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Solar Powered Automatic Irrigation System on Sensing Moisture Content Using Arduino and GSM

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***Abstract*— Agriculture and Gardening works are not trivial. There is a wide range of crops and plants and many varieties of each plant or crop. Various plants and crops have different requirements for water, fertilizers and sun. Soil fertility for any strain or gardening culture is generally judged by the level of nutrients and moisture in it. A number of times farmers and gardeners are not able to nourish the soil with enough fertilizer or water, while many times only you do it. This project is to help farmers and gardeners maintain control of the soil moisture level.**

Index Terms*— *Arduino, GSM module, Moisture sensor, Solar panel, Irrigation system, Relay

I. INTRODUCTION

Solar energy is the most abundant source of energy around the world. Solar energy is not just an answer to the current energy crisis, but also a form of energy that respects the environment. Photovoltaic generation is an efficient use of solar energy approach. Solar panels (a series of photovoltaic cells) are widely used today to work on street lights, to feed water heaters and cover domestic loads. The cost of solar panels is steadily declining, encouraging their use in various sectors. An application of this technology is used in irrigation systems for agriculture. The solar energy irrigation system can be a viable alternative for farmers in the current state of the energy crisis in India. This is a way of producing green energy that provides energy for free when the initial investment is made. The irrigation system is a misleading water supply experimental method to the area or soil that is the main base of our crop system. Water must be supplied mainly to fields or through ditches. This system should reduce the workload of the farmer and contribute to maintaining adequate soil quality for better growth. From then on the development of innovation was conceivable that they killed the cadres outlined the immediate insertion of peasant farmers irrigation in their fields. These machined frames of the entire engine irrigation system that flooded the fields. A framework of irrigation based on GSM has two significant advances behind, the "GSM" optional and being essential is the controller or processor. GSM (Global System for Mobile Communications) is a standard used to represent computerized cellular conference systems. The irrigation system in the field and sending the results to the agricultural producer with coded indications for a cell phone, which implicitly controls the entire irrigation system irrigation system. The processor or controller acts as the focal point for the robotic work process after it was released by the GSM based finally highlights the progress of the gadget.

II. IRRIGATION SYSTEM

Irrigation is the artificial application of water to the ground or soil. It is used to help cultivate agricultural crops, landscaping and drying of harsh soils in dry environments and during periods of inadequate rainfall. However, the overall irrigation scenario is characterized by poor performance, increased demand for increased agricultural productivity, reduced water availability for agriculture, increased soil salinity and the possible effects of global warming and climate change. Later, because the dried crops. Water shortages can be harmful to plants before visible depletion occurs. The slow growth rate, the weight of fruits is the shortage of lighter light water. This problem can be solved if we use a fully-flush Arduino automatic irrigation system where irrigation takes place only when there is a strong need for water. The project uses a DHT sensor to keep a moisture trace and a humidity sensor to record humidity. The system automatically checks a water pump that can be activated via SMS in response to real-time alert. Once the water pump is connected via SMS, it automatically turns off after reaching the appropriate humidity level. The farmer or caregiver can also disconnect the water pump between sending an SMS or a project manual operation interface. This system derives the power of solar energy through photovoltaic cells. Therefore, there is no need for uneven trading power dependency.

III. DESCRIPTION OF COMPONENTS

Following are the major components used from which Solar powered automatic irrigation system using Arduino and GSM has been fabricated.

