EverGreen

Software Requirements Specification

SE 409

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I. Project Drivers

1. The Purpose of the Project

1a. The User Business or Background of the Project Effort

This project is about developing software that will allow users to control and schedule watering of their landscape. This software shall run on an existing control panel hardware and communicate with different types of sensors and valves. The project is guided by the need for a more water-efficient and customizable watering system than what is currently available in the market. The primary users are homeowners who either already have an existing watering system and are looking for new software to control it or new users who are buying a brand new watering system. The users will use the system to control and automate the watering of their landscape.

1b. Goals of the Project

- To develop consumer software to control and automate a home's landscape watering system.
- To increase water-efficiency and customizability of the system compared to the competitors' systems.
- To provide users with flexibility by offering two watering modes.
- To increase the ease of watering large-scale landscapes.

2. The Stakeholders

2a. The Client

The sponsor is a person outside our organization who will own the developed system after the completion of the project. The client is responsible for describing the purpose of the system to be developed as well as the requirements for the system. The client will be during each step of the software development lifecycle and will have to approve the output before the team can move on to the next stage. The sponsor makes an investment into the product and will decide if the system satisfies all the requirements at the end of the process.

2b. The Hands-on Users of the Product

There will be one main category of hands-on users - homeowners. They will be responsible for installing the software on their control panels as well as for the initial setup of the system (by following the user manual). The users will also have to provide the system with all necessary information it needs for proper functioning (watering zones, desired moisture levels, maximum water usage, schedule). The users are expected to be knowledgeable about the process of watering their lawns. We expect users in two technological experience groups - novice and journeymen. Some users will have previously used similar watering systems and had a control panel at their homes. We also hope to attract new users with no prior experience with such systems. A typical user of the system is a resident of the United States of America older than 18 years of age and speaks American English. The system will account for the possibility that a user can have a disability.

II. Project Constraints.

3. Mandated Constraints

3a. Solution Constraints

1. *Description:* The product shall work with an existing system of valves and sensors.
   Rationale: Users will not pay for an entirely new watering system.
   Fit Criterion: Users having a pre-existing watering system will be able to add and use Evergreen software.
2. *Description:* The product shall run on different control panels with different operating systems.
   Rationale: User may have existing system using different OSs
   Fit Criterion: The product shall run on Linux, ChromeOS and Raspberry Pi OS
3. *Description:* The product should have 2 modes of operation; one manual and one automatic
   Rationale: Users may want to use different modes at different times.
   Fit Criterion: Users will be able to switch modes from the control panel.
4. *Description:* The product will allow users to control everything from the control panel only.
   Rationale: Users will find product more appealing if control all parameters and monitor reading from one place
   Fit Criterion: User will be able to set parameters for automatic mode and control individual valves from control panel and will see status of all valves and current set parameters from the control panel

3b. Partner or Collaborative Applications

Adjacent systems*: valves , sensors, control panel.*

Valves and sensors will be used from the previous existing system.

Users will enter parameters to the control panel along with selecting a mode(auto,manual). With this parameter data along with the real time sensor data and the valve status from the valves, the system will change the state of the valves i.e. turn them off and on.

3c. Anticipated Workplace Environment

The workplace is essentially a place in the home of the homeowner that is cool and dry.

The user will be standing up while working so each task shouldnt take longer than 5 minutes.

4. Naming Conventions and Terminology

4a. Definitions of All Terms, Including Acronyms, Used by Stakeholders Involved in the Project

Control Panel: A panel with which the user can change parameters of the system and monitor status.

Landscape: Area surrounding the user's home.

Maximum water usage: Critical water level value at which the system stops watering.

Mode: The method of operation(automatic and manual).

Moisture Level: Reads the amount of water in the soil, measured in %.

Parameter: A set factor by which the software will operate.

Water level: Reads the current amount of water usage by the system.

Zone: Set area of landscape that includes sprinklers and sensors.

5. Relevant Facts and Assumptions

5a. Facts

1. System will be used in household gardens/yards.
2. System will be operated by non-technical persons.
3. Watering of large zones without an automated watering system in place is tedious.
4. System will be deployed to existing watering systems.
5. Watering manually at a specific time on a watering schedule may be tough to do.
6. Only users with a passcode can access the system.
7. All systems will be entirely tested before users use it.

