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Solar Powered Smart Irrigation System

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Abstract

In any farm, the water supply is required as per the wet status of the soil. If the wet status of soil can be measured by a device, then the water can be supplied in the field as per the requirement by automatic control. In our project, the irrigation system will use soil moisture sensor to detect the moisture level and will send it to the controller(ATMega328P). When the moisture content of the soil is dry then the microcontroller will automatically start the water pump. After reaching to the higher threshold point i.e. when the farm is wet, the water pump will automatically switched off. The water pump will use the Solar energy for switching operation. The stored energy will also help for the switching of system during nights. Finally, it will help to decrease the manual power.

Moisture sensor and water pump will be interfaced through Arduino. The energy from solar panel will be given to the Arduino. Depending upon the value detected by the moisture sensor, the relay turns on and performs the switching operation of water pump. It is loaded with a program written using embedded 'C' language.

Introduction

The agricultural sector has its largest contribution in the Indian economy. Agriculture uses 85% of available freshwater resources worldwide, and this percentage will continue to be dominant in water consumption because of population growth and increased food demand. As our country is an agriculture-oriented country and the rate at which water resources are depleting is a dangerous threat to the mankind. Hence there is a need of efficient way of irrigation.

The over utilization of ground water has drastically reduced the ground water level in the last 15 years. So it is the need of hour to utilize each and every drop of water wisely so that it can also be used by our coming generations also. The existing systems has several limitations; leaching off of soil nutrients, erosion due to flooding, loss of water from plant surfaces through evaporation, water wastage which can result to water scarcity in drought areas and production of unhealthy crops.

These problems can be rectified if we use microcontroller based automated irrigation system in which the irrigation will take place only when there will be acute requirement of water, maintaining proper amount of water level in the soil is one of the necessary requirements to harvest a good crop that can be a source of various types of nutrients whether micro or macro for their proper growth.

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This project is designed to develop an automatic irrigation system which controls the watering in the fields depending on moisture content of the soil. The main advantage of this project is to reduce human intervention and still ensure proper irrigation.

The aim of this project is to provide water to the plants or paddy fields automatically using microcontroller (Arduino Uno). There are many timer based devices available in the market which waters the soil on a set interval. But they do not sense the soil moisture and the ambient temperature to know if the soil actually needs watering or not. The control unit of the system receives the signal of varying moisture condition of the soil through the sensing arrangement. The system has a network of soil-moisture sensor, an LDR sensor, humidity and temperature sensor. These sensors outputs are fed to the microcontroller which will trigger the water pump whenever necessary.

And also we should develop some new methods that use the renewable sources of energy. The development of these new techniques are going to reach our goal of sustainable development as well as to cut off the emission of greenhouse gases to a minimum level. As the name of our project that is “SOLAR POWERED SMART IRRIGATION SYSTEM” which uses Solar power for the functioning of the project and to save electricity. This technique will be a very good option for the small and medium farmers who suffer just because of failure of crops that takes place every year. The implementation of this technology has a wide scope in the nearby future. Moreover, implementing IOT in the system allows the user to control and monitor the scenario remotely. The interconnected objects referred as Internet of Things (IOT) is continuing to evolve offering more control over our living environment and allowing more ease in doing things. Many consider this as the next big horizon in the evolution of the Internet. IOT has the capability of collecting, storing, analyzing and distributing data among diverse interfaces, apps and devices.

The freedom for real-time application of data and data-driven insights has become easier than ever before. The status of the soil as well as the values of all the sensors will be transmitted over the internet and displayed on a web page which will help the user to globally access the values by any digital device like mobile phones. The smart sensors placed in the agriculture fields are also capable of real time notification about the moisture level in lands and can prevent wastage of water. This capability can be further used if the real time sensor data can trigger the water pump by switching it off or on depending on moisture content of the soil. The system is powered by photovoltaic panels and has a wireless communication link with the control unit.

Embedded System:

An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, store and also control the data in various electronics-based systems. Embedded systems are a combination of hardware and software where software is usually known as firmware that is embedded into the hardware. One of its most important characteristics of these systems is, it gives the o/p within the time

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limits. Embedded systems support to make the work more perfect and convenient. So, we frequently use embedded systems in simple and complex devices too. The applications of embedded systems mainly involve in our real life for several devices like microwave, calculators, TV remote control, home security and neighborhood traffic control systems, etc.

