



## Design and Implementation of a Microcontroller Based GSM Alert Farm Monitoring System Using Soil Moisture, Temperature, Humidity and Light

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### ABSTRACT

*This study is a farm operation monitoring system using a microcontroller device that gets the status of the farm by using the following factors: soil moisture, temperature, light and humidity and send the status of the farm to the user using a SMS alert notification system all at a given time. The Farm monitoring system was built around three sensor modules, and was programmed to read data from a monitoring device that will be attached to the sensors. The system uses hardware components, as well as software, thereby making it an embedded system. The hardware components includes DHT 11 module, Moisture Sensor, Light Dependent Resistor, a Microcontroller, and a monitoring device. In addition, a GSM Module is used to send SMS alert notifications to the user. The developed system can be applied and used on farm lands to monitor the farm's operation. At the end of these research work, microcontroller based farm monitoring system was able to get the soil moisture content, temperature, humidity and light and light of a farm at a particular time and send the status via SMS notification alert system to the farmer.*

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### INTRODUCTION

Agriculture plays a vital role in the development of a country's economy. The daily need for food shows the importance of agricultural development. Growing a particular crop in a particular region takes the privilege of monitoring the growth from cultivation till harvesting. One of the main challenges in agricultural activities is detecting soil properties. As the global climate decreases the source of water throughout the world, it is necessary to take steps for preserving it (Damas et al, 2017).

In every organised system which is dependent on accurate time and data management, there is a need to have a system which can on its own serve the purpose of automatically sending alert text messages. Time and data management plays important role in the success of any organization like a farm environment where there is always variation in soil properties such as temperature, humidity, soil moisture and PH of soils; these soil properties are to be effectively managed for maximum yield. With global mobile phone subscribers estimated to 4.5 billion by 2012 (Cellular



News, 2018), the mobile phone is by far the most adopted consumer electronic in the world. As their processing power increases, the ability to leverage their mobility and computing power to solve daily problems increases. From playing games, barcode scanning, photography, to social networking, mobile phones have become integral part of our modern existence. Hence, applications that have been traditionally confined to desktop computing are steadily being adapted for mobile phones. One of these applications is that of monitoring and tracking. While desktop computing still offers more processing power, the mobile phone has the advantage of constant reachability and mobility that desktop computing lacks with comparable rich user experience

Hence, there is the need to develop a system that will combine available resources and reach people through short message service (SMS) using GSM module (nowsms.com, 2018) This project proposes the design of a soil moisture detector using temperature and PH sensors, and also implementing it with SMS alert notification system. The system will check and monitor five soil properties which are the soil moisture, temperature, humidity, lighting and PH

## LITERATURE REVIEW

Design of Remote Monitoring and Control System with Automatic Irrigation System using GSM-Bluetooth. Design of an economical and generic automatic irrigation system based on wireless sensors with GSM-Bluetooth for irrigation system controller and remote monitoring system. This system has simpler features designed with the objective of low cost and effective with less power consumption using sensors for remote monitoring and controlling devices which are controlled via SMS using a GSM module. A Bluetooth module is also interfaced with the main microcontroller

chip. This Bluetooth module eliminates the usage charges by communicating with the appliances via Bluetooth when the application is in a limited range of few meters. The system informs user about any abnormal conditions like less moisture content and temperature rise, even concentration of CO<sub>2</sub> via SMS from the GSM module or by Bluetooth module to the farmer's mobile and actions are taken accordingly by the farmer. In future, the farmer will be able to monitor and control the parameter by GSM and **Bluetooth technologies.** (Redd, 2012)

### **Monitoring using fuzzy controller**

The system (Liai *et al.*, 2013) consists of two units, WSN and a monitoring center. Nodes in the monitoring area collect information of the soil moisture and growth information of different crops in different periods using solar power. Wireless Sensor Network (WSN) contains many sensor nodes and controller nodes. The data sensed from the WSN is given as inputs to the monitoring center which in turn gives the information about the irrigation, demand of the water level and control over the opening or closing of the valves. Zigbee network in a mesh network topology is used to meet the network coverage and reduce the energy consumption and the cost. Some of the nodes are assigned as routers and coordinators. Sensor nodes sense the temperature and humidity whereas the routing nodes route the communication information and forwarding the data to the relevant nodes and the coordinator node receives data from the routing nodes and sent it to host computer monitoring center through RS232 serial bus. The monitoring center record the real time moisture value from all the nodes and calculate crop irrigation water requirement and output the result to WSN and control to the valves. The soil moisture sensor TDR-3A is used for measuring the moisture value.



