REVIEW ARTICLE

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Automation of Water Pump using Sensors

Shantanu K. Das[1*], Aditya Thool[2], Praveen Nagesh[3]

[1]Ajeenkya D Y Patil University, Pune, Maharashtra, India

[2]G H Raisoni University Saikheda, Madhya Pradesh, India

[3]Department of Mechanical Engineering, Rewa Engineering College, Rewa, Madhya Pradesh, India

Abstract

Agriculture employs the majority of Indians and significantly impacts the country's economy. Agriculture becomes difficult in dry locations or when rainfall is scarce. As a result, it must be automated for proper plant watering and managed remotely by the farmer. The objective of this paper is to do automation using a soil moisture sensor (LM393IC) and a temperature sensor (LM35) for farm irrigation and soil moisture control with the help of Arduino. In this paper, the designing and manufacturing of printed circuit board is described with details of the working principle along with the software details. Once the electricity is turned on, this automatic irrigation system senses the soil moisture level and activates the pump. The percepts of the soil moisture and temperature sensors offer feedback to manage the soil's water content. This automated water pump is validated by comparing the values of the sensor with actual measuring instrument results and it is applied on rose flowers to check its workability.

Keywords: Automation of farm irrigation, Soil moisture control, Smart Agriculture, Temperature Sensor.

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Introduction

Due to rising labor costs and a busy lifestyle, water supply system automation is becoming increasingly important. In India, timer-based devices water the soil at predetermined intervals.[1] The main disadvantage of these devices is that they do not detect soil moisture or ambient temperature to determine whether or not the soil need watering. Various irrigation methods are available for various crops, ranging from the most basic to the most technologically advanced.[2-4] For example, using a YL-69 sensor, one system monitors plant watering status and schedules irrigation based on soil humidity level.[2] However, other important environmental factor such as temperature, is ignored. On the other side, wireless sensor networks (WSN) technology has been used to the agriculture sector, resulting in new trends such as precision agriculture. The use of a WSN with an advanced knowledge-based fuzzy controller has been proposed to automate the irrigation system's water levels.[5] Nagarajan and Minu[3] used a PIC16F877A Microcontroller for the targeted crop potato to evaluate the soil's water content, temperature, and pH. But, this irrigation system's installation and maintenance cost is higher and not applicable to localized indoor plant irrigation systems.

In order to address these challenges in the agricultural fields, an automated low-cost and efficient water delivery system with a real-time closed-loop irrigation control system is required. This system combines soil property monitoring, irrigation scheduling, and control over remote agricultural fields, making it a useful tool for cultivators. In this paper, the water supply system is automated using microcontroller and sensors for providing the fields or land water supply when the humidity of the soil is low and also show the details of the temperature and humidity of our land. The main objectives of the paper are

- Automation of water pump by which water supply will be controlled automatically.
- Determination of temperature when the pumps working status is off.
- Controlling the humidity with a knob for changing status of water supply system.

Rest of the paper is structured as follows. The various studies concerned to planned work are studied in section 2. A methodology for designing the proposed water pump automation model is presented in section 3. The software details required for automation of water pump are defined in details in section 4. In section 5, the results of implementation along with its discussions, are explained. The paper concludes with the discussion of the proposed work and its various future applications in section 6.

Corresponding Author: Shantanu K. Das, Ajeenkya D Y Patil University, Pune, Maharashtra, India, e-mail: shantanuds0206@gmail.com

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Conflict of interest: None

Literature Review

There are many ways of automation of water pump using sensors have been studied in the literature.[3,6-14] The detailed literature studies and their pitfalls are studied in this section.

Aneja *et al.*[6] reviewed the study of PLC, microcontrollers and sensors in controlling the temperature of soil. Jawad *et al.*[7] looked into the various wireless communication protocols and the taxonomy of energy-efficient and energy harvesting methodologies for WSNs that can be used in agricultural monitoring systems (WSNs). Zulkifli and Noor[8] employed Active Radio Frequency Identification (RFID) and Wireless Mesh Sensor Network (WMSN) technologies in conjunction with active RFID to maintain the WSN and provide a fully automated IoT solution for farm irrigation.

Kumar *et al.*[9] developed an autonomous solar-powered drip irrigation system that featured a solar photovoltaic system (SPV), Arduino microcontroller, soil moisture sensor, mobile Bluetooth, water tank, and pump using wireless sensor network technology (WSNT). Susmitha *et al.*[10] developed a weather prediction algorithm (AISWP) to predict the optimal water supply for efficient irrigation using temperature and humidity parameters. Nagarajan and Minu[3] developed a wireless sensor network for managing water supply using various components such as humidity, pH, and temperature sensors. The ZigBee router is utilized for real-time monitoring and water content control based on soil parameters.