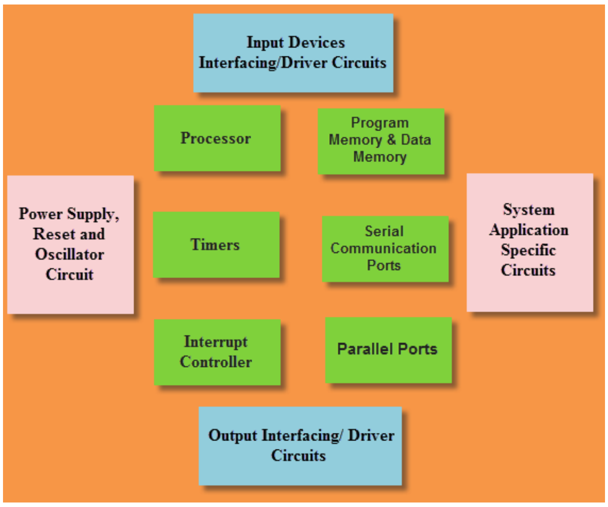

Fig: Embedded System Block Diagram

EXISTING METHODS:

Traditional Methods of Irrigation

In this method, irrigation is done manually. Here, a farmer pulls out water from wells or canals by himself or using cattle and carries to farming fields. This method can vary in different regions.

The main advantage of this method is that it is cheap. But its efficiency is poor because of the uneven distribution of water. Also, the chances of water loss are very high.

Some examples of traditional system are pulley system, lever system, chain pump and dhekli.

Among these, the pump system is the most common and used widely.

Fig 2.9: Dhekli System

Fig 2.10: Chain Pump

Modern Methods of Irrigation

The modern method compensates the disadvantages of traditional methods and thus helps in the proper way of water usage.

The modern method involves two systems:

1. Sprinkler system 2. Drip system

Sprinkler irrigation is a method of irrigation in which water is sprayed, or sprinkled through the air in rain like drops. The spray and sprinkling devices can be permanently set in place (solid set), temporarily set and then moved after a given amount of water has been applied (portable set or intermittent mechanical move), or they can be mounted on booms and pipelines that continuously travel

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across the land surface (wheel roll, linear move, center pivot).

Fig 2.11: Sprinkler irrigation

Drip/trickle irrigation systems are methods of micro irrigation wherein water is applied through emitters to the soil surface as drops or small streams. The discharge rate of the emitters is low so this irrigation method can be used on all soil types.

Fig 2.12: Drip/trickle irrigation

Surface irrigation consists of a broad class of irrigation methods in which water is distributed over the soil surface by gravity flow. The irrigation water is introduced into level or graded furrows or basins, using siphons, gated pipe, or turnout structures, and is allowed to advance across the field. Surface irrigation is best suited to flat land slopes, and medium to fine textured soil types which promote the lateral spread of water down the furrow row or across the basin.

Fig 2.13: Surface irrigation

Subsurface irrigation consists of methods whereby irrigation water is applied below the soil surface. The specific type of irrigation method varies depending on the depth of the water table. When the water table is well below the surface, drip or trickle irrigation emission devices can be buried below the soil surface (usually within the plant root zone).

Fig 2.14: Subsurface Irrigation

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Center pivots irrigates in a circular pattern around a central pivot point. Pivots are capable of applying water, fertilizer, chemicals, and herbicides. This versatility can improve the efficiency of irrigation practices by using a single piece of machinery to perform several functions. Most center pivot machines are electrically powered, using either a generator or a public power source. Pivots use both 120 and 480 volts of alternating current (VAC) to operate. 120 VAC is used as the control circuit, powering the safety circuit, the forward and reverse movement of the pivot, and, more precisely, the movement of the Last Regular Drive Unit (LRDU). The 480 VAC is the power circuit and supplies the needed energy for the drive units to move.

Fig 2.15: Center Pivot irrigation

Manual irrigation systems are easy to handle, require no technical equipment and are therefore generally cheap labor inputs. A common and very simple technique for manual irrigation is for instance the use of watering cans as it can be found in peri-urban agriculture around large cities. A more sophisticated and very water-efficient type of manual irrigation system is small-scale drip irrigation with buckets. Beside these systems, there are many other methods for manual irrigation, which are easy to install and simple to use. In general, all of these methods have high self-help compatibility and a relatively high performance.

