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Solar Operated Automatic Irrigation System

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ABSTRACT

This paper proposes a model of variable rate automatic microcontroller based irrigation system. Solar power is used as only the source of power to control the overall system. Sensors are placed on the paddy field and these sensors continuously sense the water level and give the message to the farmer informing the water level. Without visiting the paddy fields, farmers can get the information about the water level. However, if the water level reaches to the low or optimum level; the motor will automatically start and stop respectively without confirmation of the farmer to ensure the proper water level in the site. Moreover blades to plough the field are attached to the rear end of the Chassis. This project has provision to sow seeds wherever required by the farmer. The chassis is provided with a blade which makes the uneven levels of soil into even. By using this Solar Operated Automated Irrigation System, the farmer can (i) Water the fields, (ii) Plough the fields and (iii) Sow seeds in the fields. These processes could be controlled from remote places by using a mobile phone. At the end of this paper, a complete hardware implementation of this proposed automated irrigation system is presented.

1. INTRODUCTION:

The continuously increasing demand of the food necessitates the rapid improvement in food production technology. In most of the developing countries such as India, national economy mainly depends on the Agriculture. But these countries do not able to make proper use of agricultural resources due to the high dependency on rain. Nowadays different irrigation systems are used to reduce the dependency of rain and mostly the existing irrigation systems are driven by electrical power and manually ON/OFF scheduling controlled. Farmers usually control the electric motors observing the soil, crop and weather conditions by visiting the sites. These manually controlled irrigation systems cannot ensure a proper level of water in the site. Due to the lack of electricity and mismanagement in the manually controlling systems, sometimes their fields become dry and sometimes flooded with excess water. These unplanned and manually controlled irrigation systems also cause a significant amount of water waste. Automatic irrigation system is usually designed for ensuring the proper level of water for growing up the plants all through the season. Even when the farmers are away, these automatic irrigation systems always ensure the proper level of water in the sites. In addition, it provides maximum water usage efficiency by monitoring soil moistures at optimum level. Several research works have reputed aspects of development of automated irrigation system. With the development of technology in water saving irrigation and automation, automatic irrigation is going to be more popular in the farms. For example, a GSM based

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automatic irrigation water control is proposed. A mobile irrigation system has been developed which improves water efficiency by saving the water. Artificial Neural Network (ANN) based intelligent control system is proposed for effective irrigation scheduling in paddy fields. In the past, most of the proposed irrigation models are driven by electricity and their corresponding automated hardware are fixed rate. And these models are highly expensive as those were made of expensive devices. Thus, due to higher cost, the general farmers cannot buy it for their use; usually these models are used in the farms only for experiment or demonstration funded by government or any private organization. On the other hand, the variable rate automated controlling approach improves the overall irrigation system reducing the total cost and increases the production of crop yield. Therefore, low price, alternative source of electricity and variable rate automated operation are the key concerns in the design of an irrigation system for the common farmers.

2. IRRIGATION

Irrigation is the method in which a controlled amount of water is supplied to plants at regular intervals for agriculture. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soils in dry areas and during periods of inadequate rainfall. Additionally, irrigation also has a few other uses in crop production, which include protecting plants against frost, suppressing weed growth in grain fields and preventing soil consolidation. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry land farming.

Irrigation systems are also used for dust suppression, disposal of sewage, and in mining. Irrigation is often studied together with drainage, which is the natural or artificial removal of surface and sub-surface water from a given area.

Irrigation has been a central feature of agriculture for over 5,000 years and is the product of many cultures. Historically, it was the basis for economies and societies across the globe, from Asia to the Southwestern United States.

3. PRESENT EXTENT:

In the mid-20th century, the advent of diesel and electric motors led to systems that could pump groundwater out of major aquifers faster than drainage basins could refill them. This can lead to permanent loss of aquifer capacity, decreased water quality, ground subsidence, and other problems. The future of food production in such areas as the North China Plain, the Punjab, and the Great Plains of the US is threatened by this phenomenon.

At the global scale, 2,788,000 km² (689 million acres) of fertile land was equipped with irrigation infrastructure around the year 2000. About 68% of the area equipped for irrigation is located in Asia, 17% in the Americas, 9% in Europe, 5% in Africa and 1% in Oceania. The largest contiguous areas of high irrigation density are found:
Smaller irrigation areas are spread across almost all populated parts of the world.

WHAT IS AN EMBEDDED SYSTEM?

