Software Requirements Specification

for

Automated Irrigation System

Version 1.0 approved

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Revision History

Name	Date	Reason For Changes	Version

1. Introduction

1.1 Purpose

The major objective of this project is to develop a app that can monitor changes in the field in which sprinklers and soil moisture sensors are implanted. The app will show all the data in it .The SRS will help in documenting this and help us in attaining our final goal. This system can also be programmed to send the user an update via messages, with regards to the moisture level changes, from any remote location. All of the requirements of this project and various other minute details will be described as we move forward in this SRS.

1.2 Document Conventions

This SRS follows the universally accepted norms used for a formal document. There aren't many special conventions followed in this particular SRS. The few conventions, however, which we have used, are listed as follows:

- Bold letters and words signify special importance to those words in that particular context
- Words which are in title case or uppercase in the middle on any particular sentence also signify the emphasis on those words in the context of the topic
- We have also used multiple short forms in this SRS. The most important ones to be noted are mentioned as follows:
    - IOT : Internet of Things

1.3 Intended Audience and Reading Suggestions

This SRS is a formal as well as a technical document which is most suited for consumption by developers, project managers, marketing staff, testers, and documentation writers. The developers and testers will best understand the technical side of the document whereas the project managers and marketing staff will be the best people for reading and understanding the implementation side of the project. The best manner to go through the document is in a chronological order. It is better to read all the topics in the same order as given in the SRS rather than reading the topics in a random order. This is due to the fact that most topics are connected with each other and a cohesive reading makes more sense as compared to a scattered and dispersed reading.

1.4 Product Scope

This project is going to be implemented at a low level and not at a high level. Our major aim is to ensure that the system, first works perfectly for a few plants or a small portion of area and then as a future scope, it can be implemented at a entire farms can be irrigated, regulated and controlled by the means of this system. The thought behind this entire project is to ensure that the water supplied to the plants for irrigation is not wasted. Instead, this excess water is saved and used for multiple other essential purposes in farms or otherwise. The convenience of controlling it remotely is also a major factor in encouraging us to design such a powerful and easily managed system and connecting everything through the massively effective concept of IoT.

1.5 References

1. Rafael Muñoz- Carpena and Michael D. Dukes,Automatic Irrigation Based on Soil Moisture for Vegetable Crops, IFAS Extension, 2005.

