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# Smart Irrigation System Using IOT

Saravanan.S,Thangabalu.S,AdharshManivannan.D
Final Year, Department of Information Technology
Mr.V.Vignesh
Assistant Professor (Sl.Gr), Department of Information Technology
Sri Ramakrishna Engineering College,Coimbatore.

*Abstract*—An automated irrigation system was developed to optimize water use for agricultural crops. In present days, in the field of agriculture farmers are facing major problems in watering their crops. Its because they don't have proper idea about the availability of power. Even if it is available, they need to pump water and wait until the field is properly watered, which compels them to stop doing other activities. An automation of irrigation has several positive effects, the water distribution on fields or small scale gardens is easier and does not have to be permanently controlled by an operator.There is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial, and institutional improvements.Manual irrigation systems do not promote water conservation that results higher amount of water or low amount of water leads to poor plant growth. Automated irrigation systems are capable of determining and maintaining the right amount of the soil.

## I. INTRODUCTION

The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided withunique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.The Internet of Things is the ever-growing network of physical objects that feature an IP address for internet connectivity, and the communication that occurs between these objects and other Internet-enabled devices and systems. The major challenges in Internet of Things includes security concerns, privacy issues, Inter-operatability standard issues, Legal Regulatory and Rights issuesand Emerging Economy and development issues.Automating the data acquisition process of the soil condition allows plant growth with less labor requirement. The existing systems employ PC or SMS-based systems for keeping the user continuously informed of the conditions of the field.

An automation of irrigation has several positive effects, the water distribution on fields or small scale gardens is easier and does not have to be permenantly controlled by an operator. So, there is an urgent need to create strategies based on science and technology for sustainable use of water, including technical, agronomic, managerial, and institutional improvements. Manual irrigation systems do not promote water conservation that results higher amount of water or low amount of water leads to poor plant growth. Automated irrigation systems are capable of determining and maintaining the right amount of the soil.

Distributed in-field sensor-based irrigation systems offer a potential solution to support site-specific irrigation management that allows producers to maximize their productivity while saving water. This paper describes details of the design and instrumentation of variable rate irrigation, a wireless sensor network, and software for real-time in-field sensing and control of a site-specific precision linear-move irrigation system. Field conditions were site-specifically monitored by six in-field sensor stations distributed across the field based on a soil property map, and periodically sampled and wirelessly transmitted to a base station. An irrigation machine was converted to be electronically controlled by a programming logic controller that updates georeferenced location of sprinklers from a differential Global Positioning System (GPS) and wirelessly communicates with a computer at the base station. Communication signals from the sensor

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network and irrigation controller to the base station were successfully interfaced using low-cost Bluetooth wireless radio communication. Graphic user interface-based software developed in this paper offered stable remote access to field conditions and real-time control and monitoring of the variable-rate irrigation controller.

Irrigation is an essential practice in many agricultural cropping systems in semiarid and arid areas, and efficient water applications and management are major concerns. Self-propelled center pivot and linear-move irrigation systems generally apply water quite uniformly; however, substantial variations in soil properties and water availability exist across most fields. In these cases, the ability to apply site-specific irrigation management to match spatially and temporally variable conditions can increase application efficiencies, reduce environmental impacts, and even improve yields. The development of a distributed in-field sensor-based site-specific irrigation system offers the potential to increase yield and quality while saving water, but the seamless integration of sensor fusion, irrigation control, data interface, software design, and communication can be challenging.
An automated irrigation system was developed to optimize water use for agricultural crops. The system has a distributed wireless network of soil-moisture and temperature sensors placed in the root zone of the plants. In addition, a gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of temperature and soil moisture that was programmed into a microcontroller-based gateway to control water quantity. The system was powered by photovoltaic panels and had a duplex communication link based on a cellular-Internet interface that allowed for data inspection and irrigation scheduling to be programmed through a web page. The automated system was tested in a sage crop field for some days and water savings of up to 90% compared with traditional irrigation practices of the agricultural zone were achieved. Three replicas of the automated system have been used successfully in other places for 18 months. Because of its energy autonomy and low cost, the system has the potential to be useful in water limited geographically isolated areas.

Irrigation is defined as artificial application of water to land or soil. Irrigation process can be used for the cultivation of agricultural crops during the span of inadequate rainfall and for maintaining landscapes. An automatic irrigation system does the operation of a system without requiring manual involvement of persons. Every irrigation system such as drip, sprinkler and surface gets automated with the help of electronicappliances and detectors such as computer, timers, sensors and other mechanical devices.

