Smart Garden

Requirements Specifications

California State University, Long Beach -- Fall 2016
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EXECUTIVE SUMMARY

Southern California currently has a drought problem with the bulk of the water being used by agriculture. The agriculture sector consumes 80% of the water in California. The Smart Garden is an autonomous controlled garden that efficiently and effectively grows plants. With the Smart Garden, farmers will be able to use less water while growing their agriculture with greater ease.

SYSTEM VISION

While the idea of a small "smart" personal garden may seem to have limited scope, if this type of technology is adopted in large enough numbers it can be begin to have a huge impact. The scope can quickly go beyond a interested hobbyist, to a local farmer's market, to small commercial sellers and may even influence large scale producers. If the method is simple enough to put in place in a variety of systems, economically viable and is efficient in its use of resources then the product will no longer be viewed as a small enthusiasts weekend project but as an actual alternative to traditional farming methods. If we can at least begin to start the conversation of smart technology and farming then this project will be a major success.

STAKEHOLDER GLOSSARY

Stakeholder — A stakeholder is any entity that has an interest in the architecture or performance of a particular system. Stakeholders have an impact on the system on various levels and magnitudes. Each stakeholder may also have varying interests and requirements for the system.

Project Manager — *Birgit Penzenstadler*

The project manager is typically the primary stakeholder of the system and generally has the most control and influence over the system vision. The typical concerns of the project manager include the behavior, performance, budget, deadlines, and intended use of the system. The project manager may consider the interests of other external stakeholders and government agencies to further specialize any requirements.

Engineers

Engineers are stakeholders who are interested in the the design, architecture, and quality of the system. Engineers have a high degree of impact on the behavior of the system and can influence the system in many aspects. Engineers typically receive requirements from stakeholders

Requirements Engineer

The requirements engineer is responsible for gathering the prerequisites of the system in terms of behavior, performance, cost, and any aspect that may impact the system from the interests elicited from the project manager and other stakeholders. The requirements are then implemented by various engineers and developers.

Software Engineer

The software engineer is responsible for planning and designing the codebase of the system based off given requirements. Other duties may include determining team methodology for the development team, gathering information of tools and resources required for the project, and enforcing the best coding practices to developers.
The roles of software engineers and developers may overlap, but the tasks of a software engineer are typically geared towards the design and planning of the system rather than actual implementation of the code.

Test Engineer

The test engineer is a stakeholder responsible for analyzing and assessing the quality of both software and hardware of the system. The test engineer collaborates with the developers to ensure the product behaves as expected. The main concern of the test engineer is to find flaws in product quality that may be hazardous, or may cause the product to differ from expected behavior.

Developers

A developer is a stakeholder that is responsible for implementing various aspects of the system. Developers have close interaction to the performance and behavior of the system, and therefore may have a high degree of impact on the system. There are two types of developers related to the development of the Smart Garden system.

Software Developer

Software developers are responsible for programming the microcontroller to meet given system requirements received from software engineers. This includes programming the interactions between software and hardware, such as the behavior of any autonomous humidity controlling device that may be implemented. Concerns of the software developer includes implementing efficient, expected behavior of system requirements, and to also address any safety concerns that may be discovered by test engineers.

Web Developer

Web developers are responsible for designing and maintaining the web application used to access the system. Web developers are also responsible for maintaining a database of users for the web application in order to track each users' unique Smart Garden controllers. Other concerns of web developers may include designing the security of the web application, such as implementing proper user input sanitization to avoid any malicious activity that may occur.

External Stakeholders

An external stakeholder is an entity with an interest to the system, but do not have direct control or interaction with the development of the system itself. Though external stakeholders may lack thorough technical knowledge of the system, they can still have an indirect, but significant impact on the system.

Friendly Stakeholders

A friendly stakeholder is any entity that has an interest in the system and may benefit the system in some way. Water conservation groups and environmental sustainability organizations, such as Cal State University, Long Beach's Sustainability Club, support the Smart Garden system through encouraging the development and use of environmentally sustainable technologies.