5b. Assumptions

1. Landscape watering will be done once a day.
2. All users understand the basic units of measurement.
3. All users can interact with the control panel.
4. All connections to valves and sensors are hardwired to the control panel.
5. All user data is held locally.
6. The product will be installed on a control panel stored in a cool dry environment.
7. Product updates (maintenance) are not included in the scope of this document.

III. Functional Requirements

6. The Scope of the Work

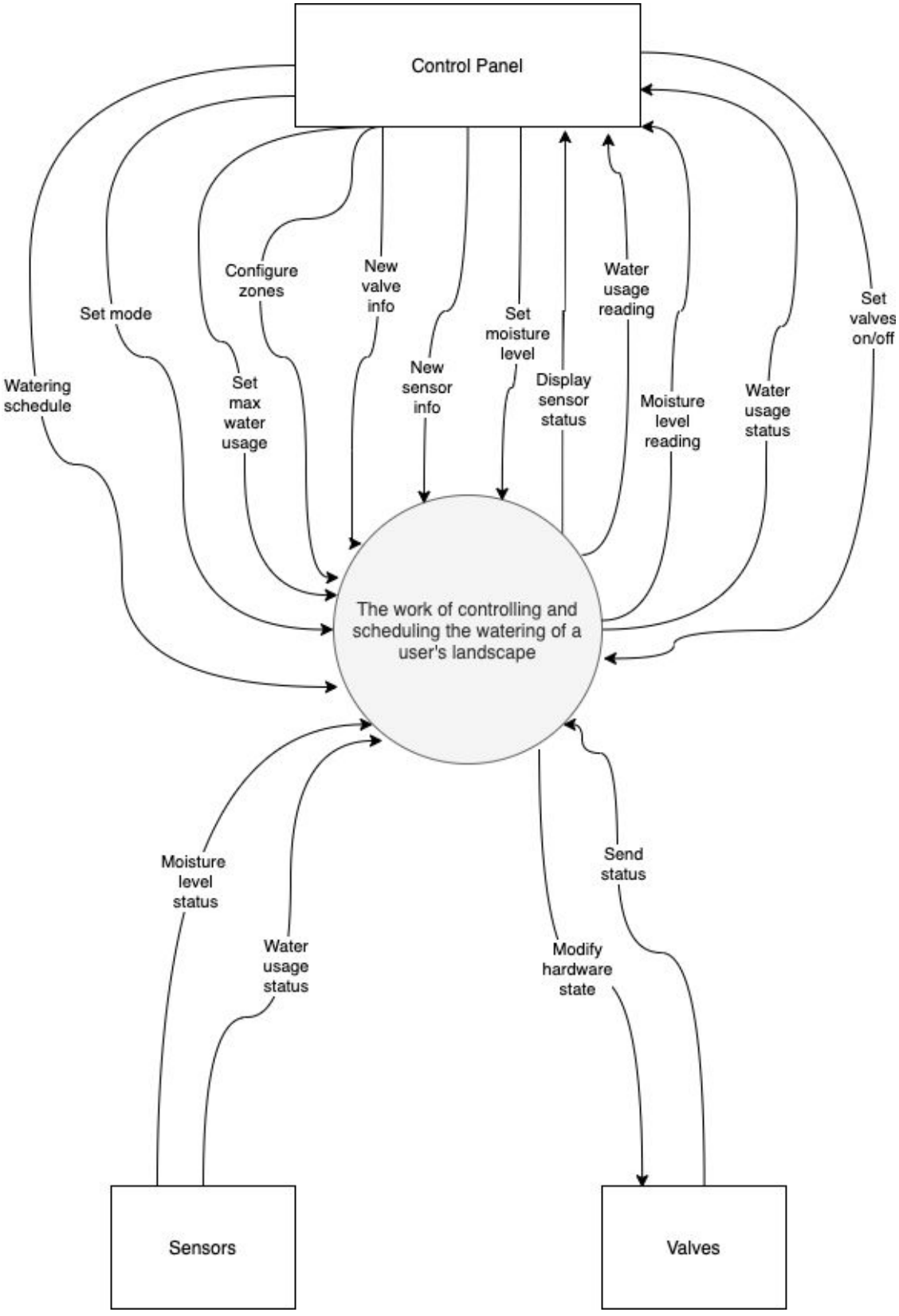

Fig.1. EverGreen Context Diagram

7. The Scope of the Product

7a. Product Boundary

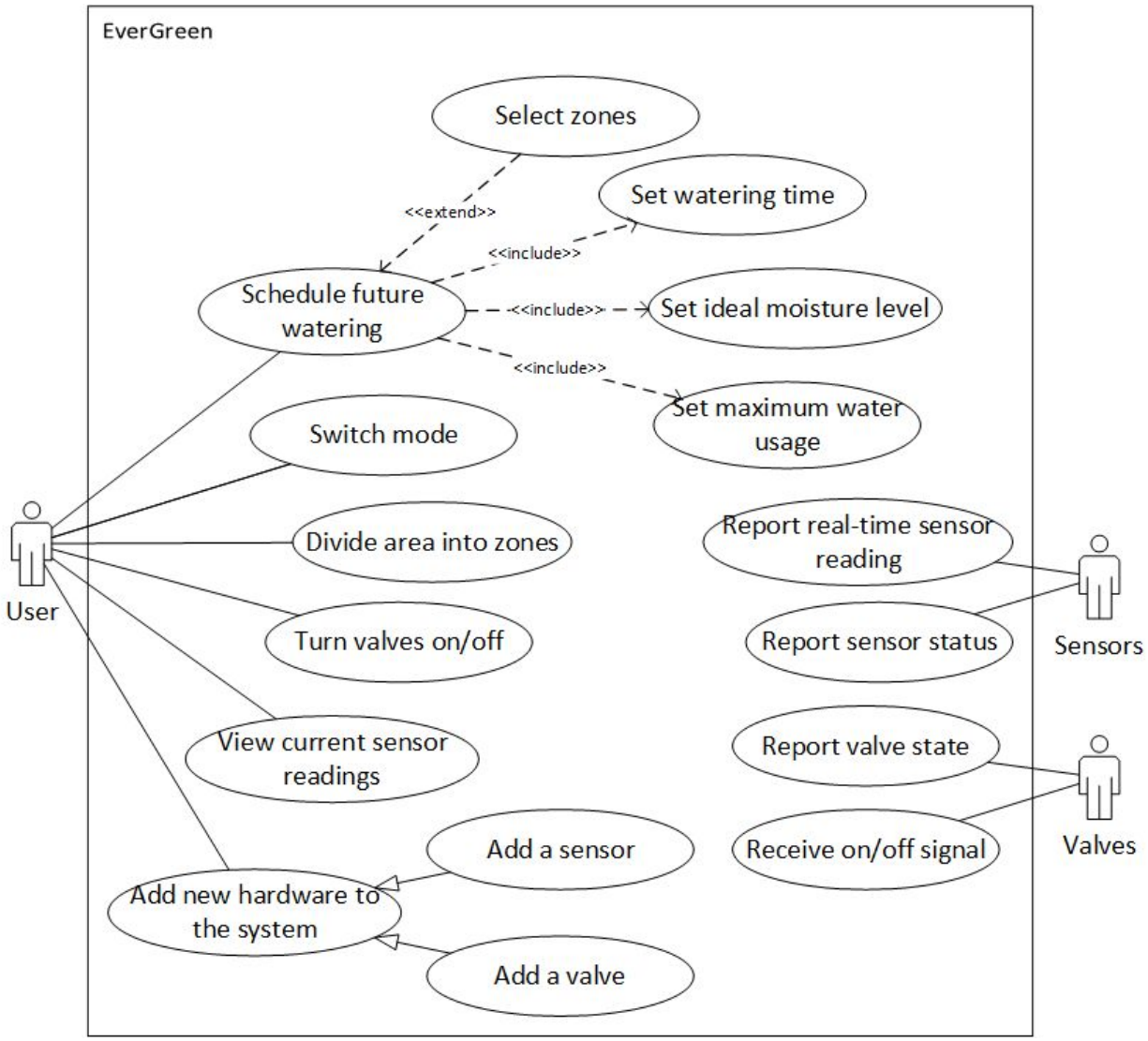

Fig.2. EverGreen Use Case Diagram

Use Cases:

