



Creation of a Utility Model: "System for Non-Destructive Testing of Soil Characteristics"

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Creation of a utility model: "system for non-destructive testing of soil characteristics"

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Abstract

This article describes the principle of operation of a utility model for a system for non-destructive testing of soil characteristics. This utility model belongs to the agricultural and computing fields of technology and is also classified as a means of measuring and processing data. Thanks to the computing devices with which we receive and process data, we can obtain data on the composition and characteristics of the soil, which can be used for agro-industrial interests. Before our invention, methods and metrics for measuring the qualitative characteristics of various types of soils were known in the scientific community, research was also carried out and existing utility models were studied. We will also talk about this in this article. To conduct a full-scale study of soil properties, it is necessary to spend a large amount of time and money, while the accuracy of non-destructive testing measurements without additional equipment remains very low. If you use laboratory research to increase the accuracy of measurements, then the time and financial costs increase even more. The results of the creation of this utility model can be used to study heat and moisture transfer in solids and gases, as well as to create more advanced prototypes based on the utility model.

Keywords

Arduino, ATmega 328P, DHT 22, Ds18b20, air humidity, air temperature, Arduino uno, lm293, non-destructive testing, sensors, soil characteristics, soil moisture, soil temperature

1. Introduction

Our utility model is characterized by the fact that it uses laboratory research methods coupled with actual soil data on the ground, which allows not only to correct calculations and obtain real-time data but also to identify anomalies in the composition.

The objective of the utility model is to develop a system for monitoring the state of the soil at agro-industrial facilities using laboratory methods of research in combination with the actual soil data obtained on the ground, which allows not only to correct calculations and obtain real-time data but also to identify anomalies in the composition.

Technical result: simplification of the design and expansion of the arsenal of means for monitoring the condition of the soil. This result is achieved by the fact that the system for non-destructive testing of soil characteristics, including a data processing unit and a soil temperature sensor, and a soil moisture sensor connected to it, according to the utility model, is equipped with a means for recording and storing information and comparators associated with the data processing unit, which is formed software and hardware platform Arduino.

There has been a pressing need to provide real-time farm information like soil moisture, and temperature to the farmer. These are vital soil parameters that influence overall crop growth and in turn, the farm produces. Monitoring of l moisture in different areas of a farm can help in overall irrigation management. Different crops require different irrigation strategies and using real-time soil moisture a farmer can increase yield by maintaining optimal soil moisture for a specific crop [1]. For example, while waterlogging is threatening the life of most of us, it is a must for paddy farms. Sometimes the

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standing water in paddy fields gets heated by sunlight and negatively affects crop growth. To avoid such situations, farmers drain off the warm water and refill their paddy fields with fresh water. Real-time moisture and temperature monitoring can be used to alleviate some of these problems faced by farmers. Soil temperature on its own is an important factor to determine the growth, it has been found that soil temperatures below 20°C inhibit nitrogen fixation which leads to decline in soil fertility [2]. Changes in acidity of soil may change the availability to plants of different nutrients in several ways. As the pH of the soil increases, ions such as iron, aluminum, manganese, copper, and zinc become less soluble. Thus neutralizing soil makes the condition more favorable to growth with of bacteria and speeds up processes by which nutrients are made available to plants [3]. Numerous researchers and manufacturers have developed sensors to measure the mechanical, chemical, and electrical properties of soils. Vellidis, Tucker, Perry, Kvien, and Bednarz [4] developed a relatively low-cost sensor that measured soil moisture and temperature and was used in automated irrigation scheduling. Multiple sensor nodes were deployed in the field and were connected to a centrally located receiver which provided the amount and timing of irrigation at different locations in the field. In another work, Mirell and Hummel [5] developed a real-time soil analysis system based on Ion Selective Field Effect Transistor (ISFET) technology.

2. Comparison

A device is known for determining the thermophysical characteristics of soils in the field, containing a temperature sensor, a constant power heater, a battery, an analog-to-digital converter, a multiplexer, a stable current source, a digital control unit and an indicator, while the input of the analog-to-digital converter is connected to the output of the multiplexer, to the first input of which a temperature sensor and a stable current source are connected, the input of a digital control unit is connected to the output of an analog-to-digital converter, and the outputs are connected to the second and third inputs of the multiplexer, a heater and an indicator [6].

The disadvantage of this device is the complexity of the design and high energy consumption.

A soil moisture control device is known, comprising a pulse shaper, a capacitive sensor, an amplitude detector, a differential amplifier, an analog-to-digital converter, a data processing unit and a transceiver, the first and second clock generators, and a reference voltage source connected in series, while the first generator clock pulse is connected to the data processing unit, the second clock pulse generator is connected to the pulse shaper, and the reference voltage source is connected to the second input of the differential amplifier and the input of the second clock pulse generator [7].

The device allows continuous remote monitoring of the state of soil moisture, however, it has a non-economical (continuous) mode of operation, which determines the time of the measurement process until the end of the power supply and increases energy consumption.

