Software Requirements Specification farm.bot

Group 17

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Revision History

Author	**Date**
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1. Introduction

This Software Requirements Specification (SRS) document is prepared for the purpose of providing a clear and structured information about the “farm.bot” open-source project which is an automation software composed of “farm.bot web application”, “farm.bot OS” and “farm.bot Arduino firmware” softwares.

1.1. Purpose of the System

farm.bot project seeks to automate and optimize farming operations to a more efficient and sustainable level. The main purpose of this system is to ease the process of planting, nurturing and harvesting crops for individual gardeners and small-scale famers via an easy-to-use web interface, structured hardware design to reduce labor costs and up to date crop database to increase efficiency.

1.2. Scope

The scope of farm.bot system includes the development and arrangement of an automated robot capable of achieving multiple farming tasks, from seed injection and watering through monitoring crop health.

Key Features and Capabilities:

- Farming setup and customization
- Manual movement control
- Seed injection
- Regiment creation
- Weed detection
- Soil moisture measuring and watering
- Environmental monitoring via sensors

1.3. System Overview

1.3.1. System Perspective

Farm.bot is a stand-alone system that interacts with external services such as a crop database called OpenFarm.cc and Farm.bot cloud services that uses google cloud storage. Farm.bot utilizes Raspberry Pi as its single board computer to run Farm.bot OS and Arduino as its microcontroller to interact with its sensors to offer a semi-autonomous device.

User interacts with Farm.bot Web Application to create the farm they desire and sends instructions to the controller. Farm.bot OS then follows the instructions according to the crop information from its database. System’s main hardware “Farmbot Genesis” injects seeds and waters them.

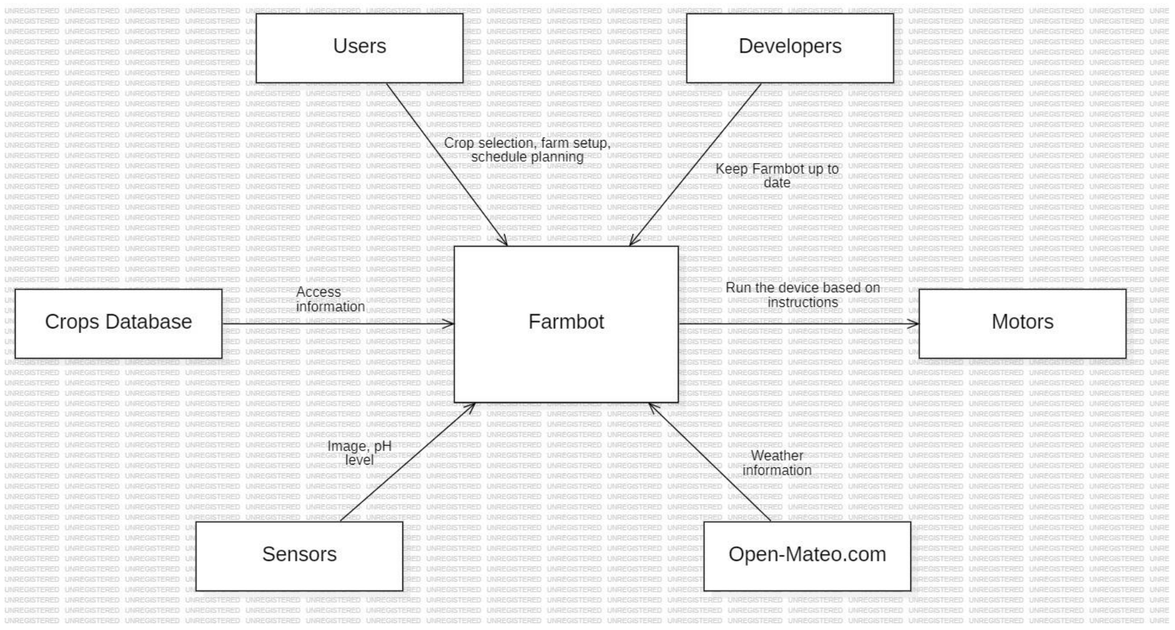


Figure 1: Context Model

1.3.1.1. System Interfaces

External Data Interfaces:

Farm.bot utilizes external data interfaces to manage the user's local farm and to offer the best actions. It uses a crop database to gather information to utilize operations.

Sensor Management Interface:

This system allows Farm.bot to take actions according to the information present in the local farm such as the crops location, weeds, pH levels of the soil, age of plants and more.

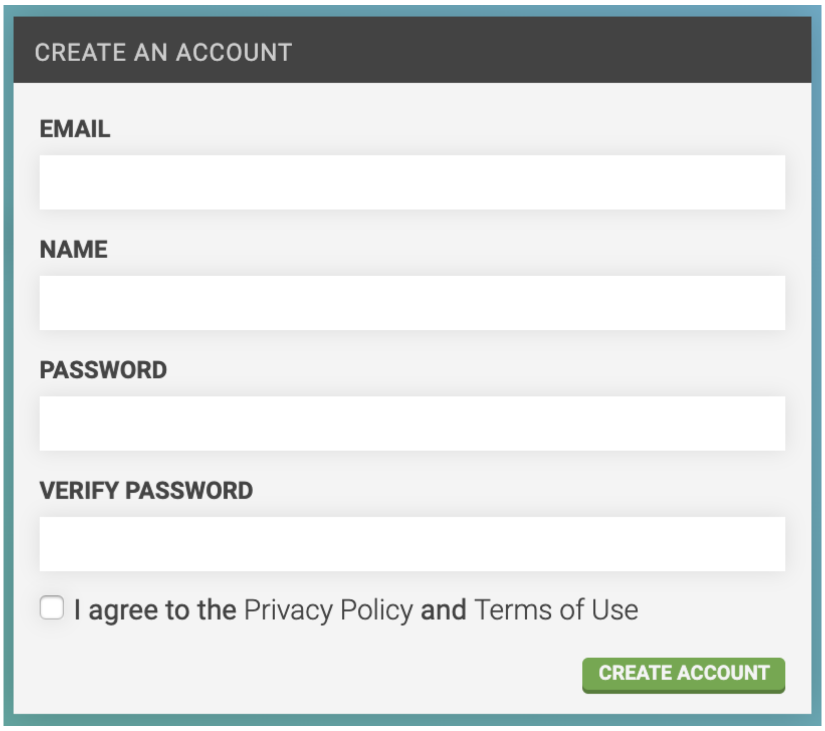
Farm.bot Web Application:

This application allows users to design and manipulate their farm and set up schedules. Then selected preferences directed to the Farm.bot OS to start the process.

1.3.1.2. User Interfaces

The user interface is handled mostly within Farm.bot Web Application, which is an easy-to-use drag and drop based system, illustrating the basic map of the garden with progress bars and various settings. Farmbot web application is available for any device with browser and internet access.

Registration Interface: To manage a farm using Farm.bot, users first need to create an account. Users must simply enter their email address, their name and then set up a password to get started.


