Engineering Clinics

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Engineering Clinics - II

Final Report

Title: Smart Farming using Solar Tracker

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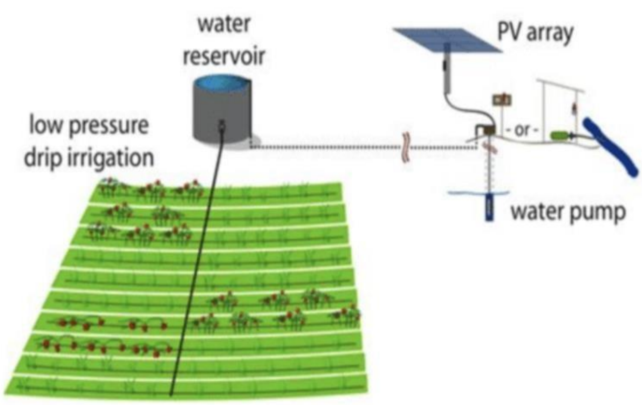
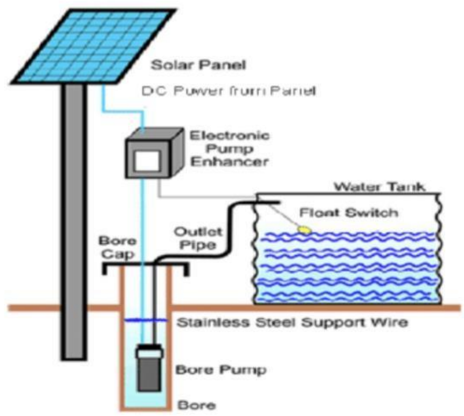
SMART FARMING USING SOLAR TRACKING

ABSTRACT

Rural areas don't have direct utility grids so assessing the grid may not be possible. Direct access to electric power will not be possible. In this type of situation, the accessibility of rich solar irradiance shows the most potential form of energy. For the use of solar energy, Photovoltaic (PV) off-grid solar systems can be a possible solution for the irrigation system. The main objective of the project is to develop an automatic irrigation system with the use of photovoltaic panels. Moisture sensors are utilized to check the soil which is required to operate the water pump to maintain the proper irrigation conditions. The pump can be operated by a photovoltaic system. A microcontroller system (Arduino) will track the position of the sun and is utilized to maintain a perpendicular angle between the sun and the photovoltaic panels. An experimental investigation has been conducted to analyze the performance of the tracking system. The outcome of the experimentation validates the control of the irrigation system.





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Introduction

Distributing the water to the required region may be defined as an irrigation system. The type of system used will influence the efficiency of the irrigation. Since ancient times, life on Earth has been dependent on agriculture. The type of irrigation system used will be the tool that makes agriculture better. In the world, many types of irrigation systems are in practice, in one or the other way each irrigation system has encountered many problems. There are few modern irrigation systems which are in practice will mostly fail in one or the other way. Automation in the area of irrigation will play a vital job; consequently, engineers battle to turn out consolidated automated devices with the end goal of making complex systems that assist humans in their exercises so the system should process itself automatically without any human mediation. For the irrigation system automation is very much essential because of the shortage of water in the soil and the lack of rain. An automatic irrigation system with solar tracking is the alternative solution for this type of situation. The agricultural system in the world is always in need and depends on the presence of water in the soil. The continuous pulling out of soil water willreduce the moisture level of the soil.

To overcome this issue, the intended irrigation system has to be followed. Thebetter utilization of the available water will reduce the amount of wastage of water significantly. For this reason, an automatic irrigation system is to bedesigned which will use solar energy.

The automatic irrigation with a solar tracking system receives sunlight through photovoltaic cells. Therefore, this system is not dependent on electric power. This automatic irrigation with solar tracking system uses solar energy to power the irrigation pump and the circuit comprises sensors that will sense the soil for its dry or wet condition. A programmable logic microcontroller is utilized to control the automatic irrigation system. The sensor available in the system will detect the level of moisture in the soil and signal the microcontroller unit connected to the pump. The signal from the sensor received from the comparator is processed by the microcontroller with the help of a program stored. The pump remains off in the wet condition of the soil and on in the dry condition. The system has a distributed network of soil-moisture sensors placed in the root zone of the plants. This system uses moisture sensors that sense the condition of the soil and acts accordingly.