Resource Suppliers

A resource supplier is an external stakeholder in the form of a tool or resource used by the system, which are generally determined under the discretion of software engineers.
The hardware for the Smart Garden system is supplied by Raspberry Pi, and the physical server space is provided by California State University, Long Beach.
The software for the Smart Garden system is supported by Adafruit's open source library to control DHT22 sensors and the soil moisture sensor. Other tools include Github for version control and Google's various services for communication and document collaboration. Various scholarly sources and research gathered from various Internet databases also help the Smart Garden team determine ideal conditions for certain plants.

Public Users

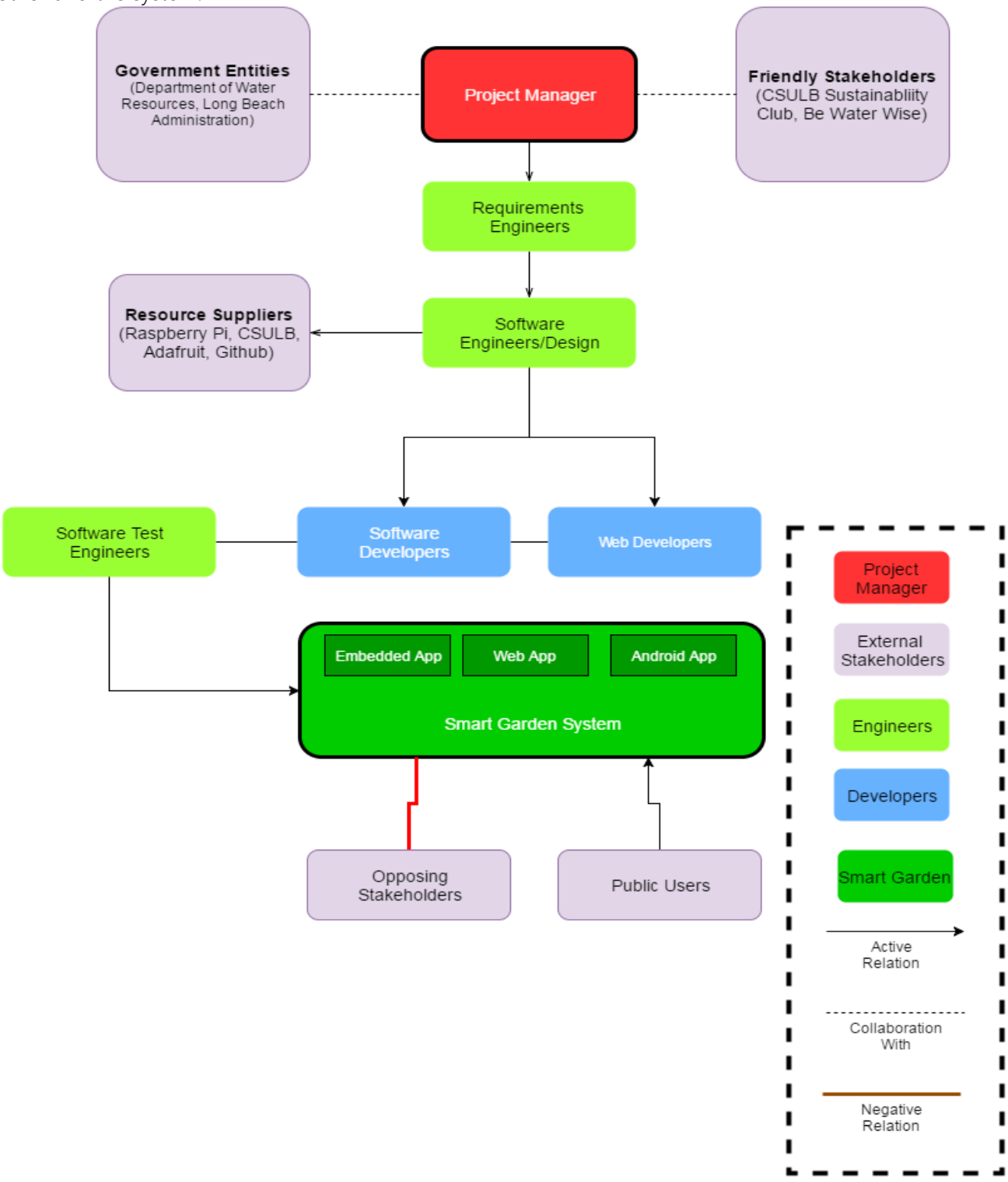
Public users are those who will use the Smart Garden system. Currently, the system is small scale and aimed towards novice gardeners to use as a learning tool. However, with success of the Smart Garden, it may possible to be eventually use the Smart Garden system in large scale settings, such as farms. Users may be concerned with the performance of the website and accuracy of the Smart Garden system and are primarily interacting with the front end web application.