A combination of computer hardware and software, and perhaps additional mechanical or other parts, designed to perform a dedicated function. Most of the controlling systems, today, are embedded systems. The complexity of the systems may differ from to the other.

4. OVER VIEW OF THE PROJECT

4.1 Project background

Irrigation is the artificial application of water to the soil for assisting in growing crops. Water is resource that all living species need. It is therefore very precious and has to be used with moderation to be preserved for the future generations. It is known that an automation system has raised evolutions in industries due to increase in production rate and cost saving. Agriculture is an industry that uses a lot of water. Most of the time, this resource is not used efficiently and substantial

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amounts of water are wasted. The ones who manage this resource efficiently will be saving time and money. Agriculture leads to the wastage of water as every time excess of water is given to the fields. There are many techniques to save water or control wastage of water from agriculture as ditch irrigation, terraced irrigation, drip irrigation, sprinkler system, rotary system and automatic irrigation techniques.

4.2 Problem statement

In many remote areas where agricultural activities are done there is drought, due to this reason the farmers waste a lot of time to perform irrigation activities manually which leads to wastage of time, water and low production because manual works tend to be slow as a result only small agricultural field is used to cultivate crops.

4.3 Objectives of the project

Objectives of this project can be categorized into two categories; these are general objective and the specific objectives as follows; Specific Objectives

i. To interface all sensors that will control all the process of automatic irrigation.

ii. To program the control unit so as to be able to receive the input from sensors, give output actions through actuators and send failure notifications through wireless communication technology.

iii. To interface GSM module with the whole system so as to notify the farmer about the critical conditions.

iv. To interface a solar power system that will provide power to the whole irrigation system.

4.3.1 General Objective

The general objective of this project is to design an automatic irrigation system that can maintain the land moisture and notify the farmer about the critical conditions such as high temperature, high humidity of the farm and low water level from the water tanks.

4.3.2 Significance of the project

This project intends to design an automatic irrigation system. Its completion will be of great value to the horticulture farmers. It will reduce the work done by the farmer by automatically detecting the moisture level and temperature of the soil and irrigating when the conditions necessary for irrigation are met.

4.4 Scope and Limitation of the project

The system is expected to work effectively under different atmospheric conditions such as rainy, sunny, and dull day. The system will be ineffective on severe weather conditions such as storms and floods. As the system goes off it the over rainfalls causes the amount of water on the ground to increases hence makes the system to be ineffective since the system will always sense the presence of water.

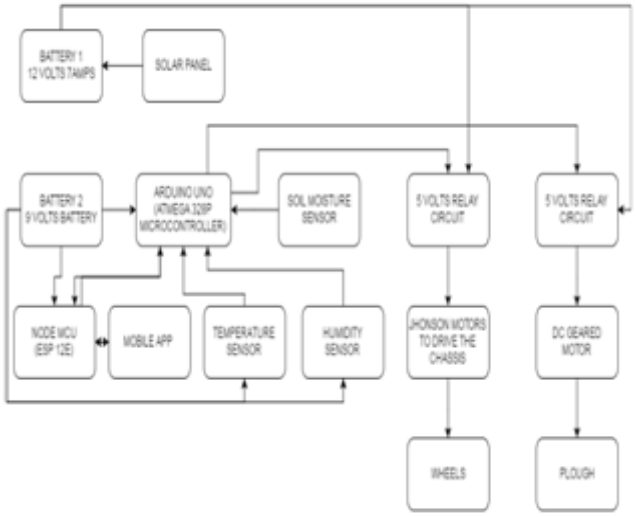

FIG 1: BLOCK DIAGRAM:

5. LITERATURE REVIEW:

1. "Design and Implementation of Real Time Irrigation System using a Wireless Sensor Network", Chaitali R. Fule and Pranjali K. Awachat [1]. This paper explains about the moisture of agricultural soils by real-time method and to minimize this manual in volvement by the farmer. which is why we are using a micro-controller(AVR ATMEGA-16) RF module. The sensor senses the amount of moisture.

2. "Automatic Drip Irrigation Unit Using PIC Controller", M. Lincy Luciana, B.Ramya, and A. Srimathi [2].The designed system basically has two inputs (i) moisture sensor and (ii)level sensor and two outputs (i) pumping motor and (ii) solenoid valve. The

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combined working of level sensor and moisture sensor for the efficient use of irrigation makes this project unique. The level sensor determines our pumping motor to run or not for fetching water from the ground to a reservoir.

