

Autonomous Surface Monitoring Robot using Arduino and GSM module

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ABSTRACT:Monitoring of surface in conventional way needs digging of surface to certain depth, which loosens up the soil. The loosening leads to the soil degradation. The health of soil is a primary concern to farmers and the global community whose livelihoods depend on well managed agriculture that starts with the dirt beneath our feet. An Autonomous Surface Monitoring Robot (ASMR) is an autonomous robot which collects the information of the health of the soil by sensing the characteristics of the soil like soil moisture and soil temperature. Also the air humidity and temperature of the surrounding environment is sensed by the robot. The robot uses the Arduino module, Motor driver module and GSM module as its main components.

KEYWORDS:Soil degradation, Agriculture, Autonomous Surface Monitoring Robot, characteristics, Arduino, GSM.

I. INTRODUCTION

In today's generation farmers are facing a huge issue in the field which primarily concerns with fertility of soil, crop productivity. A third of India's soil is degraded, and this could cast a shadow on the sustainability of agriculture in near future. Land degradation is posing a major threat to India's food and environmental security, resulting from the loss in the biological or productive capacity of soil. According to estimates of the Indian Council of Agricultural Research (2010), of the total geographical area of 328.73 mha, about 120.40 mha is affected by various levels of land degradation. The effects of soil erosion go beyond the loss of fertile land. It has led to increased pollution and sedimentation in streams and rivers, clogging these waterways and causing declines in fish and other species. And degraded lands are also often less able to hold onto water, which can worsen flooding. Sustainable land use can help to reduce the impacts of agriculture and livestock, preventing soil degradation and erosion and the loss of valuable land to desertification [7].

The conventional method which is used to detect the characteristics of the soil is not very efficient since the soil is dug up to a great extent and this in turn leads to soil degradation. Moreover, it also involves a lot of human activity which is strenuous. Hence, a method is proposed which diminishes the human activity to a great extent. This helps in getting the characteristics of the soil without causing any degradation. The characteristics mainly include in finding the humidity, moisture content of the soil, also humidity and moisture content of the surrounding air. This method also stores a database about all the crops and this further helps in identifying which kind of crop would be best suitable for a particular kind of soil.

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II. LITERATURE SURVEY

Autonomous robots are widely used today. The main intention of using this system is to solely reduce the human interaction. This prevents humans from doing any kind of intensive or dangerous labour work. Engineering widely uses Autonomous robots. Autonomous robots are intelligent machines capable of performing tasks in the world by themselves, without explicit human control. An autonomous robot may also learn or gain new knowledge like which can be used to make report about soil profile and use farming methods accordingly.

A fully autonomous robot can:

- Gain information about the environment.
- Work for an extended period without human intervention.
- Move either all or part of itself throughout its operating environment without human assistance.
- Avoid situations that are harmful to people, property, or itself unless those are part of its design specifications.

This project can be classified into various parts. Firstly, it consists of Robot Movement which as the name suggests is related to the movement of the robot in the field. Furthermore, the project has sensing characteristics. The robot has a sensor attached to it, and when it reaches a particular location in the field, the sensor is lowered in the soil and the characteristics are observed. Finally, a database for crop selection is present. Once the sensor has obtained the results from the soil, it compares with the ideal characteristics of the soil. This method is believed to help the farmers yield maximum output and reduce human intervening.

III. BASIC WORKING OF THE ROBOT

Robot Movement:

The robot divides the entire surface into number of grids depending upon its area. The center of every grid is considered as a co-ordinate. The starting position of the robot is considered as origin for robot movement. The further movement according to the co-ordinates is in with reference with this origin. The limits of the co-ordinates are given as an input to the robot. The distance to be covered for each increment on coordinate is also specified. The robot moves according to this using Atmega 328 IC. At every co-ordinate the sensors collect the information of soil and air. The robot also has the algorithm of avoiding obstacle in its path.

Sensing of characteristics:

The robot will stop at every coordinate specified by the user and will store the characteristics in an array. A motor is connected to the controller and the sensors to the motor. This motor is programmed to move down and up. When the robot reaches the coordinate the sensors attached to the motor is lowered in the soil. The air characteristics are also noted at that position.

For sensing the characteristics we use following sensors:

- a. Soil moisture sensor.
- b. LM35 Temperature sensor.

