Soil Parameter Detection: Proposed Circuit and its Impact

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1) Introduction:

Soil Parameter Monitoring involves analyzing the soil through soil tests and field observations, and seeing how the constituents of soil changes over time. Soil has many physical, chemical and biological properties that affect the growth of plants. The degradation of the physical soil properties has considerable consequence on yield and quality of crops. Degraded physical soil properties take considerable time and cost to correct.

Why Soil Monitoring is required by hobbyists, agriculturists :-

- Enable better resource utilization.
- Helps is making crop choice according to soil health.
- Crop planted keeping in view soil health, eventually reduces use of chemicals.
- Optimized irrigation keeping in mind the other factors necessary for water utilization by crop.
- Verifies the effectiveness of used remedies on soil.
- Allows the farmer to diversify cropping pattern.

How the Application of Real-Time data retrieval using IoT can facilitate better crop and soil health :-

- Facilitates Remote Management of plantation area .
- Helps the user to get the soil parameters without even visiting the site, hence saving time and enabling him to engage in other activities.
- Can warn in advance about conditions favorable for soil based diseases .
- Data collected can be analyzed and can be turned into training data for future AI models.
- End to End Production control with user.
- Data Driven decision lead to cleaner farming with reduced usage of pesticides and fertilizers eventually reducing the carbon footprint.
- Long life , affordable and easy to install and maintain than conventional soil analysis methods.

2) About the Proposed System:

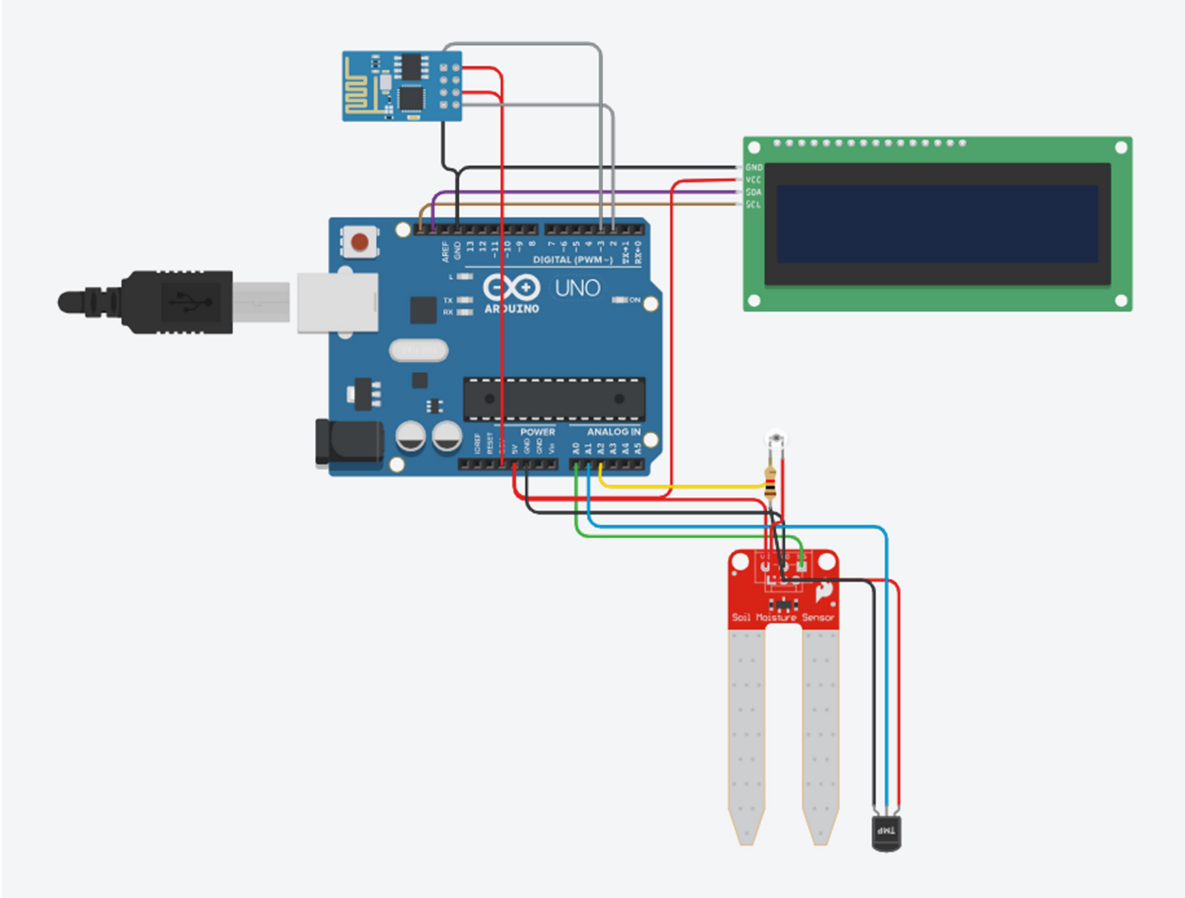

Figure 1: Screenshot of the Proposed Soil Parameter Monitoring System

With our soil monitoring system we have aimed to enable the user by giving them 3 valuable insights from the soil, whose dependencies on one another affect the yield .