- Arduino UNO
- GSM SIM module
- DHT11 humidity sensor
- 12v Relay
- BC 547 transistor
- Voltage Regulator- 7805 and 7812

- Solar panel
- Battery

A. Arduino UNO

Arduino Uno is a microcontroller based on the (specification) Atmel ATmega328. It has 14-pin digital inputs / outputs (6 of which can be used as PWM outputs), 6 analog inputs, 16 MHz resonance ceramics, a USB connector, a power connector, an ICSP and a reset button. It has each and everything mandatory to support the microcontroller; Just you have to connect it to your computer using a USB cable or connect an AC adapter or DC source. This driver does not use the FTDI USB serial chip, rather it's ATmega16U2 (Atmega8U2 to R2), programmed as a USB port converter. Version 2 plate resistance by pulling the line 8U2 HWB angle, facilitating their placement in DFU mode. Check the tab 3 has the following new features: Pin 1.0: The ASD and SCL pins are located next to the Aref pin and two new screws located near the reset IOREF allow you to adjust the target's specified voltage. In future drives will be compatible with the card using AVR, which works with Arduino 5V and the reason that works with 3.3V. The second has nothing to do with the contact, which is reserved for future purposes. "Uno" means one Italian and is called to mark the forthcoming release of Arduino 1.0. Uno and version 1.0 will be the reference versions of Arduino, moving forward. For comparison with previous versions, see the index on Arduino.

TABLE I
SPECIFICATION OF ARDUINO UNO

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	14(of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock speed	16 MHz
Length	6.86 mm
Width	5.34 mm
Weight	25 gram
Data Retain	20 year

Each ATmega328 has 32 KB (with 0.5 KB used for bootloader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can read and write to the EEPROM library).Arduino Uno can be powered via a USB connection or an external power source. The power source is automatically selected (non-USB) External power can come from a DC AC adapter (wall wart) or battery. The adapter can be connected by inserting a 2.1 mm positive centre connector into the paper feed connector. Derivations of a battery can be plugged into GND connector and Vin power connectors. The plate can operate with an external power supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin can provide less than five volts and the card may be unstable. If more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts. The power pins are as follows:
VIN. Input electrical energy to the Arduino board when via an peripheral power supply (unlike 5 volt USB or other regulated power supply).

5V. This pin outputs a 5V regulator set on the plate. The plate can be powered by the DC power connector (7-12 V), the USB connector (5V) or the VIN (7-12V) pin plate. Power supply between pins 3.3V or prevents 5V regulator, and can damage our board. I do not recommend.

3V3. A power supply 3.3V generated by the controller board. The maximum current is 50 mA.

GND. Pin of earth.

IOREF. This Arduino pin card provides the reference voltage to the operating microcontroller. A properly configured shield can read IOREF pin voltage and select the appropriate power source or enable live output transducers to work with 5V or 3.3V. An ATmega16U2 on the board channels of this serial communication via USB and looks like a virtual software port on the computer. The firmware 16U2 uses standard USB COM drivers, and no external drivers are required. However, in Windows, an inf file is required. The Arduino software includes a serial monitor that allows simple data sent to and from the Arduino card. The RX and TX LED blinks when the data is transmitted via the serial USB chip and USB connection to the computer (but not for serial communication on pins 0 and 1). SoftwareSerial library allows serial communication on one of the digital pins of one. The ATmega328 also supports I2C (TWI) and SPI. The software includes an Arduino wire library to simplify the use of the I2C bus. For SPI communication, use the SPI library.

