Design and Development of Integrated Handheld Smart Monitoring Device for Soil Moisture

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Abstract:

It is an integrated handheld soil moisture sensor device comprising a controller for controlling a soil moisture sensor and integrated to the microcontroller, an oscillator to generate an electrical signal of precise frequency and a sensing unit to determine the moisture content of the soil. The controller may be a microcontroller of 8051, AVR, PIC and the like controllers. The controller controls the sensor circuit in accordance to the program dumped in the controller. The soil moisture sensor may be a capacitance sensor, granular matrix sensor and the like sensors. The oscillator may be a crystal oscillator, Hartley oscillator and the like oscillators to provide clock signals based on type of said controller. The sensing unit may be a neutron probes, gravimetric probes and the like sensing units and material of the sensing unit may be a conducting material such as copper, aluminium, metal and thereof. The sensing unit is inserted into the soil to determine moisture content of the soil where in the moisture content is displayed with precise value. The invention consists of portable soil moisture sensor and a common display unit. This makes it possible for the user to observe the moisture level of the soil in multiple locations from a single conveniently positioned display unit.

Introduction:

The present invention relates to moisture sensors for use in irrigation and in specific to an agricultural improvement information collection system.

Background of the invention:

Handheld moisture meters are suitable for household use. However, these are standalone devices without the ability to be networked to a common display unit. This limits their functionality since the user must be in the same physical location as the soil to be measured. Moreover, if there are multiple locations, with different soil types or different watering patterns, the user must go to each location to take the moisture reading.

Estimating soil moisture content by measuring the resistance between electrodes which are placed in the soil is well known. Moisture in the soil provides a conductive path between the electrodes. As the soil becomes more moisture, the resistance between the electrodes decreases. In dry soil the resistance between the electrodes is high. Generating a response curve as a function of resistance for a particular soil type can be determined through testing. Thus, by burying electrodes in the soil and monitoring the resistance between the electrodes, soil

moisture content can be estimated. In practice, however, a number of other factors affect the resistance between the electrodes.

In the field of irrigation, it is necessary to ensure that water is properly controlled and supplied to vegetation. Some plant matter suffers in an abundance of water and others in a lack of. It is important to be able to determine the water, moisture content of the supporting soil particularly in the regions proximate to the vegetation's major root structures. In agriculture it is often desirable to detect the moisture content of the soil in a region, so that irrigation systems can be controlled in accordance with the sensed moisture content.

Therefore, there is a need to provide a sensing device to determine the water, moisture content of the soil particularly in the regions proximate to the vegetation's major root structures. Also, there is a need to provide a display unit to display the moisture level, a less dimension circuit of sensing device which may have less cost and easily configurable and provide precise moisture content of the soil.

Objectives of the invention:

1. The primary objective of the invention is to provide a portable soil moisture sensor with integrated components into a single board.
2. The objective of the invention is to provide an improved soil moisture sensor with cost effective and accuracy of moisture content.
3. Another objective of the invention is to provide a display circuit to display the parameters of the soil.
4. Another objective of the invention is to overcome the shortcomings and to provide a portable device for collecting parameters of the soil based on wireless communication.
5. Another objective of the invention is to design a small sized circuit and low cost with precise moisture content of the soil.

Summary of the Invention:

The invention proposes a smart monitoring system of soil moisture. The following presents a simplified summary in order to provide a basic understanding of some aspects of the claimed subject matter. This summary is not an extensive overview. It is not intended to identify key/critical elements or to delineate the scope of the claimed subject matter. Its sole purpose is to present some concepts in a simplified form as a prelude to the more detailed description that is presented later.

A smart monitoring system of soil moisture comprising a controller, a sensing unit coupled to the controller comprising an inner tube and an outer tube to determine moisture content of soil and a visual means to display information of the moisture content of soil. The controller may be a microcontroller of 8051, AVR, PIC and the like controllers. The controller coupled to an oscillator with an operated frequency. The soil moisture sensor may be a capacitance sensor, granular matrix sensor and the like sensors. The oscillator may be a crystal oscillator, Hartley oscillator and the like oscillators to provide clock signals based on type of said controller. The

sensing unit may be a neutron probes, gravimetric probes and the like sensing units and material of the sensing unit may be a conducting material such as copper, aluminum, metal and thereof. The sensing unit is inserted into the soil to determine moisture content of the soil where in the moisture content is displayed with precise value. The invention consists of portable soil moisture sensor integrated to a visual means may be a display unit. This makes it possible for the user to observe the moisture level of the soil in multiple locations from a single conveniently positioned display unit.