3. "Automated Irrigation System", "Micro controller based drip irrigation system". H.T. Ingale and N.N. Kasat [3]. By using sensors the changing conditions of humidity level and weather are made aware to the farmer. By which farmer would be able to schedule the proper timing for water supply.

6. DESCRIPTION:

This System consists of a Solar panel, which is the main source of energy and is given to the charge controller for extracting regulated power from Solar panel at different irradiation and also to maintain correct charging voltage and current in order to charge the battery and increase its life. Water conservation in farm land is controlled using microcontroller with soil moisture sensor.

The ATMEGA328P microcontroller is 28 pin digital IC. As this is the memory element IC, a crystal oscillator (11 to 12MHZ) which generates continuous clock pulse of constant frequencies acts as a reference timer for the micro controller. The 1st pin is used as reset button to initialize the program from the first and refresh the memory allocation of the present stage. The power supply is given at 3rd and 28th pins for micro controller.

The boost converter is used to convert AC to DC power to improve the output power of the solar panel because if solar panel receives less amount of light then boost converter gives higher voltage compared with input voltage. Boost converter is a switch mode power supply contains a diode and a transistor with one energy storage element, capacitor. Filters are used to reduce output voltage ripple.

When the switch is closed then the current flows in clockwise direction through the inductor and it stores some energy by generating a magnetic field. When the switch is opened, current will be reduced as the impedance is higher.

The magnetic field previously produced will be destroyed to maintain the current flow towards the load. For this the polarity will be reversed (means left side of inductor will be negative now). As a result two sources will be in series causing a higher voltage to charge the capacitor through the diode D. The automatic irrigation system consist of solar panel, boost converter, Inverter, motor supply, soil moisture sensor, LCD display, 4X4 key pad, microcontroller, regulator.

Soil moisture sensor is inserted into the soil for level of moisture detection and also it indicates different moisture level for different crops. In this system crops like paddy, wheat, and sugarcane can be irrigated. For the selection of crops 4X4 key pad is used in this system. The next important part of the system is solar panel here the power is driven from the solar panel. The solar panel that converts sunlight into electricity this converted electricity is send to boost converter and to the battery. Regulator is used to regulate the power from the convertor. Here the microcontroller needs 5V power supply so the IC7805 is used in the system. The power supply is also connected to the single AC motor. To ON/OFF the motor relay 12V is connected to the motor.

7. Proposed system:

The proposed system uses Solar power panel to energies the system and soil moisture sensor to sense the water level for crops. Solar power is used only the source of power to control the overall system, supply from the solar panel 12V is given to boost converter circuit. The boost converter circuit has resistance R1, R2 these are used to control the voltage from solar panel. IN4007 Diode (d1) acts as voltage controlled device, inductance (100µH) are connected in series. Through MOSFET device PWM pulse is generated to increase the stored voltage in capacitance (1000µF) with respect to T/2 cycle. Constant voltage from boost

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converter is stored to 12V Battery, 500W inverter are used to convert 12V DC to 230V AC for AC pump. Regulator IC 7805 positive regulator is used to regulate the 12V DC to 5V DC with the help 1000µF and 100µF with current limiting resistor 330Ω. 5V regulator is used to operate the PIC microcontroller and acts as a control circuit to control the overall process. It has 40pin IC and each pin is connected for respective operation. The soil moisture sensor is dipped in the soil to sense the humidity value. Soil humidity value for different crops are selected by 4x4 matrix keypad, programming for crop selection and respective humidity value are programmed in the ATMEGA328P microcontroller. Signal from microcontroller to 12V relay is operated to on/off the motor pump. Water flow from the pump depends upon the signal from PIC microcontroller which in turn controls the system.

When the soil moisture sensor senses the low level of the soil moisture then a signal is sent to the microcontroller later which checks for the condition given in program. The program stored in the microcontroller is differs for different crops just like the humidity level needed to grow the crop. Water is supplied to the crops in accordance with its requirement. The irrigation is automated with Soil moisture sensor and the relay unit. When soil moisture level is low then a signal send to the relay to switch ON the motor and when the soil is wet then motor is in OFF condition. Relay gives the ON/OFF condition to the motor. The entire system is powered by solar panel energy. When the system uses solar energy then the electricity energy can be conserved. The PIC microcontroller needs 5v supply and motor needs 230v supply. Regulator is connected to the PIC microcontroller to regulate the power supply from the solar panel.