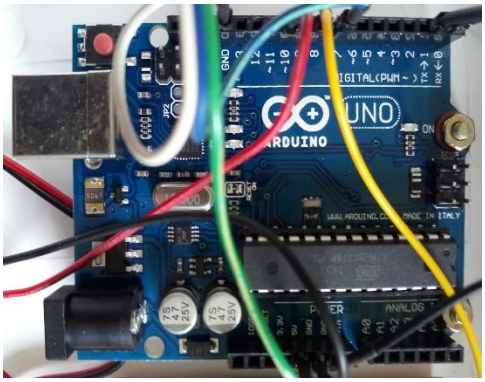


FIG 1: Arduino UNO Board

B. GSM Module

GSM acronym Global System For Mobile Communications. This is a set of standards developed by the European Telecommunications Standards Institute (ETSI) to describe protocols for second generation digital cellular networks (2G) used by mobile phones. A modem is a device that modulates and demodulates the signals as needed to meet the communication requirements. Modulates an analog carrier signal to encode digital information and demodulates the data transmitted to decode said carrier signal. A GSM modem is a device that modulates and demodulates signals and GSM in this particular case the 2G signals. The modem we are using is SIMCOM SIM300. It is a three-band GSM / GPRS modem, as it can be detected and operated at three frequencies (EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz). Operating frequencies are EGSM and DCS 900MHz 1800MHz. GSM technology has grown so much that there is literally no place in the world where there is no GSM signal. In this scenario, GSM provides a wide range of things to remotely control from anywhere with your fingertips. GSM also provides the ease of communicating more robust. SIM300 GSM module can be used to send and receive SMS by connecting it to a PC when a SIM card is inserted. The GSM modem can send commands to send or receive SMS from PC via a COM (serial or USB) port. These commands are called as AT commands. Through the AT commands you can perform several actions like sending and receiving SMS, MMS, etc. The Sim300 has an RS232 interface and this can be used to communicate with the PC. The Sim300 normally runs at 9600 baud, 1 bit stop, no parity, no hardware control, and 8 DataBit. Sim300 is widely used in many designs and therefore many developmental variants of these plates have been developed. These development boards come with several features to facilitate communication with the SIM300 module. Some motherboards provide only the TTL interface, while some cards include an RS232 interface and some others include a USB interface. If your PC has a serial port (DB9) you can buy a GSM modem with the TTL and RS232 interface economics. The sim300 GSM module used here consists of a TTL and an RS232 interface. TTL interface allows you to interface directly with a microcontroller while the RS232 interface includes a MAX232 IC to allow communication with the PC.

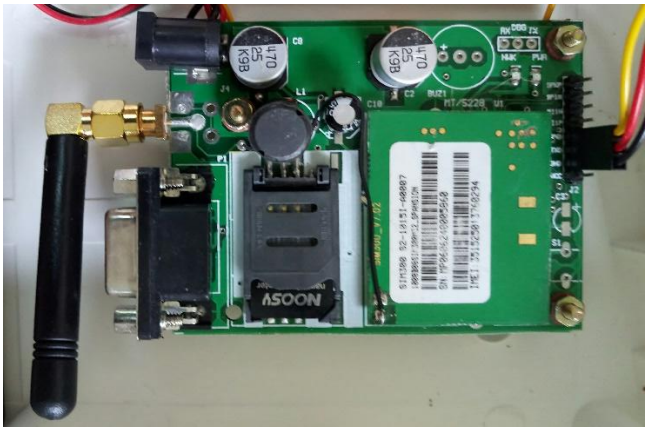


Fig 2: GSM Module

C. DHT11 Humidity Sensor

The DHT11 sensor is supplied in a four-wire package of one line and works with a power supply of 3.5 and 5.5 V. The temperature of 0-50 ° C can be measured with a precision of ± 2 ° C and Relative humidity between 20-95% comprised between with a precision of ± 5%. The sensor provides fully calibrated measurements for the two digital outputs. It has its own owner protocol thread 1, and therefore communication between the sensor and the microcontroller is not possible through a direct interface with any of its peripherals. The protocol must be implemented in the firmware of the MCU with the exact time required by the sensor. The following timing diagrams describing the data transfer protocol between MCUs and the DHT11 sensor. The MCU starts data transmission by issuing a "Start" signal. The MCU pin must be set as output for this purpose. The first low-MCU drag line for at least 18 ms and then extracted for 20-40 ms before releasing. Then, the sensor responds to the MCU start signal for 80 ms, followed by a high logic signal also lasts 80 ms. Remember that the MCU pin must be configured to enter after completing the "Home" sign. Once the signal sensor is detected, the MCU must be ready to receive data from the sensor. The sensor sends 40 bit (5 bytes) continuously data on the data line. Note that during the byte transmission, the sensor sends the most significant bit.