UC1: Schedule future watering

UC2: Select zones

UC3: Set watering time

UC4: Set ideal moisture level

UC5: Set maximum water usage

UC6: Switch mode

UC7: Divide area into zones

UC8: Turn valves on/off

UC9: View current sensor readings

UC10: Add new hardware to the system

UC11: Add a sensor

UC12: Add a valve

UC13: Report real-time sensor reading

UC14: Report sensor status

UC15: Report valve status

UC16: Receive on/off signal

7b. Individual Product Use Cases

1) Set parameters

Users can set parameters for landscape watering via the control panel.

Product use case name: Set parameters.
Trigger: User selects set parameters from the configuration menu.
Preconditions: active moisture level sensors are present and connected, water usage sensors are present and connected.
Interested Stakeholder: User.
Actor: User.

i. The system prompts the user for parameters.
ii. User provides an ideal moisture level.
iii. User sets a maximum water usage value.
iv. User sets the desired watering time.
v. User chooses what watering zones will be affected.
vi. User confirms the changes.
vii. The system displays a confirmation dialog.

Outcome: New maximum water usage; watering time; watering zones; moisture level are recorded in the system. Automated watering is now bound by them.

2) Set parameters (Unwanted behavior)

Users can set parameters for landscape watering via the control panel.

Product use case name: Set parameters.
Trigger: User selects set parameters from the configuration menu.
Preconditions: active moisture level sensors are present and connected, water usage sensors are present and connected.
Interested Stakeholder: User.
Actor: User.

i. The system prompts the user for parameters.
ii. User provides an ideal moisture level.
iii. User provides a negative number for the maximum water usage level.
iv. The system displays an error message.
v. The system rejects the user inputs.

Outcome: System state is unaltered.

3) Turn valves on/off

In manual mode, users can direct valves opened/closed via the control panel.

Product use case name: Turn valves on/off.
Trigger: User selects manual valve control from the configuration menu.
Preconditions: The system is in the manual mode.
Interested Stakeholder: User
Actor: User

i. The system displays the current status of valves and lets the user choose a valve.
ii. User selects a valve to control.
iii. User toggles valve state.
iv. User confirms the action.
v. The system displays a confirmation dialog.

Outcome: New valve state is recorded and the state is changed.

4) Display status

The control panel shows the current status of the landscape watering system and related parameters of the environment.

Product use case name: Display status.
Trigger: User wakes up the control panel.
Preconditions: The system is on.
Interested Stakeholder: User
Actor: User

i. User enters the main system screen.
ii. The system displays its current status and related parameters of the environment.
iii. User reads the status of the landscape watering system and related parameters.

Outcome: User is aware of the current state of the system.

5) Assigning valves and sensors to zones

Users can assign zone numbers to valves and sensors

Product use case name: Assigning valves to zones
Trigger: User selects zone assignment from the configuration menu.
Preconditions: The system has at least 2 sensor
The system has at least 2 valves
Interested Stakeholder: User
Actor: User

I. The system displays the current valves and sensors
ii. The user selects a zone for each valve
iii. The user selects a zone for each sensor.
iv. User confirms the action.
v. The system displays a confirmation dialog.

Outcome: New valve and sensor zone assignments are recorded and changed.

8. Functional Requirements

Note: We're using the Value Rating method to determine the priority of the requirements. 1-3 - Low priority, 4-7 - Medium priority, 8-10 - High priority.