8. HARDWARE DESCRIPTION

8.1 ARDUINO:

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, MaxMSP.) The boards can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality.

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8.2PROGRAM SOURCE CODE:

```
#include<LiquidCrystal.h>
LiquidCrystal lcd(8, 9, 10, 11, 12, 13);
#include<Servo.h>
Servo servo;
#include<Wire.h>
#include<DHT.h>
#define DHTPIN 7
#define DHTTYPE DHT11
DHT dht(DHTPIN, DHTTYPE);
int sv, so, lso, h, t;
void setup()
{
 servo.attach(6);
 servo.write(0);
 for (int i = 0; i <= 5; i++)
 {
  pinMode(i, OUTPUT);
  digitalWrite(i, HIGH);
 }
 Serial.begin(9600);
 dht.begin();
 lcd.begin(16, 2);
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("SEED SOWING");
 lcd.setCursor(0, 1);
 lcd.print("     MACHINE");
 delay(2000);
 lcd.clear();
 lcd.setCursor(0, 1);
 lcd.print("System ready.....");
 delay(2000);
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("TEMP  HUMI  SOIL");
}
void loop()
{
 h = dht.readHumidity();
 t = dht.readTemperature();
 sv = analogRead(A0);
 if (sv <= 375)
 {
  so = 100;
 }
 if (sv > 375 && sv < 980)
 {
  so = 100 - ((sv - 375) / 605) * 100;
 }
 if (sv >= 980)
 {
  so = 0;
 }
 lcd.setCursor(0, 0);
 lcd.print(t);
 Serial.println(t);
 lcd.print("*C");
 lcd.setCursor(7, 1);
 lcd.print(h);
 Serial.println(h);
 lcd.print("%");
 Serial.println();
 if (Serial.available() > 0)
 {
  int a = Serial.read();
  Serial.println(a);
  if (a == 'a')
  {
   servo.write(180);
   delay(500);
   lcd.setCursor(12, 1);
   lcd.print(so);
   Serial.println(so);
   Wire.begin(4);
   Wire.onRequest(soil);
   delay(1000);
   servo.write(180);
  }
  else if (a == 'b')
  {
   Wire.begin(5);
   Wire.onRequest(temp);
  }
  if (a == 'c')
  {
   Wire.begin(6);
   Wire.onRequest(humi);
  }
  else if (a == 'd')
  {
   m(1, 0, 1, 0);
   delay(5000);
   m(1, 0, 0, 1);
   delay(5000);
   m(0, 1, 1, 0);
   delay(5000);
   m(0, 1, 0, 1);
   delay(5000);
   m(0, 0, 0, 0);
   delay(5000);
  }
 }
}
void temp()
{
 Wire.write(t);
}
void soil()
{
 Wire.write(so);
}
void humi()
{
 Wire.write(h);
}
void m(int a, int b, int c, int d)
{
 digitalWrite(2, a);
 digitalWrite(3, b);
 digitalWrite(4, c);
 digitalWrite(5, d);
}
```

8.3LIQUID CRYSTAL DISPLAY

The alphanumeric 16character X 2line LCD requires 8data lines and also 3 control signals and they are interfaced to 3664.By using 2 ports, port 0&3 data pins are connected to LCD as data bus. Port0 can be

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basically used as I/O port i.e. it can be programmed as an input or as an output port.

Depending on the operation to be performed the control words are selected and passes to the LCD. The data to be displayed on the LCD is to be sent in the ASCII format. Thus all the character to be displayed are converted into ASCII form and then sent to the LCD along with different control words. The control words differentiated the various operations and are executed. It is also possible to read the LCD data if required.

A liquid crystal is a material (normally organic for LCDs) that will flow like a liquid but whose molecular structure has some properties normally associated with solids. The Liquid Crystal Display (LCD) is a low power device. The power requirement is typically in the order of microwatts for the LCD. However, an LCD requires an external or internal light source. There are two major types of LCD s which are:

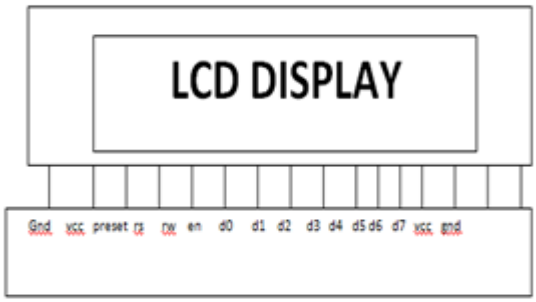

FIG 2: REPRESENTATION OF LCD DISPLAY

Sensing unit

Sensor is a device that measures the physical quantity and converts it into a signal which can be read by an instrument. There are various types of sensors but in this project, we are going to deal with the following types of sensors;

8.4Soil Moisture sensor

The required soil moisture sensor is supposed to be operating at temperature between 16 – 28 degrees Celsius, its operating voltage of about 5V, its output voltage should not exceed 5V so as to be able to send the signal to the microcontroller.