Opposing Stakeholders

An opposing stakeholder is any entity that shows interest in the system in a negative manner. Opposing stakeholders typically disapprove of the system due to the system objective conflicting with their own personal interests.

STAKEHOLDER MODEL

The following model shows the various types of stakeholders and how they are related to each other and the system.



GOAL MODEL

Business Goals

- Conserve water
- Create a means to produce vegetables/herbs easily
- Open the dialog for more green technologies
- Teach the average user to be able to go into a larger grow operation

Usage Goals

- Conserve water
    - Set limits on water moisture levels
    - Determine what kind of environment a plant will need
    - Monitor usage of water for device
    - Educate on efficient water usage for different plants

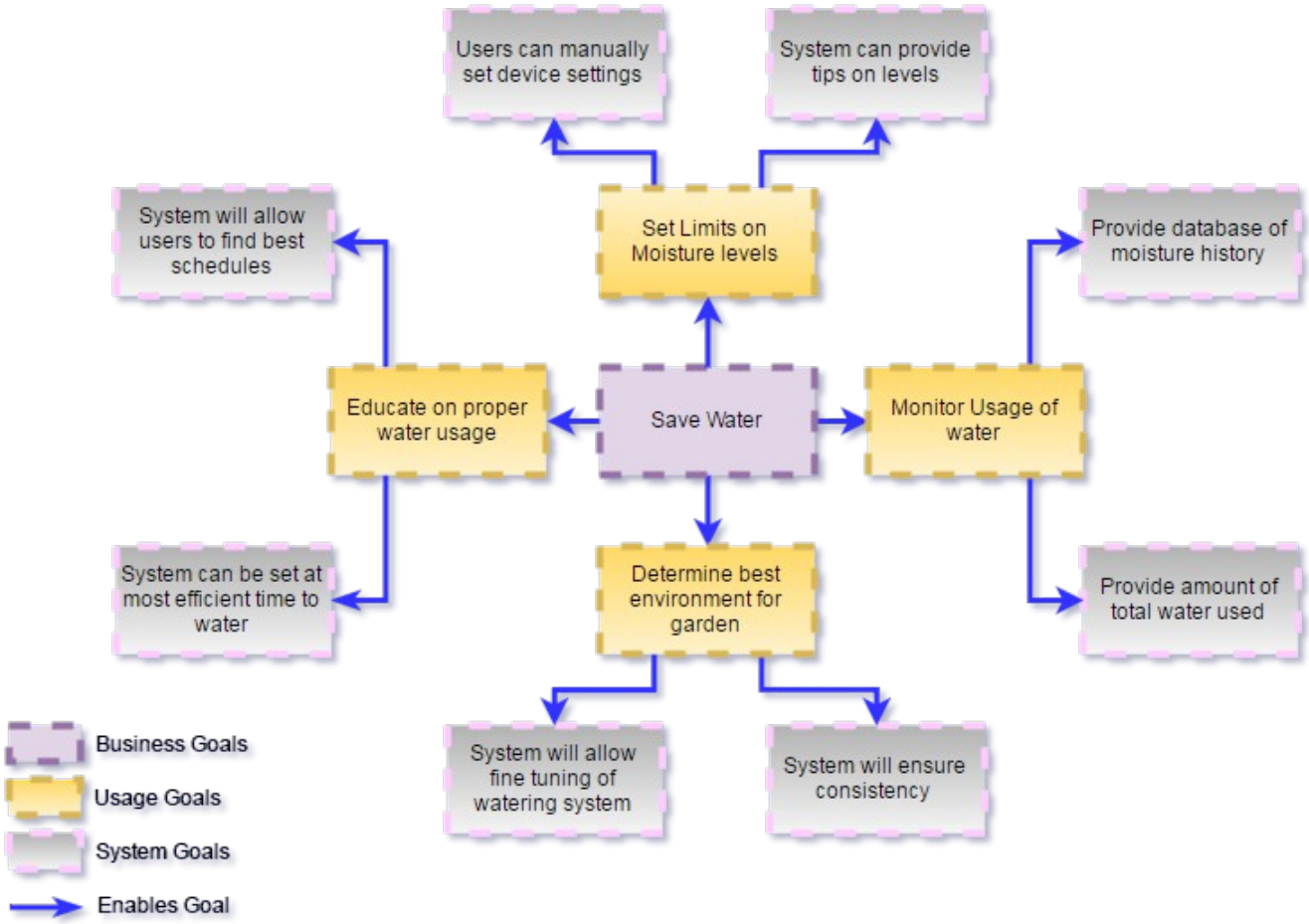
- Create a means to produce for consumption
    - Give user tips on how to begin the gardening process
    - Create a low barrier of entry
    - Can manage multiple gardens from multiple devices