Data (40 bits) = full bytes of RH + decimals RH byte + full bytes of Temp + Decimal Temp Byte + Checksum Byte

For DHT11 sensor, decimal decimals of temperature and humidity measurements are always zero. Therefore, the first and third bytes of received data actually provide the numerical values of relative measured humidity (%) and temperature (° C). The last byte is the byte checksum that is used to ensure that data transfer is verified without any error. If all five bytes are correctly transferred then the byte checksum must be the same for the last 8 bits of the sum of the first four bytes, that is,

Checksum = last 8 bits (byte integer RH + decimal RH + byte Total Temp Bytes + Decimal Temp Bytes)

Now let's talk about the most important thing, which is the signalling for the transmission of "0" and "1". To send a data bit, the first low-sensing strip for 50 ms. Then it raised the line for 26 to 28 ms if you have to send "0", or 70 ms if the bit to be transmitted is "1". So is the width of the positive pulse that carries information about 1 and 0.

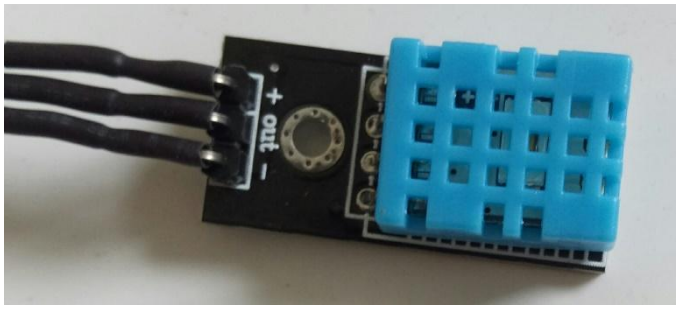


Fig 3: DHT11 Humidity Sensor

D. Relay

The relay is used to electrically isolate two circuits and connect them magnetically. Allow a circuit to change another while they are completely separate. They are often used to connect an electronic circuit (low voltage) to an electrical circuit that operates at a very high voltage. For example, a relay can create a 5 V battery circuit for a 230 VAC circuit switching network so a small sensor circuit can, for example, a fan or an electric bulb. A relay switch can be divided into two parts: input and output. The input section has a generator coil magnetic field when a small voltage is applied by an electronic circuit. This voltage is called operating voltage. Common relays are available in different operating voltage configurations such as 6V, 9V, 12V, 24V and so on. The output section is relays connected mechanically or unplugged. Three relay contacts normally open (NO), normally closed (NC) and common (COM) are present in the relay base. When no voltage is applied through the relay, NC is connected to COM. When the operating voltage is applied, the relay coil energizes and changes the NO COM contact. Various configurations are available as SPST, SPDT, DPDT, etc. relays, which have a different number of switching contacts. Using the correct combination of contactors, the electrical circuit can be switched on and off.

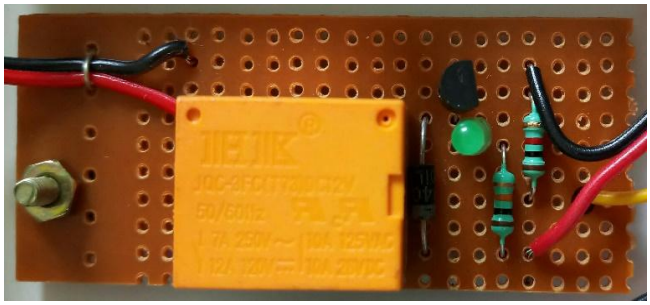


Fig 4: 12V Relay Circuit

E. Solar Panel

Photovoltaic modules are photovoltaic array of a photovoltaic plant that generates and supplies solar electricity in commercial and residential applications. Each module is classified by standard test output current (STC) conditions, typically between 100 and 365 watts (W). The efficiency of a module determines the area of a module with the same nominal power - efficient 230W module 8% will have twice the area of a 230W module with a yield of 16%. There are some commercially available solar module efficiencies over 22% and are supposed to exceed even 24%.

