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Efficient Water Usage During Irrigation Using Low-Cost Moisture Sensors

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Abstract: In the last decades serious alarms have raised in the deficiency of fresh water resources. Management of water resources efficiently plays a vital role in the agricultural sector. Because of adopting the traditional practices this is not given prime importance. An efficient irrigation system that uses low cost soil moisture sensor to control water supply in water deficient areas is used here. An affordable sensor, which works on the principle of impedance change between two points in the soil depending on moisture is used. The sensor senses the moisture content which is read using the microcontroller. These sensed values are sent to the database via a wired medium. Water supply is cutoff by the motor based on the values calculated using arduino software. This technology can be used to visualize the daily moisture data. The moisture levels in small agricultural fields can be monitored by these sensors at low cost.

Key words:

INTRODUCTION

Agriculture plays a vital role in India's economy. Major portion of India's economy depends on agricultural products. According to the economic survey of India it contributes to about 17% of GDP. Irrigation in India includes a network of major and minor canals from Indian rivers groundwater well based systems, tanks and other rainwater harvesting projects for agricultural activities. Many smart irrigation systems have been devised. A smart irrigation system, on contrary to a traditional irrigation method, regulates supplied water according to the needs of the fields and crops. Evapotranspiration (ET), thermal imaging, capacitive methods, neutron scattering method and gypsum blocks are some of the technologies that enable moisture sensing. Capacitive sensors, however instantaneous, are costly and need to be calibrated often with varying temperature and soil type. Neutron probe based moisture sensors are very accurate but present radiation hazards, calibration difficulty and are costly. Gypsum blocks are however less expensive but they dissolve in water and change their response with passage of time. Thermal imaging is an effective method but is prohibitively expensive. Due to the above reasons, an alternative, low cost sensor must be produced enabling the use of smart irrigation systems. In order to overcome the above stated flaws, in this paper we have used a low cost moisture sensor.

Moisture Sensors: Moisture sensor is a device that measures the moisture content of any environment. Moisture sensors typically refer to sensors that estimate volumetric water content. There are many types of moisture sensors, but the most common and low cost is the impedance based moisture sensor. Moisture sensor consists of two probes. The change of impedance between the two probes present in the sensor due to varying moisture content in the surrounding medium is calculated. This is the method by which our proposed sensor works. Soil moisture sensor can be easily interfaced to any microcontroller to its digital pin. If the required output is digital like put on and off the water pump depending on the water content. It can be interfaced via an ADC to the microcontroller for multi level monitoring like if the flow of water is also to be controlled. It has a voltage of 3.3V-5V. Digital output interface is (0 and 1).The soil Probe dimension is 6 x 2 cm.

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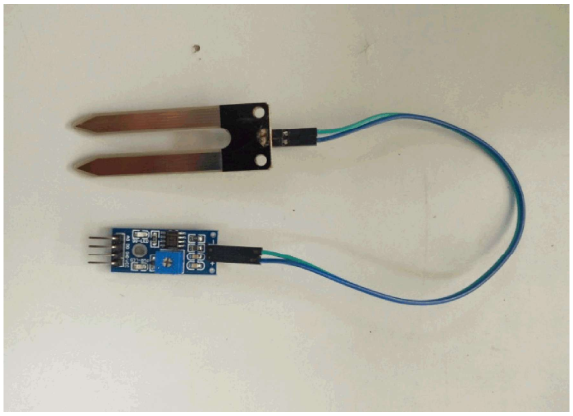


Fig. 1: Moisture Sensor

Arduino: Arduino is an open-source prototyping platform based on easy hardware and software. Arduinos are inexpensive as compared to other microcontroller platforms. Arduino software can be extended to c libraries whereas other software can be extended only up to windows. Arduino consists of both a physical programmable circuit board which is nothing but the microcontroller and a piece of software that runs on the computer. We have used the arduino of the specification type ATmega328 microcontroller which has 16 MHz clock speed. It is used to write and upload computer code to the physical board. For the arduino we use a simplified version of c which makes it easier to learn the program. The program is written in simple c and run using arduino 1.0.6 software, which is the latest version available.

Fig. 2: Arduino Kit with Moisture Sensor

Existing Model: In the previously proposed model such as Design and development of moisture sensor and response monitoring system [1], the probes made of nickel were used to determine the soil moisture. Even though nickel is an anti-corrosive and robust material, it can be easily oxidized thus leaving the previous model inefficient. The response monitoring system in this model measures the soil moisture content and compares it with the values given by the user and it sends notification to the user if soil moisture goes below the given value but in our model it is fully automated. The microcontroller used in this model is PIC (programmable interface controller) 18F452 and it has the clock frequency of about 4MHz. We have designed our model with 16MHz clock speed. Another model low cost automatic irrigation controller driven by the soil moisture sensor [2] used PIC microcontroller 16F872 for circuit designing and programming and dielectric probes. The above said microcontroller uses only 35 instructions for programming in assembly language. We have used arduino software in our model which is comparatively efficient than the PIC microcontroller 16F872. Our model is based on the calculations obtained from the impedance between the probes instead of resistance used in the model[2]. The next model is An automated data acquisition system for modeling the characteristics of a soil moisture sensor[3]. Here parallel plate lossy capacitance is employed which is quite difficult to measure. The model[3] uses INTEL 8052 AH microprocessor and BASIC-52 language for the algorithm whereas we are using general purpose C language for the algorithm.

