of resistor R4 and capacitor C1. As a result, the speaker will stop producing sound, and the reset switch of the 555 Clock IC will not receive any stable voltage. The upsides of C1 and R4 provide the 555 Clock with the best chance to produce speaker sound. The aluminium wire on the sensor is unable to transmit when there is no rainfall because it lacks conduction (open circuit). As a result, there won't be a warning as the sensor is unable to activate the 555 Clock IC.

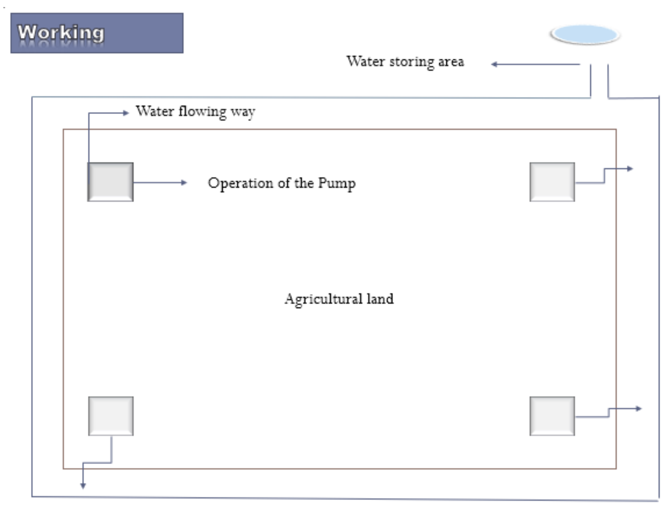

Figure 5. Working model of the sensor in the agricultural land

The sensor was building n-number of channel lines in the field as part of its operation (Figure 5). The channel was then connected by them at the same location in the vicinity, and with the assistance of the motor which is driven by the sensor and the water discharge could then happen smoothly. Water from the pump operations on agricultural land is collected by the water flowing ways, which are then primarily utilized to release the water. The collected water is subsequently stored in the water storing area.

To find the result of the rain sensor during the rain, first collect the required material, set the modal of the rain sensor material, and supply the power supply to the rain sensor for its function. When the sensor started to operate, the LED started to turn on and then blew. The mainboard modal presents a high resistance to the supply voltage during sunny days because of the dryness of the board. After it begins to supply the output voltage, the resistance begins to reduce the output voltage (as the resistance gradually reduces, the output voltage continues to fall). The voltage that is generated will be as low as feasible if the rainboard is completely wet. There are different ways to find the rain sensor, such as using an argument sensor. The raindrop sensor module rainfall because it works on the principle of Ohm's law.

$$v = ir \text{--} (1)$$

Multi vibrators are made with IC timers (555 series). In that state, the IC functions as an oscillator, producing a square pulse, and the 555 timer IC is connected. (1 is connected with the ground) (2 is connected with output) (3 is connected with the out (buzzer)) (4 is connected with the diode) (5 is connected with the capacitor (101)) (6 is connected with output) (7 is connected with the positive) (8 is connected with the supply) and the function of the buzzer is an audio signaling device during the raining a loudspeaker in which a piezoelectric effect is used to produce sound, the resonators or the diaphragms are used to convert this motion into an audible sound signal and the operated well in the range of 1 khz to 5 khz and it can go up to 10 khz. BC548 NPN Transistor is mainly used for switching and amplification. It consists of three different points: collector, emitter, and base. Each transistor consists of a gain value for this type of transistor. The gain value is between 100 and 800, and the maximum current loaded capacity is 500 mA. This is the same basic information that we need to know in the connection of the rain sensor. During the sensor work, if there is no rain (Means during the absence of rain), When there is no rain for a prolonged period of time, there will be a lot of resistance between the contacts. In the rain (it means during the absence of rain), The resistance between the contacts is lowered as a result. In this sensor, we use different values of the resistor and capacitor:When there is a decrease in the resistance between the contacts after a short period, the motor starts to generate, and then it starts to remove excess water from the field through the pipelines.