Fig 2.16: Manual Irrigation

PROPOSED WORK:

The proposed system having two working units: one is solar pumping unit and other is smart irrigation unit. The proposed system will help us to improve the irrigation system using a natural renewable power source such as solar energy. We can find the level of the water in tanks in the fields, the temperature around, the humidity in the air by using respective sensors. The most important application of this project is to sense the moisture level in the soil. Whenever the moisture content of the soil is low, it automatically sends a signal to the Arduino Uno, this microcontroller will switch on the DC pump through a relay. This system also reduces the attention which saves a lot of time and effort to the human beings. Most of the electricity bill is also reduced as we are using solar energy.

We can conveniently check the temperature, humidity in the fields, moisture level of the soil and water level in the tanks from any location by using the Internet of Things(IOT). This system can also display the measured factors in an LCD. If the moisture level in the soil is adequate, then the microcontroller switches off the motor and thus stops watering

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the fields which results in the less requirement of water. Thus, this system clearly shows that it requires very less manual attention and also saves a lot of water. This proposed system can be easily affordable by any farmer. What it takes is just a smart phone and an internet connectivity.

BLOCK DIAGRAM:

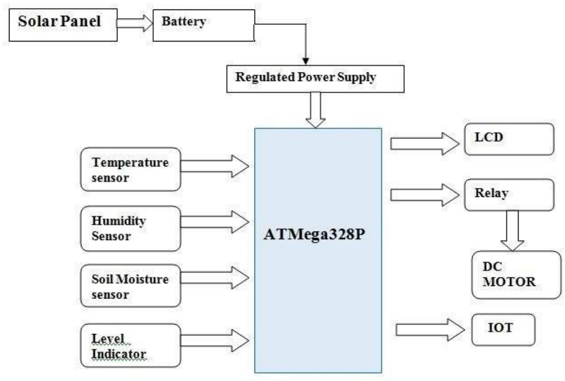

Fig 3.1: Block diagram of this project

Explanation of block diagram:

In this system, the sun rays fall on the solar panel and this solar energy in the form of photo-voltaic cells is stored in the battery. This solar energy stored in the battery is converted in to 5 volts DC. From here, the system gets its power supply to the microcontroller. The Temperature sensor, Humidity sensor, Soil moisture sensor, Level indicator acts as the inputs to the microcontroller. These values are studied by the microcontroller and are displayed on the LCD screen. Whenever the soil moisture level is low the relay is turned on and the DC motor is switched on to water the fields. If the moisture level in the soil is adequate, then the relay and Dc motor are turned off. Here, we are using IOT as a platform to write the code and also to display the measured values by the microcontroller.

FLOW CHART:

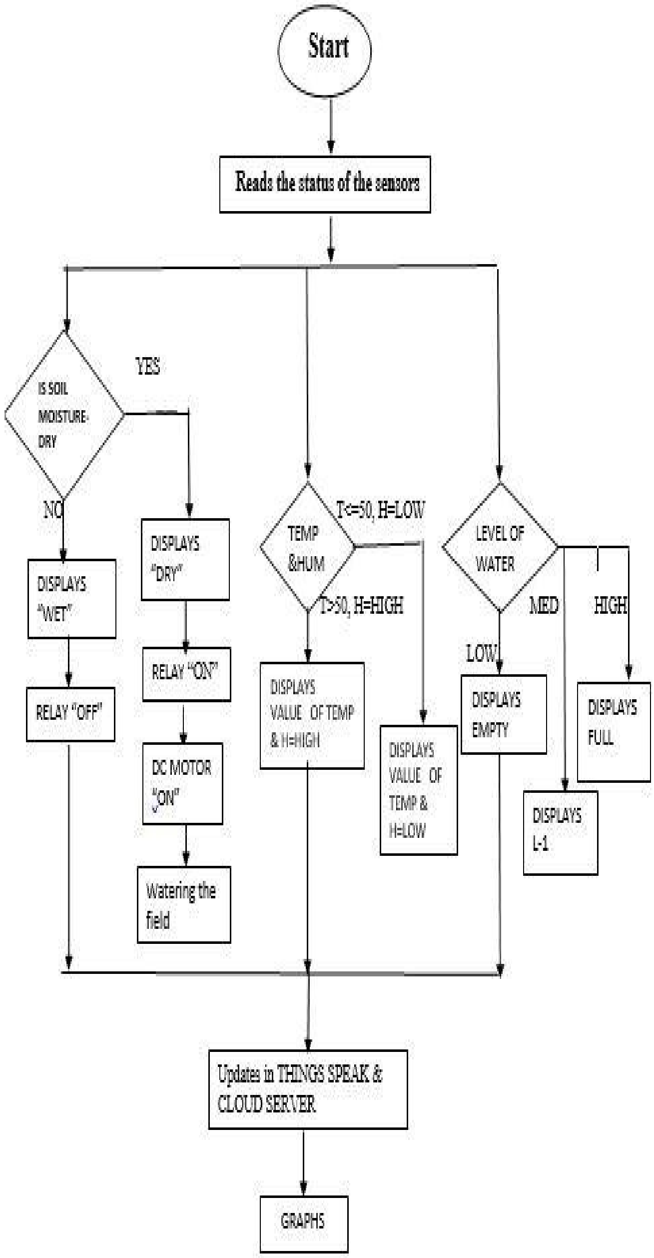

Fig 3.2 : Flow chart of the System

WORKING:

In any farm, the water supply is required as per the wet status of the soil. Depending on that the motor will automatically ON and OFF.

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The functionality of this project includes 4 factors i.e. Soil moisture, Temperature, Humidity & Level indicator.

The wet & dry status of the soil can be measured by Soil moisture sensor. If the status of the soil is Dry, the relay will get automatically ON which is interfaced with motor to pump the water to fields and also displays in LCD. As soon as the status of the soil changes from dry to wet, the relay is switched off, also displays in LCD and this information is updated in graphs and cloud server through IOT module.

This system also reads the degree of temperature. When the temperature of the field or in the atmosphere is greater the 50 degree Celsius, displays present value & it will automatically get updated in cloud server through IOT module and if it is normal it will display in LCD.

It also reads the status of humidity i.e. when the humidity is normal, it will display in LCD, if it is HIGH it will update in cloud server and displays.

It has a functioning of Level indicator i.e. if the level of the water from where the water is pumped to fields is L-1 (Medium) or HIGH it will display in LCD and if the level is near to EMPTY it will get updated in cloud server and also display in LCD.

IOT Module which is present in the System will store the data continuously, this module requires Wi-Fi i.e. internet to upload the information in local server i.e. Things Speak. So this set up requires Wi-Fi to upload data and this data will get updated in the form of graphs. Every person or Farmer can open certain respective links to monitor status of the fields.

Hardware And Software Description

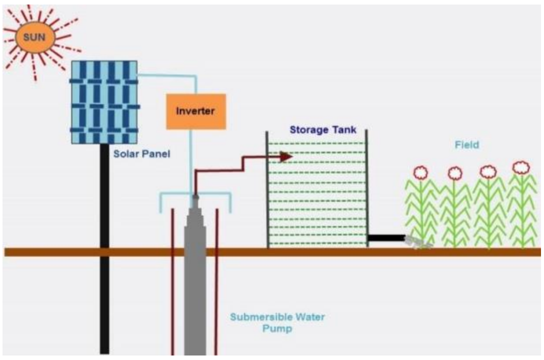

Fig 4.1: Pictorial representation of smart irrigation system This project includes following blocks:

1. Micro controller (Atmega328P)
2. IOT Module
3. Wi-Fi Module
4. DC Motor
5. Relay
6. LCD Display
7. Soil Moisture Sensor
8. Temperature and Humidity Sensor
9. Level Sensor
10. Solar panel

RESULTS

The Hardware Setup of the System is Shown in the Figure 5.1 i.e. "Solar Powered Smart Irrigation System".