#### Remote Monitoring using sensors

In the irrigation monitoring system (Lutful *et al.*, 2013), the information regarding soil moisture, temperature etc. are sensed by the Bluetooth wireless transmitters and the time specific decision for irrigation is made according to the information sensed. The irrigation control unit gets the decision and sends the position of the irrigation system using GPS receiver to the base station through real time monitoring. Base station in turn sends control signals to the irrigation control station to operate the device for water usage. Also distributed irrigation system, sensor based irrigation system and automated field-specific irrigation system are also provided good irrigation control. Yet, all these do not consider the pollution of water.

#### **Monitoring Using Humidity Sensors**

For measuring the humidity value of a region, SY-HS-220 humidity sensor (Nilesh *et al.*, 2013) is used. It works on the operating temperature range of 0 – 60°C. Temperature value is sensed by the sensor LM35IC in which the output voltage is linearly proportional to the Celsius temperature. TinyOS (Alagupandi *et al.*, 2014) is an open source component based low power operating system which is designed only for embedded system application. TinyOS based IRIS motes is used to measure the moisture level of paddy field and MD100CB sensor motes are used to reduce the number of motes used. A low cost soil moisture sensor is used to control water supply in water deficient areas. The sensor communicates the information via XBEE wireless communication module to a centralized server.

The server provides the control to the water supply and displays the moisture data in a more user friendly interface. Two galvanized metallic electrodes are kept at a distance of 30mm inside the soil area in an

acrylic sheet. The change of impedance between two galvanized metallic electrodes due to the varying moisture content in the surrounding medium is measured. Based on all these measurement, the data is transferred to the server for processing. Wireless Monitoring of Soil Moisture, Temperature & Humidity Using Zigbee in Agriculture

Monitoring agricultural environment for various factors such as soil moisture, temperature and humidity along with other factors can be of significance. A traditional approach to measure these factors in an agricultural environment meant individuals manually taking measurements and checking them at various times. This paper investigates a remote monitoring system using Zigbee. These nodes send data wirelessly to a central server, which collects the data, stores it and will allow it to be analyzed then displayed as needed and can also be sent to the client mobile (Chavan *et al.*, 2014).

#### **DESIGN AND IMPLEMENTATION OF AUTOMATED IRRIGATION SYSTEM USING ZIGBEE AND GSM**

Automated irrigation system using ZIGBEE and GSM for agricultural crop. In these system use the Wireless Technology. The system has represented the wireless sensor network of soil-moisture, temperature and humidity sensor and water level sensor placed into root zone of the plant. In traditional approach to measure these factors in an agricultural environment meant individuals manually taking measurements and checking them at various times. This paper includes the monitoring of the system using zigbee and GSM (Mamta patidar *et al.*, 2015)

#### **Remote Monitoring using GSM**

The subscriber or user sends activation command to the system via SMS. The system (Deepak *et al.*, 2015) will check

the moisture level and if it is less than the prescribed level, the system will start the motor. While the motor is running, the system will monitor the soil moisture and water level constantly. If the moisture level reaches the sufficient level, the motor will be turned off. The corresponding event of the operation of motor is notified to the user using SMS.