- Open the dialog for more green technologies
    - Show users difference in organic produce
    - Enable users to make informed decisions about more sustainable ideas
    - Show the simplicity of system to interest gardener to find new methods
    - Show users difference that can be made with small micro-management

- Teach the average user to grow larger scale
    - Enable users to create small incubation gardens
    - Allow a user to create scaled up versions of small gardens
    - Introduces new methods to current gardeners

GOAL MODEL (continued)

The following diagrams show the relationships present between business goals, usage goals, system goals, and the requirements of the system.



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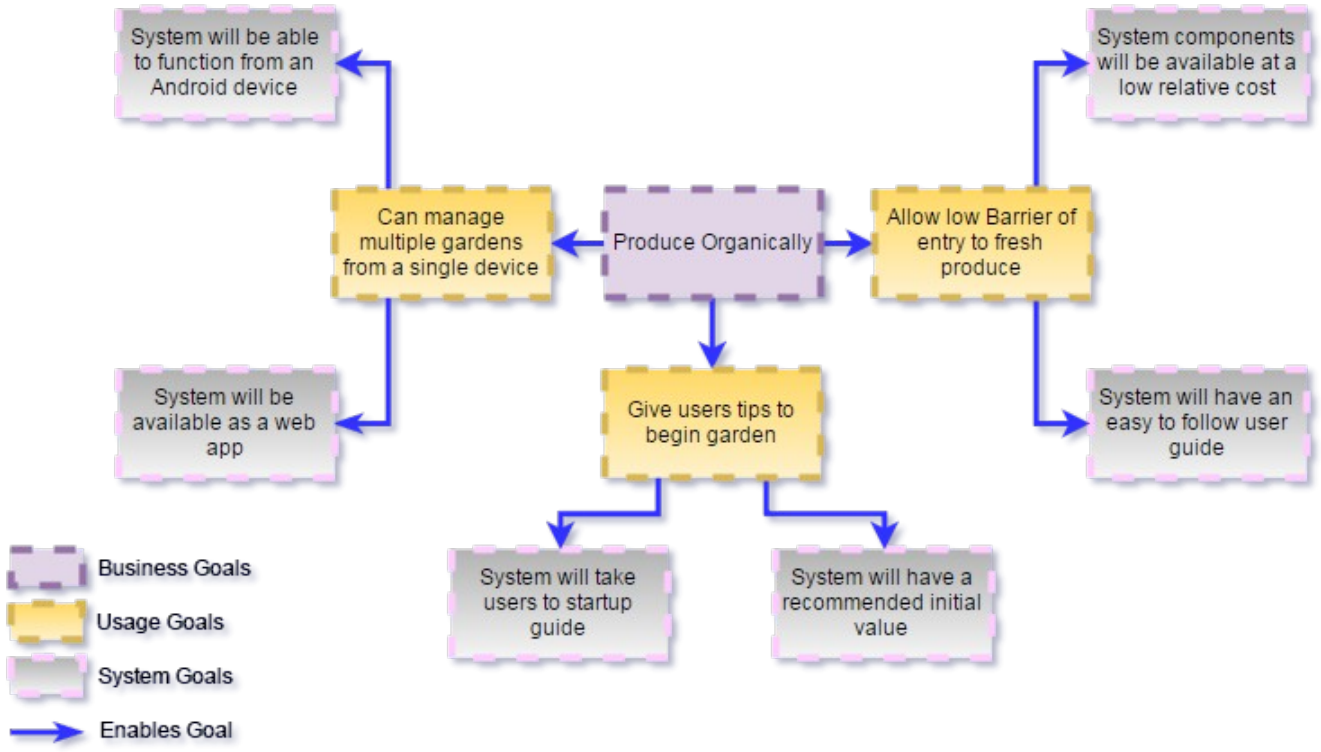