Database for Crop Selection:

There will be a database which will contain the data of crops with its suitable environmental conditions. The obtained results from the sensors will be compared and the approximately matched crop is selected. The selected crop along with the data collected is sent to the owner of the field via SMS using GSM module.

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IV.FLOWCHART FOR ROBOT MOVEMENT

The flow of the robot movement is shown in figure below. The movement happens based on the coordinates specified before the start of the robot. The coordinates are calculated based on the dimension of the surface to be monitored. As shown in Fig 1, the robot moves from the reference coordinates and moves on to the next coordinate while sensing the parameters along. When the robot reaches the final coordinate specified in the code it returns back to the initial reference coordinate. The above explanations of the block diagram and flow chart gives an idea of the flow of the project and the main components and their functions.

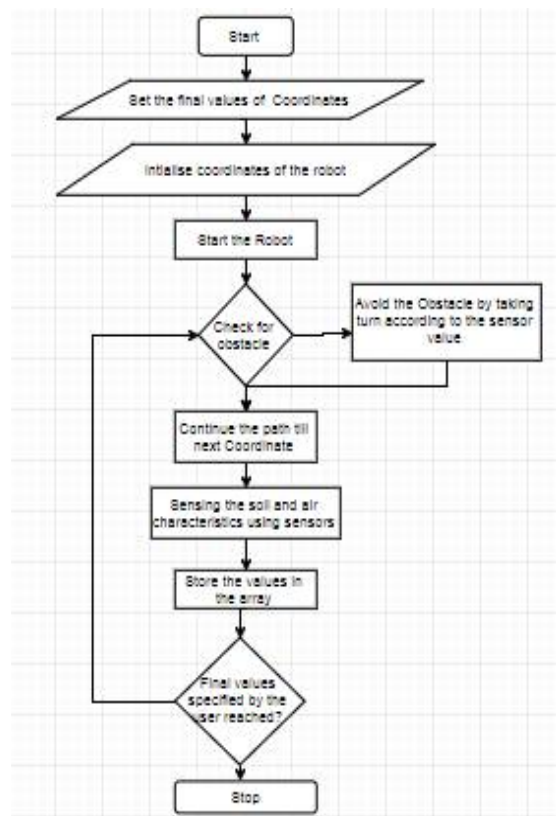


Fig. 1. Flowchart for movement of ASMR

V.BLOCK DIAGRAM

As shown in Fig.2, the main component is Atmega 328 processor which is mounted on Arduino board. The coding for all the functions is done using software Arduino which uses Embedded C language. This Atmega 328 is connected to Motor driver, LCD display, all the sensors mentioned above and GSM module.

The input of the dimensions of the land is taken as input and the land is divided into grids as specified by the user.

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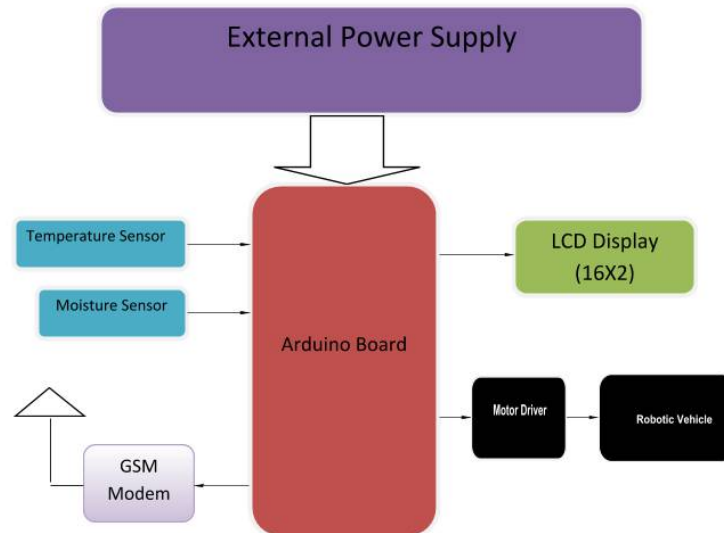


Fig 2. Block Diagram of Autonomous Surface monitoring robot

The flow of the project is as follows:

- The initial step is formation of grid. Now the Robot is placed at the start of first grid decided by the user.
- The code in arduino decides the path of the robot. At center of every grid the robot pauses to collect the characteristics.
- The sensors are lowered into the soil using Robotic arm which is part of robot vehicle shown in block diagram.
- The movement and speed of the arm is also controlled by the arduino according to the nature of soil and required pressure for lowering the sensors into the soil.
- Sensors senses the characteristics and now pass on the information to the arduino. Now the characteristics are displayed in the LCD display.
- The above procedure is repeated till the last grid and the average value is calculated, compared with the standard database of the crop and a message is sent to the owner (user) of the robot via GSM module indicating the calculated characteristics and the matched crop from database.

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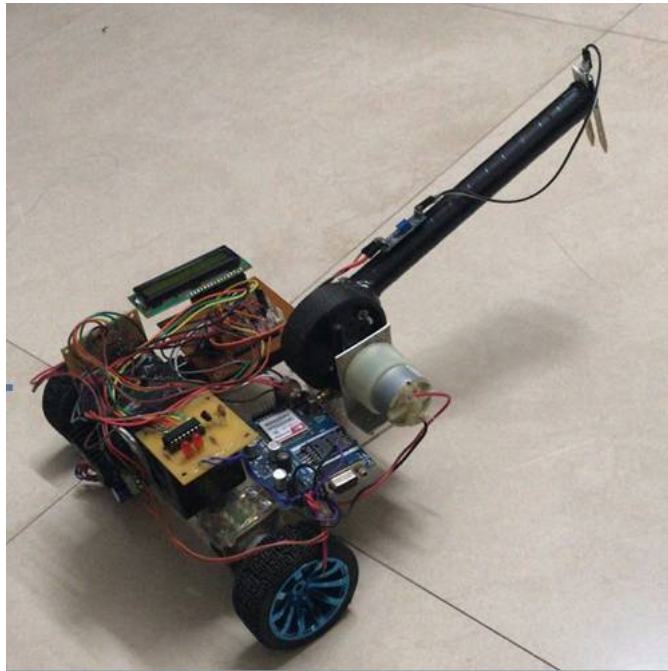


Fig 3. Autonomous Surface monitoring robot

VI.SENSORS

We have used two sensors here for the project they are as follows:

Soil Moisture Sensor:

Soil moisture sensors measure the water content in soil. A soil moisture probe is made up of multiple soil moisture sensors.

This Soil Moisture Sensor can be used to detect the moisture of soil or judge if there is water around the sensor, let the plants in your garden reach out for human help. Insert this module into the soil and then adjust the on-board potentiometer to adjust the sensitivity. The sensor would outputs logic HIGH/LOW when the moisture is higher/lower than the threshold set by the potentiometer. With help of this sensor, it will be realizable to make the plant remind you: Hey, I am thirsty now, please give me some water [3].

Application Idea of Soil Moisture Sensor [5]:-

- Botanical gardening
- Water monitoring

Features of Soil Moisture Sensor [5]:-

- Digital output, easy to adjust
- Nickel plating to avoid corrosion
- Working voltage: 3.3V-5V
- On-board LM393 chip
- Dimension of the board: 3.2cm * 1.4cm

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Vol. 7, Issue 6, June 2018

LM35 Temperature Sensor:

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4$ °C at room temperature and $\pm 3/4$ °C over a full -55 to +150 °C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supply or with plus and minus power supplies. As it draws only 60 μ A from its supply, it has very low self-heating, less than 0.1 °C in still air. The LM35 is rated to operate over a -55 to +150 °C temperature range, while the LM35C is rated for a -40 to +110 °C range (-10 ° with improved accuracy). The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA and LM35D are also available in an 8-lead surface mount small outline package and a plastic TO-220 package [4].

Features of LM35 [6]:

- Calibrated directly in ° Celsius (Centigrade)
- Linear +10.0 mV/ °C scale factor
- 0.5°C accuracy guarantee able (25°C)
- Rated for full -55° to +155°C range
- Suitable for remote applications
- Low cost due to water level trimming
- Operates from 4 to 30V.
- Less than 60 μ A current drain
- Low self-heating, 0.08°C in still air.
- Non-linearity only +1/4°C typically.
- Low impedance output, 0.1 Ω for 1 mA load.