Amu *et al.*[11] devised a system for real-time in-field sensing employing a wireless network and computer code using Arduino Microcontrollers, GSM, and moisture sensors. The information obtained by the sensing element network about the farm's status is sent to the farmer via GSM, ensuring overall fecund, ascendible, and energetic implementation. Kochhar and Kumar[12] employed the Wireless Sensor Networks (WSN) integration approach for an end-to-end survey, starting with the arrangement of crops in greenhouses and selecting the transmission interval or rate. Millan *et al.*[13] developed an autonomous irrigation approach for plum cultivars that incorporates the water balance method with continuous soil moisture readings using IRRIX software and numerous field sensors. Vera *et al.*[14] examined the study on the impact of a dielectric sensor on soil volumetric water content. The SWOT analysis has been used along with a full examination of sensor performance, which is necessary for proper sensor selection. The above literature survey found that most of the automated smart irrigation system[15,16] has higher installation and maintenance cost and is useful for large irrigation fields. Therefore, there is a need for a low cost and efficient irrigation system for the localized system.

Methodology

Designing

The schematic diagram of the model used for the automation of the water pump is shown in Figure 1. A steel tray of 1x1m

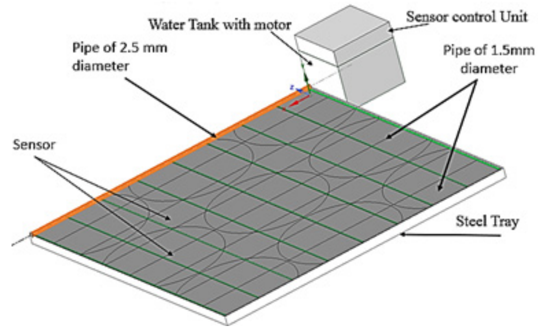

Figure 1: Schematic diagram of model.

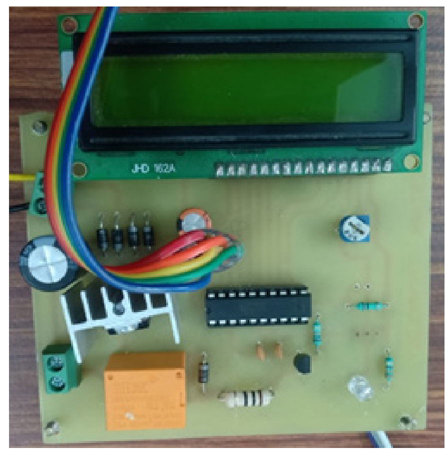

Figure 2: Front of the system.

as shown in Figure 1 with soil and crop cultivated, is taken for reference to test the sensors which transmit data from the soil in tray and the system is attached to the tray which has the sensors and microcontrollers on it to give the respective data on the LCD display. A wooden plank of 1x1 feet is taken for placing the PCB layout on it (as shown in Figure 2), which provides the safety to the operator due to poor electrical conductivity of the plank.

There are four main parts to a PCB: Substrate, Copper Layer, Solder Mask, and Silkscreen.

The Components used are as follows:

- Step Down Transformer,
- LM35
- Soil Moisture Sensor i.e. LM393
- Resistor
- Capacitor
- Voltage Regulator
- Comparator
- Potentiometer
- Diode
- Controller
- Relay
- 16x2 LCD Screen

Process and Assembly

The product assembly is done with the help of soldering iron and flux; the generated PCB layout. The front of the display

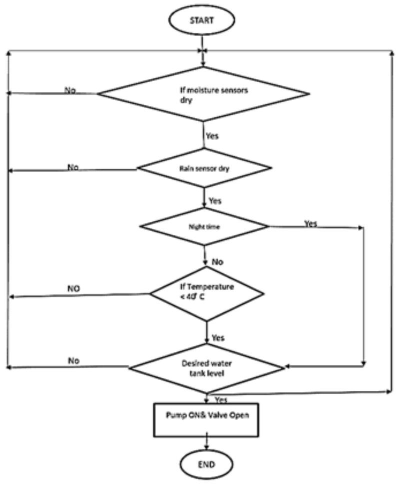

Figure 3: Flow chart of implementation process.