The main aim of this work is to design and develop an automatic irrigation system that is more efficient in comparison to a manual system. This system was implemented in the different regions of Saudi Arabia for the wheat field. Plant growths were recorded under two different conditions, 80% and 40% of the field capacity which are controlled by sensors which are connected to micro-controllers. The sensors detect the water quantity and compensate for the water loss in the soil. From the literature review, much work has been carried out on the development of automatic irrigation systems. All automatic irrigation systems consist of humidity sensors that sense the condition of the soil and acts accordingly. The signal sent by the sensors will be processed by the microcontrollers.

Thus, the irrigation system is controlled by the microcontrollers. The whole system will use electric power to operate the motor or pump to maintain the suitable conditions of the soil. Irrigation to growing plants will take a lot of time and resources. The resources may include water, power, human resources, etc. Technology advances reduce the manpower but some of the energy is still wasted. One more drawback of the available automated irrigation system is the use of electric power. In rural areas, there is a lack of availability of electric power. With this constraint,the use of automated irrigation systems will not be possible in rural areas.

Technology is probably a solution to the reduction of costs and prevents loss of resources. In this background, the effective utilization of the available resources such as sunlight i.e., solar energy is eco-friendly and best. In this work, an attempt has been made to develop the solar tracker to operate the motor/pump. A solar tracker is a system that tracks the sunlight for solar panels.

Problem Statement:

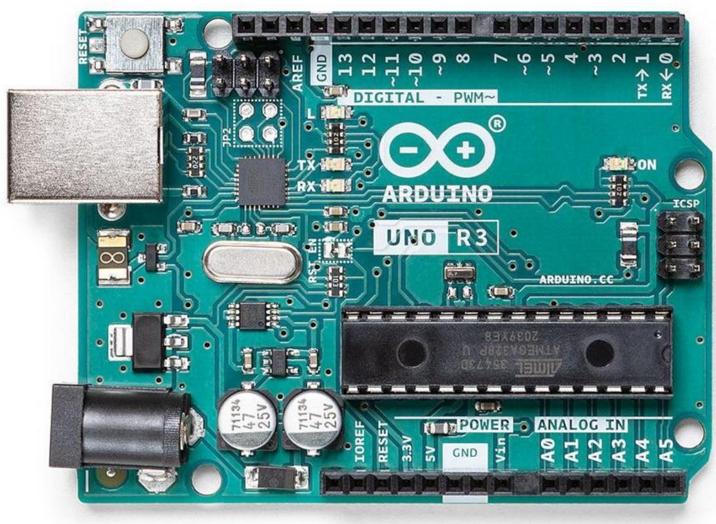
To irrigate fields, we are using electricity obtained from fossil fuels which is a nonrenewable source of energy. Hence the need of using renewable sources for our energy needs became necessary.

In this project, the renewable source that we have chosen is solar energy. We are harnessing solar energy to power the irrigation fields which are further automated by using programmed silicon chips such as Arduino.

The aim is to develop a smart irrigation system to provide automatic irrigation to agricultural fields to prevent excessive wastage of water while powering all this using solar panels which tilt/change their angles based on the sun's direction to capture the maximum intensity of sunlight for longer durations of time.

Components Required:

1. Arduino:



An Arduino is a microcontroller-based kit that can be either useddirectly by purchasing from the vendor or can be made at home using the components, owing to its open-source hardware feature. It is used in communications and in controlling or operating many devices.

1. Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - a light on a sensor, a finger on a button, or a Twitter message - and turn them into an output - activating a motor, turning on an LED, or publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.
2. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike.
3. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearables, 3D printing, and embedded environments. All Arduino boards are completely open-source, empowering users to build them independently and eventually adapt them to their particular needs. The software, too, is open source, and it is growing through the contributions of users worldwide.

2. Servo Motor:

MG995 servo is a simple, commonly used standard servo for your mechanical needs such as a robotic head, or robotic arm. It comes with a standard 3-pin power and control cable for easy use and metal gears for high torque.