## II LITERATURE SURVEY

Evapotranspiration-based irrigation controllers, also known as ET controllers, use ET information or estimation to schedule irrigation. Previous research has shown that ET controllers could reduce irrigation as much as 42% when compared to a time-based irrigation schedule. The main scope of this study was to determine the capability of ET-based irrigation controllers to schedule irrigation compared to a theoretically derived soil water balance model based on the Irrigation Association Smart Water Application Technologies (SWAT) protocol to determine the effectiveness of irrigation scheduling. Five treatments were established, replicated four times for a total of twenty field plots. This idea is proposed byS.L.Davis, M.D.Dukes as “Irrigation Scheduling Performance by evapotranspiration based controllers” in 2010.[1]. Water use and plant growth and quality were compared across different nursery stock beds, different methods of applying irrigation, and different methods of scheduling irrigation. With overhead irrigation, scheduling of irrigation according to plant demand, along with an irrigation system designed to maximise irrigation uniformity, resulted in substantial water savings, without reducing plant quality. This was the case in both wet and dry years. In the dry year, plant quality was particularly good when grown on a sub-irrigated sand bed;this system also used less water than any of the overhead irrigation systems. Two different systems were effective in scheduling overhead irrigation, one based on the volumetric moisture in the growing substrate, and the other based on plant evapotranspiration. The latter was determined with a small sensor with wet and dry artificial “leaves”, the output of which correlated with that obtained following the Penman–Monteith method based on a full set of meteorological data. Proposed by Olga M.Grant,

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Micheal J. Davies, Helen Longbottom, Christopher J.Atkinsonas "Irrigation Scheduling and irrigation systems:optimizing irrigation efficiency for container ornamental shrubs in 2008.[2].The wireless sensor network (WSN) technology is the long-duration and large-scale environmental monitoring.

The holy grail is a system that can be deployed and operated by domain specialists not engineers, but this remains some distance into the future. We present our views as to why this field has progressed less quickly than many envisaged it would over a decade ago. We use real examples taken from our own work in this field to illustrate the technological difficulties and challenges that are entailed in meeting end-user requirements for information gathering systems. Proposed by "Environmental wireless sensor Networks" by Peter corke, Tim Wark, Raja Jurdak, Philip Valencia in 2010.[3].Wireless sensor networks (WSNs) research has pre-dominantly assumed the use of a portable and limited energy source, viz. batteries, to power sensors. Without energy, a sensor is essentially useless and cannot contribute to the utility of the network as a whole. Consequently, substantial research efforts have been spent on designing energy-efficient networking protocols to maximize the lifetime of WSNs. However, there are emerging WSN applications where sensors are required to operate for much longer durations like years or even decades after they are deployed. Proposed by Winston K.G.seah, ZhiAngEu, Hwee Pink Tan as "Wireless sensor networks powered by ambient energy harvesting" in 2010

## III AUTOMATED IRRIGATION SYSTEM

**Problem definition**- The automated irrigation system implemented was found to be feasible and cost effective for optimizing water resources for agricultural production.The automated irrigation system hereby reported, consist of two components wireless sensor units (WSUs) and a wireless information unit (WIU).A WSU is comprised of a RF transceiver, sensors, a microcontroller, and power sources. This project uses Arduino board as a microcontroller.It is programmed in such a way that it will sense the moisture level of the plants and supply the water if required.

In present days, in the field of agriculture farmers are facing major problems in watering their crops. It's because they don't have proper idea about the availability of the power. Even if it is available, they need to pump water and wait until the field is properly watered, which compels them to stop doing other activities – which are also important for them, and thus they loss their precious time and efforts. But, there is a solution – an automaticplantirrigationsystem not only helps farmers but also others for watering their gardens as well.

This automatic irrigation system senses the moisture content of the soil and automatically switches the pump when the power is on. A proper usage of irrigation system is very important because the main reason is the shortage of land reserved water due to lack of rain, unplanned use of water as a result large amounts of water goes waste. For this reason, we use this automatic plant watering system, and this system is very useful in all climatic conditions.

During summers, most people are too lazy to water the potted plants on their rooftop gardens every day. Explained in this section is a simple and exciting plant watering system that you can build yourself in just a few hours. It is an Arduino based automatic plant water-feeder system that uses a soil moisture sensor.