Fig 5: Solar Panel

F. Battery

Lead batteries, also known as SLA batteries, are used for a wide variety of applications. These batteries are all rechargeable, fully sealed and maintenance; There is no need to maintain water levels. These SLA batteries are commonly used in backup power sources. Many of our customers buy them for use in Uninterruptible Power Supply Units (UPS).

Fig 6: 4V lead Acid Rechargeable Battery Connected in Series.

IV. BLOCK DIAGRAM

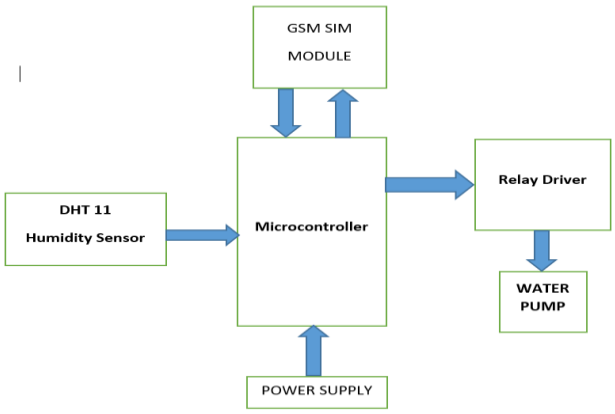


Fig 6: Block Diagram(Power supply consists of three 4V lead acid batteries connected in series to give 12V supply. The batteries are charched using Solar Panel).

The basic blocks of this system is as shown in the block diagram in figure 1. The above block diagram consists of the controller, sensor, pump and the power supply. The controller is the one which monitors the entire system. The sensor senses the environment and sends the appropriate values to the controller. The controller checks for the received values. If the values have reached a certain threshold then the controller will take certain actions based upon the algorithm provided. Here GSM module block is used for send and receive message to the user. Power supply block consists of the element which provides the energy to run the controller, sensor and pump. DHT 11, Humidity Sensor, Microcontroller, Relay Driver WATER PUMP, GSM SIM MODULE, POWER SUPPLY Here in this prototype we use Arduino as the controller as it is very reliable and user friendly. The software required is the Arduino IDE application. It is used as the interface between the Arduino and the user. It also requires the knowledge of simple c programming which is used as the language to program the Arduino. We also use DHT11 (temperature and humidity sensors). The heart of this system is the Arduino microcontroller. Temperature, humidity sensors are interfaced to Arduino. It consists of the relay module. Whenever an AC load is to be turned ON/OFF just we simply send the SMS to the GSM and control signals from Arduino are given to the relay module to controls the AC load actions. The water pump is used to pump water.

V. RESULTS

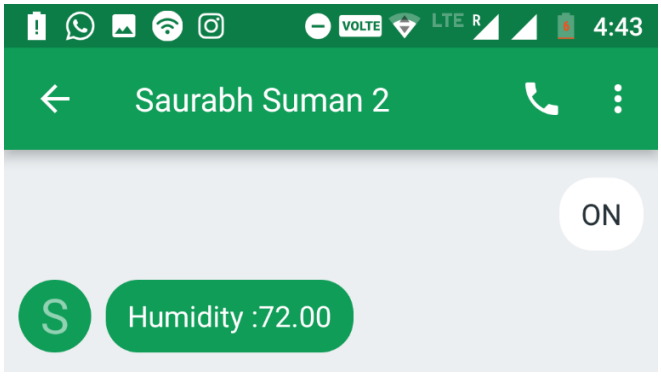


Fig 7: On sending “ON” SMS message to the system, it gets On and sends the data of humidity content. It starts the water pump if the humidity I less than the threshold value which is set as 80RH. The system automatically switches off the pump if the humidity rises beyond threshold value.