Proposed Model

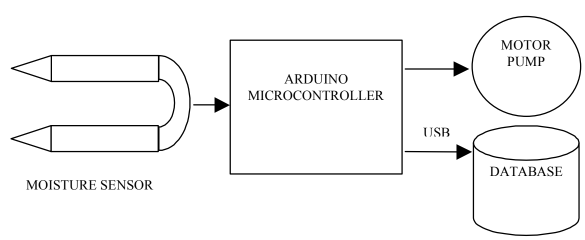
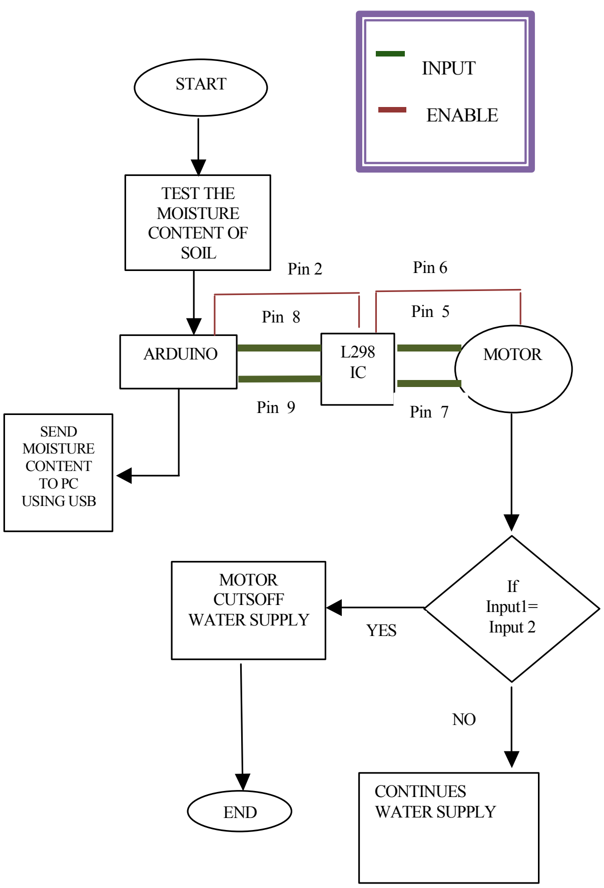


Fig. 4: Hardware Architecture

Moisture Sensor and Arduino Interface: The moisture sensor is placed in the soil. The moisture sensor contains three pins viz GND, VCC and OUTPUT. The VCC of the sensor is connected to +5V of the arduino, the output and GND of the sensor are connected to the corresponding terminals of arduino. The arduino 1.0.6 software is installed in the pc. The code for measuring and displaying the moisture content is written using C. The output is taken and the moisture content is displayed on the screen.

Arduino and Motor Interface: The water pump motor is connected to the arduino using an L298 bridge IC. The motor has 2 leads, one positive and one negative. The L298 can control the speed and direction of DC motors and stepper motors. There are 3 input pins for the motor. The two inputs of the motor are given on pin 5 and pin 7 of the L298 IC. The pins 5 and pin 7 are digital. The enable is given to pin 6 and it is analog. The two input of the IC is connected to pin 8 and pin 9 of the arduino. The enable pin of IC is connected to pin 2 of arduino. The inputs to the pin 8, pin 9 and pin 2 of arduino is set using the code executed in the arduino IDE software. If both the inputs to the motor are same, the motor brakes and the water supply is cut off otherwise the motor will continue to supply water.

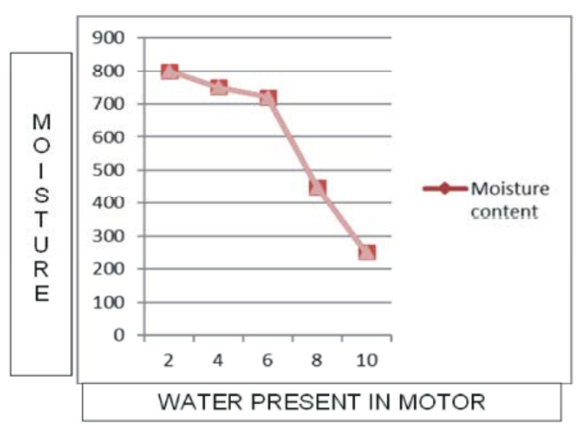
Flow Chart



Analysis: The sensor value is recorded by the arduino with the help of code which is written in C language using arduino software. When the specified voltage exceeds its limit, the motor water supply is stopped. The sensor value is less than 300 for a dry soil. It is greater than 300 for normal irrigation. If the moisture content increases 700, excess water is used. The information is sent to the motor to stop the supply of water in this case. All this is done with the use of program on the arduino software. The code for displaying the sensed moisture content and instructing the motor to cutoff water supply is executed. The code for the above operations may be written using the below format.

```
if (sensVal >=300&&sensVal<=700)
{
 DisplayWords = "continue water supply!";
Serial.print(DisplayWords);
//continues the water supply
Write(motorPin, 4);
}
 else if (sensVal>= 700)
{
DisplayWords = "Wet, cutoff water supply!";
Serial.print(DisplayWords);
// turns the motor off
Write(motorPin, 8);
}
```

The below graph represents the change in water level present in the motor and moisture content in the soil. X-axis represents the water present in motor and Y-axis represents the moisture content. As the moisture content increases the water present in the motor decreases. In this way water is used in an efficient manner.



Future Enhancement: One problem with the impedance sensors is that the resistance of a material changes with the temperature. So when the sun rays fall on the soil, the soil warms up and the resistance changes.

This will produce a false dry reading. For this reason we employ soil temperature sensors in order to remove the false reading. In future it can be further extended by analyzing water parameters like temperature, pH and turbidity and also soil parameters like porosity, density, degree of saturation for environmental studies in an efficient manner. We can also acknowledge the user of irrigation about the moisture content used by him with the use of gsm interfaced alert system on mobile.

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