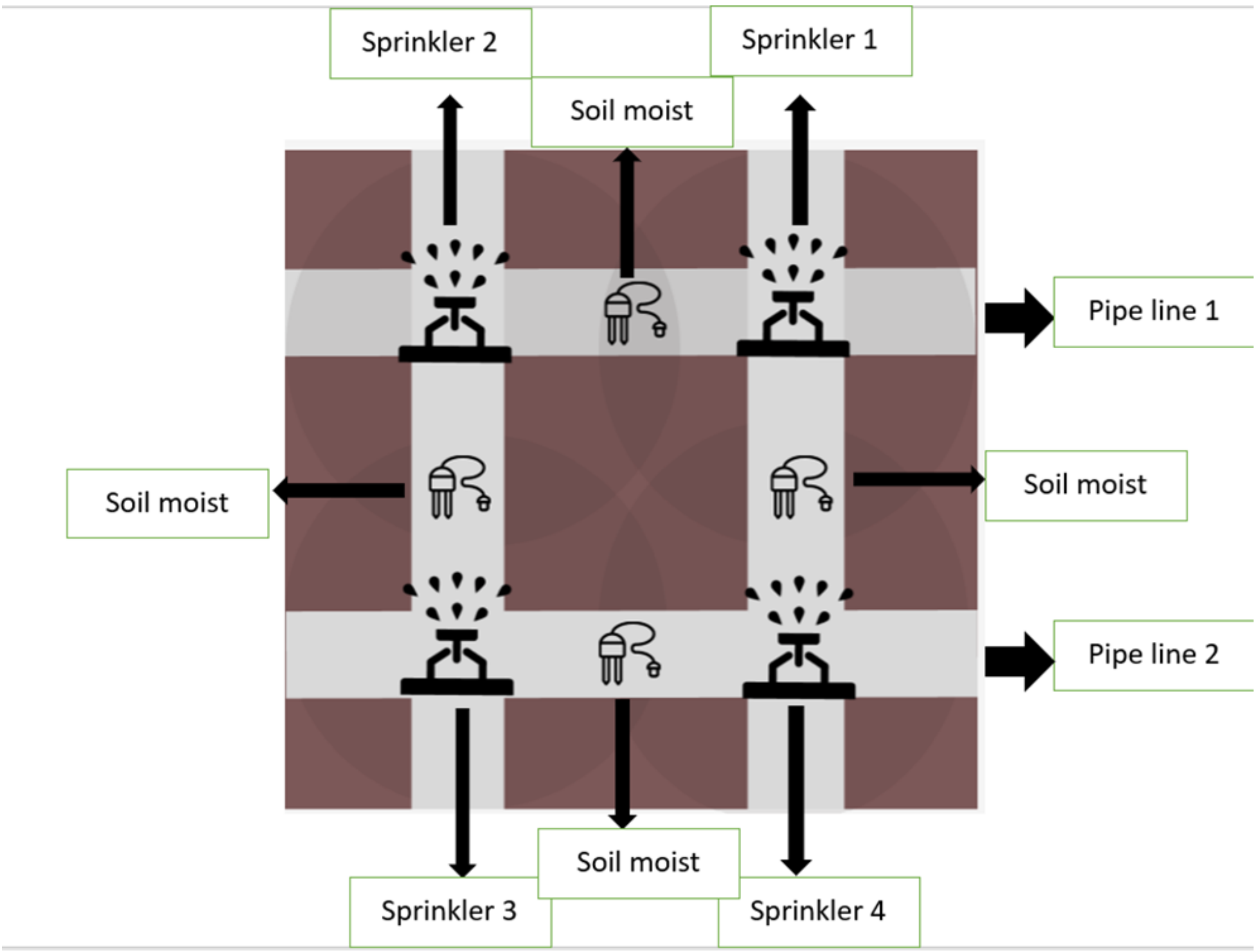
2. K.N.Manjula B.Swathi and D.Sree Sandhya, Intelligent Automatic Plant Irrigation System

3. G. Vellidis , M. Tucker, C. Perry, C. Kvien, C. Bednarz, “A Real Time Wireless Smart Sensor Array for Scheduling Irrigation”,National Environmentally Sound Production Agriculture Laboratory (NESPAL), 2007.

4. Constantinos Marios Angelopoulos,Sotiris Nikoletseas, Georgios Constantinos Theofanopoulos, A Smart System for Garden Watering using Wireless Sensor Networks, MobiWac ,October 31– November 4, 2011.

2.Overall Description

1.6 Product Perspective



The automated irrigation system automatically and continuously measures the moisture level in the soil using a monitoring unit that comprises of several sensors. The water pump at the water source is also fitted with a control unit. When the moisture level drops below a certain threshold, the system sends a wireless message to the water pump and the pipeline valves of the irrigation system. Once these valves receive the message, the power supply to the water pump and valves are altered to activate the pump and open the valves, causing water to flow through the system and water the soil in that particular region. When the moisture level rises above a certain level, the system sends a wireless message to the water pump and the pipeline valves in the irrigation system, altering the power supply to the water pump and valves to close them, causing water to stop flowing through the system and the pump to stop allowing water from the water source flow into the irrigation pipelines and into the soil in that particular region.
Figure shows the automated irrigation system used for localized irrigation for multiple land sections. As shown in Figure 11b, the automated irrigation system can be used to water grass, agricultural crops, flowers and even trees. The soil moisture content requirement for grass, agricultural crops, flowers and trees vary. In Figure 11b, the water requirements for each of the