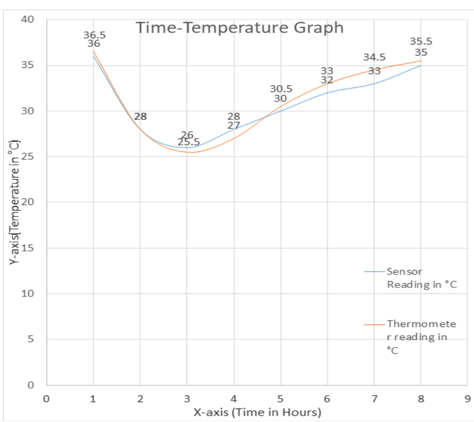

Figure 4: Time temperature graph.

system is given as shown in Figure 2. In this figure, an LCD on it along with the Soil moisture sensor (LM393) and temperature sensor (LM35) sensor are used on the agriculture fields for gathering the information of temperature and moisture level of the soil.

Working

The Whole system will be working in a closed-loop system. This closed loop block diagram as shown in Figure 5 includes a power supply, a voltage regulator, temperature and humidity sensors, and a 16x2 LCD display. The humidity sensor's feedback signal will be critical to the system's overall performance.

Two probes are inserted into the soil to operate this device. When the soil is dry, the probes will not behave; when the soil is wet, the probes will behave. The running of the two probes in the soil is dependent on the resistance. For example, if the resistance is high, the soil is dry; if the resistance is low, the soil is wet. The battery or the AC mains supply linked to the circuit provides the voltage to the two probes.

Working Procedure

Our system operates in stages, which are listed below:

- The rain sensor will verify the system if the moisture sensor is dry in the line (its locations); if there is rain, the system will not operate because there is no need to irrigate at the same time. Otherwise, the temperature sensor will be compared to the light sensor. If the temperature is high and the percentage of light is similarly high, the system will not operate because it is not the appropriate period for irrigation because the water would quickly evaporate; otherwise, the system will compare the temperature and light sensors.
- The controller will send a signal to open the valve and pump if the temperature is low, the light is dim, and there is no rain, but the moisture sensor is dry.
- The system will shut down automatically and send an SMS to the user when the water level in the tank goes below a particular level.
- When the system is turned on, a flow metre sensor connected to the LCD calculates the amount of water that flows from the tank to each line, and the LCD recognises if there is a leak in the pipe. The intricacies of how a water pump works are depicted in Figure 3 in the form of a flow chart.

Software Details

The Keil Software is used to program the microcontroller in this study. The most popular microcontrollers are supported by Keil's tools, which come in a range of packages and configurations depending on the architecture. In addition to software, Keil offers a variety of evaluation boards, USB-JTAG adapters, emulators, and third-party tools. The following are the steps to utilize Keil tools:

- Create and choose the target device from the Device database, then set the tool Settings.
- Your source files should be written in C/C++ or Assembly.
- With the Project Manager, you may create your application.
- Verify and optimize your program by debugging and correcting mistakes in source files.
- Test the linked application after downloading your code to Flash ROM or SRAM.

The "Blinky" programme is an example of an evaluation board application that blinks LEDs. The blinking LEDs make it simple to check that the application loads and runs correctly on the target hardware. Because the "Blinky" programme is a board-specific application, it may display other board-specific features depending on the board. The programming codes for our system is written as given in appendix 1.

Result and Discussion

The results of the various tests after using this automated device are calculated and cross checked to verify its reliability. The Crosschecking the temperature sensor is done by using below procedures-

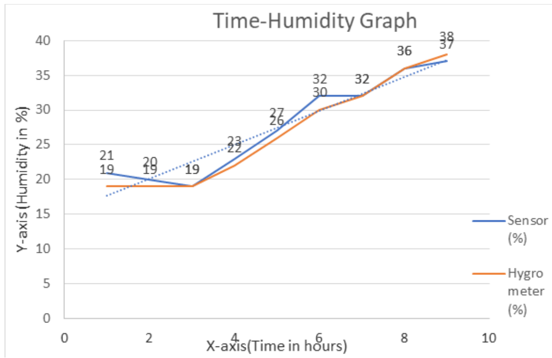

Figure 5: Time humidity graph

- Measuring the temperature in thermometer and the temperature sensor simultaneously in dry atmosphere.
- After measuring the temperature on dry atmosphere in summer, the temperature sensor readings are accurate with accuracy of ± 1°C.
- The readings of the sensor as well as the thermometer are shown in graph as given in Figure 4, therefore it is concluded that the temperature sensor is working properly.