Qualitative analysis

Table Types of soil moisture sensors

SENSOR	AVAILABITY	SENSITIVITY	COST
Frequency Domain Reflectometry(FDR)	High	Good	Cheap
Time Domain Reflectometry(TDR)	Moderate	average	Expensive
Gypsum Blocks	Moderate	Good	Average

The sensor requires input voltage range between 3.3V to 20V and output voltage range between 0V to 5V in relation to the soil moisture content in the soil. It measures the dielectric constant of the soil using transmission line technique and its output voltage is proportional to the moisture content in the soil.

8.5Temperature Sensor:

The following are the suitable temperature ranges for irrigation of different types of crops

Type of crops	Temperature range (°C)
Cool season crops	16 – 22
Warmer season crops	18 – 28

Suitable temperature ranges for irrigation of different types of crops

There are various ways of measuring temperature of the soil through the use of temperature sensors. There are different temperature sensors in the market. The main temperature sensors which were analysed include thermocouple, thermistors and linear IC temperature sensor (LM 35).

8.6 Thermocouple

A thermocouple is a sensor used to measure temperature. Thermocouples consist of two wire legs made from different metals. The wires are welded together at one end, creating a junction. This junction is where the temperature is measured. When the junction experiences a change in temperature, a voltage is

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created. There are several common types of thermocouple available, each with a characteristic sensitivity and optimal temperature measurement range. The following table shows thermocouple sensitivity and useful temperature ranges for different thermocouple types.

Type	Sensitivity	Temperature range
Type B	5 to 10uV/°C	+250 to +1820°C
Type E	40 to 80uV/°C	-270 to +1000°C
Type J	50 to 60uV/°C	-210 to +1200°C
Type K	28 to 42uV/°C	-250 to +1200°C
Type N	24 to 38uV/°C	-250 to +1300°C
Type R	8 to 14uV/°C	-50 to +1768°C
Type S	8 to 12uV/°C	-50 to +1768°C
Type T	17 to 58uV/°C	-250 to +400°C

Thermocouple sensitivity and useful temperature ranges for different thermocouple types.

8.7 Thermistors

Thermistors are temperature sensors built with semiconductor materials which can have either positive or negative temperature coefficient. Thermistors are temperature sensitive resistors. All resistors vary with temperature, but thermistors are constructed of semiconductor material with a resistivity that is especially sensitive to temperature

Type of plants	Ideal humidity levels
Vegetable plants	50% - 70%
Flowering plants	50% - 60%

8.8Humidity Sensor

The humidity level required to be measured in this project is about 50% - 70%

Qualitative analysis

Table Types of humidity sensors available

SENSOR	AVAILABITY	SENSITIVITY	COST	RANGE (%)
DHT 11	Moderate	Good	Cheap	20 – 90
DHT 22	High	Average	Average	0 – 100
HS1101 sensor	Moderate	Good	Average	0 – 100

The selected humidity sensor is the capacitive humidity sensor (HS1101 sensor) which gives output in capacitive form. They change their capacitance with respect to change in sensing parameter which is the amount of water vapors in air.

8.9Plough Blade:

A plough blade is a tool used in agricultural farming for soil cultivation and to prepare to turn the soil and sow seeds. The plough set up is made of iron and supported over a steel frame resembling a fork to cut the earth' surface. The main purpose of this is to turn over the top layer of the soil surface to bring the nutrients to the surface, while removing weeds and other remains and allowing its break down.

8.10Watering System:

Water is vital to plant growth and health. Irrigation is implemented for controlled amount of water being supplied to plants at regular intervals. Watering systems are used for dust suppression and other added benefits like consistent moisture with the help of sensors like Moisture sensor etc

Here usage of water splitter helps in vast spread of the water being sprayed in the fields. For this purpose a three way water splitter is used whose outlets are given above the plough blades.