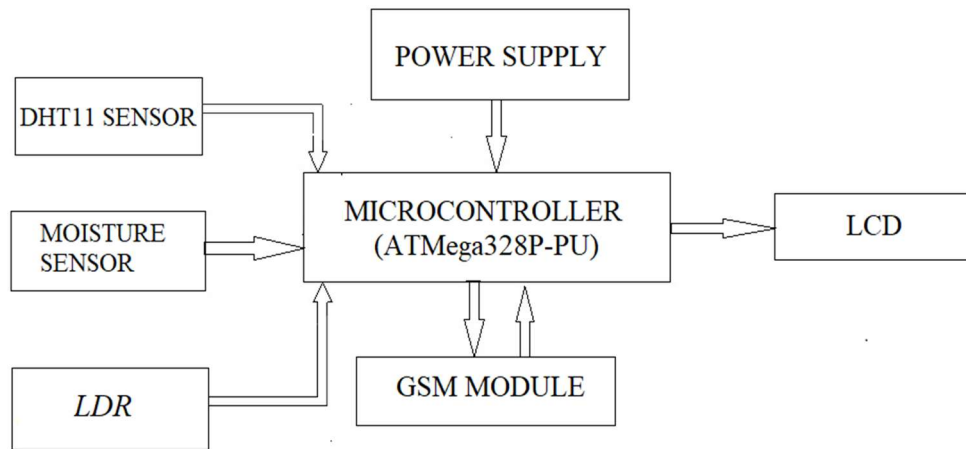
### **Weather Monitoring System using Microcontroller**

The measurement of temperature and humidity remotely by using the sensor is not only important in weather monitoring but also crucial for many other applications such as agriculture and industrial processes. A device for real time weather monitoring is presented in this paper to monitor the temperature and relative humidity of the

atmosphere via GSM network, using analog and digital component. The sensor output will be given to the ADC. The microcontroller will read the ADC output and display the parameter value on the LCD. An LCD display is also connected to the microcontroller to display the measurement. For analysis and achieving purposes, (Karishma *et al.*, 2016)

### **METHODOLOGY**

The diagram below shows the block diagram of the system. The system will use hardware components, as well as software, thereby making it an embedded system. The hardware components are DHT 11 module, Moisture Sensor, Light Dependent Resistor (LDR), a Microcontroller, and a monitoring device. In addition we will use a GSM Module to send SMS alert notification to the user.



**Figure 3.1:** Block diagram of the farm alert monitoring system

The construction of this system was done in four different stages: Firstly, the implementation of the components in the system design onto a solderless experiment board (breadboard). Next is the transfer of components from the solderless experiment board to the development board, and then

soldering the components permanently on the development board. Thirdly, the development board was connected to the power source and the system was tested to ensure it was connecting and sending notifications correctly to the connected GSM mobile device. Finally, the entire project was



coupled together into a casing. The Bill of Engineering Measurement and Evaluation (BEME) which highlights all the components used for the system implementation are listed in the Appendix section of this report.

The sensors in this paper was used to obtain the required soil properties which are moisture, temperature, and humidity and they include:

#### *DHT11 Sensor Module*

The DHT11 sensor module is a humidity and temperature sensor module. This module integrates DHT11 sensor and other required components on a small PCB. This sensor uses a 3.3V - 5.5V DC supply, measures humidity between the range 20% – 90% humidity, and measures temperature between 0 – 50°C.

#### *Moisture Sensor*

The Soil Moisture Sensor uses capacitance to measure the water content of soil (by measuring the dielectric permittivity of the soil, which is a function of the water content). Power sources, which are sometimes called power adapters, are available in various voltages, and they have varying current capacities, which is the maximum capacity of a power supply to deliver current to a load. For this project, a 5V power source was used as the sensors require a 5V DC to work. This power source will convert a 110/240V AC into 5V DC. The power unit is developed following this stages;

Step Down Stage *has an* Alternate Current Input Coming from the wall, the AC alternates from a minimum to a maximum voltage at a frequency of 50Hz between the range of 220 – 240 volts (in Nigeria and other 60Hz countries) is step down through the use of step down transformer to about 22 - 24 volts.

Rectification is the conversion of alternating current (AC) to direct current

(DC). This involves a device that only allows one-way flow of electrons. In smoothing stage we have at least consistently positive voltage levels, but they still dip down to zero 120 times per second. A large capacitor, which can be thought of like a battery over very short time periods, is installed across the circuit to even out these rapid fluctuations in power. The capacitor charges when the voltage is high and discharges as the voltage is low. (Audrey, 2005)

During the Regulation process the smoothed voltage is then controlled to maintain a constant range. For this project I utilize two voltage regulator LM7805 and LM7812 which are to regulate the voltage to 5V and 12V respectively. 5V to power the micro controller, light emitting diodes (LED), Liquid crystal display (LCD) and 12V to power the relay. For this paper, the ATmega 328 microprocessor chip was used. ATmega 328 microprocessor is a high-performance single-chip microchip created by the Atmel in the mega AVR family. The Atmel 8-bit AVR RISC-based microcontroller combines 32kB ISP flash memory with read-while-write capabilities, 1kB EEPROM, 2kB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter, programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5V. The device achieves throughout approaching 1 MIPS per MHz. The ATmega 328 is commonly used in many projects and autonomous systems where a simple low-powered, low-cost microcontroller is needed (Microchip, 2018).

