AUTOMATIC IRRIGATION SYSTEM USING ARDUINO WITH THE HELP OF MOISTURE SENSOR

ABSTRACT

The project we have undertaken is "Automatic Plant Irrigation System". This project is taken up as India is an agriculture-oriented country and the rate at which water resources are depleting is a dangerous threat hence there is a need of smart and efficient way of irrigation. In this project we have implemented sensors which detect the humidity in the soil (agricultural field) and supply water to the field which has water requirement. The project is 8051 microcontroller-based design which controls the water supply and the field to be irrigated. There are sensors present in each field which are not activated till water is present on the field. Once the field gets dry sensors sense the requirement of water in the field and send a signal to the microcontroller. When the soil is dry (>400), the timer activates the irrigation system, when wet (<400), it deactivates it. A motor-driver circuit controls the irrigation, both the motor status and soil moisture are displayed on an LCD for monitoring. Microcontroller then supply water to that particular field which has water requirement till the sensors is deactivated again. In case, when there is more than one signal for water requirement then the microcontroller will prioritize the first received signal and irrigate the fields accordingly.

Keywords: 8085 Microcontroller, Automatic, Agriculture Plant, Irrigation, Humidity, Sensor.

1. INTRODUCTION

The main aim of this project was to provide water to the plants or gardening automatically using microcontroller (Arduino Uno). We can automatically water the plants when we are going on vacation or don't we have to bother my neighbors, Sometimes the neighbors do too much of watering and the plants end up dying anyway. There are timer-based devices available in India which waters the soil on set interval. They do not sense the soil moisture and the ambient temperature to know if the soil actually needs watering or not.

Assimilation is that the artificial application of water to the land or soil It is used to assist in the growing of agricultural crops, maintenance of landscapes, and re vegetation of disturbed soils in dry areas and during periods of inadequate rainfall. When a zone comes on, the water flows through the lateral lines and ultimately finally ends up at the irrigation electrode (drip) or mechanical device heads. Several sprinklers have pipe thread inlets on the lowest of them that permits a fitting and also the pipe to be connected to them. The sprinklers are usually used in the top of the head flush with the ground surface.

As the method of dripping will reduce huge water losses it became a popular method by reducing the labor cost and increasing the yields. When the components are activated, all the components will read and gives the output signal to the controller, and the information will be displayed to the user (farmer). The sensor readings are analog in nature so the ADC pin in the controller will convert the analog signals into digital format.

Then the controller will access information and when the motors are turned on/Off it will be displayed on the LCD Panel, and serial monitor windows. There are many systems are available to water savings in various crops, from basic ones to more technologically advanced ones. For instance, in one system plant watering status was monitored and irrigation scheduled based on temperature presents in soil content of the plant.

2. CIRCUIT DIAGRAMS

2.1 MICROCONTROLLER UNIT

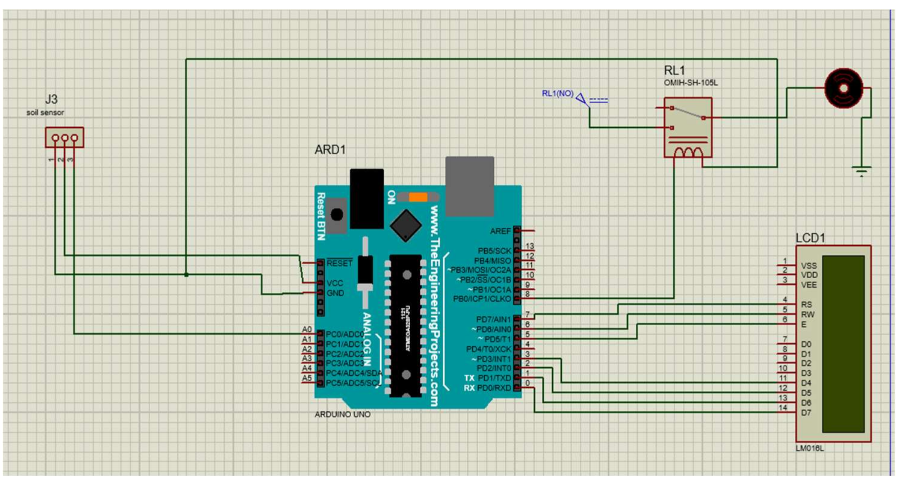

Figure -2.1 Microcontroller Unit

- Monitor the moisture content of the soil using a soil moisture sensor and the water level of the tank using a float switch.
- Turn the motor ON when the soil moisture falls below a certain reference value and if there is enough water in the tank.
- Display the status of the soil and the tank using a 16×2 LCD.
- Let’s begin to build our project Â Soil Moisture Based Automatic Irrigation System.