CREATE AN ACCOUNT

EMAIL

NAME

PASSWORD

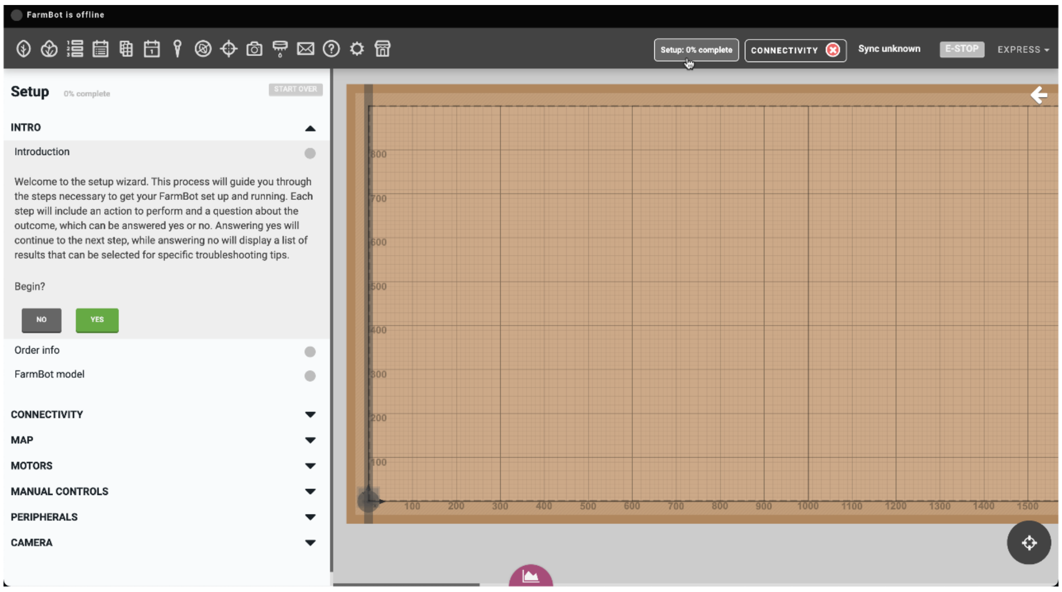
VERIFY PASSWORD

☐ I agree to the Privacy Policy and Terms of Use

CREATE ACCOUNT

Figure 2: farm.bot Web Application Registration Interface

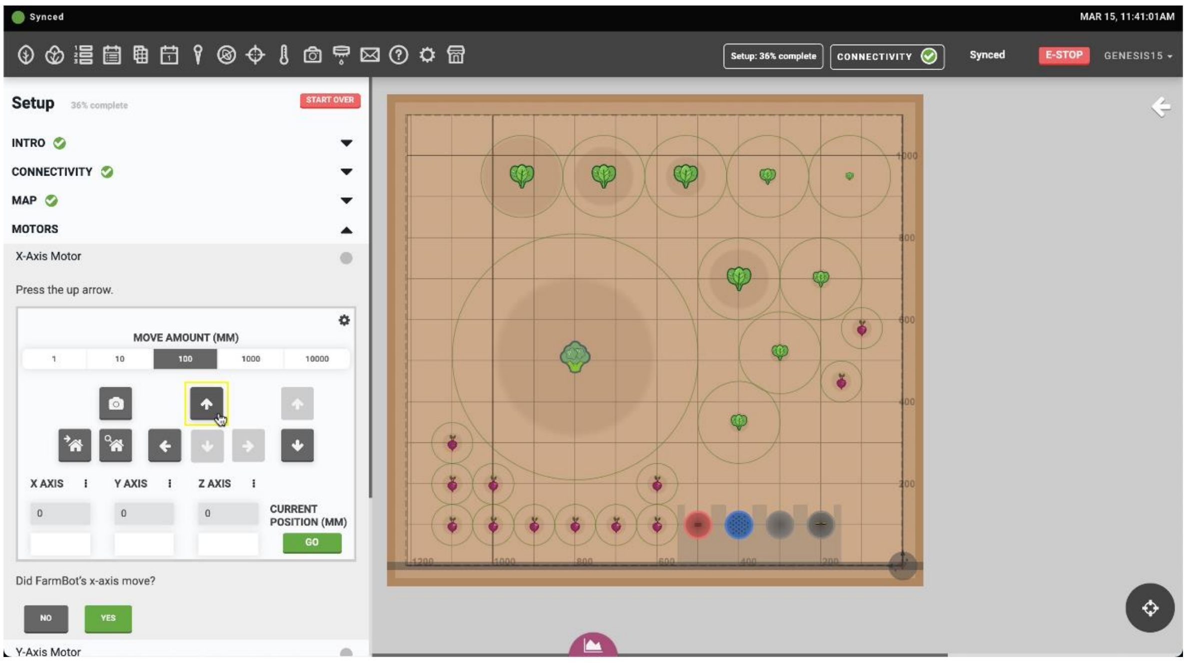
Users then should follow the easy instructions to get started.



Welcome to the setup wizard. This process will guide you through the steps necessary to get your FarmBot set up and running. Each step will include an action to perform and a question about the outcome, which can be answered yes or no. Answering yes will continue to the next step, while answering no will display a list of results that can be selected for specific troubleshooting tips.

Begin?

Figure 3: farm.bot Web Application Tutorial I

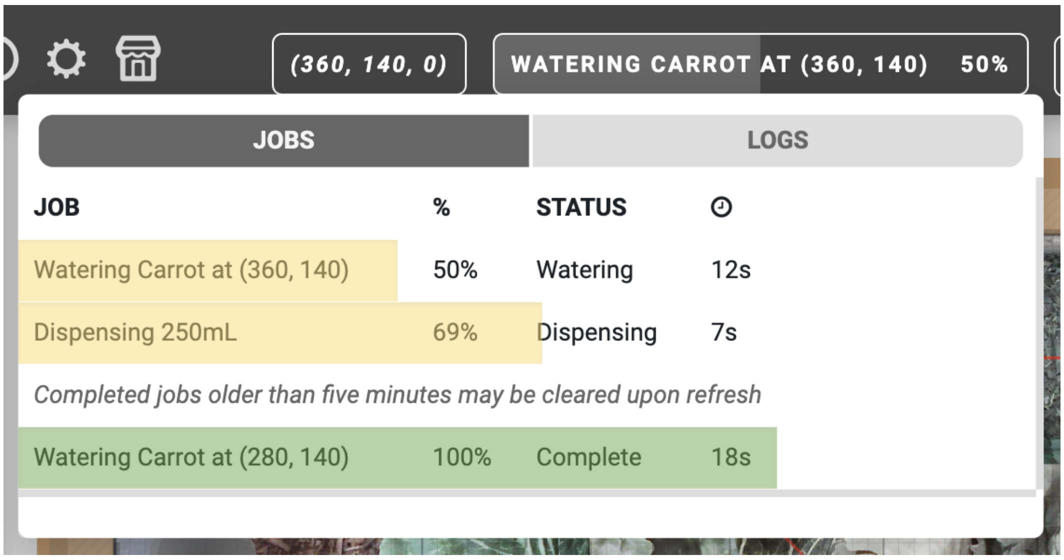


Press the up arrow.

Did FarmBot's x-axis move?

Figure 4: farm.bot Web Application Tutorial Instructions II

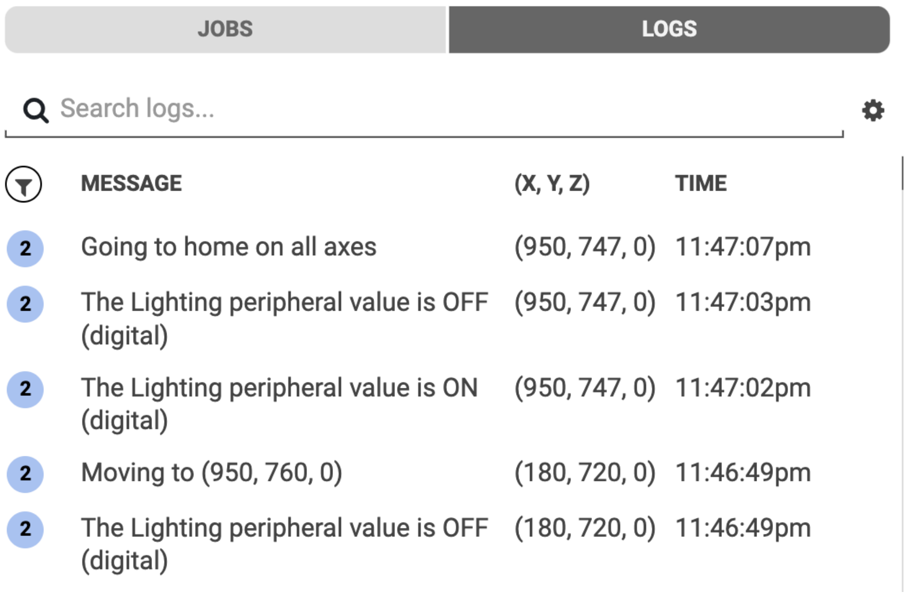
Jobs and Logs Interface: Jobs are long-running actions that are tasked by the users. Jobs and Logs Popup in Farm.bot Web Application allows users to check the status and duration of the jobs given.



JOB	%	STATUS	⏲
Watering Carrot at (360, 140)	50%	Watering	12s
Dispensing 250mL	69%	Dispensing	7s
Completed jobs older than five minutes may be cleared upon refresh			
Watering Carrot at (280, 140)	100%	Complete	18s

Figure 5: farm.bot Web Application Jobs view

Logs view functions like Jobs view, but they are low level single operations that are not intended to be used by general user but available as an option to debug or check individual processes.



	MESSAGE	(X, Y, Z)	TIME
2	Going to home on all axes	(950, 747, 0)	11:47:07pm
2	The Lighting peripheral value is OFF (digital)	(950, 747, 0)	11:47:03pm
2	The Lighting peripheral value is ON (digital)	(950, 747, 0)	11:47:02pm
2	Moving to (950, 760, 0)	(180, 720, 0)	11:46:49pm
2	The Lighting peripheral value is OFF (digital)	(180, 720, 0)	11:46:49pm

Figure 6: farm.bot Web Application Logs view

Designer Interface: This interface will be the most used part of user experience. Users interact with the virtual map to manage their crops type and location. Users can also edit soil preferences, its moisture, groups of the crops, weeds and many more details.

