WATER CONTENT DETERMINATION BY MICROCONTROLLER AND SENSORS

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ABSTRACT

Evident profile soil electrical conductivity (EC) can be indirect indicator of various soil physical and chemical properties. Industrially accessible sensors can be utilized efficently and cheaply build up the spatially thick informational indexes alluring for portraying inside field spatial soil water fluctuation. The goal of this was to contemplate water content using microcontroller and sensor. Along with the limitation.

Keywords: arduino, electrical conductivity(EC), moisture content, sensors, microcontroller.

I.INTRODUCTION

There is a need to determine water content in soil quick and accurate so the construction work can easily speed up. Knowing the water content of the soil we can know the various properties of soil like strength properties, bearing capacity, etc. for construction purpose. By using microcontroller and sensor we can find water content in soil. An ideal controller is user friendly i.e., easy to program and requiring a minimum number of keys or push-buttons to operate the controller. To add flexibility it should be possible to selectively deactivate any of the moisture sensor to thereby override the modification to the controller performance caused by sensor input. The system should be easy to trouble shoot in the event of faults in any of the plurality of zones.This article represents the prototype design of microcontroller using arduino for measuring adequate soil moisture in field. Sensor work on the electrical conductivity(EC) method. We study EC as function of water content (θ) and in situ soil water conductivity(EC_w).

II. COMPONENT

Scientific research requires the collection of data in order to study, monitor, analyze, describe, or understand a particular process or event. Data collection efforts are often a compromise: manual measurements can be time-consuming and labor-intensive, resulting in data being collected at a low frequency, while automating the data-collection process can reduce labor requirements and increase the frequency of measurements, but at the cost of added expense of electronic data-collecting instrumentation. Rapid advances in electronic technologies have resulted in a variety of new and inexpensive sensing, monitoring, and control capabilities which offer opportunities for implementation in agricultural and natural-resource research applications. An Open Source Hardware project called Arduino consists of a programmable microcontroller development platform, expansion capability through add-on boards, and a programming development environment for creating custom microcontroller software. All circuit-board and electronic component specifications, as well as the programming software, are open-source and freely available for anyone to use or modify. Inexpensive sensors and the Arduino development platform were used to develop several inexpensive, automated sensing and data logging systems for use in agricultural and natural-resources related research projects.

2.1 Arduino Microcontroller DevelopmentPlatform

The current standard Arduino development platform is based on an ATmega328 8-bit programmable microcontroller. A printed-circuit board positions the microcontroller in a circuit so that the input/output (IO) pins are easily accessible.The microcontroller contains 32 kilobytes (KB) of flash memory for program storage and 1 KB of non-volatile data-storage memory. IO lines consist of 14 digital pins and 6 analog pins, which provide 6 channels of 10-bit analog-to-digital (A/D) conversion capability. The microcontroller contains many built-in features, including timer/counters, internal and external interrupts, serial and other communication-protocol capabilities, programmable watchdog timer, and low-power, energy-saving modes. Versions of the Arduino board are available which use other, more-powerful microcontrollers, have additional IO pins, and have different physical sizes. Devices operate at either a 5-V level and oscillator speed of 16 MHz or a 3.3-V level and 8 MHz. While many boards have an on-board USB connector to interface with a personal computer, the ATmega microcontroller communicates via a two-wire serial connection. Boards with on-board USB connector also have a USB-serial converter chip and use a standard USB-USB cable, while other boards, to simplify design and lower cost, do not incorporate the USB-serial chip. A special cable, which contains the USB-serial chip and creates a virtual serial port, must be used. The Arduino board is designed to allow expansion through the connection of auxiliary boards or shields. The shields connect via mating pins which are arranged in the same physical configuration as the Arduino board, and simply plug onto the headers on the top of the Arduino board. The shields are then controlled by the Arduino microcontroller and program, which access the shields' pins through the Arduino pins. Programming libraries allow users to quickly integrate new devices and sensors into projects without needing to write extensive new program routines.

Fig.no.1 Arduino board

2.2 Software

The software environment for programming and interacting with the Arduino board is available for download and installation for several computer operating systems (GNU/Linux, Mac OS X, and Windows). Using the

IDE, the user writes programs in a language based on C++. The IDE then compiles and error-checks the program, and downloads the compiled routine to the microcontroller. A terminal window is available for outputting text and data from the Arduino board to the computer monitor and for interacting with the microcontroller. As an open-source project, the Arduino benefits from the collective efforts and expertise of developers from around the world. Programming libraries, which contain routines to simplify programming and incorporate advanced features, sample code, and complete programs are available to download, use, and modify as needed. The IDE, libraries, and sample code can be accessed via the Arduino project website.

2.3 Sensors

A large number of sensors are available to monitor and measure many types of environmental parameters or physical processes. The rapid advances and usage of programmable microcontrollers have brought an increase in the availability and ease of use of sensing devices designed to interface with microcontrollers. The sensors operate at low voltages, and output signals compatible with microcontrollers, including analog voltages, varying frequencies, and a selection of digital communications protocols. While the number of parameters sensed, and the number of sensors available, is vast, a few example are presented and discussed.

Sensors do not require a voltage measurement to be made, allowing the use of microcontrollers which do not have A/D converters. Digital sensors interface with the microcontroller through one of several communications protocols, such as I2C, 1-Wire, and SPI, with transfer of information accomplished via the microcontroller program. Digital sensors often have the feature of a unique identification number, allowing multiple sensors to be connected to the same IO pins on the microcontroller, thus not using additional pins. In contrast, since each analog sensor would require its own A/D input pin, multiple analog sensors could quickly fill available A/D converter pins. For making non-contact temperature measurements, infrared thermometer (IRT) sensors are available which are inexpensive and easy to interface.