Closest to the proposed system is a device for remote control of soil moisture and temperature, including a power supply unit, a data processing unit and environmental parameters sensors connected to it, and a transmitting unit. Processing block data is made in the form of the main controller with a built-in analog-to-digital converter, environmental parameters sensors are made in the form of a digital temperature sensor and at least one capacitive humidity sensor, a series-connected power controller connected to the power supply, a key, a pulse converter and linear converter, the output of which is connected to capacitive humidity sensors, the output of the pulse converter is connected to a digital temperature sensor, the main controller and the transmission unit, and the output of the main controller is connected to the control input power controller [8]. The disadvantage of this device is the complexity of the design.

2.1.

The useful model is explained by the drawing, which shows the scheme of the device.

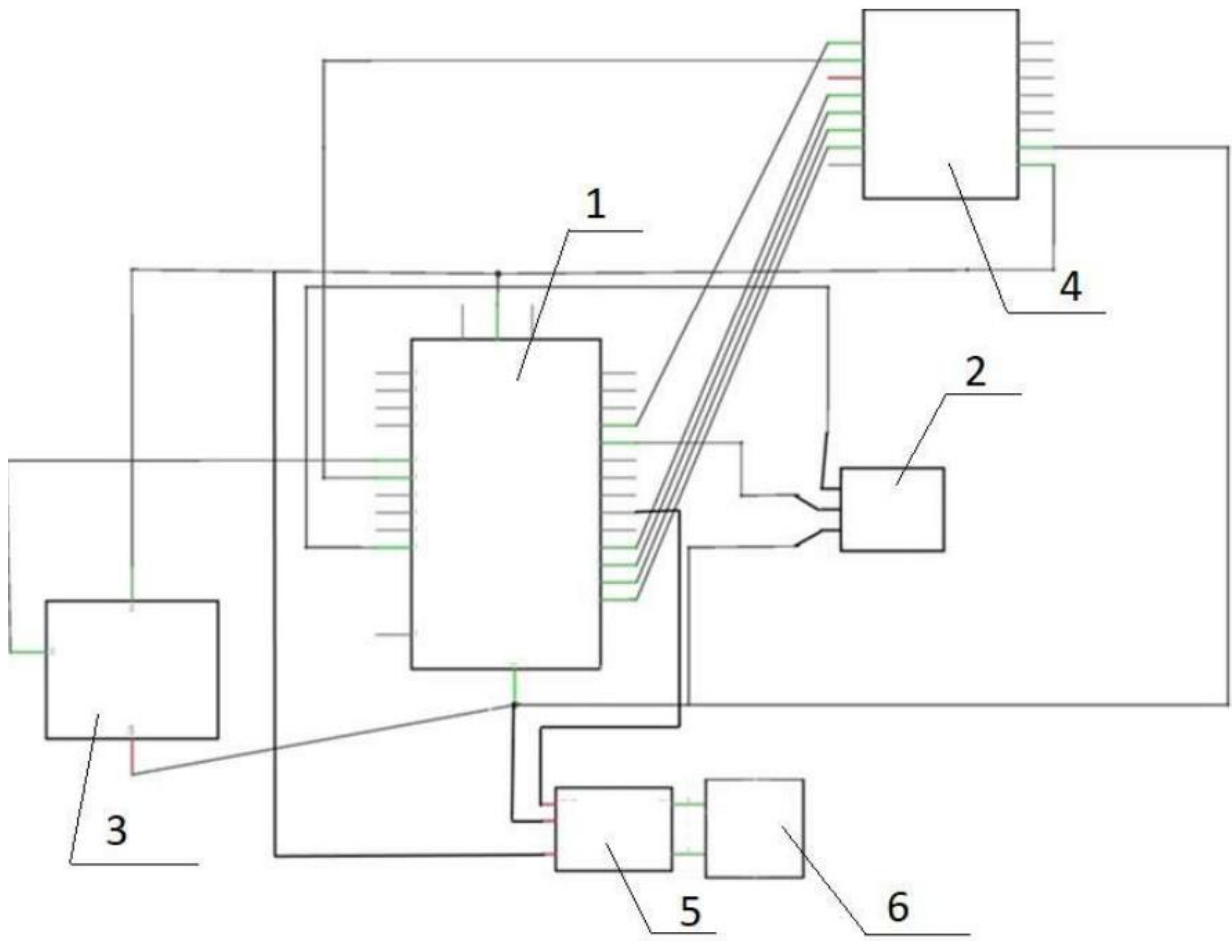


Figure 1: Utility model schematic diagram

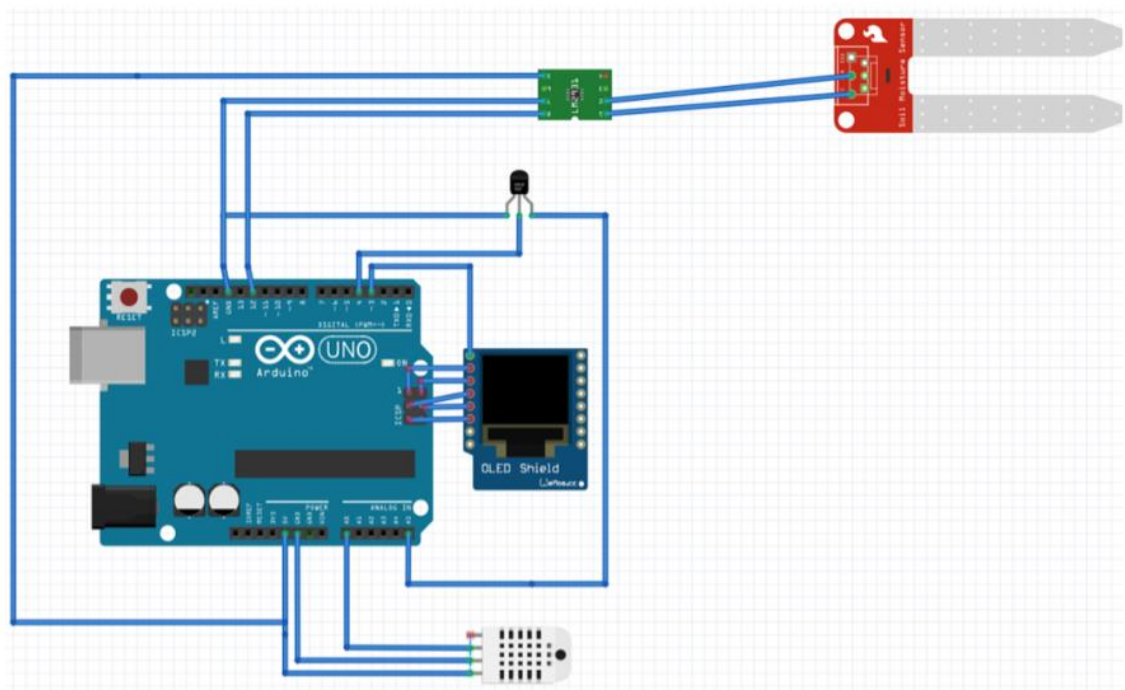


Figure 2: structural diagram of the utility model

The system of non-destructive control of soil characteristics includes data processing unit 1 and connected to it soil temperature sensor 2 and soil moisture sensor 3 connected to it. The system is equipped with a mean for recording and storing information 4, a comparator 5 and a system of electrodes 6 connected to the data processing unit 1, which is formed by an Arduino hardware and software platform.

In this utility model, the Arduino is represented by a Uno model board, on a ATmega328P microcontroller [9]. Arduino was chosen as a flexible and practical platform for collecting and analyzing data from sensors, thanks to which it is possible to increase the number and variety of connected devices. The Arduino uno is also equipped with 14 digital inputs/outputs, 6 analog inputs, USB connectors, an ICSP connector and a reset button. [10].

The module (Micro-SD card adapter) is a card reader module Micro SD memory card, as well as SPI interface through the file system driver and microcontroller system to complete the reading and writing of Micro-SD card files. Users of Arduino can directly use the Arduino IDE that comes with the SD card to complete the initialization of the library card and read-write [11].

The DS18B20 digital thermometer provides temperature measurements ranging from 9 Celsius to 12 bits and has a non-volatile alarm function with user programmable upper and lower user-programmable upper and lower trigger points. THE DS18B20 communicates over the 1-Wire bus, which by definition requires only one data line (and ground) to communicate with the central microprocessor. In addition, The DS18B20 can receive power directly from the data line ("parasite power power"), which eliminates the need for an external power supply [12].