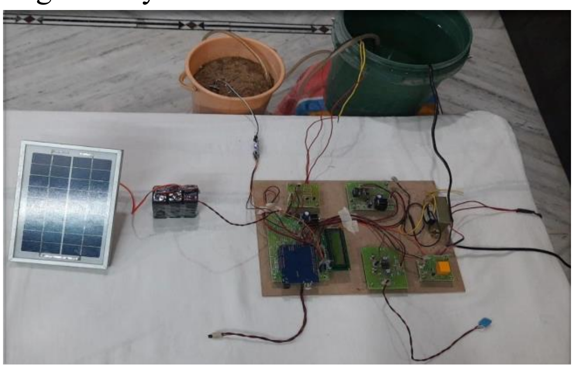

Fig 5.1: Hardware Kit of the project

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When the solar energy is provided as power supply to the setup, the kit is in “ON” state and it displays “IOT Irrigation” as shown in the figure 5.2.

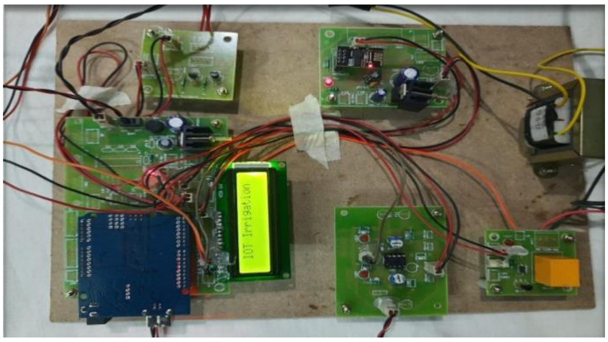

Fig 5.2: After Kit is “ON”

This System has to update the data continusly in the server i.e. Things Speak which requires Wi-Fi connection, as soon as Kit is ON it waits to get connected to the network which has username and password as mentioned in the Code i.e. iotserver and iotserver@123 respectively ,displays connected as shown in Figure 5.3.

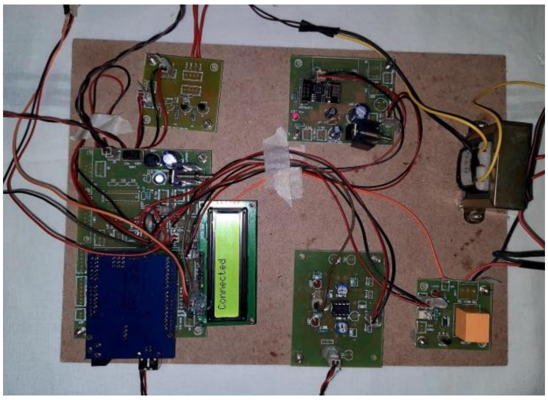

Fig 5.3: After the kit is “Connected” to wifi

Figure 5.4 shows the initial state of all the sensors which displays their measured values on the LCD screen i.e., Temperature, Moisture level, Humidity, Level of water.

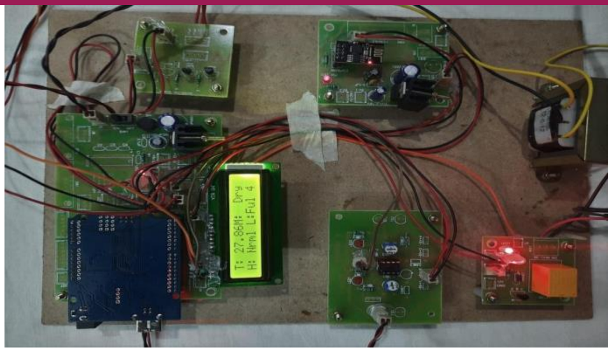

Fig 5.4: Initial state of all sensors is displayed

When the humidity is HIGH, it is displayed in LCD in Figure 5.5 and it effects the fields as plants transpire, the humidity around saturates leaves with water vapor. When relative humidity levels are too high or there is a lack of air circulation, a plant cannot make water evaporate (part of the transpiration process) or draw nutrients from the soil.

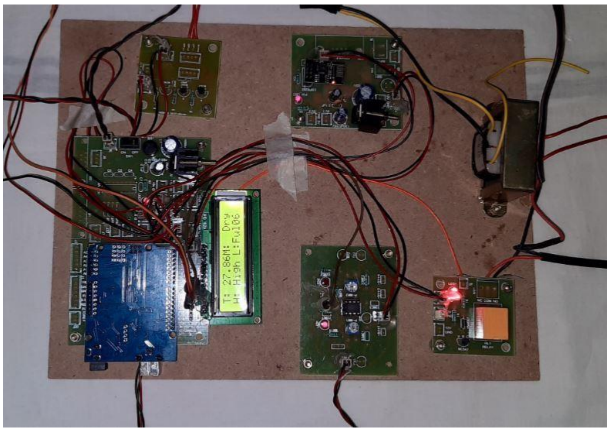

Fig 5.5: When Humidity is “HIGH”

Figure 5.5a and 5.5b shows the graph which is updated in the server with accurate time and date.