The MG995 servo motor provides precise rotation over the 180º

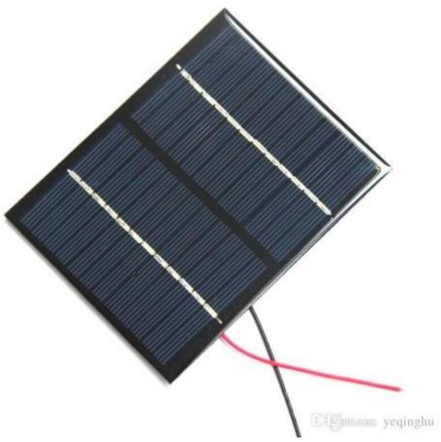
range itsapplications are many and in them a few are stated below

- The servo is suited for designing robotic arms in which the wear andtear of the motor is high. Being metal geared, the servo has a long life and can be installed on systems like robotic arms where motor work is huge.
- The servo is also suited to be used in drones and toy planes. Having a satisfying torque that is enough to overcome air resistance and control the wings of the plane, the servo is preferred in toy planes and drones which need precision control no matter the condition.

3. LDR Sensor:

Light Dependent Resistor (LDR) The LDR sensor is a resistor whose resistance decreases with the increase of light intensity. It can also be referred to as a photoconductor. A photoresistor is made of a high-resistance semiconductor. If light, falling on the device is of high enough frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump to the conduction band. The resulting free electron and its hole partner conduct electricity, thereby lowering resistance. The reverse is the case when darkness falls on the LDR, for this will increase its resistance. This characteristic of the LDR is used to vary the input voltage as the sun moves over it. There are many different symbols used to indicate LDR, one of the most commonly used symbols is shown in the figure below. The arrow indicates light falling on it.

4. Solar Panel:



The solar panel converts sunlight into DC electricity to charge the battery. This DC electricity is fed to the battery via a solar regulator which ensures the battery is charged properly and not damaged.

5.10 K OHM RESISTOR:

A 10K Ohm resistor can be identified via resistor color codes of Brown-Black-Orange-Gold or Brown-Black-Black-Red-Gold.

Commonly used in breadboards and other prototyping applications, these 10K ohm resistors make excellent pull-ups, pull-downs, and current limiters.

5. Moisture sensor:

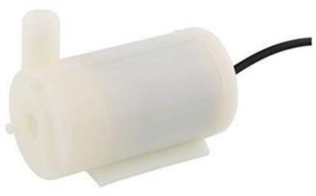
The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. The straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

6. Relay Module:

A relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. The single-channel relay module is much more than just a plain relay, it comprises components that make switching and connection easier and act as indicators to show if the module is powered and if the relay is active or not.

A relay typically has five pins, three of which are high-voltage terminals (NC, COM, and NO) that connect to the device being controlled. The device is connected between the COM (common) terminal and either the NC (normally closed) or NO (normally open) terminal, depending on whether the device should normally remain on or off. Between the remaining two pins (coil1 and coil2) is a coil that acts as an electromagnet.

7. Water Pump:

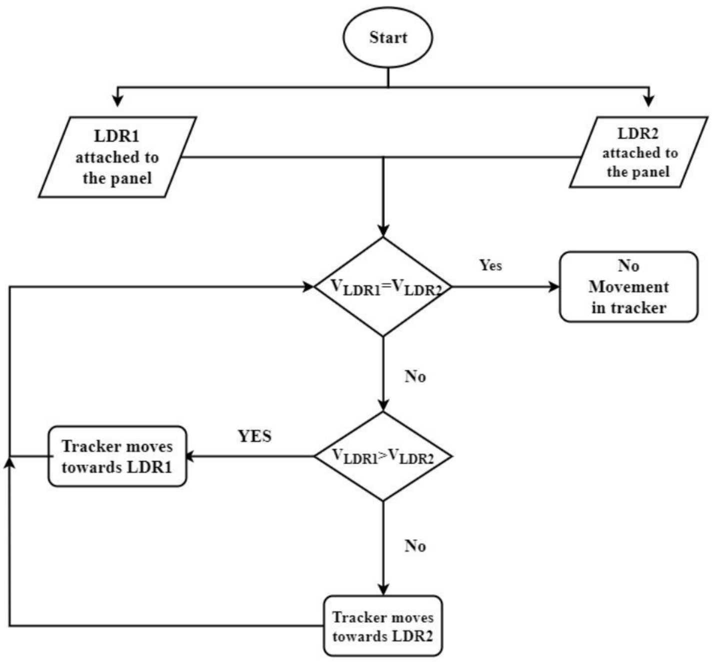


A 12 Volt High-Performance nonsubmersible dc water pump is a device that has a hermetically sealed motor close-coupled to the pump body. Some parts of the assembly are submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitations a problem associated with a high elevation difference between the pump and the fluid surface. Submersible pumps push fluid to the surface as opposedto jet pumps having to pull fluids.