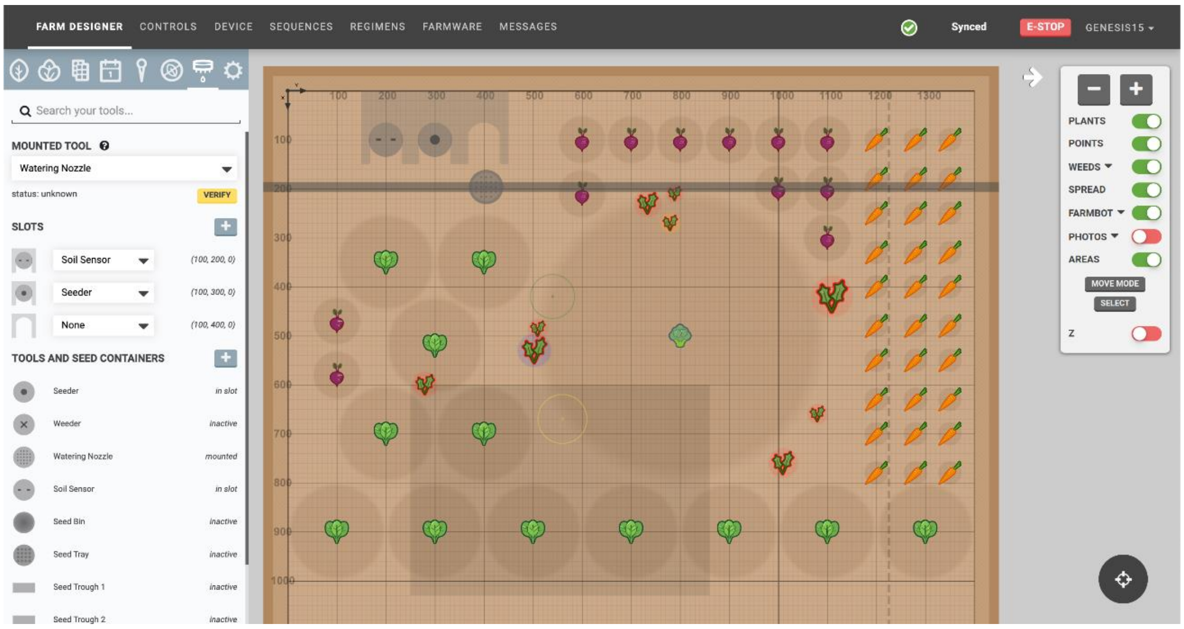


Figure 7: farm.bot Web Application Farm Design Interface

1.3.1.3. Hardware Interfaces

farm.bot is a hardware dependent project. After users set up the farm they want to use in the application, farm.bot then transfers the information gathered to its hardware components.

- **Raspberry PI Controller:** This controller runs on farm.bot OS. It executes scheduled events, uploads logs and sensor data. OS is connected to the microcontroller Arduino to send commands.

- **Arduino Microcontroller:** Arduino or farmduino is responsible for operating the motors, sensors, tools, and other electronics. It takes commands from Raspberry Pi and executes them.

farm.bot also requires a medium to run farm.bot Web Application on. It can be many available devices in our current times including phones, tablets, PCs, or laptops. It can be easily set up and it is then ready to use.

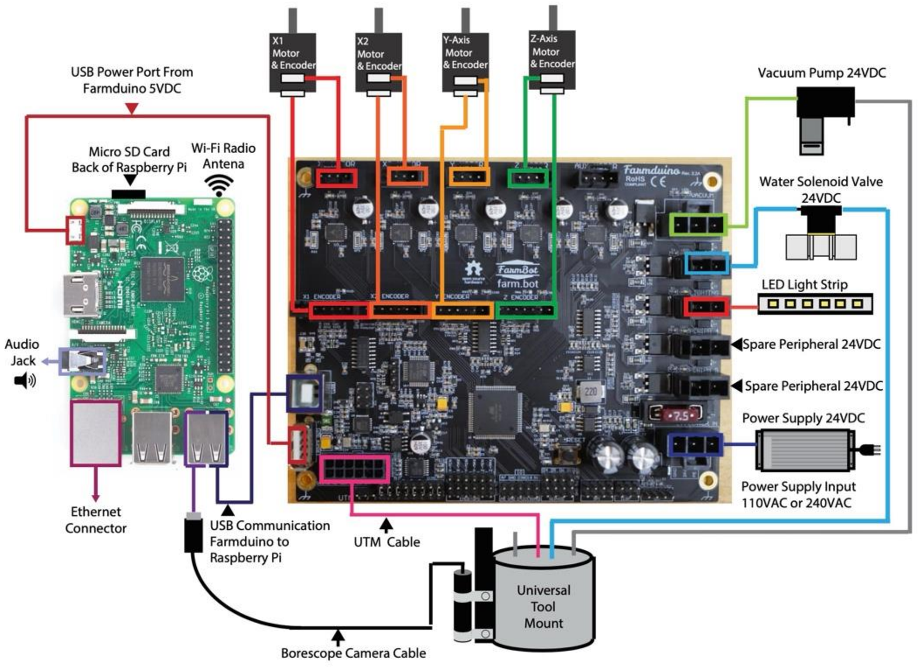


Figure 8: Farmduino and Microcomputer schema

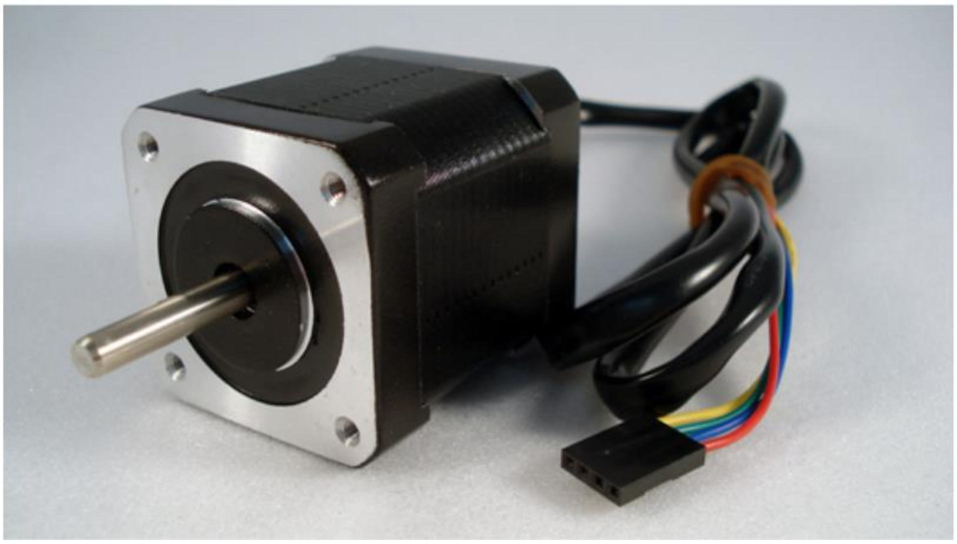


Figure 9: Nema 17 stepper motor

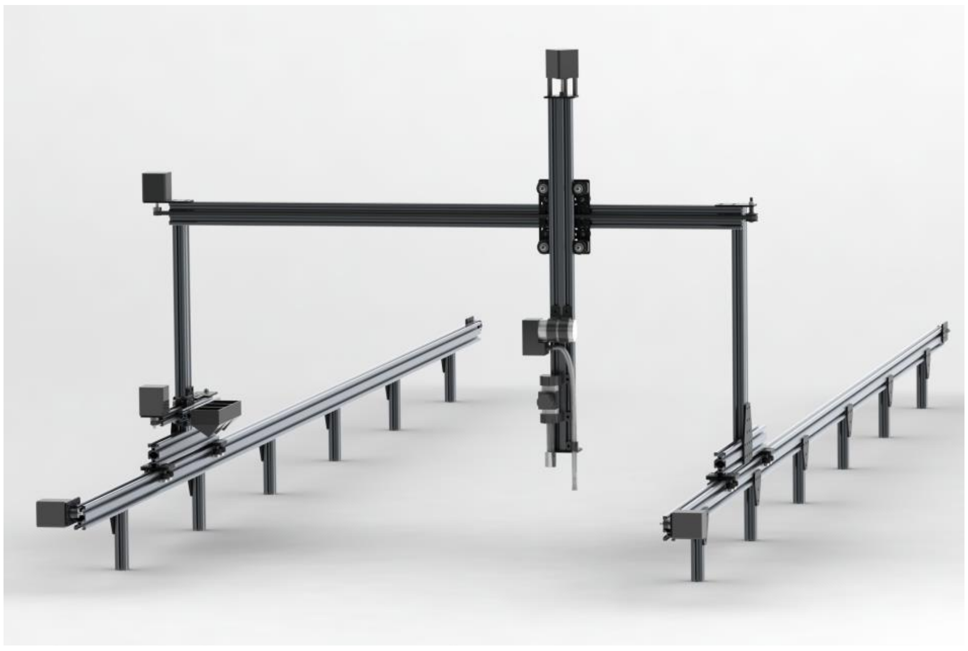


Figure 10: Farmbot Genesis

1.3.1.4. Software Interfaces

farm.bot executes its functions on Raspberry Pi running on farmbot OS. Raspberry Pi communicates in both directions with arduino microcontroller to get sensor information and control the movement via stepper motors. On the other side, Raspberry Pi gets instructions from user via farmbot web application interface which is available on any OS with a web browser and internet connection.

1.3.1.5. Communication Interfaces

farm.bot relies on external data. That means farm.bot requires internet connection to perform accurately. Data transit is encrypted via SSL and HTTPS. This data is then passed through MQTT gateway to safely transmit the message to the hardware. Raspberry Pi is connected to Arduino Firmware by USB connection or serial connection to send G and F code commands.

1.3.1.6. Memory Constraints

There are no memory constraints to run farm.bot.