Table1. Comparison of rain sensor

S. No.	Rain Gauges	Capacitive Rain Sensors	Optical Rain Sensors	Ultrasound Rain Sensors	Hygroscopic Rain Sensors
Technology	Tipping bucket mechanism/ a graduated cylinder	Utilizes changes in capacitance caused by the presence of water to detect rainfall.	Interruption of an infrared light beam to detect rainfall.	Ultrasonic waves to detect the presence of raindrops.	Electrical conductivity of a hygroscopic material in the presence of moisture to detect rainfall.
Accuracy	Limitations in detecting light rain/mist	Can accurately detect rainfall intensity.	Highly accurate in detecting the presence and intensity of rain.	Provide accurate detection of rainfall.	Offer reliable detection of rainfall.
Sensitivity	Detect both light and heavy	Highly sensitive and can detect light rain and mist.	Detect light rain and mist.	Highly sensitive to raindrops, capable of detecting light rain.	Sensitivity, capable of detecting light to moderate rainfall.
Response Time	Can provide real-time/near real-time data.	Generally provides quick response times.	Typically offers fast response times.	Generally fast response times.	Offers moderate response times.
Cost	vary depending on the design	Moderate to high cost depending on the features and build quality.	Moderate to high cost.	Moderate to high cost.	Lower compared to other sensor types.
Application	Weather stations, agricultural monitoring, and hydrology research.	Used in automotive applications (automatic windshield wipers), weather stations, and IoT devices.	Automatic rain detection systems for vehicles and weather monitoring stations.	Automotive rain sensing systems, weather monitoring, and smart irrigation systems.	Various weather monitoring applications and IoT devices.

However, we performed all this work at the final stage and made some mistakes, and there were some problems with the sensor at the final stage. We are still working on this to improve the model. The other is that when choosing rain detection sensors, one must consider a number of criteria, including application applicability, cost, reaction time, sensitivity, accuracy, and technology. Rainfall is usually collected and measured using a graduated cylinder or a tipping bucket mechanism in traditional rain gauges. It has the potential to be limited in its ability to detect light mist or rain, but it is often reliable in measuring precipitation. Can, depending on the design, detect both light and heavy rainfall. Able to deliver data in real-time or almost real-time. Can change based on the material and design chosen. Frequently employed in hydrological research, agricultural monitoring, and weather stations. Uses variations in capacitance brought on by the presence of water to identify precipitation. Able to recognize the intensity of rainfall with accuracy. Extremely perceptive; capable of picking up light mist and rain. Usually, it offers rapid reaction times. Depending on the features and construction quality, it is moderate to expensive. Utilized in weather stations, internet of Things devices, and automobile applications (automotive wipers). Rain Sensors Using Optics depends on the stopping of an infrared laser beam to identify precipitation. Able to identify the presence and severity of rain with a high degree of accuracy.

Able to detect mist and mild rain. Usually provides quick response times. Costly to very expensive. Frequently utilized in weather monitoring stations and automated rain sensing systems for automobiles.Rain Sensors with Ultrasound Technology makes use of ultrasonic waves to find raindrops. Able to detect rainfall accurately. Incredibly sensitive to droplets and able to pick up mild rain. Response times are often quick. Costly to very expensive. Utilized in smart irrigation systems, weather monitoring, and car rain sensor systems.Hygroscopic rain sensors use a change in a hygroscopic material's electrical conductivity when moisture is present to detect rainfall. It can provide dependable rainfall detection. Sensitivity is modest; it may pick up mild to moderate rainfall. Often provides mediocre response times. Generally, it is less than those of other sensor kinds. Ideal for a range of Internet of Things devices and weather monitoring applications.We may take into account a number of variables, including sensitivity, reaction time, accuracy, cost, and power consumption, to evaluate rain-detecting sensors statistically (Table 1).

