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Agricultural Domain Monitoring and Controlling Mobile Robot

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ABSTRACT

It is an automated agricultural mobile robot designed and developed to monitor and control various parameters such as temperature, humidity, light intensity and soil moisture. The microcontroller used for this work is AT89s51 which belongs to the family of 8051 microcontrollers. Humidity sensor, temperature sensor, light sensor, and soil moisture sensor are four sensors used in this work to measure various parameters that contribute to monitoring the environment. In the designed prototype, soil moisture content was measured for three different types of soils which are Loam soil, Clay soil and Sandy soil (these three soils are widely used for agricultural purposes, which is the reason why they were used in this work), a LCD-display was used to observe the recorded values of these soils. This particular designed prototype will help reduce the manual efforts of the farmers and give the optimal values of the parameters.

Keywords: Humidity Sensor, Temperature Sensor, Soil Moisture Sensor

1. INTRODUCTION

Farmers generally do not use ideal conditions to grow the crops; they use fertilizers, pesticides, and insecticides, and to grow crops in more amounts, they overuse these things, which does harm not only the quality of the crop but also harms the quality of the soil which is not good in the long run as the toxic chemicals turn it into the barren land, recent researches have proved this. It is also hazardous to human health as farmers use various chemicals to accelerate the growth of the crops, which degrades the quality of the crop; thus, it also affects the health of the people or even animals who consume the crops.

All the techniques used by the farmers to grow the crops are done manually, and they are unaware whether the amount of water given is sufficient or not; they are also unaware of the optimal temperature and humidity of the surrounding environment.

Hence automation of these processes is required to grow crops in optimal conditions. This is where agricultural robotics comes into the picture; it has various sensors like humidity, temperature, light, and soil moisture to monitor multiple parameters (6,8). Fig. 1 shows the barren land affected by the farming method.

Fig.1: Photo of a barren land affected by the farming method

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2. METHODOLOGY

2.1 Block Diagram and Working

The mobile robot monitors and controls various agricultural parameters, including soil moisture, temperature, humidity, and light intensity. The designed robot is a prototype based on the 8051 microcontrollers, AT89s51; we have interfaced four sensors with the microcontroller to measure the above parameters.

The first sensor used is the temperature sensor which measures the environment's temperature (3). The sensor used is LM35 which has an operating range of 4V-20V and has an accuracy of 0.5 centigrade at 25 degrees. The second sensor used is the humidity sensor which measures the humidity of the surrounding environment (1,3). The sensor's name is SYHS220 which has an operating range of 30 - 90%RH and an accuracy of 5RH at 25 degrees. The third sensor used is the soil moisture sensor which measures the moisture content present in the soil. Two metal probes are used to measure the soil moisture. The last sensor used is LDR (light dependent resistor) which measures the amount of light present in the surrounding environment.

Sensor output is in analog form, but the microcontroller requires a digital input; hence we have used ADC so that the output of sensors is given to ADC, and then the digital output is given to the microcontroller. The ADC used here in this work is ADC0808, with eight input analog channels. To provide clock signals to the ADC, a timer IC555 is used.

A LCD display is also used at the output to display the values measured by the sensors; it has a 16x2 line display and the capability to display 224 different characters. IC7805 and IC7812 supply 5V and 12V, respectively to the power module. Two sugarcube relays are used for controlling actions at the output, i.e., for controlling fans, bulbs etc. Fig. 2 shows the block diagram of the work consisting of various sensors and controllers.

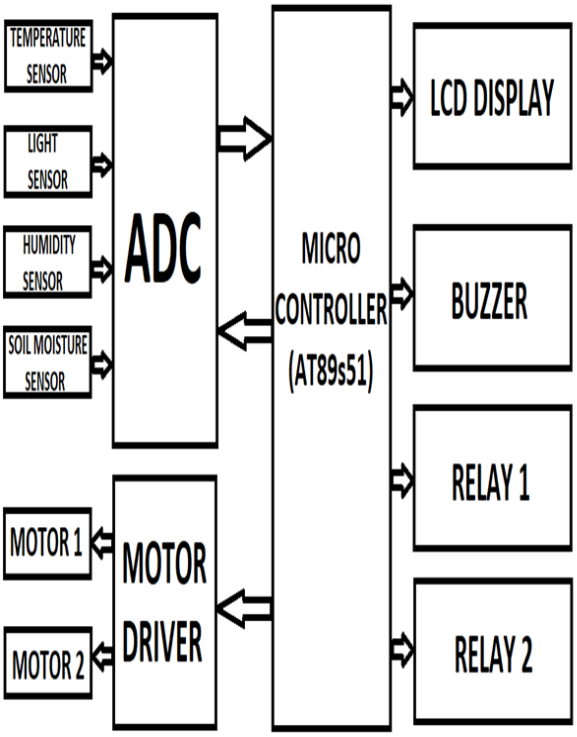

Fig.2: Block diagram of the work

The block diagram consists of four sensor blocks, i.e., the temperature sensor, light sensor, humidity sensor and soil moisture sensor. The primary function of these blocks is to sense the mentioned parameters and give the output to the ADC. The ADC converts the analog signal to a digital signal and provides the control signal to the microcontroller. The AT89s51 microcontroller is the brain of the circuit and controls all the output actions.