The soil moisture sensor module used here have two output pins (Digital output and Analog output). The output from the probe of the moisture sensor is compared with a reference value using alarm393 comparator.

2.1.1 COMPONENTS LIST

LED	
Resistor	470 ohm (for LED), 8.2 K (for power on reset Circuit.), 10 K (for sensors), potentiometer (100K)
Capacitor	1000 u f (for Power supply), 10 u f (reset circuit.) 33p F (for crystal oscillator)
LCD	16 x 2
Stepper motor	step angle 7.5 degree, +12V
Relay	220V/3-4A
Microcontroller	Arduino
ULN	ULN 2003
Water pump	
Power cables & ribbon wires	

2.1.2 COMPONENTS DESCRIPTION

LCD

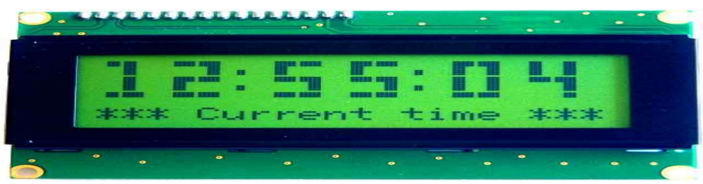

Figure 2.2 Liquid Crystal Display

Liquid Crystal Display

Liquid crystal displays (LCD) are widely used in recent years as compares to LEDs. This is due to the declining prices of LCD, the ability to display numbers, characters and graphics, incorporation of a refreshing controller into the LCD, there by relieving the CPU of the task of refreshing the LCD and also the ease of programming for characters and graphics. HD 44780 based LCDs are most commonly used.

LCD pin description

The LCD discuss in this section has the most common connector used for the Hitachi 44780 based LCD is 14 pins in a row and modes of operation and how to program and interface with microcontroller is describes in this section.

D7 The voltage VCC and VSS provided by +5V and ground respectively while VEE is used for Controlling LCD contrast. Variable voltage between Ground and V_{cc} is used to specify the Contrast (or "darkness") of the characters on the LCD screen.

CODES COMMAND TO LCD INSTRUCTION

(HEX) Register

1	Clear display screen
2	Return home
4	Decrement cursor (shift cursor to left)
6	Increment cursor (shift cursor to right)
5	Shift display right
7	Shift display left
8	Display off, cursor off
A	Display off, cursor on
C	Display on, cursor off
E	Display on, cursor blinking
F	Display on, cursor blinking
10	Shift cursor position to left
14	Shift cursor position to right
18	Shift the entire display to the left
1C	Shift the entire display to the right
80	Force cursor to beginning of 1st line
C0	Force cursor to beginning of 2nd line
38	2 line and 5x 7 matrix

Pin Symbol I/O Description

1 VSS	Ground
2 VCC	+5V power supply
3 VEE	Power supply to control contrast
4 RS I RS	0 to select command register, RS=1 to select data register
5 R/W I R/W	0 for write, R/W=1 for read

6 E I/O Enable	
7 PB0 I/O	The 8bit data bus.
8 PB1 I/O	The 8bit data bus
9 DB2 I/O	The 8bit data bus.
10 DB3 I/O	The 8bit data bus
11 DB4 I/O	The 8bit data bus.
12 DB5 I/O	The 8bit data bus.
13 DB6 I/O	The 8bit data bus.
14 DB7 I/O	The 8bit data bus.

STEPPER MOTOR

Motion Control, in electronic terms, means to accurately control the movement of an object based on either speed, distance, load, inertia or a combination of all these factors. There are numerous types of motion control systems, including; Stepper Motor, Linear Step Motor, DC Brush, Brushless, Servo, Brushless Servo and more.

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. Stepper motor is a form of ac. motor. The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied.

For every input pulse, the motor shaft turns through a specified number of degrees, called a step. Its working principle is one step rotation for one input pulse. The range of step size may vary from 0.72 degree to 90 degree. In position control application, if the number of input pulses sent to the motor is known, the actual position of the driven.

A stepper motor differs from a conventional motor (CM) as under:

a. Input to SM is in the form of electric pulses whereas input to a CM is invariably from a constant voltage source.

b. A CM has a free running shaft whereas shaft of SM moves through angular steps.

c. In control system applications, no feedback loop is required when SM is used but a feedback loop is required when CM is used.