Description of Drawings:

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate an embodiment of the invention, and, together with the description, serve to explain the principles of the invention.

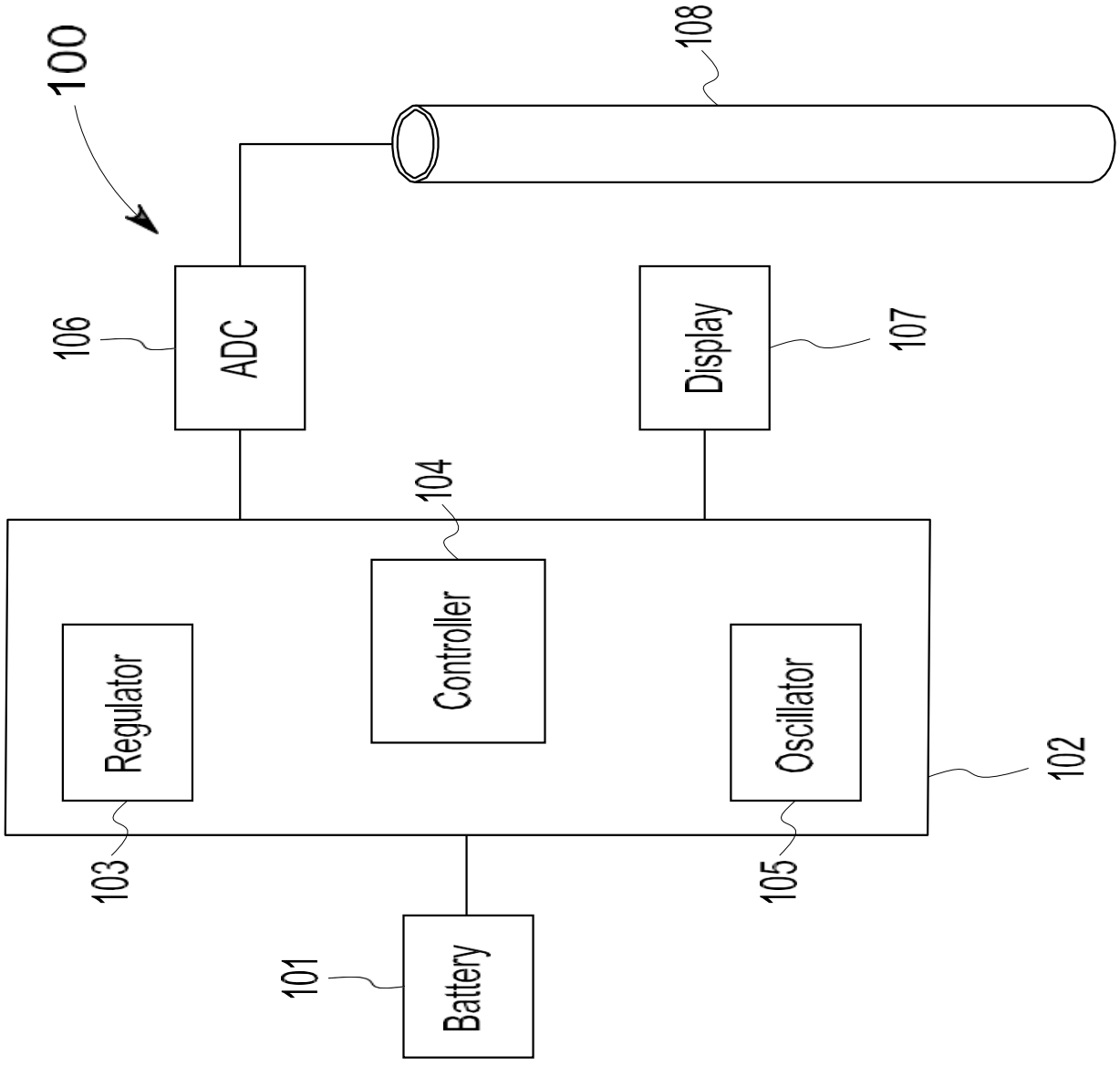

FIG: 1

Fig. 1 illustrates a block diagram of a soil moisture sensor.