1.3.1.7. Operations

User Operations:

- Login
- Setup virtual farm
- Setup hardware
- Connect the systems accordingly

Crops Database Operations:

- Provide information to farm.bot

Sensor Operations:

- Receive information on physical farm
- Send data to Arduino

Open-Mateo.com Operations:

- Regularly update recent weather information in detail
- Provide information to farm.bot

Motor Operations:

- Move the watering head
- Help sensors to gather information

Developer Operations:

- Listen to user feedback
- Keep farm.bot up to date and resolve bugs
- Provide open source for users

1.3.2. System Functions

The FarmBot system is designed to automate and optimize the agricultural process from planting to monitoring. This section outlines the key functionalities of how each functionality of farmbot system contributes to achievement of creating an accessible, open-source, small scale farming solutions.

Function	Description
Moisture Levels and Watering	The system adjusts watering amount depending on the current moisture and whether information

Growth Tracking and Logging	Stores plant growth data, sensor data and system operations to help users analyze their farming strategies.
Manual Device Control	Through the web application, users can manually control the FarmBot hardware motion.
Database Integration	Enables the OpenFarm database access to a large storage of crop information to support users with useful, related information
Crop Planning	Users can graphically design their farming area on the web application, determining the most effective area to plant various crops.
Data Mapping	software can create data maps that the farmer and the decision support system can be used to make smarter, data-driven decisions
Precision Weeding	Make use of computer vision to differentiate crops from weeds. FarmBot detects weeds as targets and uproots them without disturbing nearby plants, relies on pre-set or user-defined criteria for weed identification.
Weather Integration	Adjusts operations based on local weather data.
Growth and Health Monitoring	Keeps track of plant growth progress and health status for each individual plant by logging sensor readings and photographing changes over time.

Table 1: System Functions And Descriptions

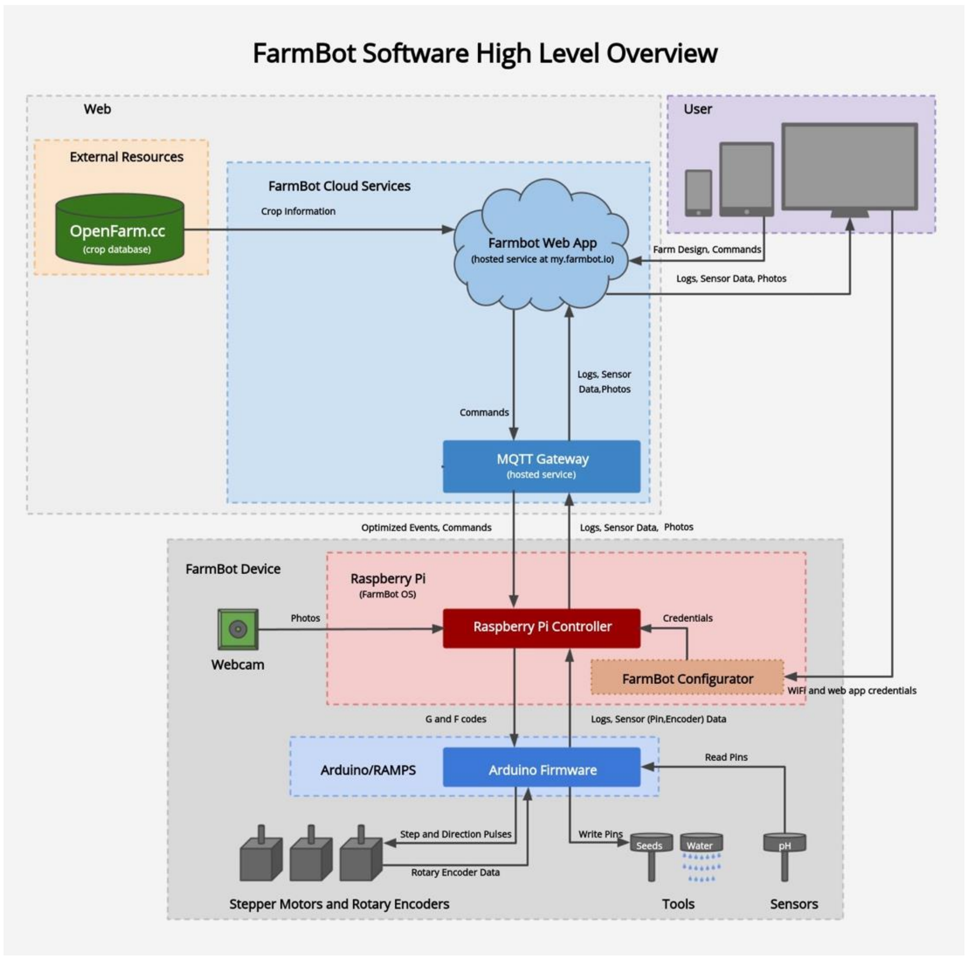


Figure 11: Farmbot Software High Level Overview

1.3.3. Stakeholder Characteristics

Gardeners Hobbyists and Families: Individuals or families whose focus is to use an automated system to keep their small-scale farm or garden in good shape and need a user-friendly interface and easy setup for automation.

Entrepreneurs and Tech Hobbyists: Individuals who are interested in developing or integrating additional features to the existing farmbot system and become a part of this project and/or tinker with it.

1.3.4. Limitations

The Farmbot system faces several limitations that stakeholders should take into account when planning for implementation or integration. These limitations mainly stem from the nature of open source projects and hardware resistancy to physical factors.

Software Integration: FarmBot software integration with external farm management systems and third-party applications can require extensive customization or more time fixing the compatibility problems.

Hardware Compatibility: The system may face limitations in scaling or adapting to new agricultural technologies without significant hardware upgrades

Software Maintenance: Regular maintenance is required to ensure FarmBot's operational efficiency, including regular checks of the system notifications and software updates, and hardware checks. May be challenging for regular users.

Hardware Maintenance: System’s hardware components should be regularly checked and cleaned for optimal efficiency in long term usage.

Durability: System's reliance on internet connectivity and cloud services and a stable power source requirement may be affected by geography, low quality infrastructure and whether conditions

Climate and Weather Resistance: The electronic and mechanical components have limited resistance to extreme weather conditions, requiring additional protection or isolated spaces.

Soil and Terrain Variability: FarmBot's efficiency can be influenced by soil composition and different types of terrains. May require additional calibration or hardware modifications to the installation site.

Data Privacy and Security: Given the system's reliance on internet connectivity and cloud services, ensuring the privacy and security of user data is important. Catching up with global data protection standards is necessary to protect user information.

1.4. Definitions

Term	**Definition**
CNC	**Computer Numerical Control** A method to control machine tools with software and an embedded microcomputer.
MQTT	**Message Queuing Telemetry Transport** A lightweight messaging protocol designed for small sensors and mobile devices, bridging efficient communication between hardware and software components
API	**Application Programming Interface** A set of libraries, protocols, and tools for building software and applications.
G-Code	A language used to tell computerized machine tools how to perform functions.
IoT	**Internet of Things** The network of hardware that uses sensors and APIs to connect and exchange data over the Internet

2. References

ISO/IEC/IEEE 29148 International Standard Systems and software engineering
Life cycle processes Requirements engineering (Second Edition-2018)