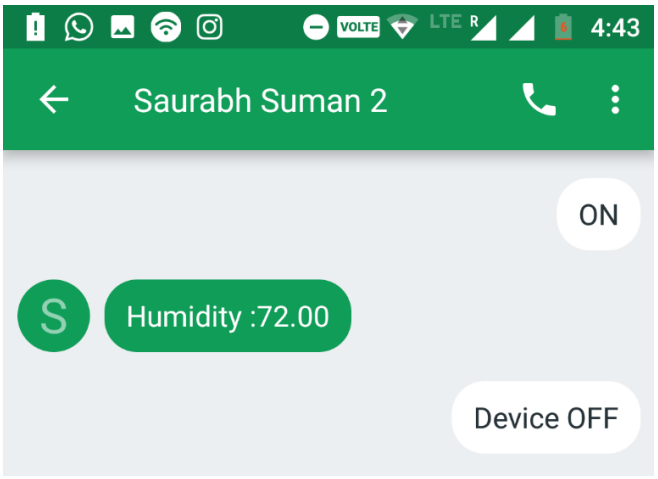


Fig 8: We can switch off the system any time by sending a SMS message “Device OFF”.

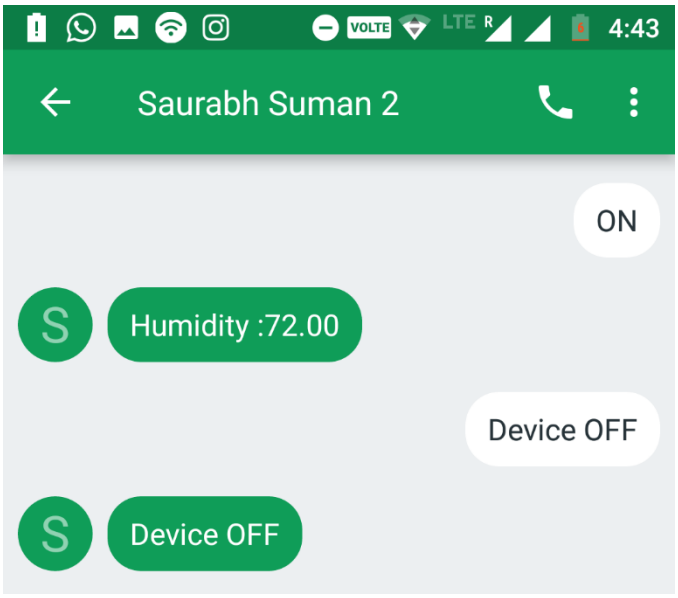


Fig 9: The device gets switched off and send the conformation message.