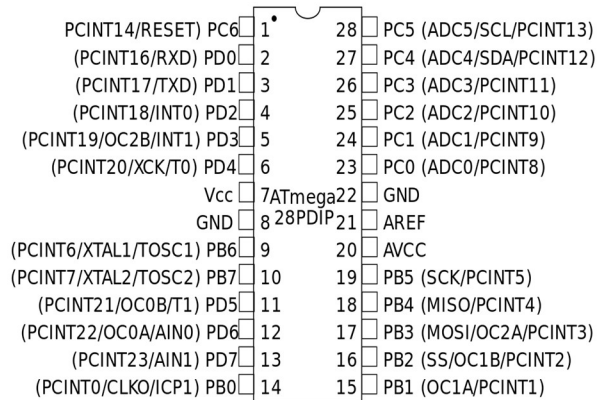


Figure 3.2: ATmega 328 Microprocessor Schematic Diagram.

The GSM module shall be connected to the microcontroller to read and output the data obtained and to

wirelessly transmit this data via the GSM to the display paired with it.



Figure3.3: GSM A6 Module (Audrey selian, 2005).

The LDR is a component that has a variable resistance that changes with the light intensity that falls upon it. This allows them to be used in light sensing circuits. There are several applications of the LDR, and the most common application is in the

lighting switch, to turn on a light at a certain level. LDRs can also be used to control the shutter speed on a camera; the LDR would measure the light intensity which then adjusts the camera shutter speed to the appropriate level.



**Design Algorithm**

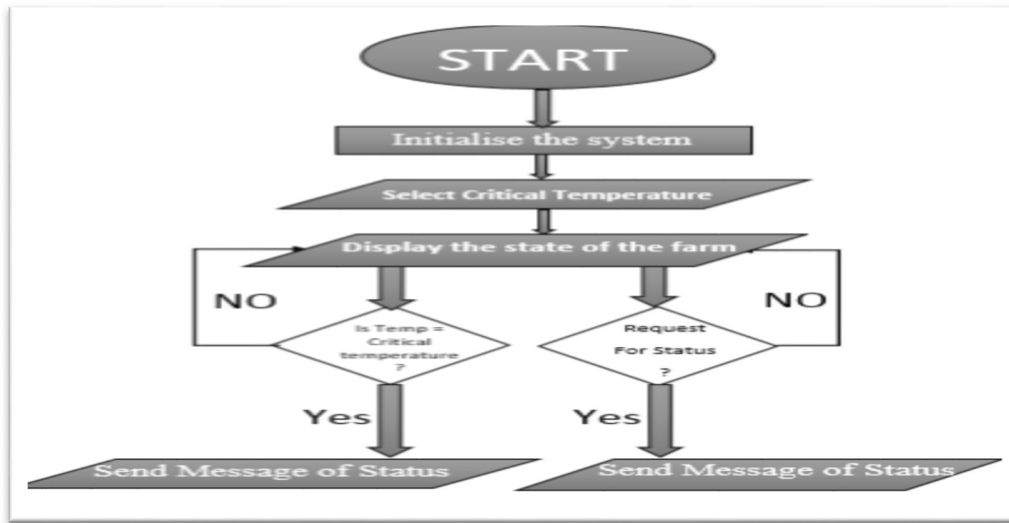


Figure3.4: Flow-chart for the farm alert monitoring system.

**RESULTS AND DISCUSSION**

*Simulation Results*

When the simulation of the design of the Soil Moisture Detector system was carried out using Proteus simulation tool, the LCD display of the system design showed

a result 'Farm update: CRITICAL ALERT!' (see picture below), indicating that the program is compatible with the system design and that the GSM module will send an update to the mobile device that has been programmed to work with it.