Farmbot Whitepaper, Rory Landon Anderson, 19 September 2013

3. Specific Requirements

3.1. External Interfaces

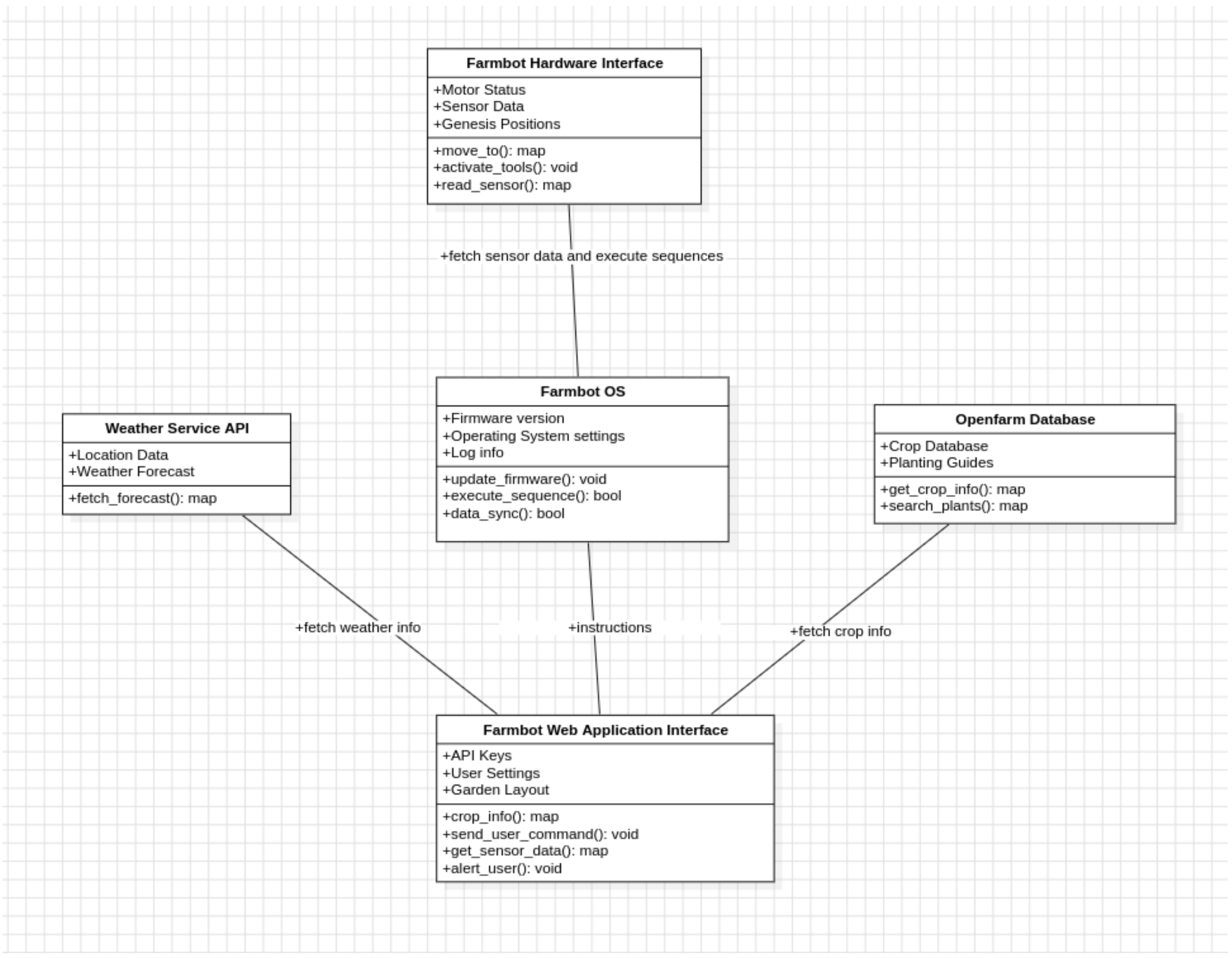


Figure 12: External Interfaces Class Diagram

3.2. Functions

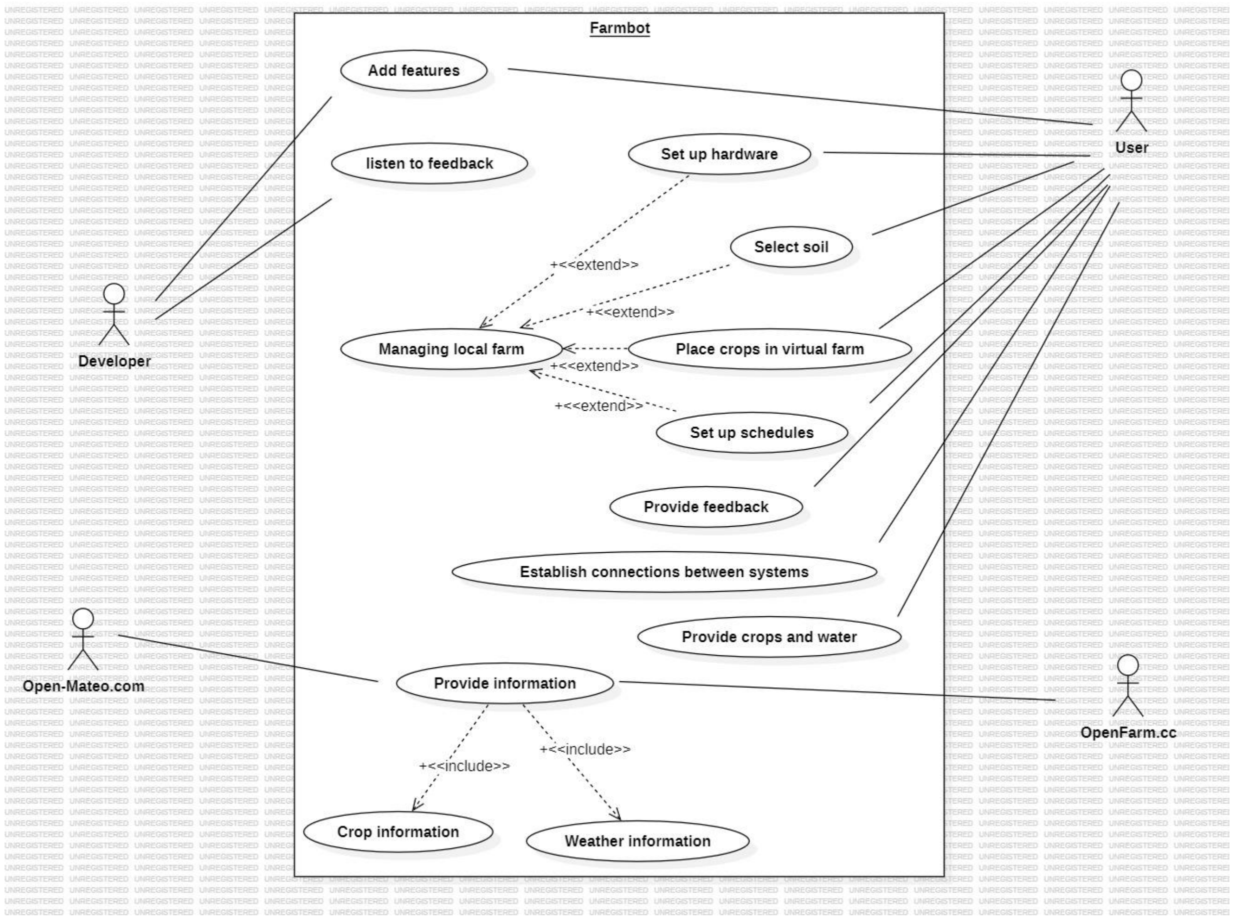


Figure 13: Use Case Model

User Case Name	Set up hardware
Actors	User
Description	Setting up the hardware part of farm.bot project.
Data	-
Preconditions	User has the working components of the device. User has farm.bot Web Application open. User has farm.bot manual.
Stimulus	-
Basic Flow	Step 1: Log in to the application and start setup. Step 2: follow the instructions written. Step 3: Set up Raspberry Pi and connect it to Arduino Step 4: Place local farm to an appropriate location and place the device as instructed.
Alternative Flow	-
Exception Flow	If an error occurs during setup, retrace steps to find the possible error or check FAQ on website.
Post Conditions	farm.bot is ready to take action.

Table 2: Use Case "Set up hardware"

User Case Name	Add features
Actors	Developer, User

Description	Since the project is open source and hardware devices are available, user can add desired features without waiting for developer.
Data	A new function for farm.bot
Preconditions	Knowledge on coding
Stimulus	-
Basic Flow	Step 1: Decide on desired feature Step 2: Implement accordingly
Alternative Flow	-
Exception Flow	It is wise to debug regularly and have an extensive understanding of software engineering. In the event of an unresolved error, it is best to set up the developer's version.
Post Conditions	New features are added. If it is by developer, users can access it.

Table 3: Use Case "Add features"

User Case Name	Listen to feedback
Actors	Developer
Description	Check user feedback to see if there is an unnoticed bug or complication to create a better user experience.
Data	Feedback
Preconditions	-
Stimulus	An issue or suggestion presented by a user.
Basic Flow	-
Alternative Flow	-
Exception Flow	-
Post Conditions	If the developers decide to act on it, they will add a feature or edit an existing feature.

Table 4: Use Case "Listen to feedback"

User Case Name	Select soil
Actors	User
Description	For crops to grow better, user decides on the type of soil and its details.
Data	Soil information
Preconditions	User must be logged in to the website
Stimulus	-
Basic Flow	Step 1: User navigates to soil tab in the application

	Step 2: User edits the information given Step 3: User saves the data
Alternative Flow	-
Exception Flow	There might not be specific data about soil that the user is searching for. In this case the user should simply inform the developer.
Post Conditions	Soil is ready to be planted on.