three land sections will vary because what is being grown in each land section is different. When the measurement of the moisture sensor in Land Section 1 drops below the minimum moisture level for grass, it sends a wireless message to Valves V1, and V2, as well as the control unit for the water pump. This message causes the power supply to both valves and the water pump to be altered, switching on the water pump and the valves and allowing water from the well to flow into Land Section 1 only. When the measurement of the moisture sensor in Land Section 1 rises above the maximum moisture level for grass, it sends a subsequent wireless message to Valves V1 and V2 and the water pump, causing the power supply to both valves and the water pump to be altered, closing the valves and the water pump, preventing water flow from the reservoir to Land Section 1.

1.7 Product Functions

One of the major concerns is the generally poor efficiency with which water resources have been used for irrigation. A relatively safe estimate is that 40 percent or more of the water diverted for irrigation is wasted at the farm level through either deep percolation or surface runoff. These losses may not be lost when one views water use in the regional context, since return flows become part of the usable resource elsewhere.

Irrigation in arid areas of the world provides two essential agricultural requirements: (1) a moisture supply for plant growth which also transports essential nutrients; and (2) a flow of water to leach or dilute salts in the soil. Irrigation also benefits croplands through cooling the soil and the atmosphere to create a more favourable environment for plant growth.

The method, frequency and duration of irrigations have significant effects on crop yield and farm productivity. For example, annual crops may not germinate when the surface is inundated causing a crust to form over the seed bed. After emergence, inadequate soil moisture can often reduce yields, particularly if the stress occurs during critical periods. Even though the most important objective of irrigation is to maintain the soil moisture reservoir, how this is accomplished is an important consideration.

1.8 User Classes and Characteristics

There are two types of users that interact with the system: users of the mobile application, and administrators. Each of these three types of users has different use of the system so each of them has their own requirements.

The mobile application users can use the application to know about the irrigation status of the field. This means that the user get to know about the field, about the moisture present in the soil, its nutrient contents on a single click.

The administrators also only interact with the web portal. They are managing the overall system so there is no incorrect information within it. The administrator can manage the information for each type of crop as well as the options for the mobile application users.

1.9 Operating Environment

The system will peacefully work on windows operating system for both client and server. The proper hardware integration of the equipment is most important for using the application. The hardware requirement needed are

- Relay module
- Water pump
- Sprinkler
- Flow meter
- Node mcu 8266

- RTC sensor (DS3231)
- Jumper wires

1.10 Design and Implementation Constraints

The central processing unit will also include communication device to receive data from the sensors and to be relayed to the user's device. This will be done using a higher communication device such as a Wi-Fi module. The data processed by the central module is converted to meaningful data and relayed to the user. The user can view the data with the help of a handheld device such as a mobile phone or a tablet.
One of the most important constraint is internet for the application. Since, continuously data needs to be fetched from the database, so internet is needed for the application to function.

1.11 Assumptions and Dependencies

One assumption about the product is that it will always be used on handheld devices like mobile phones, tablets that have enough performance. If mobile does not supports enough resources like internet the application will not work.
The application is totally dependent on hardware components on of the field. If some errors occurs there then it will not work efficiently. The hardware requirements should be check regularly to check whether it is working well and good.
Another assumption is that the wifi module is sharing data efficiently about the field if not there may be scenarios where the application does not work as intended or even at all.

2. External Interface Requirements

2.1 User Interfaces

This will include the end user GUI. It will be an android app that will have buttons like login and Registration. A first time user will have to register first and and already registered user can login directly. Registration tab will contain all required information to be entered by the user. Once logged in, there will be a home dashboard which will provide information like soil moisture, sprinklers and the valve status, pipelines, motors, also the amount of water used. It will also provide information about next scheduled watering.