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The microcontroller's output is given to LCD, motor drivers and the relays. The motor driver runs the motors connected to the wheels of the mobile robot. The output of the relays is given to fans, bulbs etc.

2.2 Programming Software

The software which was used for programming the prototype is known as Keil. It has a compiler specially designed for 8051 microcontrollers; it has a massive range of tools such as IDE, Simulator, tools for debugging etc. The following steps are used to develop a prototype for 8051 works using Keil. The first step is to create a source file C or assembly; then the next step is to compile the source files, correcting the errors in the source files. The next step is to link the object files from the compiler and test the attached application.

2.3 Types of Soil (10)

1. Loam Soil

Loam soil retains moisture well, making it the optimal soil type for thriving gardens and can be watered usually. Identify loam soil by its color and texture: it has a darker brown or black shade and is crumbly to the touch but still holds water well. Garden flowers and plants grow best in loam soil.

2. Sandy Soil

Sandy soil drains quickly, requiring slow watering to saturate soil root zones thoroughly. It is usually light brown in color with a gritty texture to distinguish sandy soil from other soil types. Because of this porous characteristic, it is not ideal for seedlings as water drains away quickly.

3. Clay Soil

Clay soil holds more water than other soil types but is slow to absorb and release moisture. It is not recommended to over-water or water faster than the clay can soak. Clay soil is characterized by its small particles and texture. When wet, clay soil is sticky to the touch but feels smooth when dry. Due to its high water capacity, it is often considered a heavier soil, and less commonly known is that clay soil can also take longer to warm up in the spring.

2.4 Hardware

Fig. 3 & 4 shows the hardware implementation in the prototype.

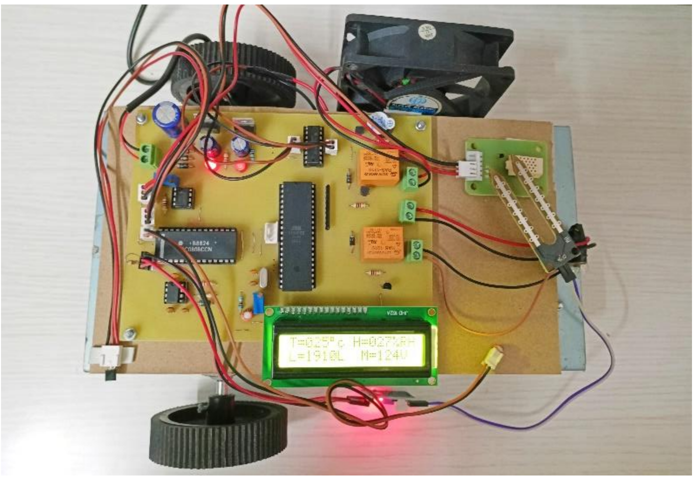

Fig.3: Top view of the prototype

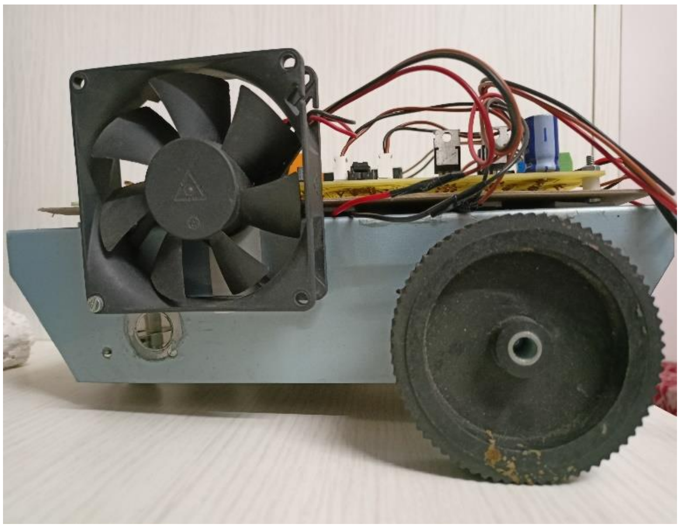

Fig.4: Side view of the prototype

2.4 List of components used

Following table 1 shows the components used for the model and its description.