The LM393B and LM293B devices are the next generation of the standard LM393 and LM293 family of comparators. These next-generation B-version comparators have a lower bias voltage, higher allowable supply voltage, lower supply current, lower input bias current, lower propagation delay, as well as improved electrostatic discharge characteristics of 2 kV and input immunity thanks to special electrostatic discharge clamps. All devices consist of two independent voltage comparators, which are designed to operate from a single power supply in a wide voltage range. The quiescent current is independent of the supply voltage supply voltage [13].

The device supplies voltage to 2 isolated contacts which, when moisture from the soil changes the resistance between the contacts. Thanks to this we can read not only electrical conductivity, but also moisture. Output calibrated electronic sensor DHT22. digital signal acquisition technology and moisture sensing technology that ensures its reliability and stability. Its sensing elements are linked to an 8-bit single-chip computer. Each sensor in this model is temperature-compensated and calibrated in an accurate calibration chamber, and the calibration coefficient is stored as program in the OTP memory, when the sensor detects, it will quote the coefficient from memory. The small size, low consumption, and long transmission distance allow DHT22 to be used in the harshest environments [14].

The system of non-destructive control of soil characteristics works as follows: The soil moisture and temperature sensors are placed on the surface as well as at a depth of 20 cm and 40 cm. Sensor air moisture and temperature sensor is placed on the surface. The system reads the sensors at regular intervals and The system saves the data on an SD card which can be SD card which can then be used for soil analysis.

Based on the measured data, the developed method allows to find all the thermo-physical parameters of the soil, such as coefficient of heat conductivity of soil, coefficient of heat capacity coefficient, specific weight of soil and coefficient of heat transfer of soil into air. Our method allows to determine all enumerated characteristics of soil having pores. In addition the methodology developed allows us to determine the thermophysical characteristics of building materials (new, artificial constructions being in operation).

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