FR1: The system shall operate in one of the two modes: manual and automatic.
Use Case: UC6
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR2: The system shall provide a user with a way of switching modes via the control panel.
Use Case: UC6
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR3: The system shall display its current status - operating mode, scheduled watering time, malfunctioning valves or sensors - and related environmental parameters - moisture level, water consumption level.
Use Case: UC6, UC9, UC13, UC13, UC14, UC15
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR4: If the user enters a value greater than 100 for moisture level, the system shall reject the value and display an error message.
Use Case: UC4
Priority (1-10): 7 - Medium
- Satisfaction rating: 4
- Dissatisfaction rating: 3

FR5: When the water consumption reaches the maximum water level, the system shall close all the valves.
Use Case: UC5, UC16
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR6: The system shall support division of landscape into 1 to 32 zones.
Use Case: UC7
Priority (1-10): 5 - Medium
- Satisfaction rating: 3
- Dissatisfaction rating: 2

FR7: The system shall support only one moisture sensor per watering zone.
Use Case: UC11
Priority (1-10): 4 - Medium

- Satisfaction rating: 2
- Dissatisfaction rating: 2

FR8: The system shall support 1 to 32 valves per watering zone.
Use Case: UC12
Priority (1-10): 4 - Medium
- Satisfaction rating: 2
- Dissatisfaction rating: 2

FR9: The system shall display sensor data for each watering zone.
Use Case: UC9, UC13
Priority (1-10): 3 - Low
- Satisfaction rating: 2
- Dissatisfaction rating: 1

FR10: The system shall support simultaneous watering of each zone.
Use Case: N/A
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR11: When the user switches modes, then the system will operate according to the values used previously for that mode.
Use Case: UC6
Priority (1-10): 3 - Low
- Satisfaction rating: 2
- Dissatisfaction rating: 1

FR12: While in automatic mode, when the desired moisture level for a zone is reached, the system shall close all valves in the zone.
Use Case: UC4, UC16
Priority (1-10):
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR13: While in manual mode, the system shall accept and record the user's input about the status of the valves.
Use Case: UC8
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR14: While in automatic mode, the system shall accept and record the set user parameter for the ideal moisture level.
Use Case: UC4
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR15: While in automatic mode, the system shall accept and record the user parameter for maximum water usage.
Use Case: UC5
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR16: If the user enters a negative value or non-numerical value for desired moisture level or maximum water usage, the system shall reject the values and display an error message.
Use Case: UC4, UC5
Priority (1-10): 5 - Medium
- Satisfaction rating: 3
- Dissatisfaction rating: 2

FR17: While in automatic mode, the system shall accept and record user time settings for watering intervals.
Use Case: UC3
Priority (1-10):
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR18: The system shall provide the user with watering time values to choose from (e. g. Monday - Sunday, 12:00 am - 11:59 pm).
Use Case: UC3
Priority (1-10): 6 - Medium
- Satisfaction rating: 5
- Dissatisfaction rating: 1

FR19: While in automatic mode, the system shall accept and record parameters for individual watering zones.
Use Case: UC2, UC3, UC4, UC5
Priority (1-10): 4 - Medium
- Satisfaction rating: 3
- Dissatisfaction rating: 1

FR20: While in automatic mode, when the user provides only a total maximum water usage value, then the system shall compute maximum water usage for each zone individually.
Use Case: UC5
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR21: While in automatic mode, when the user provides new parameters, then the system shall recompute the watering parameters.
Use Case: UC2, UC3, UC4, UC5
Priority (1-10): 10 - High
- Satisfaction rating: 5

- Dissatisfaction rating: 5

FR22: When in automatic mode, when the current time reaches the watering time, the system shall start watering the landscape.
Use Case: UC1
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR23: While in manual mode, if one of the sensors/valves becomes inoperable, then the system shall inform the user by displaying a warning message.
Use Case: UC9, UC14, UC15
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR24: If one of the sensors/valves becomes inoperable, then the system shall close all valves in the corresponding watering zone and treat the zone as if it had reached the critical moisture level.
Use Case: UC14, UC15
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

FR25: While in automatic mode, the system shall not let the user control the valves.
Use Case: UC8
Priority (1-10): 10 - High
- Satisfaction rating: 5
- Dissatisfaction rating: 5

IV. Non-Functional Requirements

9. Non-functional Requirements

NFR1: The system shall record entered data fast.
Rationale: Users become annoyed when the system takes a long time to respond, and may forget what they wanted to do with the system next.
Fit criterion: The response time shall be no greater than a second 90% of the time, and no greater than 2 seconds for the remainder.

NFR2: The system shall be accurate.
Fit criterion: The system shall maintain desired parameters with an error margin no greater than 2%.