Table 5: Use Case “Select soil”

User Case Name	Place crops in virtual farm
Actors	User
Description	By using the virtual map in the application, the user manages the plants and their location.
Data	Crop information on map
Preconditions	User must be logged in to the website
Stimulus	-mq
Basic Flow	Step 1: User navigates to designer tab in the application Step 2: User selects crops and their location. Then edits the remaining data as desired Step 3: User saves the data
Alternative Flow	-
Exception Flow	There might not be specific data about crops that the user is searching for. In this case the user should simply inform the developer.
Post Conditions	Plants are ready to be planted if user issues command to the hardware

Table 6: Use Case “Place crops in virtual farm”

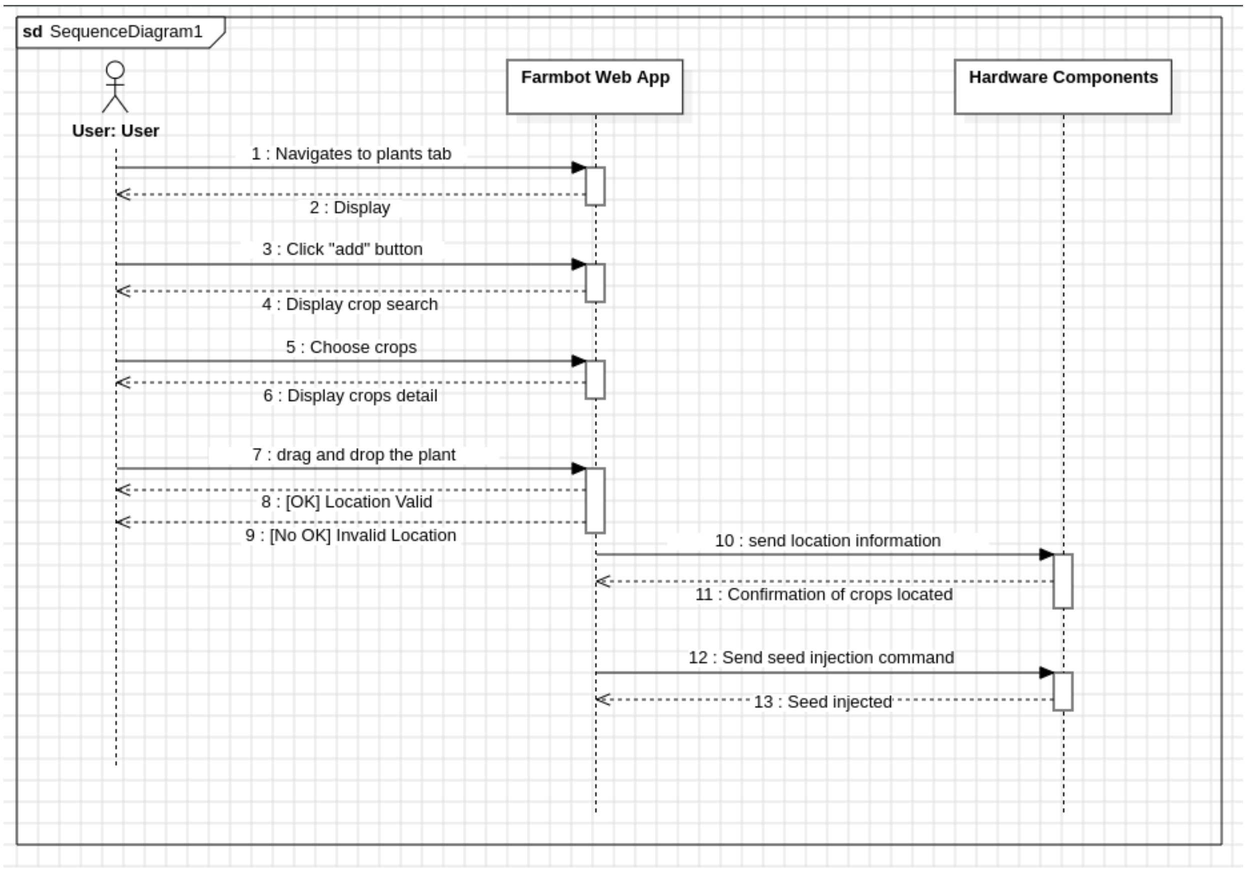


Figure 14: Sequence Diagram for “Place Crops” use case

User Case Name	Set up Schedules
Actors	User
Description	Schedule is needed to make a watering plan for the crops. User is responsible for schedules.
Data	Schedule information
Preconditions	User must be logged in to the website
Stimulus	-
Basic Flow	Step 1: User navigates to schedules tab Step 2: User selects the type of schedule. Then edits the rest of the data Step 3: User saves the data
Alternative Flow	-
Exception Flow	-
Post Conditions	Schedule is ready to be followed once the user sends the information to the hardware.

Table 7: Use Case “Set up Schedules”

User Case Name	Provide feedback

Actors	User
Description	User shares an issue or suggests a feature to the developer.
Data	Feedback
Preconditions	-
Stimulus	-
Basic Flow	-
Alternative Flow	-
Exception Flow	-
Post Conditions	Developers might take the feedback into consideration to improve farm.bot project.

Table 8: Use Case “Provide feedback”

User Case Name	Establish connection between systems
Actors	User
Description	farm.bot project requires communication between its application and its hardware. User is responsible for the action.
Data	-
Preconditions	A reliable internet connection
Stimulus	-
Basic Flow	Step 1: User checks the internet connection Step 2: User checks the data available from crops database and weather forecast Step 3: User checks the uploaded data to the hardware is accurate and all physical connections are done Step 4: Battery is charged
Alternative Flow	-
Exception Flow	-
Post Conditions	farm.bot is ready to take action.

Table 9: Use Case “Establish connection between systems”

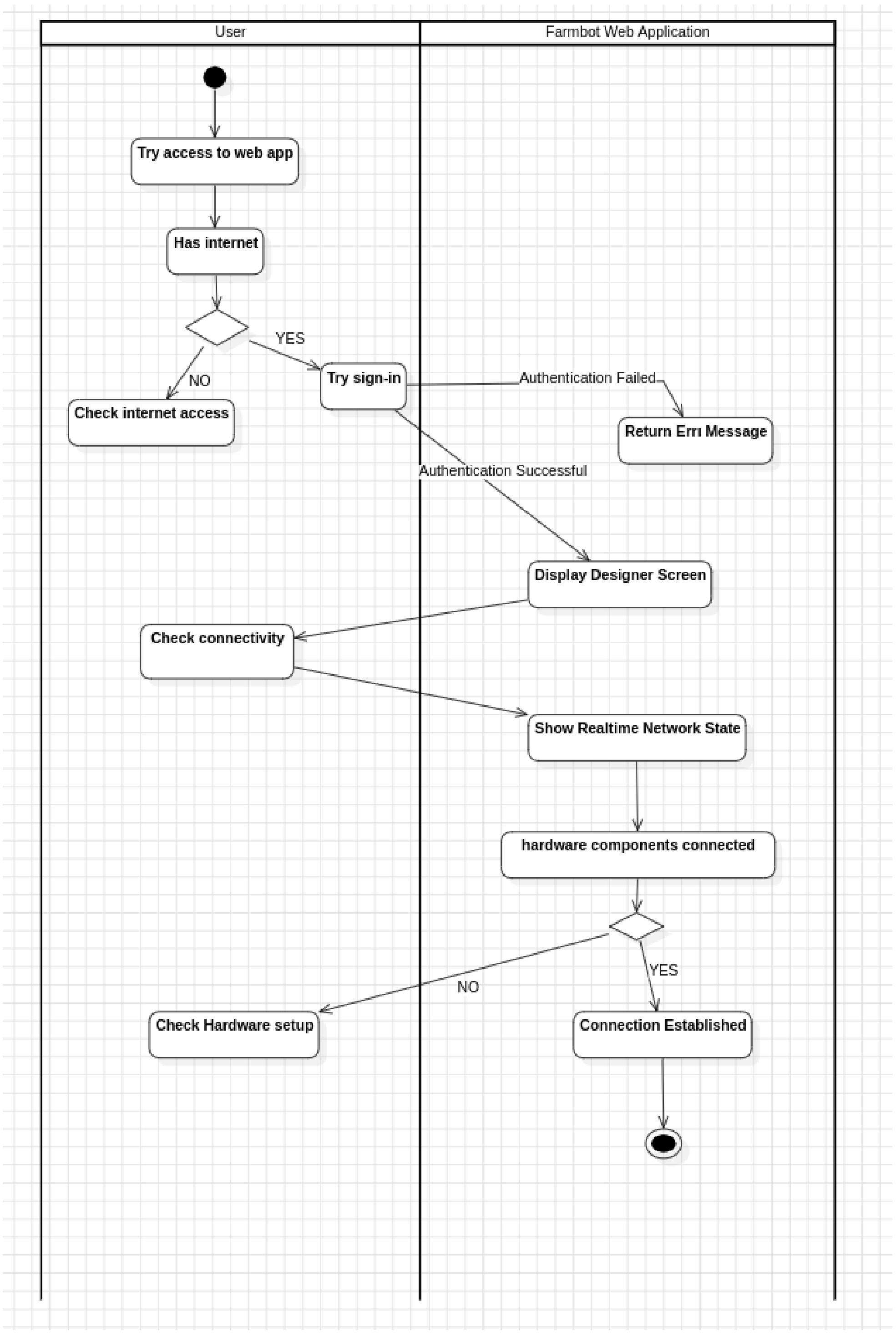


Figure 15: Activity Diagram for "Establish Connection Between Systems" use case

User Case Name	Provide crops and water
Actors	User
Description	farm.bot is a farming project and therefore is need of physical farming requirements.
Data	-
Preconditions	Clean water source and seeds
Stimulus	User wants to plant crops
Basic Flow	Step 1: User places required objects to their respected places
Alternative Flow	-
Exception Flow	-
Post Conditions	Hardware is ready to follow instructions.