Table 2. Evaluation of rain sensor

Sensor Model	Sensitivity (mm/hr)	Response Time (ms)	Accuracy (%)	Cost ($)	Power Consumption (mA)
Sensor A	0.1	100	95	20	5
Sensor B	0.2	150	90	15	8
Sensor C	0.15	120	93	25	6

Sensitivity (mm/hr): The sensor's sensitivity to environmental changes is indicated by this parameter. With a sensitivity of 0.2 mm/hr, Sensor B is the most sensitive, followed by Sensor C (0.15 mm/hr) and Sensor A (0.1 mm/hr). In general, more sensitivity is preferable since it makes it possible to identify minute changes in the surroundings. Response Time (ms): The sensor's ability to respond swiftly to environmental changes is measured by this parameter. With a reaction time of 150 ms, Sensor B is the fastest, followed by Sensor C at 120 ms and Sensor A at 100 ms (Table 2). Once more, quicker reaction times are often favored, particularly in situations where real-time data is essential.

Accuracy (%): How closely the sensor's measurements match the real value is indicated by accuracy. With an accuracy of 95%, Sensor A leads the group, followed by Sensor C with 93% and Sensor B with 90%. Although accurate measurements need great precision, it's crucial to weigh the trade-offs between sensitivity, accuracy, and response time. The particular needs of the application would determine which of these sensors would work best overall. For example: Despite Sensor B's somewhat poorer accuracy and greater cost, it would be the ideal option if the application required high sensitivity and rapid reaction time. Despite Sensor A's lesser sensitivity and reaction time, it can be the better choice if accuracy is of the utmost importance and cost is an issue. B With moderate sensitivity, reaction speed, and accuracy at a fair price and power consumption, Sensor C could be a good option. The optimal sensor selection ultimately comes down to making trade-offs that fit the particular requirements and limitations of the application.

Rain alarm project circuit applications

It will detect the rain in the water system and promptly notify the farmer (Nethmini et al., 2022). In cars, a downpour identifier will activate the wipers and light the driver when precipitation is detected (Green, 2010). In letters, it will strengthen the radio wire's power and increase the transmission solidarity to deliver or receive the messages (Besnoff & Reynolds, 2015). In a normal household, we may preserve the rainfall water using a downpour water finder. (This should only be feasible if home automation is complete and appropriate rainwater collection equipment is available. In this case, a downpour water identifier will detect the deluge and help activate the equipment, saving downpour water for later use) (Venkatesha et al., 2020). It is also possible to use this in the case of heavy rain. This is exceptionally normal in modern regions (Kandalgaonkar, 2007). And also, it is used to remove the excess amount of rainwater from the field surface.

Conclusion

By using this experiment, Assess what is more helpful to farmers in the event of rain, and it is very helpful to ascertain the field's surface water level in the event that any surplus water eventually drains away from the water level in the farmed region. It is employed to regulate the water's flow or runoff during the rainy season. Excess water can be controlled by constructing a designed structure. The coconut shell in this sensor is used to reduce e-waste and then to develop future products. This sensor is used to conserve soil and water. The use of coconuts is more appropriate in India, but it is very challenging to put into practice since the material used for the sensor detector is biomaterial, which makes it inappropriate for field use. In agricultural regions, using biomaterial-based rain detector plates—like those composed of coconut shells can provide a long-term way to control excess water flow, lessen soil erosion, and enhance soil fertility. This is a thorough method that takes into account both environmental sustainability and usefulness.

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Author contributions

B.Baranitharan,Perarul Selvan M,Sivakumar D: Conducted experiment, data collection, analysis and manuscript writing, Kannabiran K,Priyanka S,:Conducted experiment and data collection.Victoriya Princy J,:Design and conducted experiment. Hariharan K: Manuscript editing.

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Conflict of interest

The author declares no conflict of interest. The manuscript has not been submitted for publication in any other journal.

Ethics approval

Not applicable.

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