2.4 Soil-water

A water potential sensor provides a measure of how tightly the water is held to the soil particles. Many of the currently available water-content sensors rely on a measure of the capacitance of the soil-water environment. Dielectric properties of the soil-water system vary weakly with soil properties, such as mineral composition, bulk density, and organic-matter content,but are strongly influenced by water content consist of a capacitive-sensing element and on-board electronic circuitry. When powered by the microcontroller, the sensors return a voltage signal proportional to the water content in the soil. Measuring the voltage with the microcontroller’s A/D converter and applying a calibration equation in the microcontroller program results in a water-content value, expressed in units of volume of water/volume of soil. Sensor manufacturers may provide calibration equations for limited soil types and other porous media, such as potting soil or greenhouse media, but the user often must develop a calibration, or at least verify the manufacturer's, under his specific soil conditions to obtain accurate water-content measurements.

2.5 Time-Keeping

In many data-collection efforts, proper timing of measurements and date- and time-stamping of sensor data are required. The microcontroller on the Arduino board has a very accurate 16 MHz oscillator and the ability to measure time increments with microsecond accuracy, but is not designed to provide real time (hours, minutes) and date information. If electrical power to the microcontroller is lost, the oscillator and microcontroller program cease to function, and any timing information is also lost. External real-time clock (RTC) chips are used to provide time-keeping functions, with dedicated built-in or added backup batteries to retain accurate time information. Simple routines in the microcontroller program access the RTCs to set or read time and date information, which can then be used to trigger sensor measurements at regular time intervals or record timing information of events.

2.6 Data Storage

Data collection often involves long-term, automated storageof sensor measurements. While the Arduino's microcontrollerhas extensive memory available for programstorage, non-volatile data-storage capability is limited.On-board memory consists of 1 kb (1000 bytes), soa maximum of 1000 data values could be stored and retainedif battery power were interrupted. To expand thestorage capacity, external storage must be added.External memory chips are available with varyingamounts of non-volatile memory. For permanent or large-capacity storage, add-on boards are available which provide data storage to standard SD memory cards or micro SD memory cards. Memory cards are commonly available with storage capacities from 1 gigabyte (GB) to several GB, are inexpensive, and can be easily interfaced with the Arduino hardware. Since the memory cards can be read with a computer, data can be transferred quickly and easily between datalogger and computer.

Software libraries have been written to provide all memory card reading, writing, and data-access functions, enabling rapid incorporation of memory-card storage into a datalogging project.

III. THEORETICAL MODEL OF ELECTRICAL CONDUCTIVITY

The condition of zero divergence for the current, q, is

$$\nabla * q = 0 \qquad [1]$$

The current, q, is assumed to be given by Ohm's law:

$$q = -EC\nabla\boldsymbol{\phi} \qquad [2]$$

Where EC is the electrical conductivity, and $\boldsymbol{\phi}$ is the electrical potential. The current, q, and the conductivity, EC,are defined on a bulk volume basis. Introducing Eq. [2] into

Eq. [1] and assuming that EC is independent of position gives Laplace's equation for the potential, $\boldsymbol{\phi}$

$$\nabla^2\boldsymbol{\phi}=0 \qquad [3]$$

Bulk soil EC may be regarded as resulting from two parallel conductors, a bulk liquid-phase conductivity, EC_b associatedwith the free salt in the liquid-filled pores, and abulk surface conductivity, EC_s, associated with theexchangeable ions at the solid/liquid interface:

$$EC_a = EC_b + EC_s \qquad [4]$$

Assuming that EC_bdepends linearly upon the EC of the soil water, EC_w, and that only the fraction of the total cross-sectionalarea occupied by the liquid phase conducts current.

IV. LIMITATION

4.1 Understanding Field Variation

Preliminary investigations are necessary to evaluate the soil features as referred to soil texture, soil depth, and hydraulic characteristics, as well as and their variability over the irrigated fields. Under large variability of soils, appropriate number of sensors and installation sites should be carefully selected. A calibration is required through the development of a soil-specific moisture release curve to derive coefficients for converting moisture tension to soil moisture content. This procedure is laborious and time consuming, besides requiring multiple soil testing, laboratory determinations and field evaluations.

4.2 Placement of Sensors

Proper placement of sensors is also critical to represent soil moisture in the soil and obtain meaningful data for effective work.

4.3 Importance of Layers

Changes in soil texture along the soil profile usually act as temporary barriers to uniform water movement. Most of the soil moisture sensors available on the market today have low maintenance needs or are maintenance free. Often, problems occur as a result of corrosion of electrical contacts, dissolution of matrix materials, lost contacts between electrodes, and erratic readings due to air gaps between the sensor and surrounding soil, or off-scale (very high) electrical resistance within the sensor.

4.4 Understanding Soil Moisture Data

When using soil moisture tension sensors, the lower the reading the higher the soil moisture content and vice-versa. As soil moisture is depleted, the sensor readings gradually increase. Plotting moisture tension data on graphs helps growers visualizing what is happening in the soil.

V. CONCLUSIONS

Determining water content using sensor and microcontroller in soil is quick and accurate so the construction work can easily speed up. Knowing the water content of the soil we can know the various properties of soil like strength properties, bearing capacity, etc. for construction purpose and other. But there are some limitation of using it. Sensor work on the electrical conductivity (EC) method. We examined the functional relation between soil EC, water content, soil water relation and soil properties.

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