The Crosschecking the humidity sensor is done by using below procedures-

- Measuring the Humidity in dry atmosphere with the help of sensor and for reference taking the hygrometer or we can use the weather report application in cell phones.
- After measuring the humidity on dry atmosphere in summer, the humidity sensor readings are accurate with accuracy of ± 5%.
- It is concluded that the humidity sensor is working properly. The observations for the readings of the sensor and the readings of the hygrometer are shown in graph as shown in Figure 5.

In this research, the device is tested and analyzed on rose plants. Roses like to grow in good, fertile, well-drained soil with moisture retention capacity. A soil mixture should also contain 1 part farm yard manure & part bio-compost. Roses grow best on soil with a pH of 6.0 to 7.5. Roses are extremely susceptible to saline soils, as the sodium carbonate found in saline soil is toxic to plants. It grows well on soil that is high in organic matter and has a high water-holding capacity.

This automatic water supply system has the following requirements:

- Constant electric supply
- Water pump attached to the PCB layout at the connection provided
- The sensors should be tested
- A sample soil or plant to test on
- The water supply should be proper, no leakage should be there in pipes
- Pump should have a sufficient amount of water supply to fulfill the demand of water
- The system should be automatically displaying the temp and humidity accordingly

The following observations are done on rose plant:

The surrounding temperature is 31°C and the relative humidity (%) is 20% at the atmosphere. The temperature of rose sample plant is 30°C when sensors are installed. The humidity of rose sample plant is 20%, same as the humidity of the atmosphere as the soil is totally dry. The humidity level of the sensor can be changed with the control unit given over there. This system runs on its own and is controlled by a mobile application, which the user must download. The complete device is a reasonably low cost irrigation system while simultaneously addressing the underlying issue (reduced water use).

Conclusions and Future Work

This research uses a soil moisture sensor (LM393IC) and a temperature sensor to automate a water pump (LM35). For the automation of a water pump, the design and production of a printed circuit board, a display system, and its software details are used. This autonomous irrigation system monitors soil moisture and turns on the pump. The percepts of the soil moisture and temperature sensors offer feedback to manage the soil's water content. This automated water pump is validated by comparing sensor values to actual measuring instrument results, and it is then used to test its functionality on a rose flower.

This automatic irrigation system can be configured to discharge more accurate volumes of water in a specific area, which helps conserve water. This smart irrigation system can also be expanded, allowing it to be altered and updated in response to changing environmental conditions.

Ethics Approval

We declare that accepted principles of ethical and professional conduct have been followed in our research.

Conflict of Interest

The authors declare no competing interests.

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Appendix-1

```
#include <LiquidCrystal.h> //LCD Library
int temp;
int T_Sensor = A4;
int M_Sensor = A0;
int W_led = 7;
int P_led = 13;
int val;
int cel;
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);
void setup()
 {
   lcd.begin(16, 2);
   lcd.clear();
   pinMode(13,OUTPUT);
   pinMode(7,INPUT);
   pinMode(9,OUTPUT);
    val = analogRead(T_Sensor); //Read Temperature sensor
value
   int mv = ( val/1024.0)*5000;
   cel = mv/10;
   delay(1000);
}
void loop()
{

 lcd.clear();
  int Moisture = analogRead(M_Sensor); //Read Moisture
Sensor Value
 lcd.setCursor(0,0);
 lcd.print("TEMP:");
 lcd.setCursor(5,0);
 lcd.print(cel);
 lcd.setCursor(7,0);
 lcd.print("*C");
 if (Moisture> 700)   // for dry soil
 {
      lcd.setCursor(11,0);
      lcd.print("DRY");
      lcd.setCursor(11,1);
      lcd.print("SOIL");
     if (digitalRead(W_led)==1) //test the availability of water
in storage
     {
       digitalWrite(13, HIGH);
       lcd.setCursor(0,1);
       lcd.print("PUMP:ON");
     }
     else
     {
       digitalWrite(13, LOW);
       lcd.setCursor(0,1);
       lcd.print("PUMP:OFF");
     }
    if (Moisture>= 300 && Moisture<=700) //for Moist Soil
   {
    lcd.setCursor(11,0);
    lcd.print("MOIST");
    lcd.setCursor(11,1);
    lcd.print("SOIL");
    digitalWrite(13,LOW);
    lcd.setCursor(0,1);
    lcd.print("PUMP:OFF");
 }
 if (Moisture < 300)  // For Soggy soil
 {
   lcd.setCursor(11,0);
    lcd.print("SOGGY");
    lcd.setCursor(11,1);
    lcd.print("SOIL");
    digitalWrite(13,LOW);
    lcd.setCursor(0,1);
    lcd.print("PUMP:OFF");
 }
 delay(1000);
 }
```