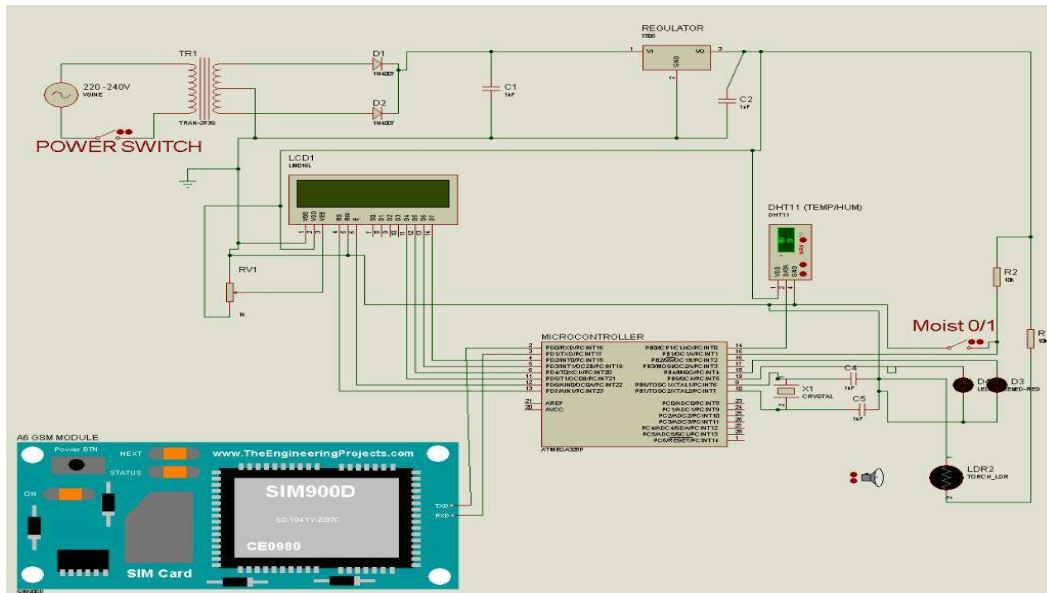


Figure 4.1: Simulation Setup on Proteus Application

### System Implementation

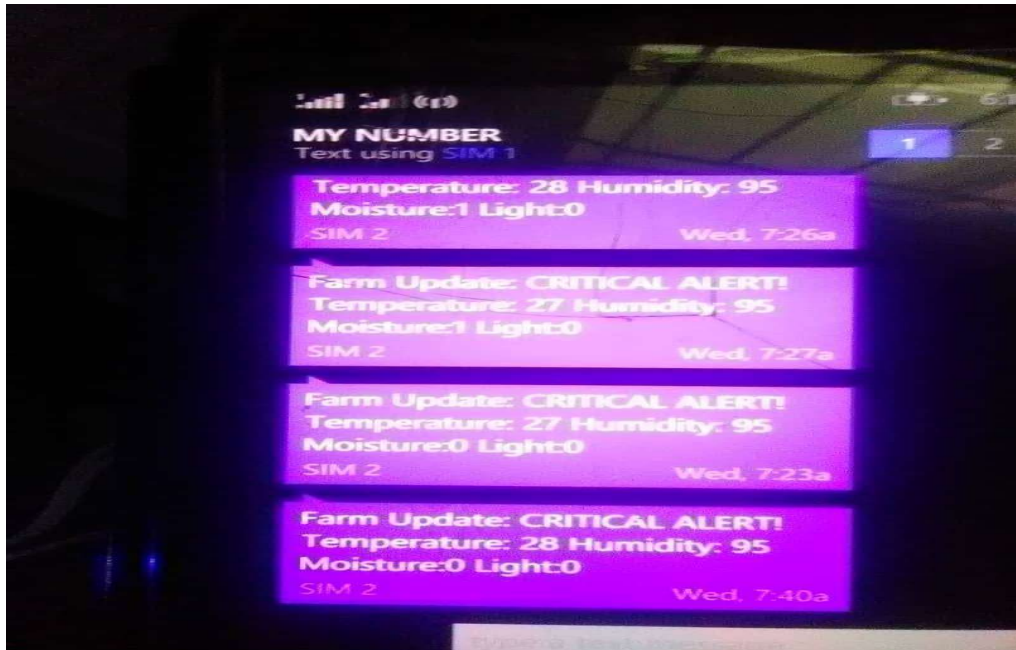
After a successful layout of components on the development board, there is need to interconnect the development board with the electromagnetic door lock and the power source using connecting cables. The working process of the system is shown in the pictures below. The GSM A6 module requires a 5V power supply, and this power is supplied by the power source. The development board is also connected to the power source through its ports 5V/12V and GND. There are two situations upon which the system sends notifications to the mobile device: firstly, when the system reaches its critical points, and secondly, when the user request for the status of his farm (see picture below). When the device started working, it