Table 10: Use Case "Provide crops and water"

User Case Name	Provide information
Actors	OpenFarm.cc, Open-Mateo.com
Description	farm.bot relies on a crops database and weather information to accurately function. These external systems provide this information.
Data	Crops and weather data
Preconditions	Internet access
Stimulus	User wants to plant crops
Basic Flow	Step 1: farm.bot requests information from these available external data systems. Step 2: They provide requested data.
Alternative Flow	-
Exception Flow	-
Post Conditions	-

Table 11: Use Case "Provide information"

3.3. Logical Database Requirements

hardware_configuration: Stores hardware configuration information along with hardware identification number and connected devices.
sensor_data: Stores sensor and pin information with sensor mode.
sequences: Stores sequence information and customized setting properties such as color code with a description.
web_app_config: Stores user information, map layout information and connected device identification number.
devices: Stores device information and device serial number which is used for authentication by the web application.
users: Stores user communication information and user login information.

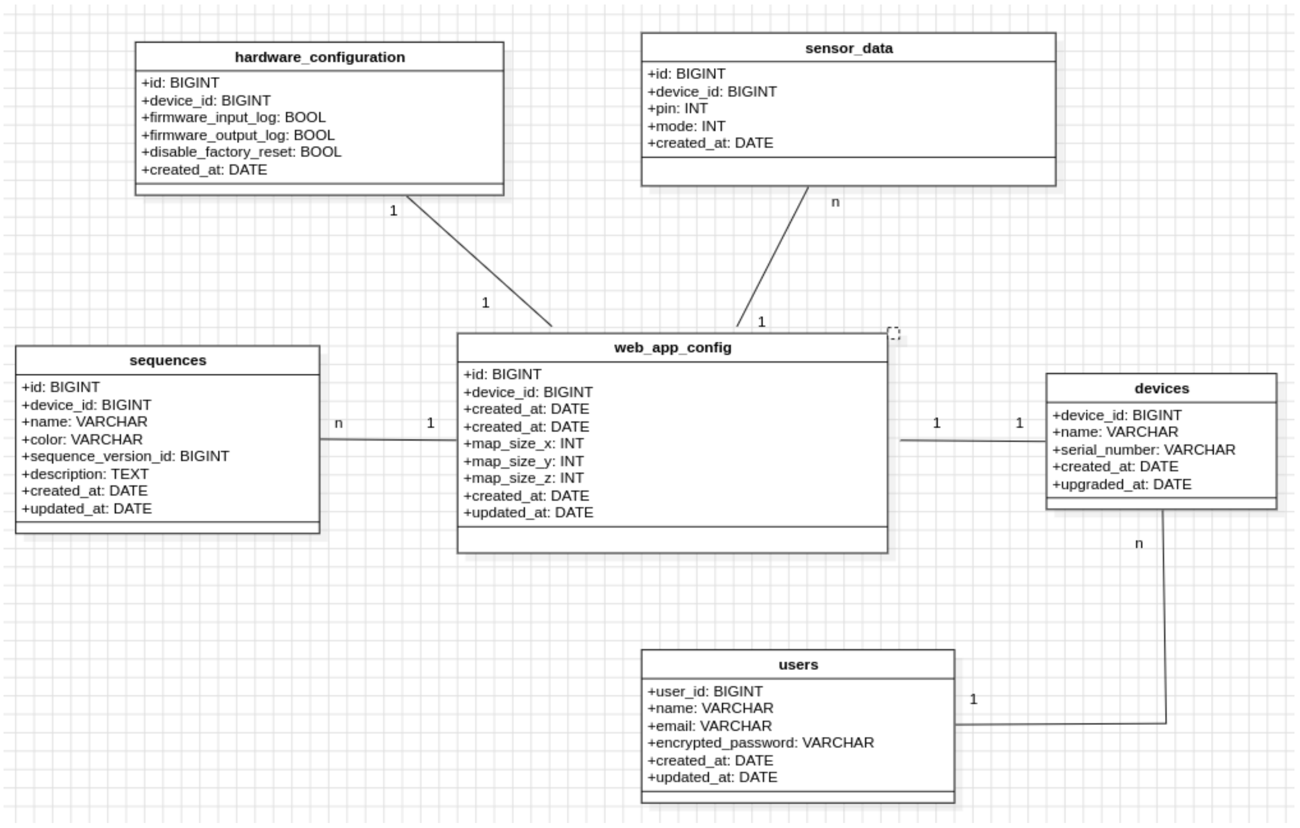


Figure 16: Logical Database Requirements Class Diagram

3.4. Design Constraints

Open-Source License: Adherence to open-source software principles do not allow integrating proprietary technologies that may be beneficial for the overall project but against the project's ethos and accessibility.

Local Restrictions and Regulations on Agricultural Activities: Compliance with local agricultural regulations and practices may limit the use of FarmBot in certain regions or require ineffective modifications of design and functionality of the system.

Hardware Compatibility: Ensuring all hardware components are in contact and work properly together may not be easy to scale and create additional implementation problems.

Power Consumption: Modular nature and open-source nature of the project may result in less efficient and more energy consuming result. Optimization on the energy consumption side may require extra attention.

Software Compatibility: Even though the components are all open source and regularly updated, new modifications from the public side may result in software compatibility problems among different hardware components using different software versions such as farmbot OS and the Web application.

Internet & Energy Connection Requirement: To properly work, farmbot components require consistent energy and internet access 7/24, which limits the portability of the whole design.

3.5. System Attributes

Reliability

Durable Hardware Design: The hardware components are selected and designed durable and resistant to regular use and exposure to external physical factors.

Availability

Cloud-Based Services: The FarmBot web application and helping cloud services are hosted on platforms provided by trusted systems ensuring users a consistent, high-quality access.

Data Security: All data transmitted between the hardware components, the web application, and the cloud services is encrypted using industry-standard protocols to protect user data privacy.

Regular Software Updates: The software receives regular updates to protect against vulnerabilities and ensure the system is safe.
Maintainability

Modularity: Both the hardware and software components of FarmBot have modular design, making it easier to update, repair, or replace parts of the system without affecting the entire system.

Portability

Cross-Platform Web Application: The FarmBot web application is designed to be cross-platform, accessible from any device with internet connectivity and a web browser.

Scalable Cloud Services: The backend infrastructure supporting FarmBot's web services can scale to handle a growing number of users, ensuring system’s performance remains stable as the user base expands without any additional requirements for adjustment or disks.

Portable Hardware: FarmBot system, along with the Farmbot Genesis hardware, is completely modular and lightweight which makes it easy to displace via disintegration and integration of the system.

3.6. Supporting Information

The farmbot project is an open-source agriculture project with the source code available on GitHub which is accessible on farmbot website, “Learn more” section. Contributions to the system and more information about the system’s requirements are accessible on both the same tab and the GitHub repository, which is accessible from the same tab.

4. Suggestions to Improve the Existing System

4.1. System Perspective

The improved version of farmbot system contains a mobile application, available on all mobile devices from smartphones to tablets on all operating systems. This improvement makes farmbot control easier to use and make alerts regarding the overall system way more eye-catching.

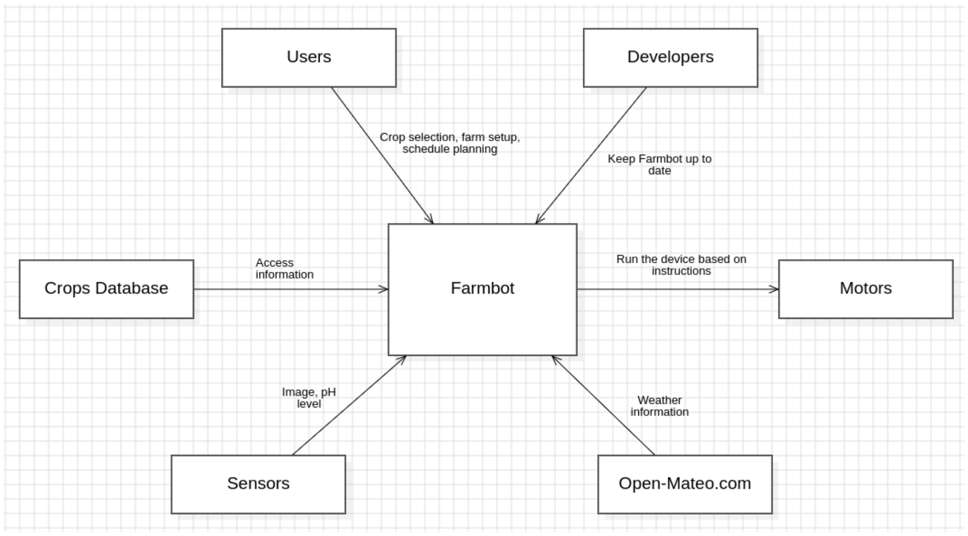


Figure 17: Context Diagram (No change)