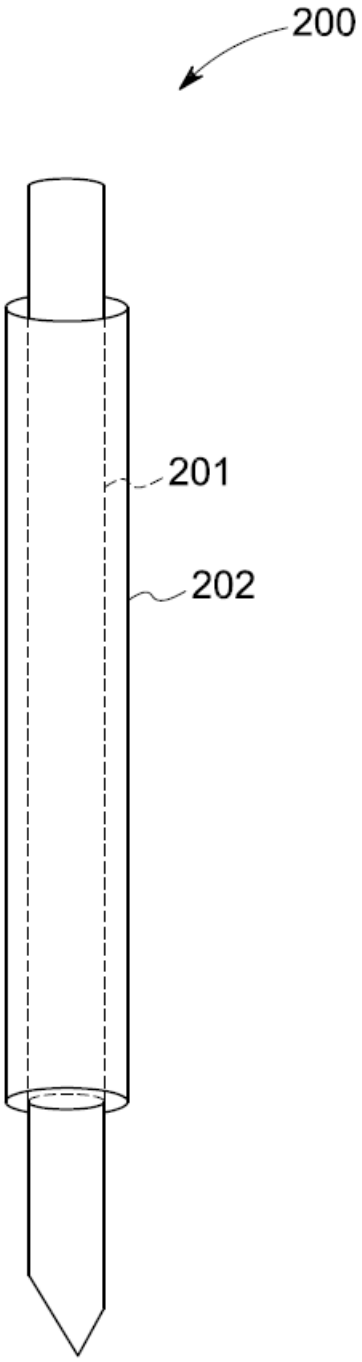

FIG: 2A

Fig. 2A illustrates a schematic diagram of the sensing unit.

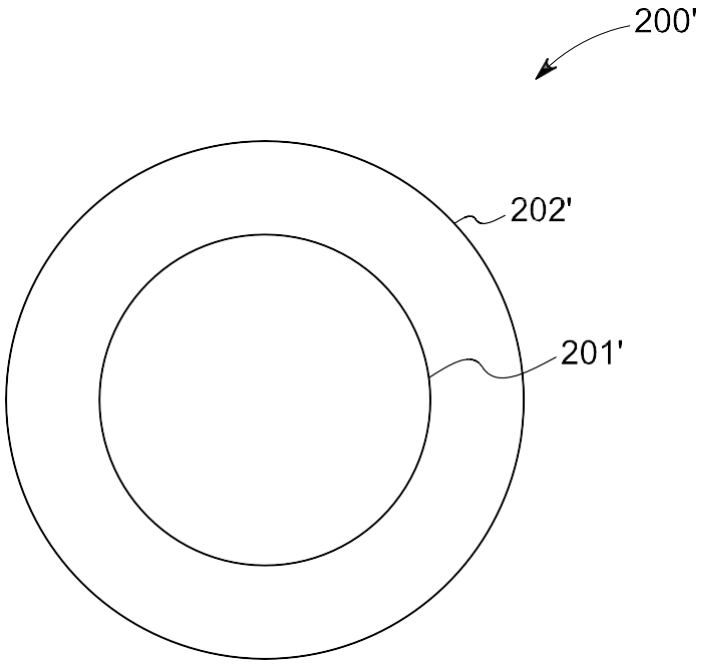

FIG: 2B

Fig. 2B illustrates a top view of the sensing unit.

Detailed description of Drawings:

An exemplary embodiment of the present invention will be described in reference to the accompanying drawings. Wherever possible, same or similar reference numerals are used in the drawings and the description to refer to the same or like parts or steps.

Fig. 1 illustrates a block diagram of a soil moisture sensor 100. The soil moisture sensor 100 comprises a battery 101, a control board 102, a regulator 103, a controller 104, an oscillator 105, an analog to digital converter (ADC) 106, a display 107 and a sensing unit 108. The battery 101 may be a lithium-ion battery, Lead–acid battery, Aluminium-ion battery and the like batteries. The battery 101 is coupled to the regulator 103 which regulates the input voltage and provides constant voltage at output pin. The regulator 103 maintains the output voltage at a constant value. The output voltage of regulator 103 is transferred to the controller 104 and the display 107. The oscillator 105 is coupled to the controller 104 to provide a clock signal at a certain frequency. The regulator 103, controller 104 and the oscillator 105 are integrated in a single control board 102. Capacitors (not shown) in control board 102 are connected in parallel with the DC power circuits to provide smooth current fluctuations for signal or control circuits. The capacitor may be ceramic, electrolytic, mica and the like capacitors. The controller 104 is coupled to the ADC converter 106 with sequence of clock signals. The ADC 106 is coupled to the sensing unit 108 is inserted in the soil to calculate the moisture level.