2.2 Hardware Interfaces

In our model, we are demonstrating watering of only small 2 by 2 grid, with 4 soil moisture and and 4 sprinklers. When the soil moisture sensor is interfaced with the board, the sensor reports values of resistances of the soil in which it is immersed into. As soil moisture sensor is analog, an inbuilt ADC in Arduino is used to convert into its digital form (0-1023), which represents resistance. Dry soil will have the maximum resistance and wet soil will have least resistance. Similarly, the temperature sensor (RTD) reports values of temperature in terms of resistance. If the temperature of the soil is high, then the sensor reports high value of resistance and vice versa. The servo motor is programmed to rotate from 0 to 180 degree. It is a 3.3V motor and does not require any driver. The rotating platform is attached on the motor to provide a base for the movement of the pipe. If the soil is dry, temperature sensor and moisture sensor values will be high, so the pump is turned on using a relay and switched off when the values reach a threshold .The vice versa is applicable for moist soil.

2.3 Software Interfaces

The software used in our project is Arduino IDE. It provides a number of libraries to make programming simple, such as NTP client, ESP 8366 WIFI AND WIFI udp. The program in software Arduino shows the working of sprinklers and soil moisture that will store in database and hence to be showed in app.

2.4 Communications Interfaces

There will be a server hosting our web application with an associated URL for domain user access. The user will be able to set watering schedules through the web application to send a signal to the central control unit to initiate watering. This must happen in a timely manner to ensure consistency between the scheduled start/end times and the actual start/end times.. This must be accomplished periodically in an accurate and timely manner in order to avoid errors and to ensure consistency throughout the system. There will be a DBMS that will store all data from soil sensor readings as well as all the information for the web application. This information includes user account information, settings, reports, and weather data necessary for the application to perform as expected. If the server fails to receive communication from the central control Unit for a specified period of time, it will notify the user that the system is offline.

3. System Features

3.1 Remote Access and Convenience

3.1.1 Description and Priority

This is one of the most important and impressive features of the entire project. It is due to this feature that we will be able to control the water flow to the plants. It is the highest priority feature of the entire project and it is this feature that compels us to implement the project using Arduino or NodeMCU.

3.1.2 Stimulus/Response Sequences

The system will measure the moisture content of the soil according to the sprinklers and that will be notify to the user through message or mails.

3.2 Cost Effective and easy installation

1The cost of the materials used isn't very high. This makes the system to be highly desirable for the farmers who will be the major consumers of this particular system. Also, the installation process is very easy. The device just needs to be installed directly into the soil in order to measure the soil moisture. The module required for sending messages to the user's phone will be installed inside the casing and hence no separate installation is required.

4. Functional Requirements

4.1 Node MCU

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SOC) called the ESP8266.

4.2 Relay

Relay modules use low-level data signals to switch relays capable of handling loads up to 10 Amps. Ideal for devices like PIR detectors and other sensors that output low level signals that need to turn another device on or off.

4.3 Soil Moisture Sensor

Soil moisture sensors measure the water content in the soil and can be used to estimate the amount of stored water in the soil horizon. Soil moisture sensors do not measure water in the soil directly. Instead, they measure changes in some other soil property that is related to water content in a predictable way.

4.4 Jumper Wires

Jumper wires are electrical wires with connector pins at each end. They are used to connect two points in a circuit without soldering. You can use jumper wires to modify a circuit or diagnose problems in a circuit.

4.5 Rain Sensor

Rain Sensor sends out a beam of infrared light that, when water droplets are on the windshield, is reflected back at different angles. This tells the system to activate the wipers, as well as adjust wiper speed and frequency based on the intensity of the precipitation combined with the vehicle's speed.

4.6 ESP 8266

The ESP8266 Wifi Module is a self-contained soc with integrated TCP/IP protocol stack that can give any microcontroller access to your Wifi network.