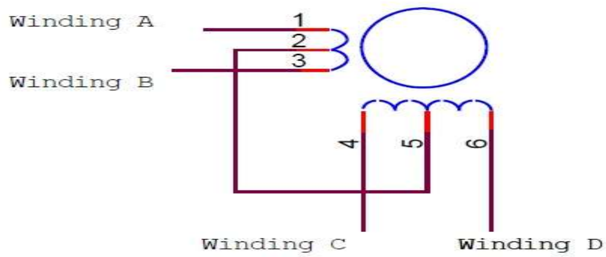

Figure 2.3

Step Angle & Steps per Revolution

Movement associated with a single step, depends on the internal construction of the motor, in particular the number of teeth on the stator and the rotor. The step angle is the minimum degree of rotation associated with a single step.

Step per revolution is the total number of steps needed to rotate one complete rotation or 360 degrees (e.g., 180 steps * 2 degrees = 360)

Since the stepper motor is not ordinary motor and has four separate coils, which have to be energized one by one in a stepwise fashion. We term them as coil A, B, C and D. At a particular instant the coil A should get supply and then after some delay the coil B should get a supply and then coil C and then coil D and so on the cycle continues. The more the delay is introduced between the energizing of the coils the lesser is the speed of the stepper motor and vice versa.

RELAY

The electromagnetic relay consists of a multi-turn coil, wound on an iron core, to form an electromagnet. When the coil is energized, by passing current through it, the core becomes temporarily magnetized. The magnetized core attracts the iron armature. The armature is pivoted which causes it to operate one or more sets of contacts. When the coil is de-energized the armature and contacts are released. The coil can be energized from a low power source such as a transistor while the contacts can switch high powers such as the mains supply. The relay can also be situated remotely from the control source. Relays can generate a very high voltage across the coil when switched off. This can damage other components in the circuit. To prevent this a diode is connected across the coil.

2.2 INTRODUCTION TO ARDUINO MICROCONTROLLER

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, 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. 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.

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, wearable, 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.

The Arduino Uno R3 board includes the following specifications.

It is an ATmega328P based Microcontroller

The Operating Voltage of the Arduino is 5V

The recommended input voltage ranges from 7V to 12V

The i/p voltage (limit) is 6V to 20V

Digital input and output pins-14

Digital input & output pins (PWM)-6

Analog i/p pins are 6

DC Current for each I/O Pin is 20 mA

DC Current used for 3.3V Pin is 50 mA

Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader

SRAM is 2 KB

EEPROM is 1 KB

The speed of the CLK is 16 MHz

In Built LED

Length and width of the Arduino are 68.6 mm X 53.4 mm

The weight of the Arduino board is 25 g

2.2.1 PIN CONFIGURATION

The Arduino Uno R3 pin diagram is shown below. It comprises 14-digit I/O pins. From these pins, 6-pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator-16Mhz, a power jack, an ICSP header an RST button.

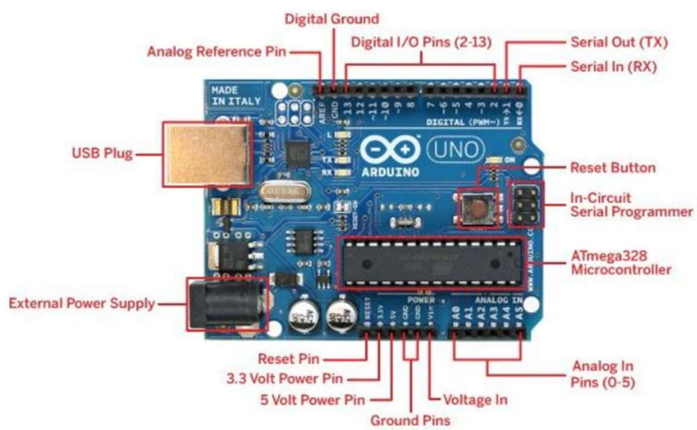

Fig-2.4 Pin Diagram of Arduino

The power supply of the Arduino can be done with the help of an exterior power supply otherwise USB connection. The exterior power supply (6 to 20 volts) mainly includes a battery or an AC to DC adapter. The connection of an adapter can be done by plugging a center-positive plug (2.1mm) into the power jack on the board. The battery terminals can be placed in the pins of Vin as well as GND. The power pins of an Arduino board include the following.