Accordance to the invention, the regulator 103 is an integrated circuit IC. The IC is of 5V voltage regulator that restricts the voltage output to 5V and draws 5V regulated power supply.

It comes with a provision to a heat sink. The IC can provide a constant steady voltage flow of 5V till the threshold limit of 35V. It regulates a steady output of 5V if the input voltage is in the range of 7.2V to 35V. The voltage source in circuit may have fluctuations and would not provide the fixed voltage output. The voltage regulator 103 maintains the output voltage at a constant value. The regulator 103 have input, ground and output pins. The voltage regulator 103 IC is a series of 78XX voltage regulators. It's a standard from the name the last two digits 05 denotes a number of voltages that it regulates. The pin description of the regulator 103 is shown ion below Table 1.

In accordance to the invention, the controller 104 may be a microcontroller of 8051, AVR, PIC and the like controllers. The controller 104 of the present invention is of Atmega328 microcontroller. It has a 28 pin of dual in line package or DIP. The required program for the invention is dumped in the respective controller 104 for the functioning of the sensor. The controller 104 comprises a variable frequency oscillator 105. The controller 104 stores the dumped program and can be reset the program as per the functioning of the sensor. The program in the controller 104 is dumped in a separate board. The controller 104 retrieves the moisture content of soil through ADC converter 106 in accordance to the program dumped in the controller 104. The pins of the controller 104 have a different purpose as receiver, transmitter, analog data input, digital input or output data, and power (3.3V and 5V). The voltage regulator 103 which supplies 5-volt DC power to the controller 104. The computing device as controllers are used to process the data in order to derive the relevant characteristics of the tested material, such as moisture content and the like, may be implemented as a separate processing unit which can be located remotely from the portion of the system.

In some embodiments, the microcontroller can include a processor and memory device. Processor can be implemented as a general purpose processor, an application specific integrated circuit (ASIC), one or more field programmable gate arrays (FPGAs), a group of processing components, or other suitable electronic processing components. Memory device (e.g., memory, memory unit, storage device, etc.) is one or more devices (e.g., RAM, ROM, Flash memory, hard disk storage, etc.) for storing data and computer code for completing or facilitating the various processes. The memory device may include a volatile memory or a non-volatile memory. The memory device may also include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures.

The oscillator 105 may be a crystal oscillator, Hartley oscillator and the like. The oscillator 105 uses mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency. The oscillator 105 used in the present invention is a crystal oscillator of 16MHz. The controller 104 operated at 16MHz frequency clock signal which can be controlled by the oscillator 105 of 16MHz itself. The purpose of the oscillators depends on the clock frequency of the controller. The oscillator 105 can be changed for further aspects of the invention.

The ADC converter 106 is powered from the output of the controller 104 with a required clock frequency. The ADC converter 106 is an analog to digital converter which converts the analog voltage to the digital voltage. The converter can divide the analog input voltage between 0v and 5v to 210 levels (1024 levels). The ADC converter 106 calculates the resistance of water in the soil. The ADC converter 106 is coupled to the sensing unit 108. The output voltage of the sensing unit 108 is provided as an input to an ADC converter 106 incorporated into the controller 104 which converts the analog output voltage to a digital signal indicative of the sensing unit 105. The resistance, moisture content of the soil can be displayed in a display 107. The display 107 may be a liquid crystal display (LCD), light emitting display (LED) and the like displays. The current used to drive the display 107 is provided by the regulator 103. The content of the moisture level in the soil is displayed in a binary format.

The sensing unit 108 is inserted into the soil to determine moisture content of the soil. The content of the soil can be displayed in the display 107 in a binary format. The sensing unit 108 may be a neutron probes, gravimetric probes and the like. The sensing unit 108 material may be a conducting material such as copper, aluminium, metal and thereof. The sensing unit 108 uses capacitance to measure dielectric permittivity of the surrounding medium. In soil, dielectric permittivity is a function of the water content. The sensor creates a voltage proportional to the dielectric permittivity, and therefore the water content of the soil.