NFR3: The product shall support an easy addition of new sensors and valves.
Fit criterion: The user can register new equipment with the system in less than 5 minutes without any errors.

NFR4: The product shall support an easy addition of new watering zones.
Fit criterion: The user can modify the watering zones in the system in less than 5 minutes without any errors.

NFR5: The product shall retain past watering schedules and parameters for a month.
Rationale: The user may want to switch to past settings quickly.
Fit criterion: Past schedules are accessible for only the last 30 days, and older data is deleted.

NFR6: The product shall run on different control panels with different operating systems.
Fit criterion: The system shall run on control panels with the Linux operating system starting with version 17 and later.
Fit criterion: The system shall run on control panels with the Chrome operating system starting with version 75 and later.
Fit criterion: The system shall run on control panels with the Raspberry Pi operating system starting with version 2019-06-20 and later.

NFR7: The product shall be intuitive.
Rationale: New users must find the system easy-to-use, otherwise they will not use it.
Fit criterion: New users shall be able to create new watering schedules in the automatic mode or control valves in the manual mode within 5 minutes of their first encounter with the product without any outside help.

NFR8: The product's user interface shall make use of graphics to make it more appealing to the user.
Rationale: The users must like the system to start using it instead of the competitors' systems.
Fit criterion: 60% of the users will recognize the system as more appealing than the competitors' systems.

NFR9: The product shall be accessible to users with disabilities.
Rationale: The system shall be used by wider demographic groups.
Fit criterion: 95% of users with disabilities will be able to interact with the system after initial training.

NFR10: The product shall prevent access to the user's confidential information by unauthorized parties.
Fit criterion: The system shall only display data to users who provide a valid passcode.

NFR11: The product shall correctly compute maximum water usage for each zone.
Fit criterion: The system shall compute the maximum water usage by dividing the maximum water usage value by the number of valves in the system and then multiplying the result by the number of valves in each zone.

NFR12: The product shall use American English spelling.
Rationale: The product targets residents of the United States of America.

V. Project Issues

10. Open Issues

1. If a user does not have an existing watering system installed on their property, they will not be able to use our system. We do not know if our system will provide these individuals with the means to acquire the necessary hardware that is compatible with the system we are building.
2. Users must have installed equipment on their property to use our system. We are unsure how we can expect the hardware they have already installed to be seamlessly compatible with our system if there are many alternative options to consider.
3. Our system has sensors that will collect information such as water usage and moisture level. We do not know to what degree of accuracy they must be able to collect these measurements.
4. We do not know what kinds of sensors our system is expected to support.
5. Our system will be potentially installed in a variety of areas with different climates. We do not know how different climates will impact the operation of our system.

11. Costs

Function Point counting was used to approximate development costs.

UC1: Schedule future watering

References 3 classes: Schedule, WateringTime, Zone.

Classes have 21 attributes (estimate): Schedule (“id”, “watering_times”, “moisture_level”, “water_level”, “zones”, and 4 other), WateringTime(“day”, “time”, and 2 other), Zone (“name”, “id”, “valves”, “moisture_sensor”, “water_sensor”, and 3 other).

Watering schedule is an input from the user: From Fig. C4, FP = 6

Starting watering is a timed triggered output: Fro Fig. C8, FP = 6.

UC2: Select zones

References 2 classes: Schedule, Zone

Classes have 17 attributes (estimate): Schedule (“id”, “watering_times”, “moisture_level”, “water_level”, “zones”, and 4 other), Zone (“name”, “id”, “valves”, “moisture_sensor”, “water_sensor”, and 3 other).

Watering zones are an input from the user: From Fig. C4, FP = 6

UC3: Set watering time

References 2 classes: Schedule, WateringTimes

Classes have 13 attributes (estimate): Schedule (“id”, “watering_times”, “moisture_level”, “water_level”, “zones”, and 4 other), WateringTime(“day”, “time”, and 2 other).

Watering times are an input from the user: From Fig. C4, FP = 4.

Recomputed values due to changes in inputs are system outputs: From Fig. C6, FP = 5.

UC4: Set ideal moisture level

References 2 classes: Schedule, MoistureLevel

Classes have 12 attributes (estimate): Schedule (“id”, “watering_times”, “moisture_level”, “water_level”, “zones”, and 4 other), MoistureLevel (“desired_level”, “current_level”, and 1 other).