Vin: The input voltage or Vin to the Arduino while it is using an exterior power supply opposite to volts from the connection of USB or else RPS (regulated power supply). By using this pin, one can supply the voltage.

5Volts: The RPS can be used to give the power supply to the microcontroller as well as components which are used on the Arduino board. This can approach from the input voltage through a regulator.

3V3: A 3.3 supply voltage can be generated with the onboard regulator, and the highest draw current will be 50 mA.

GND: GND (ground) pins

Memory

The memory of an ATmega328 microcontroller includes 32 KB and 0.5 KB memory is utilized for the Boot loader), and also it includes SRAM-2 KB as well as EEPROM-1KB.

Input and Output

We know that an arguing Uno R3 includes 14-digital pins which can be used as an input otherwise output by using the functions like pin Mode (), digital Read (), and digital Write (). These pins can operate with 5V, and every digital pin can give or receive 20mA, & includes a 20k to 50k ohm pull up resistor. The maximum current on any pin is 40mA which cannot surpass for avoiding the microcontroller from the damage. Additionally, some of the pins of an Arduino in Serial Pins.

The serial pins of an Arduino board are TX (1) and RX (0) pins and these pins can be used to transfer the TTL serial data. The connection of these pins can be done with the equivalent pins of the ATmega8 U2 USB to TTL chip.

External Interrupt Pins

The external interrupt pins of the board are 2 & 3, and these pins can be arranged to activate an interrupt on a rising otherwise falling edge, a low-value otherwise a modify in value.

PWM Pins

The PWM pins of an Arduino are 3, 5, 6, 9, 10, & 11, and gives an output of an 8-bit PWM with the function analog write ().

SPI (Serial Peripheral Interface) Pins

The SPI pins are 10, 11, 12, 13 namely SS, MOSI, MISO, SCK, and these will maintain the SPI communication with the help of the SPI library.

LED Pin

An arguing board is inbuilt with a LED using digital pin-13. Whenever the digital pin is high, the LED will glow otherwise it will not glow.

TWI (2-Wire Interface) Pins

The TWI pins are SDA or A4, & SCL or A5, which can support the communication of TWI with the help of Wire library.

AREF (Analog Reference) Pin

An analog reference pin is the reference voltage to the inputs of an analog i/ps using the function like analog Reference ().

Reset (RST) Pin

This pin brings a low line for resetting the microcontroller, and it is very useful for using an RST button toward shields which can block the one over the Arduino R3 board.

Communication

The communication protocols of an Arduino Uno include SPI, I2C, and UART serial communication.

Uart

An Arduino Uno uses the two functions like the transmitter digital pin1 and the receiver digital pin0. These pins are mainly used in UART TTL serial communication.

I2C

Arduino UNO board employs SDA pin otherwise A4 pin & A5 pin otherwise SCL pin is used for I2C communication with wire library. In this, both the SCL and SDA are CLK signal and data signal.

SPI Pins

The SPI communication includes MOSI, MISO, and SCK.

MOSI (Pin11)

This is the master out slave in the pin, used to transmit the data to the devices

MISO (Pin12)

This pin is a serial CLK, and the CLK pulse will synchronize the transmission of which is produced by the master.

SCK (Pin13)

The CLK pulse synchronizes data transmission that is generated by the master. Equivalent pins with the SPI library are employed for the communication of SPI. ICSP (in-circuit serial programming) headers can be utilized for programming AT mega microcontroller directly with the boot loader.

Arduino Uno R3 Programming

The programming of an Arduino Uno R3 can be done using IDE software. The microcontroller on the board will come with pre-burned by a boot loader that permits to upload fresh code without using an exterior hardware programmer.

The communication of this can be done using a protocol like STK500.

An We can also upload the program in the microcontroller by avoiding the boot loader using the header like the In-Circuit Serial Programming. Clude specific functions.