Fig. 2A illustrates the schematic diagram of the sensing unit 200 for sensing a parameter of a soil medium. In the present case, the sensed parameter is the soil moisture content of the soil medium. Thus, the illustrated sensor is arranged to be installed in the soil of a monitoring site and the sensing unit 200 is designed to sense the moisture content of the soil medium. The circuit includes a processing unit (not shown) and associated circuitry (not shown) for processing a sensed signal generated by a sensing circuit. In the present case, the processing unit includes an ATMEGA328 controller with 16MHz crystal oscillator containing program instructions in the form of application code. In this embodiment the circuitry may be mounted on a flexible PCB. A casing is provided for securing the sensing unit 200 so as to prevent entry of moisture or other contaminants there into which may damage the sensing unit 200.

The sensing unit 200 comprises two coaxial tubes (inner tube 201 and outer tube 202) made of a conducting material and held apart at a fixed distance with some insulating material. The sensing unit 200 is inserted into the soil and it calculates or senses the range of resistance level of the water in the soil. Moisture in the soil provides a conductive path between the electrodes. The resistance between the inner tube 201 and the outer tube 202 is determined with type of soil. More water makes the soil conduct electricity with less resistance, while dry soil conducts electricity with more resistance. The resistance level of the water is displayed in the display 107. Fig. 2B shows the top view of the sensing unit 200'. The inner tube 201' and outer tube 202' of a conducting material with an air gap. An effective conducting area is developed by the soil particles in contact with the sensing unit 200.

In accordance to an embodiment of the invention, the sensor units and the display unit are all portable, making the network quick and easy to set up. Once established, the network provides

a convenient way to monitor the moisture level of the soil in various locations. The low cost of the network makes it suitable for household use. It is simple to add more sensors to the network, so the network can be scaled up to accommodate lawns, gardens, and potted plants of various sizes. The circuit can be fabricated in the programmable circuit board (PCB) for the device and minimizing the circuit without compromising the performance.

The present invention is also desirable for other purposes, e.g., for monitoring and evaluating the soil condition in construction sites, landscaped sites, mining operations, forest areas, flood control areas, or bio-remediation areas, such as areas in which liquid or other contaminant has spilled. The invention consists of portable soil moisture sensor integrated to a display unit. This makes it possible for the user to observe the moisture level of the soil in multiple locations from a single conveniently positioned display unit.

It will readily be apparent that numerous modifications and alterations can be made to the processes described in the foregoing examples without departing from the principles underlying the invention, and all such modifications and alterations are intended to be embraced by this application.

Claims:

We Claim:

1. A smart monitoring system of soil moisture comprising of:
   a controller;
   a sensing unit coupled to the controller, wherein said sensing unit comprising:
   an inner tube and an outer tube to determine moisture content of soil; and
   a visual means to display information of the moisture content of soil.
2. The smart monitoring system of soil moisture as claimed in claim 1, wherein said controller may be a microcontroller of 8051, AVR, PIC and the like controllers.
3. The smart monitoring system of soil moisture as claimed in claim 1, wherein said sensing unit may be a capacitance sensor, a granular matrix sensor and the like.
4. The smart monitoring system of soil moisture as claimed in claim 1, wherein said controller coupled to an oscillator with an operated frequency where the oscillator may be a crystal oscillator, Hartley oscillator and the like oscillators.
5. The smart monitoring system of soil moisture as claimed in claim 1, wherein said controller retrieves the moisture content of the soil based on a program dumped in said controller and displays by means of said visual means.
6. The smart monitoring system of soil moisture as claimed in claim 1, wherein said sensing unit may comprise a neutron probe, a gravimetric probe and the like, wherein said sensing unit material may be a conducting material such as copper, aluminium, metal and thereof.
7. The smart monitoring system of soil moisture as claimed in claim 1, wherein said inner and outer tubes of said sensing unit kept apart with an air gap or an insulating material between the tubes.

8. The smart monitoring system of soil moisture as claimed in claim 1, wherein said sensing unit is configured to be inserted into the soil to determine moisture content where the moisture content is displayed with precise value.

Conclusion:

To build small and portable but cheap, soil moisture sensor to help the farmers to help them determine the adequate soil moisture to obtain maximum possible yield. It can be operated by all age-groups of farmers. It can be reprogrammable to add more features. The moisture is measured up to the root zone of the crop. Thus, it can be used to check the moisture value for any crop. Sensor can be placed vertically in the soil to check the depth of irrigated water and also it can be placed horizontally at different heights in the soil according to the crop. To increase efficiency and speed, accuracy and to decrease cost, the recent approaches in developing decision support systems for agriculture, and more generally for environmental problems management, tend to adopt a "systemic" approach.

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