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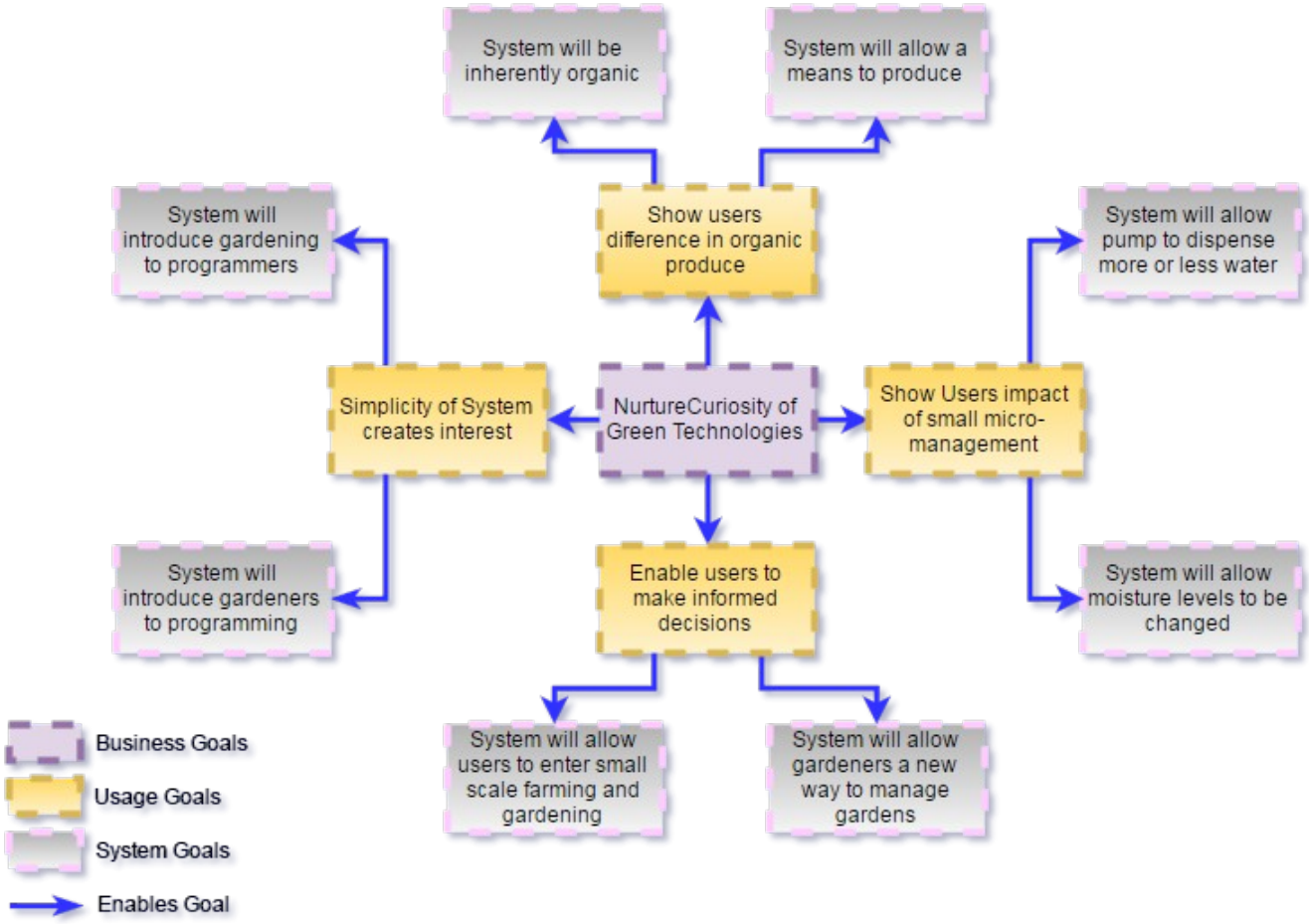