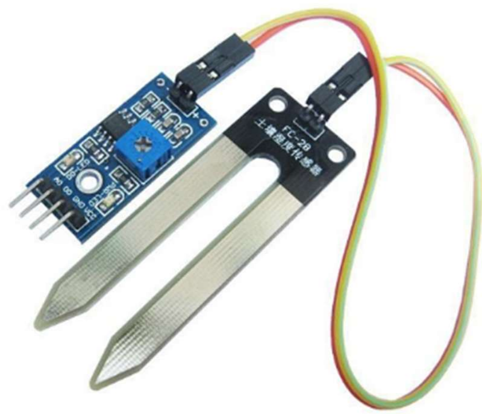

Figure-2.5 Soil Moisture Sensor

How to use a very interesting soil moisture sensor with pic microcontroller. Let’s get started and let’s say wanted to use the sensor for a longtime since I find it quite an interesting one the sensor is very cheap. It costs around two dollars. The sensor can measure the levels of moisture in the soil so it can be extremely useful if you want to monitor the soil moisture of your plants or automate the watering procedure. Let’s see the project we are going to build today I have one cup with me with dry soil if I place the sensor in the cup. We can read a low soil moisture value at 16×2 LCD display. If I pour some water in the cup, you will see that the moisture levels rise and we can visually check the moisture levels of the soil of course. This is just a demonstration of the sensor I am going to build more useful projects in the future with this sensor**.**

2.3 WORKING OF SOIL MOISTURE SENSOR

Let’s now see how to build this simple project the two large exposed pads function as probes for the sensor the more water in the soil the better the conductivity between the pads that results in a lower resistance the sensor is an analogue one so in the analog output. We get about that as the soil gets drier, we get more voltage at the analog output since the resistance between the probes gets higher, we can set a threshold in order to enable the digital output at a certain moisture level using this potentiometer given with electronics part of sensor.

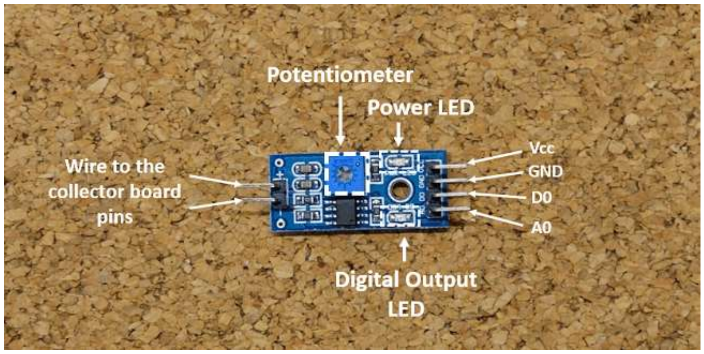

Figure 2.5 Hardware

3. SOFTWARES USED

Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

4. APPLICATIONS

- Agriculture: Optimizes water usage in farming by ensuring crops receive the right amount of water based on soil moisture levels.
- Smart Gardening: Assists in maintaining gardens by automating watering schedules, reducing human effort.
- Greenhouses: Maintains a consistent environment for plants by automating irrigation, improving plant growth conditions.
- Landscape Irrigation: Helps in efficient watering of lawns, parks, and public green spaces, reducing water wastage.
- Drought Management: Conserves water by watering only when necessary, addressing water scarcity issues.
- Research and Studies: Used in research environments to study plant growth under controlled irrigation conditions.
- Urban Agriculture: Supports urban farming or rooftop gardening by automating watering systems for small-scale food production.
- Home Automation: Integrates with home automation systems for smart home features, offering remote or automatic control of irrigation.
- Soil Health Monitoring: Improves soil health by preventing over-watering, which can lead to root rot or other plant diseases.
- Sustainable Agriculture: Promotes sustainable farming practices by reducing water consumption and minimizing environmental impact.

5. CONCLUSION AND FUTURE SCOPES

The Automatic Irrigation System using Arduino with a moisture sensor effectively enhances water management in agricultural and gardening applications. By monitoring soil moisture levels in real-time, it ensures that plants receive the right amount of water, optimizing resource use. This system reduces water wastage and promotes sustainable irrigation practices, making it ideal for both large-scale farming and small gardens. It also minimizes the need for manual intervention, saving time and labor. Additionally, it contributes to environmental conservation by conserving water and preventing over-irrigation. Overall, this system represents a cost-effective and efficient solution for modern irrigation needs.

The future scope of the Automatic Irrigation System using Arduino with a moisture sensor includes integration with smart farming technologies like IoT and AI, allowing for more precise data analysis and remote control. It could incorporate weather forecasting to adjust irrigation schedules based on upcoming rain or temperature changes. The system could be expanded to support multiple sensors for different soil types and plant needs, enhancing its adaptability. Additionally, it could be integrated with solar power systems for off-grid, energy-efficient operation. Advanced machine learning algorithms could be used for predictive maintenance and irrigation optimization. As technology evolves, this system may become a critical component in sustainable and automated agriculture worldwide.

6. REFERENCES

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