Table 1

LIST OF COMPONENTS

SR. NO.	COMPONENT	DESCRIPTION
1.	Humidity Sensor	SYHS220 is the sensor's name used here to measure the humidity of the surrounding environment (1,3).
2.	Light Sensor	LDR light sensor is used to monitor the light intensity.
3.	Soil Moisture Sensor	It is a sensor based on the LM393 chip used here to measure the moisture content present in the soil.
4.	Temperature Sensor	LM35 is the name of the sensor used here to monitor the temperature of the surrounding environment (3).
5.	LCD Display	16x2 LCD Display is used here to display the values of the parameters.

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6.	8051 Microcontroller	AT89s51 microcontroller, which belongs to the family of 8051, is the brain of this prototype.
7.	DC Motors	Two dc motors were used to rotate the wheels.
8.	Sugarcube relays	12V single pole double throw (SPDT) relays were used to control the fan.
9.	Fan	It is used to cool down the surrounding environment when the temperature exceeds the threshold value.
10.	ADC (Analog to Digital Converter)	0808 ADC converts analog signals received from the sensors to digital signals.
11.	IC555 timer	It is used to provide clock signals to ADC.
12.	Others	Various types of resistors were used to control the current throughout the circuit.

4. RESULT

The soil moisture content of the three different soil types was tested, which are widely used in agriculture, namely Loam Soil, Clay Soil and Sandy Soil. The soil moisture measures the moisture content of the soil, thus avoiding overwatering or underwatering the plants (5). The fork-shaped probe, which has two exposed conductors, works as a variable resistor (similar to a potentiometer) whose resistance fluctuates with soil moisture content.

The soil moisture has an inverse relationship with this resistance: The more water in the soil, the better the conductivity and the lower the resistance. The less water in the soil, the worse the conductivity and the higher the resistance. The resistance causes the sensor to create an output voltage, which we can measure to estimate the moisture level (5). The higher value of M indicates that the soil has less moisture content present in it. The following results were observed keeping humidity and temperature constant.

1. Loam Soil

Fig.5: Testing of loam soil

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Fig.6: Results for loam soil

Fig. 5 and 6 show the testing and results of loam soil. The value of M observed here is 108 ohms, indicating higher resistance and low conductivity in the soil; thus, we can conclude that the Loam Soil has slightly less moisture content than Clay Soil.

2. Sandy Soil

Fig.7: Testing of sandy soil

Fig.8: Results for sandy soil

Fig. 7 and 8 show the testing and results of sandy soil. The value of M observed here is 121 ohms, indicating the highest resistance and lowest conductivity among the three soils tested in the experiment; thus, we can conclude that the Sandy Soil has the lowest moisture content among the three soils.

3. Clay Soil

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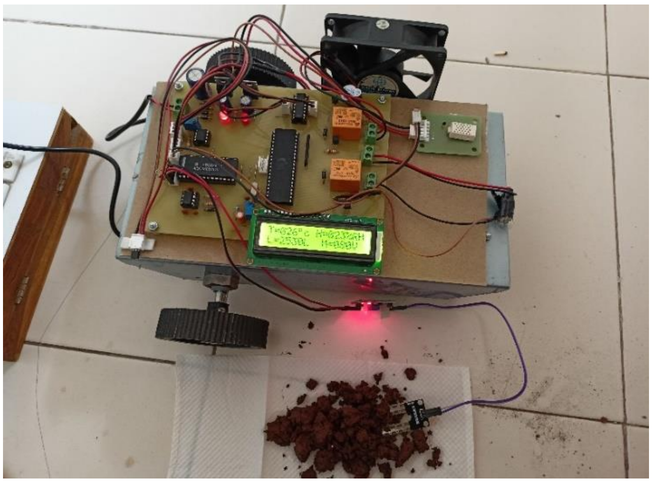

Fig. 9: Testing of clay soil

Fig. 10: Results for clay soil

The value of M observed here is 80 ohms, indicating the lowest resistance and highest conductivity among the three soils tested in the experiment; thus, we can conclude that the Clay Soil has the highest moisture content among the three soils. For experimental purposes, the threshold value of the temperature sensor is taken as 35 degrees Celsius above which the fan gets turned on, and the value of temperature is denoted by T

The threshold temperature is taken as 35 degrees Celsius because it is an optimal temperature for the growth of plants; if the temperature exceeds 35 degrees Celsius, then there is a risk of plants getting damaged (3). Fig. 11 shows the testing of the temperature sensor, and Fig. 12 indicates that the temperature observed above the threshold value.