sent an SMS notification to the mobile device as seen in the picture below. The working principle of the system is such that a user can at any time request for the status of the farm by sending a request status message to the system, and the designed system will respond with an update through a SMS notification. Also, the system will alert the user automatically whenever the soil properties reach critical point. If the status of the soil properties is requested by the user, the system alerts the microcontroller does not only respond by sending a SMS notification to the mobile device, it also shows the result of the soil properties on the LCD screen in front of the system. Whenever soil properties reach critical point, the system keeps alerting the user after every ten minutes delay



Figure 4.2: shows a picture of how to request for the status of the farm





**Figure4.3:** shows the picture of the notification of the status of the farm

After a successful components interconnection, the whole connection is tested to check whether or not it is in good working condition. If the connections perform the desired operation, then there is need to couple the components together into a casing. For this project, the casing used is made up of plastic which has been formed into the shape of a box, and the

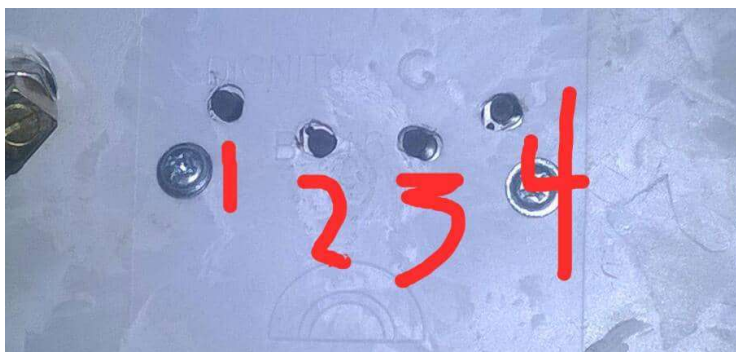
components are well laid and screwed to the box. The LCD is placed in front of the designed system so as to be the first point of contact whenever a user wants to access the system. The power source is as well housed inside the box. The picture below shows the developed prototype of the soil moisture detector system.



**Figure 4.4:** The prototype of the Soil Moisture Detector System using Temperature and PH sensors, with SMS alert Notification System.

The four black buttons labelled from 1 – 4 in the picture below have their respective functions: button 1 is used to clear/cancel the displayed soil properties, button 2 is used to decrease the value of temperature (i.e. for minimum temperature settings), button 3 is used to increase the value of temperature (i.e. for maximum temperature settings) and, button 4 is used

to set maximum temperature settings as well as to select maximum temperature. The button indicated with an arrow in the picture above is used to carry out some hidden functions which are: whenever the network is bad and message sent to the system is delaying, tap this button for five seconds so as to reset the GSM network.



The prototype of the Soil Moisture Detector System (a closer view).

#### CONCLUSION AND RECOMMENDATION

The system that has been designed and implemented is a Soil Moisture Detector System which used Temperature and Humidity sensors, with alert notification system to notify the user of the soil properties. Whenever the soil properties reach critical points, the system automatically sends a SMS to the user notifying him about the status of the soil. This notification repeats every ten minutes till the user takes action. The system sends notifications of four soil properties which are: temperature, humidity, pressure and light intensity.

The system is so user friendly that, it can be deployed even by those who do not have good knowledge of electronics. It can not only be implemented in farm environments, it can be adapted for usage in poultries, homes, etc. A PH sensor could be added so as to obtain the PH value of the soil as part of the soil properties that will be gotten. A space for water pump could also

be added. This is because there may be need to pump water to the soil for the purpose of irrigation, especially when the temperature of the soil goes above critical point, thereby making life easier for the user. Improvements can be made in order to make soil moisture detector system safer, more reliable and better.

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