Desired moisture level is an input from the user: From Fig. C4, FP = 4.

Recomputed values due to changes in inputs are system outputs: From Fig. C6, FP = 5.

UC5: Set maximum water usage

References 2 classes: Schedule, WaterConsumptionLevel

Classes have 13 attributes (estimate): Schedule (“id”, “watering_times”, “moisture_level”, “water_level”, “zones”, and 4 other), WaterConsumptionLevel (“max_level”, “current_level”, and 2 other).

Maximum water consumption level is an input from the user: From Fig. C4, FP = 4.

Recomputed values due to changes in inputs are system outputs: From Fig. C6, FP = 5.

UC6: Switch mode

References 1 class: OperationMode.

The class has 3 attributes (estimate): mode, and 2 other attributes.

Operation mode is an input from the user: from Fig. C4, FP = 3.

Recomputed values due to changes in inputs are system outputs: From Fig. C6, FP = 4.

UC7: Divide area into zones

References 2 classes: Landscape, Zone.

Classes have 13 attributes (estimate): Landscape (“area”, “zones”, “location”, and 2 other), Zone (“name”, “id”, “valves”, “moisture_sensor”, “water_sensor”, and 3 other).

Dividing landscape is an input from the user: from Fig. C4, FP = 4.

UC8: Turn valves on/off

References 1 class: Valve

The class has 5 attributes (estimate): Valve (“id”, “alias”, “state”, “zone_id” and 1 other).

Valve status is an input from the user: from Fig. C4, FP = 3.

UC9: View current sensor readings

References 2 classes: MoistureLevelReading, WaterConsumptionReading.

Classes have 14 attributes (estimate): MoistureLevelReading (“timestemp”, “sensor_id”, “value”, “zone_id”, and 3 other), WaterConsumptionReading (“timestamp”, “sensor_id”, “zone_id”).

Sensor readings are system outputs: From Fig. C6, FP = 5.

UC10: Add new hardware to the system

See the following two use cases.

UC11: Add a sensor

References 2 classes: Zone, Sensor

Classes have 12 attributes (estimate): Zone (“name”, “id”, “valves”, “moisture_sensor”, “water_sensor”, and 3 other), Sensor (“id”, “zone_id”, and 2 other)

New sensor information is an input from the user: From Fig. C4, FP = 4.

UC12: Add a valve

References classes: Zone, Valve

Classes have 13 attributes (estimate): Zone (“name”, “id”, “valves”, “moisture_sensor”, “water_sensor”, and 3 other), Valve (“id”, “alias”, “state”, “zone_id”, and 1 other).

New valve information is an input from the user: From Fig. C4, FP = 4.

UC13: Report real-time sensor reading

References 2 classes: Sensor, SensorReading

Classes have 9 attributes (estimate): Sensor (“id”, “zone_id”, and 2 other), SensorReading (“timestamp”, “sensor_id”, “zone_id”, “value”, and 3 other).

Sensor readings are system inputs from the sensors: From Fig. C4: FP = 4.

UC14: Report sensor status

References 2 classes: Sensor, SensorStatus

Classes have 8 attributes (estimate): Sensor (“id”, “zone_id”, “state”, and 2 other), SensorStatus (“sensor_id”, “timestamp”, “status”).

Sensor status is a system input from the sensors: From Fig. C4, FP = 4.

UC15: Report valve status

References 2 classes: Valve, ValveStatus

Classes have 8 attributes (estimate): Valve (“id”, “alias”, “state”, “zone_id”, and 1 other), ValveStatus (“valve_id”, “timestamp”, “status”).

Valve status is a system input from the valves: From Fig. C4, FP = 4

UC16: Receive on/off signal

References 1 class: Valve

The class has 5 attributes (estimate): Valve (“id”, “alias”, “state”, “zone_id”, and 1 other).

Valve status is a system output: From Fig. C6, FP = 4.

Total number of function points: 88.

Effort in person months = $\frac{FP}{150} * FP^{0.4} = \frac{88}{150} * 88^{0.4} \approx 0.59 \times 6 \approx 3.5\ person-months$