Fig 5.5a: Graphs Showing Humidity Level

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Fig 5.5b : Graphs Showing Humidity Level

The Temperature is continuously displayed in LCD shown in Figure 5.6.

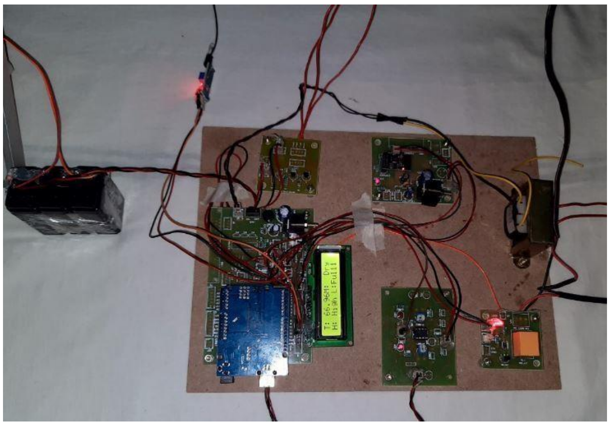

Fig5.6: When Temperature is increased Above 50 degree

Inorder to increase the temperature for testing we have used a candle as shown in Figure 5.7.

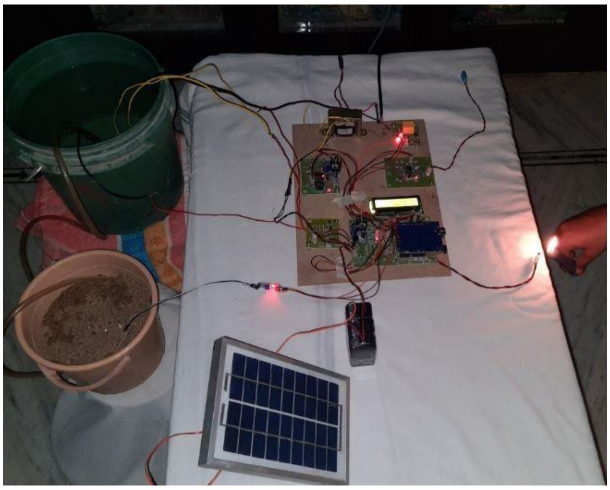

Fig 5.7: Increasing temperature for testing

If the temperature in the agriculture fields is greater than 50 degrees, it will get updated in the Server as shown in Figure 5.7a and 5.7b.