Nowadays, many people are facing a lot of problems watering the plants in the garden, especially when they are away from home. In such cases, watering plants become difficult as they are involved in other works. Without losing their time and efforts, many people can avail a better option in the form of an automatic plant watering system that helps watering the plants in the garden. This automatic plant watering system senses soil moisture, and then automatically switches the pump when the power is available. A proper use of the water to the plants is most important due to lack of rain and shortage of water. For this reason, we use this automatic plant watering system as

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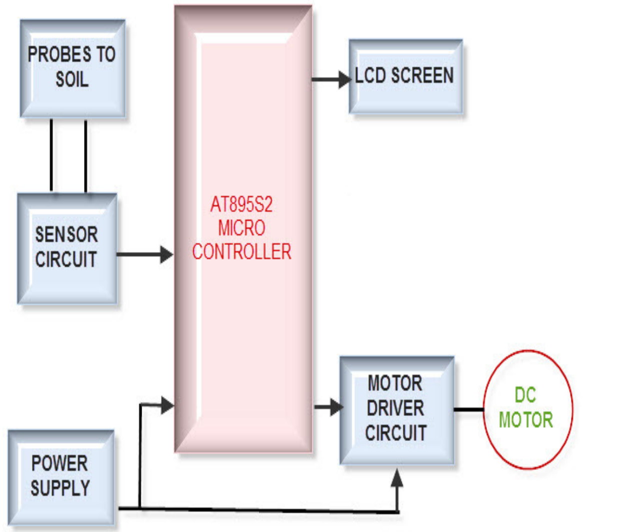
it is very useful in all climatic conditions.




## IV MODULES DESCRIPTION

### 4.1 MOISTURE DETECTION

A moisture sensing device in automated irrigation system is a pair of concentrically disposed cylindrical conductors are separated by a layer of beads, such that a capacitor is formed whose resistance will vary in response to the level of moisture present in the fibrous material. An electrical circuit is connected across the cylindrical conductors for measuring the variable resistance caused by the level of moisture present in the layer of beads. If the soil is dry enough to require watering, the sensor circuit will produce an output signal to the appropriate solenoid in the irrigation system to permit watering.

A moisture sensing device, comprising a sensor having a pair of concentrically disposed conductors, each said conductor being in the form of a hollow cylinder, and both said conductors being contained in a generally cylindrical enclosure having screen means for permitting moisture to ingress and egress through said sensor, said conductors being separated by a porous layer of dielectric bead-like material to form a capacitor whose resistance will vary in response to the level of moisture present in said dielectric bead material, a porous layer of said bead-like material also being interposed between the outer one of said conductors and said enclosure, said outer conductor being constructed of an electrically conductive, tubular formed mesh material and having a different length than the inner one of said conductors; andcircuit means connected across said conductors for measuring the variable resistance caused by the level of moisture present in said dielectric bead material. Vegetation and crops always depend more on the moisture available at root level than on precipitation occurrence. Water budgeting for irrigation planning, as well as the actual scheduling of irrigation action, requires local soil moisture information. Knowledge of the degree of soil wetness helps to forecast the risk of flash floods, or the occurrence of fog. Soil water content is an expression of the mass or volume of water in the soil, while the soil water potential is an expression of the soil water energy status. The relation between content and potential is not universal and depends on the characteristics of the local soil, such as soil density and soil texture.

The basic technique for measuring soil water content is the gravimetric method. Because this method is based on direct measurements, it is the standard with which all other methods are compared. Unfortunately, gravimetric sampling is destructive, rendering repeat measurements on the same soil sample impossible. Because of the difficulties of accurately measuring dry soil and water volumes, volumetric water contents are not usually determined directly. The capacity of soil to retain water is a function of soil texture and structure. When removing a soil sample, the soil being evaluated is disturbed, so its water-holding capacity is altered. Indirect methods of measuring soil water are helpful as they allow information to be collected at the same location for many observations without disturbing the soil water system. Moreover, most indirect methods determine the volumetric soil water content without any need for soil density determination.Soil moisture sensors measure the volumetric water content in the soil.