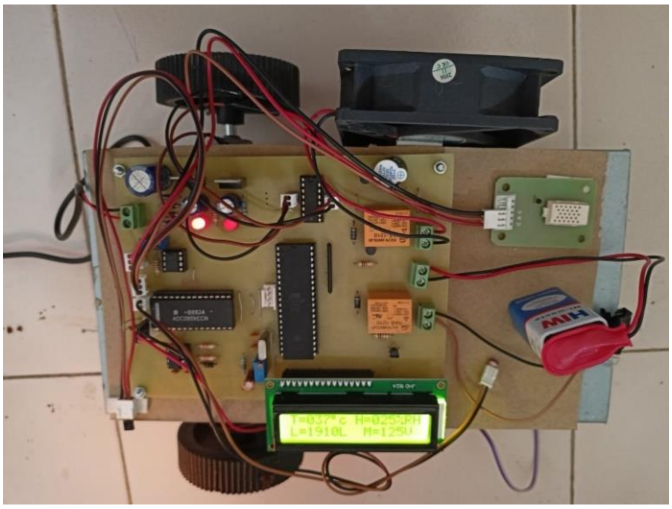

Figure.11: Testing of temperature sensor

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Figure.12: Temperature observed above the threshold value

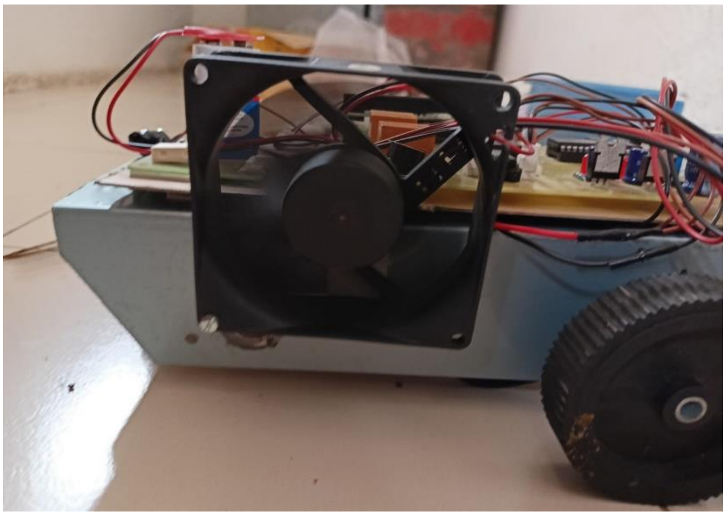

Figure.13: When the temperature was observed above the threshold value, the fan started rotating

Fig. 14 shows the graphical results of loam soil, sandy soil and clay soil.

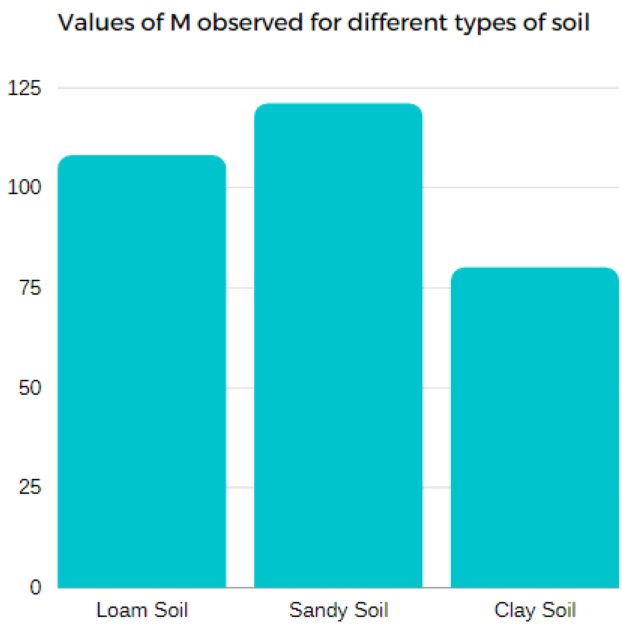

Fig.14: Graphical result of the obtained result

4. CONCLUSION

A mobile robot was designed and developed for agricultural purposes, various sensors such as temperature sensors, humidity sensors and soil moisture sensors were tested, and their readings were recorded. Different types of soils were tested using the soil moisture sensor, and it was observed that the Clay soil had the highest amount of moisture content present in it, followed by Loam and Sandy soil, respectively.

When the temperature went above the threshold value, the fan was turned on, thus controlling the temperature aspect of the surroundings.

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