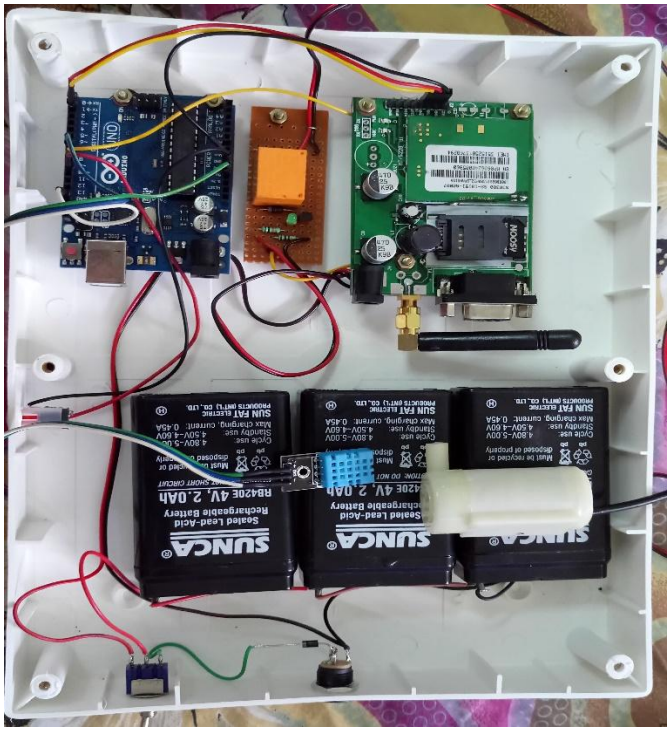
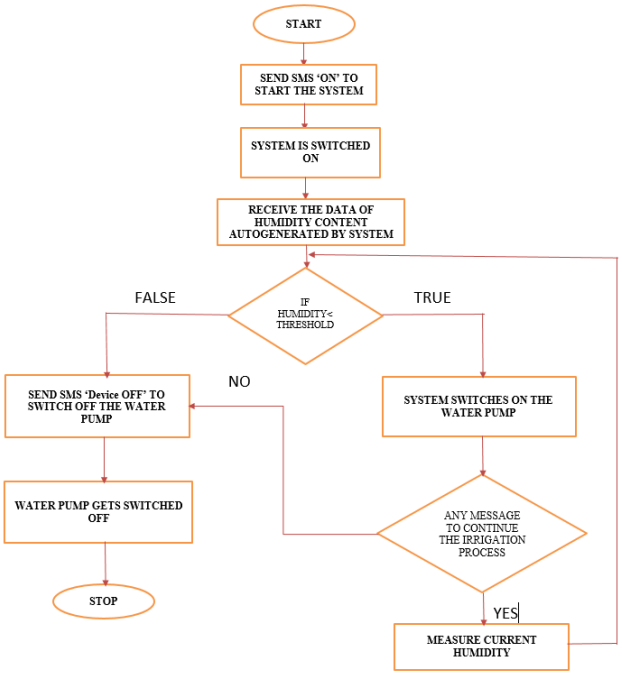


Fig 10: The Whole Setup.

VI. FLOWCHART

The system automatically checks a water pump that can be activated via SMS in response to real-time alert. Once the water pump is connected via SMS, it automatically turns off after reaching the appropriate humidity level. The farmer or caregiver can also disconnect the water pump between sending an SMS or a project manual operation interface. This system derives the power of solar energy through photovoltaic cells. Therefore, there is no need for uneven trading power dependency.



VII. CONCLUSION AND FUTURE SCOPE

There is an urgent need for a system to facilitate the agricultural process and the burden on farmers. With the recent advancement in technology, India has been increasing its production of annual crop production, a completely-centric economy. The ability to conserve natural resources and give impetus to superb agricultural production is one of the main goals of setting up this technology in the country's agricultural sector. To save the farmer's fatigue, water and time were the most important consideration. Therefore, systems must be designed to provide this efficient functionality by using sensor networks, sprinklers, GSM, SMS technology.

Day after day, the field of electronics is flourishing and has caused great impact the human beings. The project will be implemented as an automatic irrigation method and has great potential for future development. The project can be extended to greenhouses where manual monitoring is rare and rare. The principle can be extended to create fully automated gardens and farmland. Combined with the principle of rainwater harvesting, it could lead to great water savings if applied in the right way. On farmland with severe shortage of rain, this model can be successfully applied to achieve great results with most types of soil. By developing an intelligent wireless sensor and using techniques coming from a farmer can increase your profit by solving various problems faced by farmers in their routine life. And also to involve Arduino - Regulator with a video capture using a material management structure on the crop location and at the same time sending video to the farmer.

The operation of the project above basically depends on the output of the humidity sensors. Whenever you need excess water in the desired field (paddles), then you will not be able to use sensors technology. To do this we have to take DTMF technology. Using this we can irrigate the desired field and the desired quantity.

Further we can also attach a smoke sensor to prevent fire in the fields. The smoke sensor will sense the smoke or fire and will start sparkling water through Raingun or pipes.

We can use the concept of solar tracking to make our solar panel, a solar tracker which will track sunlight and increase efficiency of system by giving more output.

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