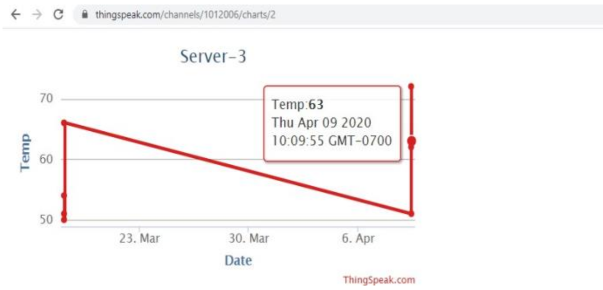

Fig 5.7a: Graphs Showing Temperature Level

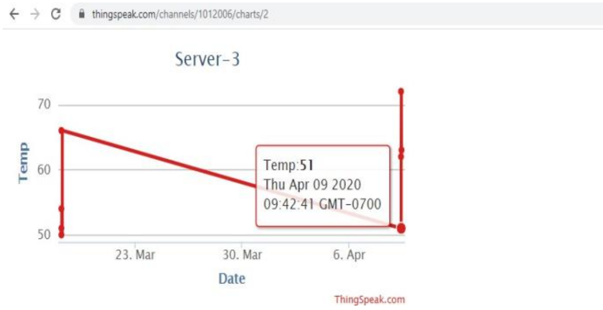

Fig 5.7b : Graph Showing Temperature Level

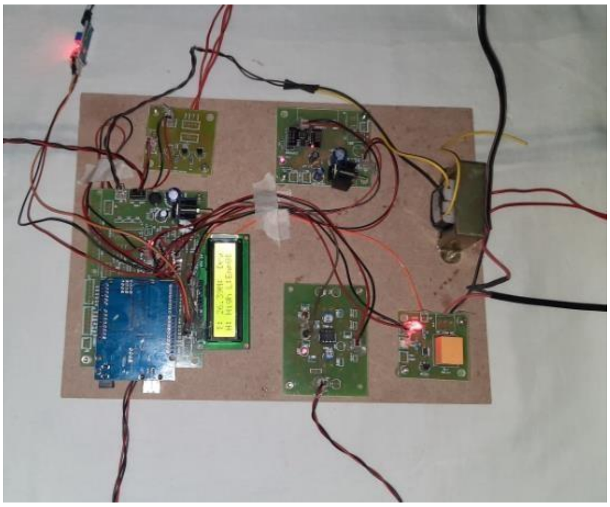

Figure 5.8 shows that the Level of the water in the Tank is EMPTY which is displayed in LCD.

Fig 5.8: When the Level of water is "EMPTY"

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Figure 5.8a and 5.8b shows the graph which is updated in the server i.e. when the level of the water is empty with accurate time and date to take further actions.

Fig 5.8a: Graph Updated when Level of Water is Empty

Fig 5.8b: Graph Updated when Level of Water is Empty

Figure 5.9 shows that the Level of the water in the Tank is FULL which is displayed in LCD.

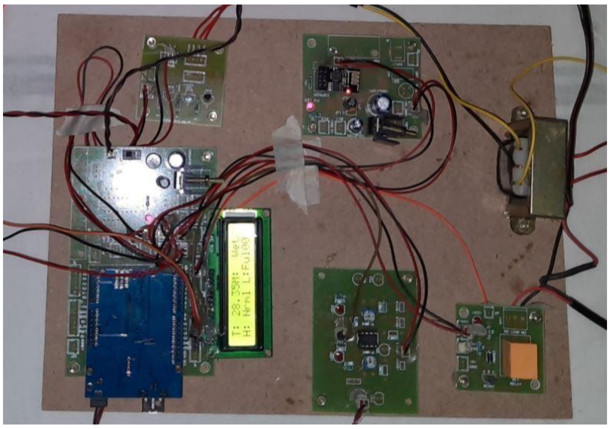

Fig 5.9: When the Level of the water is “FULL”

Figure 5.10, shows L-1 is displayed in LCD i.e. when the water is at medium level in the tank.

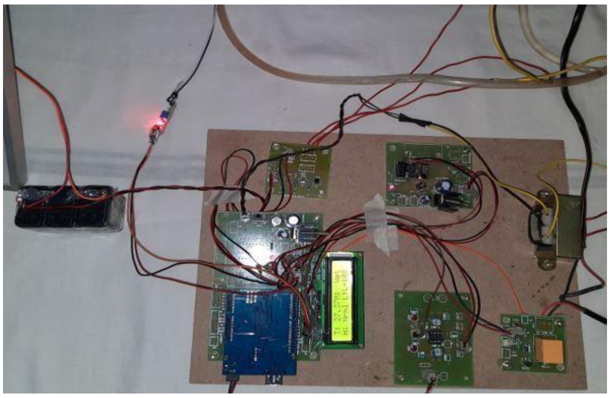

Fig 5.10: When the Level of Water is L-1 (Medium)

In Figure 5.11, we can see the status of the soil is dry. If the status of the soil is dry, the relay is turned on. Through this relay motor is also turned on. The status of the soil is also displayed on the LCD.

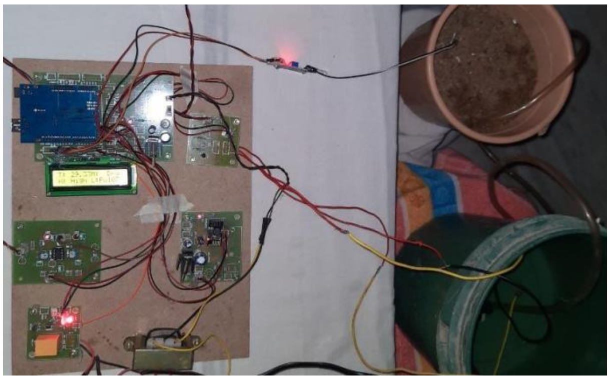

Fig 5.11: When Soil is “DRY”

In figure 5.12 we can see that whenever the status of the soil turns from dry to wet, it displays its status on the LCD and is updated

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in the server as shown in the figure 5.12a and 5.12b.