VII. STIMULATION AND RESULTS

We considered a path as shown below in Fig 4 (a). From the figure you can see that there are 4 sensing points P1, P2, P3 and P4 (chosen by the user). The sensors collected the characteristics of soil at these sensing points. The table 1 below shows the result at each point. The characteristics collected at this point are then sent to the owner of the surface via a SMS using GSM module as shown in Fig 4 (b).

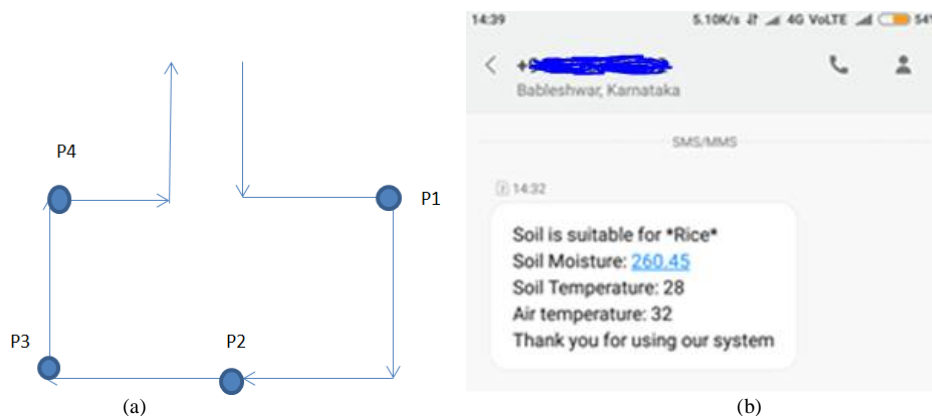


Fig 4. (a) Path traced by the ASMR (b) Screenshot of the message sent.

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Sensing Points	Soil Moisture	Soil Temperature	Air Temperature
P1	261.1	28	32.3
P2	259.4	27.7	32.1
P3	261.2	28.1	31.9
P4	260.1	28.2	31.7

Table 1. Readings obtained at each sensing point.

VIII. ADVANTAGES OF OUR ASMR

In Nivantra 2013 competition, Bharat Gera (ECE 7th sem), Bhavjeet Singh (ECE 7th sem), Robin Kaul (EEE 5th sem), RohanArora (ECE 5th sem), SidharthKwatra (EEE 5th sem) of University Institute of Engineering and Technology, Panjab University under the guidance of Dr. Manu Sharma & Asst. Prof. SumitBudhiraja have first created ASMR using following components [1]:

1. NI Crio 9075
2. NI 9201 analog input module.
3. NI9421 digital input module
4. Ni9472 digital output module
5. Vegtronix VH-400 soil moisture sensor
6. Vegetronix THERM-200 soil temperature sensor
7. HSM-20G humidity and temperature sensor
8. LISY300 gyro sensor module
9. Bump Sensor
10. NI LABView

(NI is the prefix used before the components provided by Nivantra Competition.)

In above project they have used Crio 9075 is main processor used. It is just a controller with a fixed number of ports hence the components like 2, 3 and 4 from above is required [2]. Also the Vegtronix sensors used are expensive and not available that easily.

In our project the main processor is arduino which do not need those additional components because it carries all the tasks itself. It is also available easily everywhere in a considerable cost. The sensors used also are easily available and are cheaper when compared.

IX. CONCLUSION

Hence the use of the AMSR is explained briefly in this paper. The main components and its advantages are also mentioned above. This makes ASMR very useful for estimating the required moisture for the crop, which will decrease the water wastage. Also the information about which crop is suitable for the particular climate conditions is supplied to the owner for healthy and profitable growth of the crop. This project can be improved further by using NPK sensor (Nitrogen, Phosphorous and Potassium Sensor). This will give us the information of those chemical's content in the soil and by knowing that preventive measures can be taken if exceeds amount is found. The amount of pesticide can also be predicted with above information. Another harmful substance whose presence is increased in soil due to blindly using pesticides and other chemicals for healthy and profitable growth of crop is Ammonia which is harmful to human health. Any sensor indicating Ammonia's value will be useful to prevent Ammonias content to increase beyond the permitted level.

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Vol. 7, Issue 6, June 2018

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