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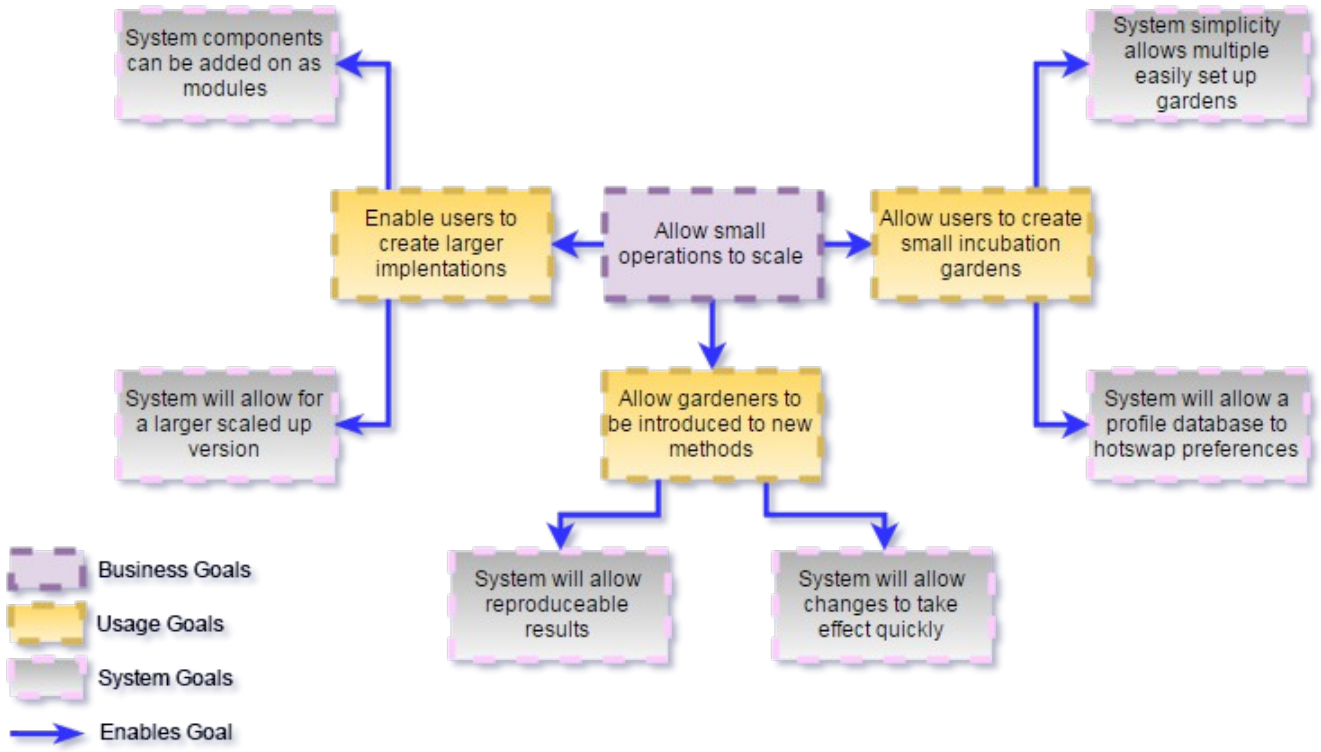

USAGE MODEL

In order to clarify requirements, several user stories have been designed in order to ensure delivery of a high quality product.

Story Title	User Signs Up
User Story	As a user, I want to register my system, So that I can monitor my garden
Acceptance Criteria	1. Given that the system has been registered, when user enters a duplicate username, then ensure error message displayed “Username already exists” 2. Given that user does not enter required information in fields, when user clicks on register, then ensure message is shown “Information Missing” and blank fields are highlighted. 3. Given that this a new system, when user enters system information, then ensure user is successfully signed up and is sent to user "Welcome Screen on app"

Story Title	User logs in
User Story	As a user, I want to login to my account, So that I can see my garden's information
Acceptance Criteria	1. Given that the user does not have an account, when the user enters log-in information, then an error message should appear “Invalid Username.” 2. Given that the user has an account, when the user enters the wrong password, then ensure a message is displayed “Invalid Password.” 3. Given that the user has an account, when user enters username and password, then user should see the "Welcome Screen"

USAGE MODEL (continued)

In order to clarify requirements, several user stories have been designed in order to ensure delivery of a high quality product.