Due to limitations in availability of sensors (NPK sensor, pH sensor, BMP286) and some networking components (ESP8266) in TinkerCAD we have compiled our project with following three constituents :-

1) Soil Moisture Content

2) Ambient Lighting

3) Temperature

To better comprehend the insights from the data retrieved from the system, the following Cause- Effect Table can be referred:-

Sr. No	Ambient Light	Moisture Content	Temperature	Insight for Action on Soil
1	Low Ambient Light	Low Moisture Content	Low temperature	Moderate water, sow only cold tolerant crop
2	Low Ambient Light	Low Moisture Content	High Temperature	Moderate water, sow sun ripening cold season crop
3	Low Ambient Light	High Moisture Content	Low Temperature	Water Sparingly, sow only cold tolerant crop
4	Good Ambient Light	Low Moisture Content	Low temperature	Water moderately only in daytime
5	Low Ambient Light	High Moisture Content	High Temperature	Water just to maintain required moisture level once in 3 days
6	Good Ambient Light	High Moisture Content	Low temperature	Check for fungus growth, prevent overwatering

7	Good Ambient Light	Low Moisture Content	High Temperature	Water frequently , Use heat tolerant crop
8	Good Ambient Light	High Moisture Content	High Temperature	Water to maintain moisture , Use heat tolerant crop

The three variables which we are tracking in our system collectively affect the soil health , and eventually the crop health in various patterns.

Excessive Ambient light can burn the leaves if combined with high temperature but can be prevented if moisture level is adequate so that heat escapes through transpiration. Such examples are available in real world, with more number of sensors better output can be obtained.

About the working process of the system:-

1) The Arduino R3 is connected to the USB output power adapter.

2) The sensor probes are inserted into the ground while the ambient light sensor in left on top of the ground surface/sensor probe cap.

3) The raw sensor data gets processed by the microcontroller present in Arduino r3 which is ATmega328 AVR

4) After interval of 5 seconds , each parameter gets displayed on the LCD screen connected to the system.

5) Real time data transmission is done through the Mobile network through a sim inserted in the sensor module in the control unit , which sends data in SMS form, the interface app collects that data from sms and provides insights for the user.

Due to limitation in TinkerCAD's simulation capabilities, a dummy WiFi based chip has been connected for demonstration purpose.

6) The app communicates with the cloud and sends in data for storage and analysis.

3) Benefits and Application of IoT Soil Parameter Monitoring system:

→ How the Application of Real-Time data retrieval using IoT can facilitate better crop and soil health :-

- Crop planted keeping in view soil health, eventually reduces use of chemicals.
- Optimized irrigation keeping in mind the other factors necessary for water utilization by crop.
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- Allows the farmer to diversify cropping pattern.
- Facilitates Remote Management of plantation area .
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→ Applications of IoT based Soil Parameter Monitoring Sytem :-

- For personal use by small to large scale agriculturists .
- Preventing Overwatering and under watering of fields.
- Can calculate the inter-dependency among the factors and provide insights accordingly.
- Reduced wastage of pesticides, insecticides and fertilizers.
- Prevent groundwater contamination due to reduced usage of chemicals.
- Prevent Eutrophication by reducing surface water runoff due to reduced water consumption .
- Industrial utilization by Agro Product companies to maintain standards over locations and to keep a QC check.
- Use in research by geologists .
- Keep check on Phytoremediation and increase it.
- Maintaining high commercial value stadium turfs across world.
- Access to Soil Carbon Sequestration data for Climate change modelers.
- Verification of satellite findings with actual ground truth by using UAV with sensor probe to remote verify the results.

4) Sustainability and Environmental Impact:

The environmental impact of using IoT-based soil monitoring system can be both positive and negative.

Positive impacts

- IoT based sensor system can help to reduce water waste by providing real-time data on soil moisture levels. This can help farmers to irrigate their crops more efficiently, which can save water and reduce the amount of runoff that pollutes waterways.
- Facilitates natural regeneration of nutrients in soil due to effective insights provided through application.
- This system can also help to reduce the use of pesticides and herbicides by providing data on pests and diseases. This can help farmers to target their applications more effectively, which can reduce the amount of chemicals that are used in the environment.
- It can also help to improve crop yields by providing data on soil health and nutrient levels. This can help farmers to make better decisions about

fertilizer application, which can lead to healthier plants and higher yields.

Negative impacts

- The production of IoT sensors requires the use of some resources, such as energy and materials. This can have a negative impact on the environment if the sensors are not disposed of properly.
- The data collected by IoT sensors can be used to track the movement of people and animals. This could be used for surveillance purposes, which could have a negative impact on privacy.
- The excessive and unnecessary use of sensors could lead to the development of new agricultural technologies that are more harmful to the environment. For example, some experts have raised concerns that the use of drones for crop spraying could lead to an increase in pesticide use.

~Overall, the environmental impact of using IoT-based soil monitoring systems is likely to be positive. However, it is important to be aware of the potential negative impacts and to take steps to mitigate them.

Here are some ways to mitigate the negative environmental impacts of IoT-based soil monitoring systems hence paving a sustainable path for their rapid deployment and acceptance:

- Use sensors that are made from recycled materials and that can be easily recycled.
- Using Secure waterproof casing for sensor body for long life.
- Dispose of sensors properly, in accordance with local regulations.
- Use data collected by sensors in a way that respects privacy.
- Support the development of agricultural technologies that are environmentally friendly.

5) Summary:

The key takeaways of using our IoT based Soil Parameter Detection are as follows:-

- Easy to install
- Easy to use

- Intense QC checks and calibrated
- Low Maintenance
- Low power Consumption
- Upgradable with more sensor attachment options
- Remote operation possible
- Real time data retrieval
- Facilitating healthier soil, healthier crops and a healthier world!!!!

Call to action--

" Grab now!! the disruptive Soil Monitoring system with proven results!!!! "

Accepting new technologies is the way forward, i encourage you to provide your valuable feedback so that I can improve and work towards enhancing sustainability as - *we have inherited this planet from our children and there's no planet B.*