This setup allows the farmer to enable effective watering to the plants.

9. CONSTRUCTION:

Automated Irrigation System consist of three important processing components 1) Watering system, 2) Ploughing System and 3) A System for sowing seeds.

Watering System consists of water splitter that splits the water output into vast spread in the fields through three flow pipes. This water is initially stored in a feed tank that is placed in the upper rack of the chassis.

Ploughing system consists of iron frame which is fixed to the body of the chassis. The plough set up is made of

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iron and supported over a steel frame resembling a fork to cut the earth' surface. The plough has the provision of up and down movement. This setup is powered by motor which is fixed to the chassis of the system. Solar power is the source for running of the motor.

A System for sowing seeds is integrated to this Automated Irrigation System. The Fibre bin for seeds is placed on the upper rack of the chassis. This bin could be operated whenever the seeds flow is required. This flow of seeds is enabled with the aid of PVC pipes.

10. WORKING:

The setup is integrated with Solar panel, Arduino UNO board, Wi-Fi modem, Relays, LCD display, Pump-motor, Plough blade, watering system, Pulley, Seed sowing system.

Initially Solar panel acts as the Power source and power is also stored in a battery. This power is utilised to actuate the motors and operate the sensors integrated in the Automated Irrigation System.

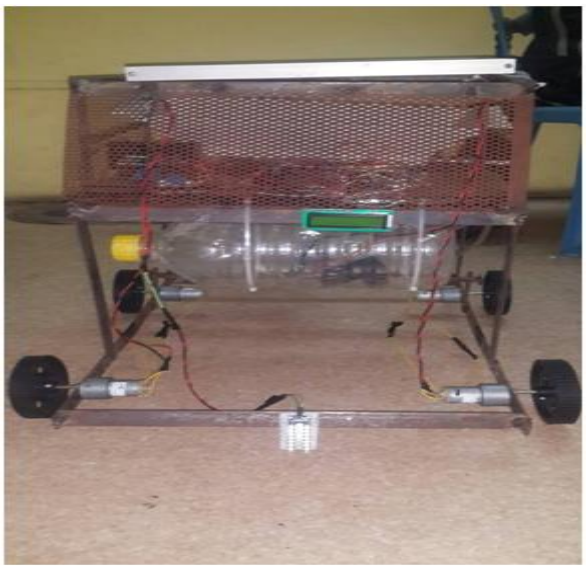
The Watering system runs the pump motors which emit the water through the pipes with the help of the water splitter. The operation of this Water supply could be controlled by the user interface.

Ploughing System has the fork shaped blade which could be raised up and down enabling a controlled plough in the agriculture fields. This movement is executed using a pulley and a nylon rope. The plough blade is integrated with the chassis.

A provision for sowing seeds is also availed in the system. The seeds are initially stored in a fibre bin. When required the bin could be opened and closed simultaneously.

The Commands could be given through android app, which are communicated through Wi-Fi modem to the Arduino UNO board

Fabrication model of automatic irrigation system side view



Fabrication model of automatic irrigation system front view

Fabrication model of automatic irrigation system top view

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11. Advantages:

1. Automatic irrigation system is used to optimize the usage of water by reducing wastage and reduces the human work.
2. The energy needed to the water pump and controlling system is given by solar panel. Solar panels which are small grid that can be produce excess energy.
3. By using solar energy reduces the energy crisis problem.
4. The system requires minimal maintenance and attention because they are self-starting.
5. To further enhance the daily pumping rates tracking arrays can be implemented.
6. Even though this system requires more investment but it solves more irrigation problem after long run of this system.

12.Conclusion:

1.The proposed system is beneficial to the farmers when this system is implemented.
2. This system conserves energy and a solution for energy crisis problem
3.When the soil needs water is indicated by the sensor by this automatic irrigation system is implemented. When the button is pressed, the irrigation system detects the moisture level of the crop, moisture content of soil is detected and irrigated automatically.
4. The amount of the moisture content and temperature of the field are detected and displayed in the LCD display.
5.Ploughing of fields was executed over soil and it was found that effective ploughing could be done.
6. Due to the movement of system,the seeds from te fibre bin are placed sow.

13. Future scope:

1. Integration of closed circuit cameras to this system would help in detailing of the fields to the farmers even at remote places.
2. Inclusion of separate cabin for fertilizers /pesticides would make this system more effective.
3. Up gradation of motors, tank capacities, using an effective 2-stroke engine to this system.

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