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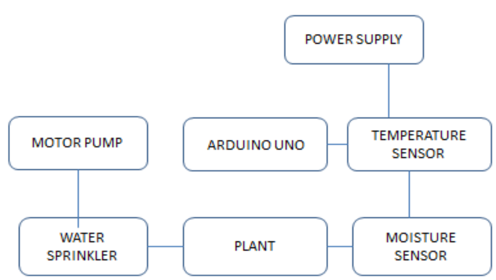
The soil moisture may vary depending on environmental factors such as soil type, temperature, or electric conductivity. For conversion of change in resistance to change in voltage, the sensor is connected with a resistor in series to form a potential divider arrangement .It gives a voltage output corresponding to the conductivity of the soil. The conductivity of soil varies depending upon the amount of moisture present in it. The higher the water content in the soil, the lower the electrical resistance.The voltage output is taken from the output terminal of this circuit. The moisture sensor is immersed into the specimen soil whose moisture content is under test. Optimum water level for clayey sands 11-10% .Optimum water level for Inorganic clay 24-12%.

**IOT BASED AUTOMATED IRRIGATION SYSTEM-BLOCK DIAGRAM**




## 4.2TEMPERATURE DETECTION

Soil temperature sensors come in a variety of designs using thermistors, thermocouples, thermocouple wires, and averaging thermocouples. The electrical signals transmitted from the sensors to our dataloggers can be converted to different units of measurement, including °C , °F, and °K. Our dataloggers are also capable of measuring most commercially available soil temperature sensors. The features of temperature sensor includes Low cost , No need to calibrate, Rugged design for long term use, Small size, Consumes less than 3mA for very low power operation Precise measurement. The application of temperature sensors are Environmental monitoring, Weather stations, Ice detection systems.

Irrigation and sprinkler systems, Temperature monitoring of bulk foods.Soil moisture and temperature are important variables in controlling the exchange of water and heat energy between the land surface and the atmosphere through evaporation and plant transportation. As a result, soil temperature and moisture play a significant role in the development of weather patterns and the production of precipitation and irrigation. Current techniques for detecting soil moisture and temperature such as gamma attenuation, soil heat flux, and GPR are mostly surface measurements and these surface measurements cannot provide profound temperature and moisture profile. In addition the noisy environment can significantly alter their results thus requiring a complex and expensive signal processing. The objective of this paper is to study the feasibility of using inexpensive wireless nanotechnology based devices for the field measurement of soil temperature and moisture. The developed temperature and moisture MEMS sensors are composed of micromachined MEMS cantilever beams equipped with a water sensitive nano-polymer and an on-chip piezoresistive temperature sensor.

The sensor is based on a shear stress principal, which the microsensor chip combines a proprietary polymer sensing element and Wheat stone Bridge piezoresistor circuit to deliver two DC output voltages that are linearly proportional to moisture and temperature. Preliminary results obtained from embedded wireless MEMS for soil temperature and moisture.Moisture and temperature of soil are two main concerns in agricultural area. This sensor is prepared for applications that require precise monitoring over moisture and temperature conditions. The Sensor inside brings satisfying high resolution. The typical temperature resolution is 0.4°C, while typical moisture resolution is 3%RH. The Temperature Sensor is a three-terminal integrated circuit sensor whose output voltage is linearly proportional to the Fahrenheit temperature. This sensor does not require any external calibration or trimming to provide typical accuracies of ± 0.5°F at room temperature and ± 1.5°F over a full 0-120°F temperature range. It operates from 5-30 Vdc and has a linear 10mV/°F output. With a common reference to input and output, it easily interfaces with most dataloggers and outputs a direct reading analog output. An algorithm is developed to

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solve the inverse problem for the retrieval of the soil moisture and temperature profiles based on remotely sensed observations of multispectral irradiance.

A model of coherent wave radiative transfer and a model of coupled heat and moisture diffusion in porous media are combined in order to estimate the liquid volumetric water content and temperature profiles in a soil column using low-frequency passive microwave and infrared emitted radiation observations and without the use of empirical relations. The central purpose of this mainly theoretical paper is to pose the inverse problem and present the physics-based algorithm as the solution. The algorithm is tested on a basic synthetic example in order to ascertain that the retrieval is feasible. Additional work in the future is necessary and planned in order to test the algorithm with field observations, extend it to include vegetation, and refine it for detail in the specification of heterogeneity in soil types and boundary conditions.