Story Title	User Logs Out
User Story	As a user, I want to logout, So that no one else can change or access my system.
Acceptance Criteria	1. Given that the user is logged in, when user clicks on the back button, then the user should be brought back to Login screen.

Story Title	User changes moisture level
User Story	As a user, I want to adjust the humidity, So that the pump will activate at the correct time.
Acceptance Criteria	1.Given that the user is not logged in, the user cannot change the current moisture level. 2. Given that the moisture level entered is outside of limits,when the gardener enters moisture level, then ensure an error message is displayed. 3. Given that the user is logged in, when the gardener changes the moisture, then ensure moisture level is updated through out the system.

USAGE MODEL (continued)

In order to clarify requirements, several user stories have been designed in order to ensure delivery of a high quality product.

Story Title	User wants to view history
User Story	As a user, I want to view the history of my garden So that I can analyze the data.
Acceptance Criteria	1. Given that the user is logged in, when the user clicks on view history of information (humidity, temperature, water usage, etc.), then a graph with information selected is displayed over specified time period (day, week, month, year) 2. Given that the user is viewing history, when the user clicks on different time period, then graph should update to display information only for that time period. 3. Given that the user is viewing history, then user should see arrows to move forward or backward. 4. Given that the user is viewing history, then the user should see buttons for different time periods. 5. Given that the user is viewing the most up to date history, an arrow pointing forward should not appear.

Story Title	User wants to view user manual
User Story	As a user, I want to view the user manual So that I can properly set up my system.
Acceptance Criteria	1. Given that the user is on the website, when the user clicks on help manual, then user should see instructions on how to set up system and use system. 2. Given that the user has downloaded the Smart Garden app, when the user clicks "Startup Guide" they will be taken to the website guide.

DETAILED REQUIREMENTS

Functional Requirements

Web Application.

- Display moisture, humidity, temperature of the soil for each user.
- Allows user to create a new garden or modify a pre-existing garden.
- Allow user to set moisture levels.
- Allow user to view startup guide and parts list.

Embedded Application

- Detects the humidity, moisture, and temperature of the soil through a peripheral sensor.
- Sends user data from the soil to the database server every time interval.
- Monitors the amount of water being used to maintain the soil.
- Sends data related to water use to the database server.
- Activates pump when moisture level is below current setting

Quality Requirements

Web Application

- **Mobile Friendly**

  The web application should be accessible through a mobile phone without any distorted content.

- **Aesthetically Appealing**

  The layout of the web application should be visually appealing to the user in both desktop and mobile settings.

- **Organized**

  All content should be easily accessible and organized in a logical manner.

- **Fast Performance**

  Any important notifications should promptly notify the user in order to maintain ideal conditions for the garden.

Embedded Application

- **Safety**

  The embedded application will not be able change settings to dangerous levels.

- **Usability**

  The embedded board and sensor should be easy and intuitive to use with the user manual.

Internal Requirements

- **Readability**

  All code should be well organized with consistent styling rules and thorough comments that explain code.

- **Modularity**

The application is to be designed with logically divided components of code in order to promote flexible design.

- **Scalability**

The system is to be designed with scalability in mind. This allows the system to be easily ported for large scale use in the future.

- **Robustness**

The system is to be designed to prevent abnormal termination or unexpected actions which may cause the system to function incorrectly.

External Requirements

- **Cost Efficient**

The entire system should be cost efficient and affordable in order to be used by others interested in the Smart Garden technology.

- **Weatherproof**

The system should be weatherproof in order to be used with other systems that may be used in harsh environments.

Constraints

- **Limited Scale**

The system will be primarily tested in a small scale setting, therefore the system may not perform the same when implemented on a larger scale with several sensors.

- **Small Garden Size**

The size of the garden may affect the accuracy of the sensors, therefore we must have a consistent setting for our initial gardens and determine the most accurate method of collecting data.

- **Limited Time**

Plants may take time to grow, and sometimes may unexpectedly die from various factors.
The current engineers developing the Smart Garden system are only adjusting the moisture level of the garden, any imbalance with nutrients are out of scope of this system.