WORKING:

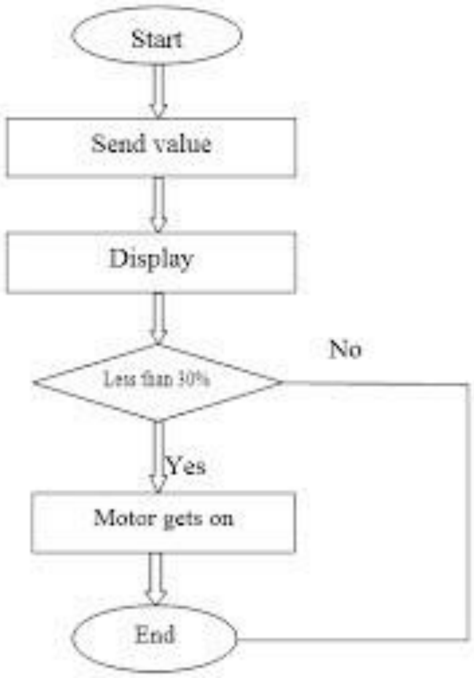
Solar Tracking System:

In this tracking operation, a servo motor fixed to the structure holds the solar panel and is also responsible for the movement of it. Servo motors specifically, are used as they allow precise control of angular position, and the solar panels are embedded with LDR sensors which measure the sunlight intensity as a reference input signal. The imbalance in voltages generated by the LDR sensors generates a voltage difference. The voltage difference produced is proportional to the variation between the sunlight location and the solar panel location. The microcontroller compares the difference in voltage produced by individual LDRs. If any of the LDRs receive more light, the motor driver is activated and in turn, rotates the servo motor in that direction, until the values become the same or the voltage difference becomes zero, in turn bringing the panel to face the sun, at every instant of the day. Also, if a heavy load is placed on the motor, suchas a panel itself, the motor driver (element responsible for its movement), will increase the current to the motor coil as it attempts to rotate the motor. In short, there is no out-of-step condition.



Smart Irrigation:

We are using soil moisture sensors that can sense the moisture content of the soil and send the output data to Arduino. Place the soil moisture sensors in the soil. If the soil is dry that means the plants need some water so the sensor sends the signals to the Arduino. The Arduino sends the signals to the relay module and the water pump is turned on for some time until the moisture content of the soil rises. If allthe water from the water pump will stay in a specific position/ place, then there is a chance that crops may be destroyed. To overcome this problem, we can use an efficient form of water irrigation such as drip irrigation as it provides the perfect amount of water to the plants without any water wastage.