## 4.3 ANALYSING THE RESULT

The optimum water moisture level for clayey sand is 11~10%. The moisture level is different for different soil. The optimal level is programmed in the Arduino based on the soil ,if the water level goes below condition the plant is watered . The automated control is implemented here to avoid damage of crops due to surplus or deficit usage of water. The already existing system uses simple water pumps to supply water to the crops as and when required by manual control. Another disadvantageous method is the discontinuous monitoring of the water level by using GSM (global system for mobile communications) technology. But, the proposed system uses automatic control by using continuous monitoring. Thus the continuous monitoring of the agriculture was designed and developed using various microcontrollers. In existing method, only discontinuous was obtained by the use of GSM which led to inefficient use of water and electricity. Hence by incorporating this method, the water and electricity was used efficiently. Compared with the existing method it gives better performance. So we can avoid these problem in a very efficient and innovative manner with the help of micro controller with the help of wireless technology of zigbee protocol through very sensitive sensors.

The moisture sensor is interfaced with the microcontroller. The input data signals from the moisture sensor are sent to the microcontroller and based on that it activates the DC Motor with the help of a motor driver. After the soil gets wet, the Motor gets switched off automatically. Simultaneously it is possible to send messages through a mobile to kit through the GSM modem. Thus, the irrigation motor can be controlled by using a mobile and a GSM modem. The optimum level is programmed, if the level goes below the optimal level the motor is turn on to sprinkle.

| **Sensor in Air** | **Sensor in Dry soil** | **Sensor in Humid soil** | **Sensor in Water** |
|---|---|---|---|
| **0** | **0<value<300** | **300<value<700** | **Value>700** |
| **Ideal value=0** | **Ideal value=35** | **Ideal value=578** | **Ideal value=934** |

## 4.4 MOISTURE SENSOR READING

## 1 DRY STATE READING

| BLACK SOIL | RED SOIL |
|---|---|
| 240 | 19 |
| 100 | 251 |
| 128 | 18 |
| 100 | 35 |
| 212 | 40 |

 

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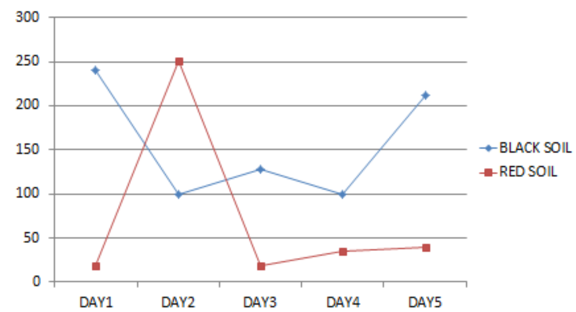
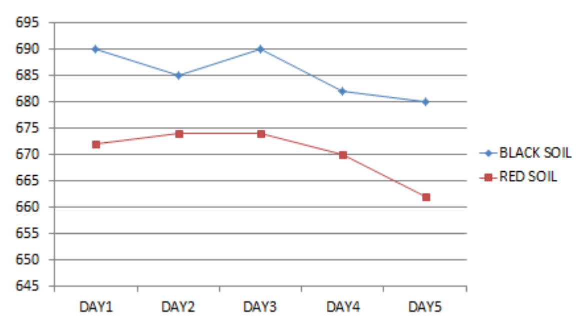
SOIL AT DRY STATE




| BLACK SOIL | RED SOIL |
|---|---|
| 690 | 672 |
| 685 | 674 |
| 690 | 674 |
| 682 | 670 |
| 680 | 662 |

SOIL AT WET STATE




## V CONCLUSION

The primary applications for this project are for farmers and gardeners who do not have enough time to water their Crops/plants. It also covers those farmers who are wasteful of water during irrigation. The project can be extended to greenhouses where manual supervision is far and few in between. The principle can be extended to create fully automated gardens and farmlands. Combined with the principle of rain water harvesting, it could lead to huge water savings if applied in the right manner. In agricultural lands with severe shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.The automated irrigation system implemented was found tobe feasible and cost effective for optimizing water resourcesfor agricultural production. This irrigation system allowscultivation in places with water scarcity thereby improvingsustainability.The automated irrigation system developed proves that theuse of water can be diminished for a given amount of freshbiomass production..The irrigation system can be adjusted to a variety of specificcrop needs and requires minimum maintenance. The modularconfiguration of the automated irrigation system allows it tobe scaled up for larger greenhouses or open fields. In addition,other applications such as temperature monitoring in compostproduction can be easily implemented.

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