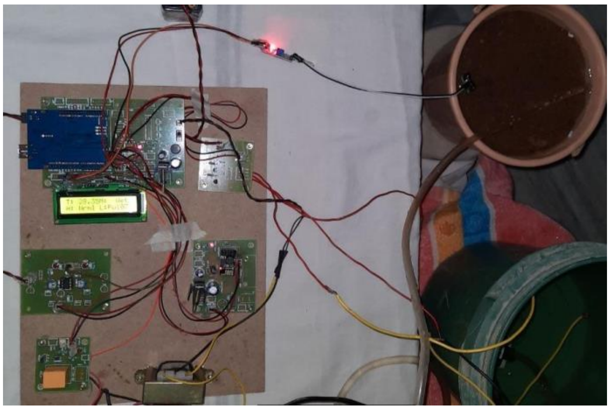

Fig 5.12: When the Soil is “WET”

In the figure 5.12a and 5.12b we can observe that whenever the status of the soil is changed, it is directly updated in the sever through a graph. Here, in this graph, the information is updated on accurate date and time

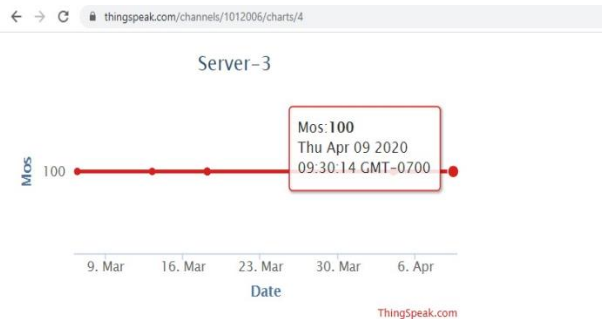

Fig 5.12a: Graph Showing the moisture level of the Soil

Fig 5.12b: Graph Showing the moisture level of the Soil

Considering the state of the soil moisture sensor the motor gets turned on or off. Whenever the level of moisture is low in the soil then the sensors analog voltage value is 5 volts and the digital value is 1023(from calculations). Hence the motor is turned on by sending a signal to the microcontroller. If the level of moisture in the soil is adequate, its analog voltage is 1.71 volts and its digital value is 350. Whenever the moisture sensor reaches these values, the sensor sends a signal to the microcontroller and thus the motor is stopped.

Calculation: ADC reading = (Resolution of the ADC x analog voltage measured)/System voltage.

CONCLUSION:

This innovative smart irrigation system is very beneficial for government as well as farmers. This is one of the best solution for energy crisis and water consumption. The smart irrigation system reduces the human intervention during the irrigation of field and also optimizes the water usages. Once the system is installed, unutilized energy produced by the solar PV

can also be linked with grid system which can be revenue source for farmers. Hence, this irrigation system is motivating farming in India and at the same time it is giving solution for the energy crisis.

Despite the fact that it required high initial investment for implementation of this system but in the long run this system is more

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economical than the conventional irrigation method. Government should also demonstrate this type of innovative system to motivate the farmers for adopting such type of system.

Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using advanced sensors with the help of growing technology, the project has been successfully implemented. Thus, the project has been successfully designed and tested.

FUTURE SCOPE:

Our project "Solar Powered Smart Irrigation System" is mainly intended for detection of the moisture level of the soil. This project uses a Soil moisture sensor, Humidity and Temperature sensor(DHT11), Level sensor which are capable of detecting the moisture level of the soil, humidity and temperature in the atmosphere of the fields and to detect the water level in the tanks respectively. This system use Internet of Things as a platform to display the measured values. Not only on the even land, we can also use this project on uneven surfaces by taking few points in the fields as reference.

This project can be extended by adding GSM module and we can also control irrigation pump using mobile anywhere. It can also be extended as an Agricultural Robot which helps in harvesting, picking, weed control, autonomous mowing, pruning, seeding, spraying and shinning.

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