RESULTS AND DISCUSSION

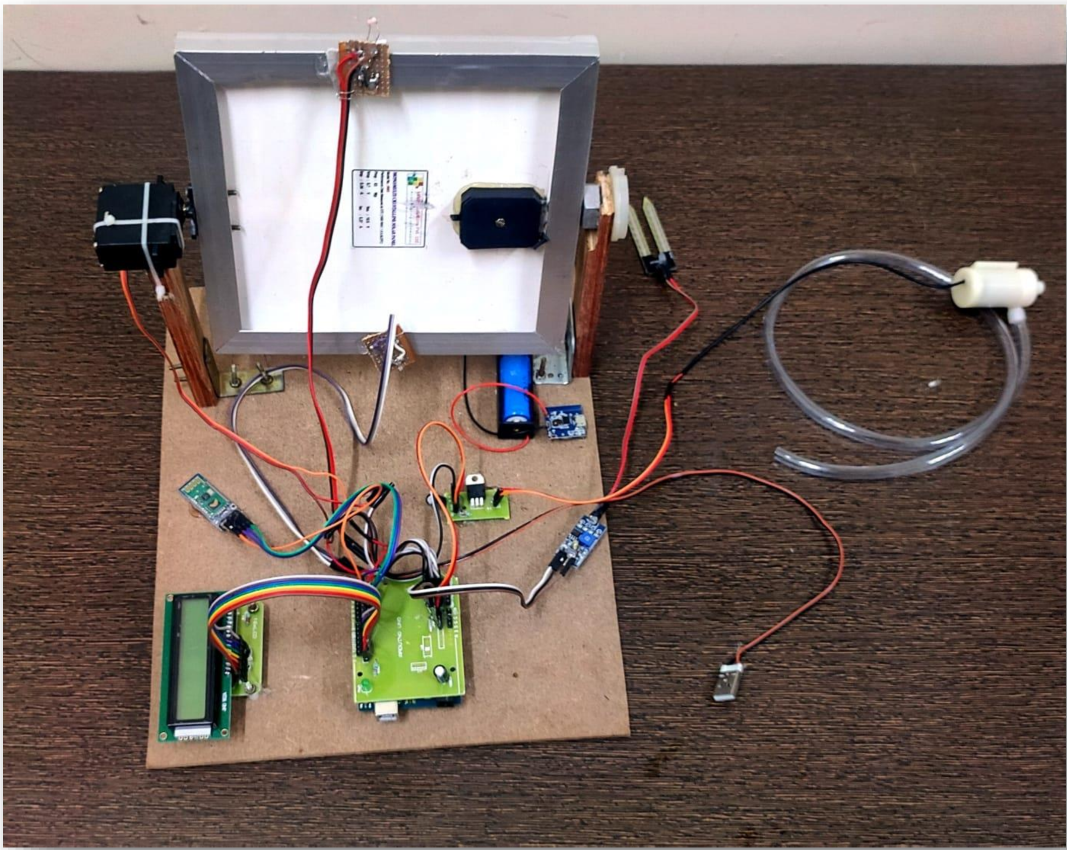
Solar Tracking

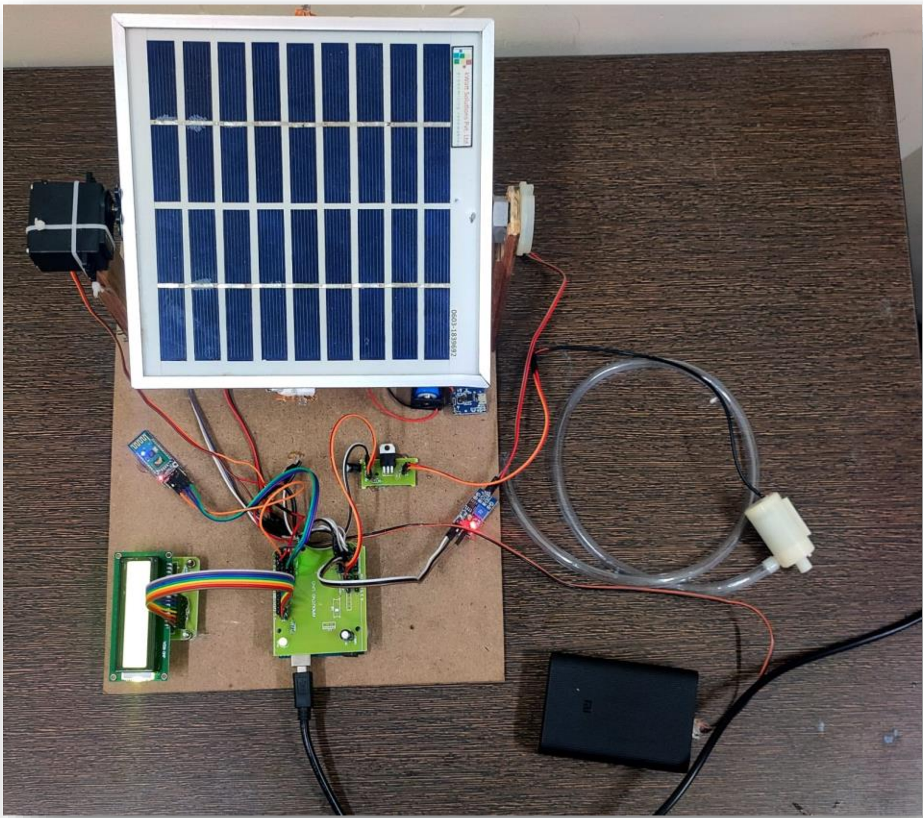
The proposed solar tracking system was tested in real-time for a period of 12 hours on a particular day from morning 6 am to evening 6 pm.

The average voltage output for the dynamic panel is observed as 3.00427 V, whereas for the static panel, it is 1.4166V. Therefore, the efficiency of the tracker comes out to be 52.8%. The efficiency of the system could be further increased drastically by placing a concave lens on top of the panel as it enables a large amount of sunlight to be concentrated on the panel at each time thus generating an impressive amount of power. Also, it can reduce the size and number of solar cells required to generate similar power.