5. Other Nonfunctional Requirements

This section details all additional requirements for the project that do not directly fit in previous sections. All of the following requirements should be completed for the project to be deemed complete.
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5.1 Performance Requirements

5.1.1 Sensor Accuracy

1. Description: Proper sensor readings of soil moisture levels must be captured to ensure accurate and efficient watering schedules. This requires solid construction of the sensor modules and proper software analysis of the data provided by the sensors.
2. Constraints: Soil moisture sensors must be properly installed according to the provided instructions.
3. Priority: 2 – High Priority

5.1.2 Rain Detection

1. Description: In the event of rainy weather, the rain sensor must quickly transmit an alert to the control unit to interrupt or delay any active watering.
2. Constraints: The rain sensor must be properly placed and installed in order to ensure this functionality.
3. Priority: 3 – Moderate Priority

5.1.3 Communication between the Mobile Application and Central Control Unit

1. Description: The user will be able to set watering schedules through the web application to send a signal to the central control unit to initiate watering. This must happen in a timely manner to ensure consistency between the scheduled start/end times and the actual start/end times.
2. Constraints: None
3. Priority: 2 – High Priority

5.1.4 Communication between the Soil Moisture Sensors and Central Control Unit

1. Description: The soil moisture sensors will communicate with the central control unit to relay information about soil moisture levels. This must be accomplished periodically in an accurate and timely manner in order to avoid errors and to ensure consistency throughout the system.
2. Constraints: None
3. Priority: 2 – High Priority

5.2 Safety Requirements

This section specifies the various safety requirements associated with proposed system. The minimization of possible risk and/or injury to our customers is a top priority. Special attention is being applied to this section due to the nature of this project dealing with electricity and water.

5.2.1 Soil Moisture Sensor Insulation

1. Description: The electronic components of the soil moisture sensors must be properly insulated against external environmental conditions. This is to ensure that they do not malfunction while in use.
2. Constraints: None
3. Priority: 2 – High Priority

5.2.2 Proper Wiring of Central Control Unit

1. Description: The central control unit will be powered from an external wall plug.It is crucial that the control unit is wired properly to accept this input and cause no harm to the device or the user.
2. Constraints: None
3. Standards: NEMA 5–15R power connector
4. Priority: 1 – Critical Priority

5.3 Maintenance and Support Requirements

This section details the requirements for ongoing use of Master NODEMCU after its final delivery to the user. Achieving maximum long-term performance is the key to reducing product maintenance. These requirements aim to minimize system errors and hardware failures.

5.3.1 Sensor Maintenance

1. Description: The soil and rain sensors will be replaceable in the event of hardware failure.
2. Constraints: Replacement sensor must be compatible with the device.
3. Priority: 2 – High Priority

5.3.2 Software Maintenance

1. Description: All source code files and relevant documentation must be available for software maintenance and troubleshooting. The software will be split into loosely coupled parts so it would be easier to make changes and improvements to the system over time.
2. Constraints: None
3. Priority: 3 – Moderate Priority

5.3.3 Source Code Documentation

1. Description: All source code files required for system will be extensively commented to support future updates and troubleshooting.
2. Constraints: None
3. Priority: 3 – Moderate Priority

5.3.4 Scalability

1. Description: The central control unit will support adding additional slaves and slaves will support adding additional soil sensors.
2. Constraints: The central control unit will support up to 8 slaves and salves will further support up to 8 soil moisture sensors.
3. Priority: 2 – High Priority

6. Other Requirements

6.1 Rain Sensor Mounting

1. Description: The rain sensor must be placed outdoors in a location where there are no obstructions directly above it. The best placement for this sensor is on the roof of the user's home in a location where other water sources will not interfere with it.
2. Constraints: Rain sensor must be mounted in a location free from obstructions and must be properly connected to the central control unit.
3. Priority: 3 – Moderate Priority

6.2 Central Control Unit Mounting

1. Description: The central control unit must be mounted in a location where it can interface with wires and soil moisture sensors.
2. Constraints: Master NODEMCU should not be exposed to water.
3. Priority: 2 – High Priority

Appendix A: Glossary

IoT- Internet of Things is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data, creating opportunities for more direct integration of the physical world into computer-based systems, resulting in efficiency improvements, economic benefits, and reduced human exertions.