Smart Irrigation:

The system is powered by a solar tracker. The switching on and off of the water pump takes place automatically based on the soil. In the automatic mode, when the soil moisture is less than the threshold level the water pump will be automatically switched on and when the soil moisture becomes greater than the threshold level, the water pump will be automatically switched off. Switching off the motor takes place automatically when the soil moisture reaches the threshold level.






16xLCD
JHD 162A
L1:40 L2:27
AUTO MODE M:1021


JHD 162A
L1:41 L2:27
MANUAL MODE:1020

Advantages & conclusions

The proposed solar tracker-assisted automatic irrigation system for agricultural fields is successfully constructed and tested in real-time. Additional simulator scripts are created to check the system response for a specific soil moisture value. It is observed that water wastage is reduced considerably. The energy consumption is also handled effectively using our solar tracker. This system will be of prominent use in drought areas or areas with water scarcity. The system can be improved further by adding pH sensors and further automating the system with the help of a web interface and IOT for weather forecasts, rains, etc. By monitoring the pH values, fertilizer usage can also be reduced. The energy efficiency of the system can be further improved by putting the system in sleep mode during the night.

A single-axis sun-tracking solar-powered smart irrigation system with an automatic tanker filling motor pump is simulated. The simulation result shows it is very beneficial for the government as well as farmers. This is one of the best solutions for the energy crisis and water consumption. The smart irrigation system reduces human intervention during the irrigation of fields and optimizes water usage.

Code:

```
#include <LiquidCrystal.h>
const int rs = 8, en = 9, d4 = 10, d5 = 11, d6 = 12, d7 = 13;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#include <Servo.h>
Servo myservo;
int ms=A0;
int mot=A1;
int x;
int md=0;
//int mot1=A2;
int l1=A4;
int l2=A5;
int kk=0;
void setup() {
 lcd.begin(16,2);
 lcd.print("   WELCOME");
Serial.begin(9600);
myservo.attach(2);
```

```
pinMode(mot,OUTPUT);
//pinMode(mot1,OUTPUT);
pinMode(ms,INPUT);
pinMode(A4,INPUT);
pinMode(A5,INPUT);
digitalWrite(mot,0);
}

void loop()
{
int mval=analogRead(ms);
int lv1=analogRead(l1)/10;
int lv2=analogRead(l2)/10;
Serial.println("L1:");
Serial.println(lv1);
Serial.println("L2:");
Serial.println(lv2);
delay(1000);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("L1:");
lcd.setCursor(3,0);
lcd.print(lv1);
lcd.setCursor(8,0);
lcd.print("L2:");
lcd.setCursor(11,0);
lcd.print(lv2);
lcd.setCursor(10,1);
lcd.print("M:");
lcd.setCursor(12,1);
lcd.print(mval);
x=Serial.read();
if(x=='1')
  {
    md=0;
  }
    if(md==0)
   {
    Serial.println("sensor mode");
    lcd.setCursor(0,1);
    lcd.print("AUTO MODE");
 if(mval<600)
{
  digitalWrite(mot,0);
}
else
{
```

```
  digitalWrite(mot,1);
}
}
if(x=='2')
  {
    Serial.println("Remote mode");
    lcd.setCursor(0,1);
    lcd.print("MANUAL MODE");
    md=1;
   }
   if(md==1)
   {
  if(x=='3')
  {
   digitalWrite(mot,1);
    lcd.setCursor(0,1);
    lcd.print("MANUAL MODE");
    delay(1000);
  }
  if(x=='4')
  {
   digitalWrite(mot,0);
    lcd.setCursor(0,1);
    lcd.print("MANUAL MODE");
    delay(1000);
  }
 }
if(lv1>70 && kk==0)
{
  kk=1;
myservo.write(30);
}

if(lv2>70 && kk==1)
{
  kk=2;
myservo.write(130);
}

if(lv1<70 && lv2<70 &&kk==2)
{
  kk=0;
myservo.write(60);
}
delay(500);
}
```

References:

https://www.arduino.cc/

https://components101.com/

https://create.arduino.cc/projecthub/336271/arduino-solar-tracker-41ef82

https://create.arduino.cc/projecthub/Techatronic/smart-irrigation-system-using-arduino-uno-afcb31