4.2. External Interfaces

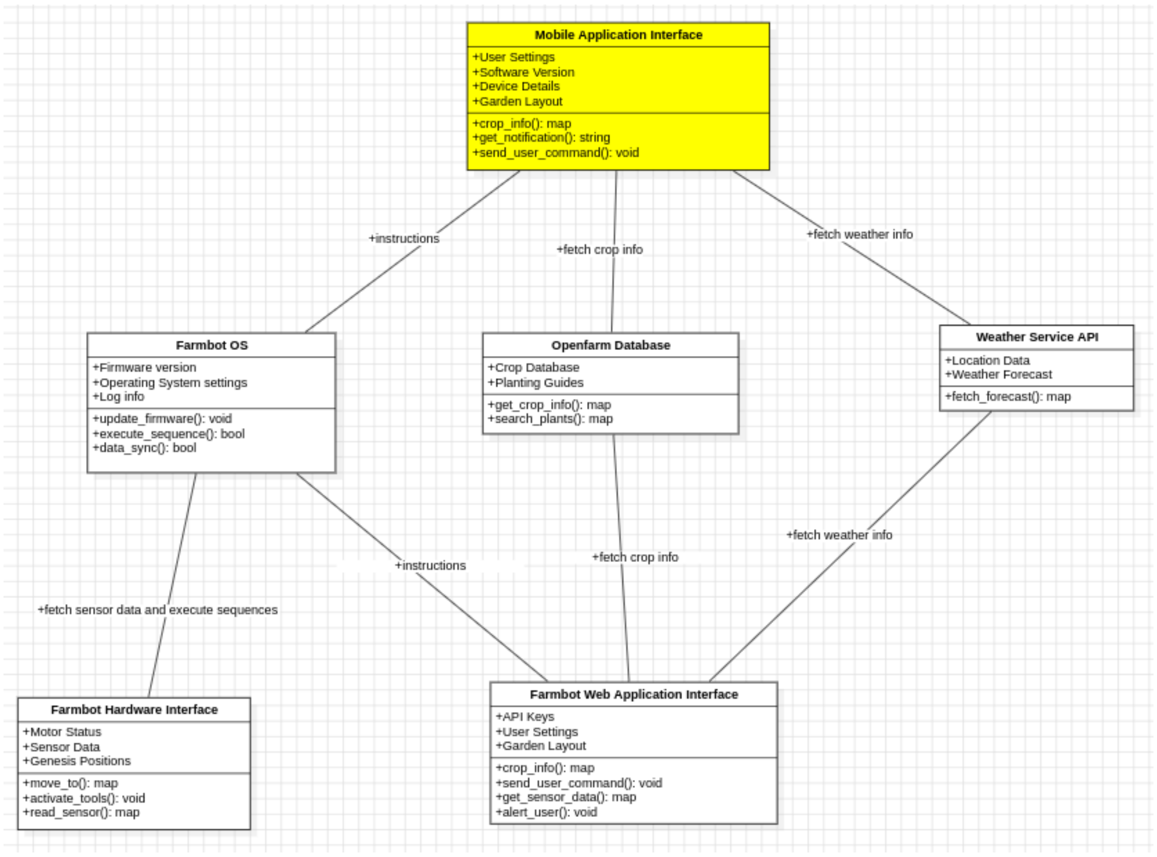


Figure 18: External Interfaces Class Diagram for improved system

4.3. Functions

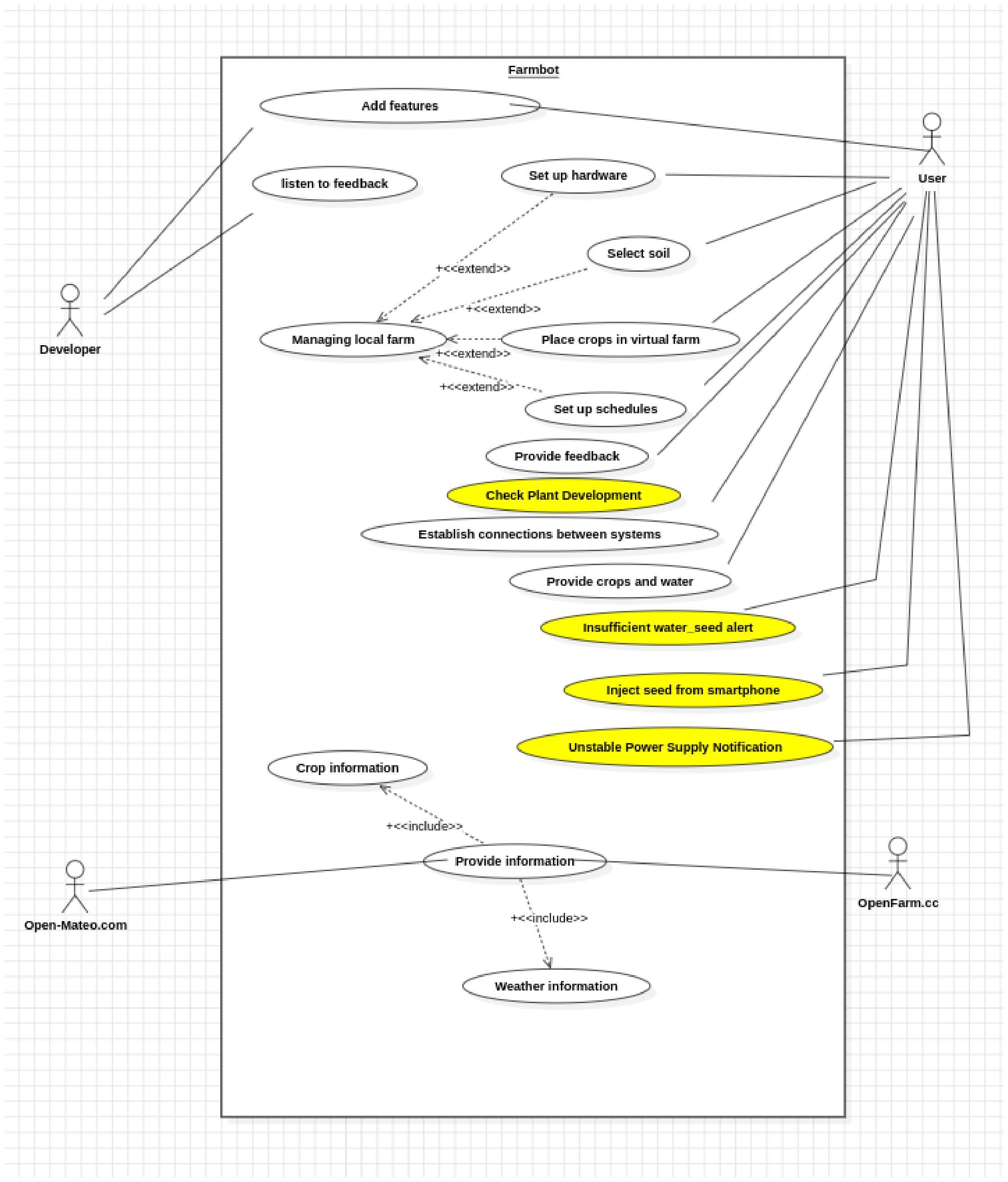


Figure 19: Use Case Model for improved system

User Case Name	Insufficient Water/Seed Alert

Actors	User
Description	An alert with either noise or phone light to alert the user that water or seed is insufficient.
Data	Water or seed amount
Preconditions	Internet access and power supply
Stimulus	Noise/led signal
Basic Flow	Step 1: Raspberry checks the amount of water and seed of genesis Step 2: Water or seed shortage Step 3: Send notification to mobile device
Alternative Flow	-
Exception Flow	-
Post Conditions	-

Table 12: Use Case for improved system "Insufficient Water/Seed Alert"

User Case Name	Check plant development
Actors	User
Description	Send plant photo on user demand
Data	Picture of the plant
Preconditions	Internet access and power supply
Stimulus	-
Basic Flow	Step 1: User demands a photo via mobile application Step 2: Related hardware components and integrated camera relocates according to the demanded plant's position. Step 3: Camera takes the picture and system sends the file to mobile app.
Alternative Flow	-
Exception Flow	-
Post Conditions	-

Table 13: Use Case for improved system "Check Plant Development"

User Case Name	Unstable Power Supply Notification
Actors	User
Description	Unexpected stability on power supply notifies the user via mobile app.
Data	Power connection

Preconditions	Internet connection
Stimulus	-
Basic Flow	Step 1: Raspberry checks the stability of power supply Step 2: Abnormality on power input Step 3: Send notification to mobile device
Alternative Flow	-
Exception Flow	-
Post Conditions	-

Table 14: Use Case for improved system "Unstable Power Supply Notification"

User Case Name	Inject seed from smartphone
Actors	User
Description	Plant seed from mobile
Data	Seed type, location
Preconditions	Internet access
Stimulus	-
Basic Flow	Step 1: User locates the plant via drag and drop on the mobile application interface Step 2: Raspberry checks the necessary conditions and sends command to arduino Step 3: Arduino executes the injection process by its control system and genesis hardware.
Alternative Flow	-
Exception Flow	-
Post Conditions	-

Table 15: Use Case for improved system "Inject seed from smartphone"

4.4. Logical Database Requirements

mobile_app_config: Stores user information, map layout information and connected device identification number alogside with mobile device information.

notification: Keeps notification information to be sent to mobile device.

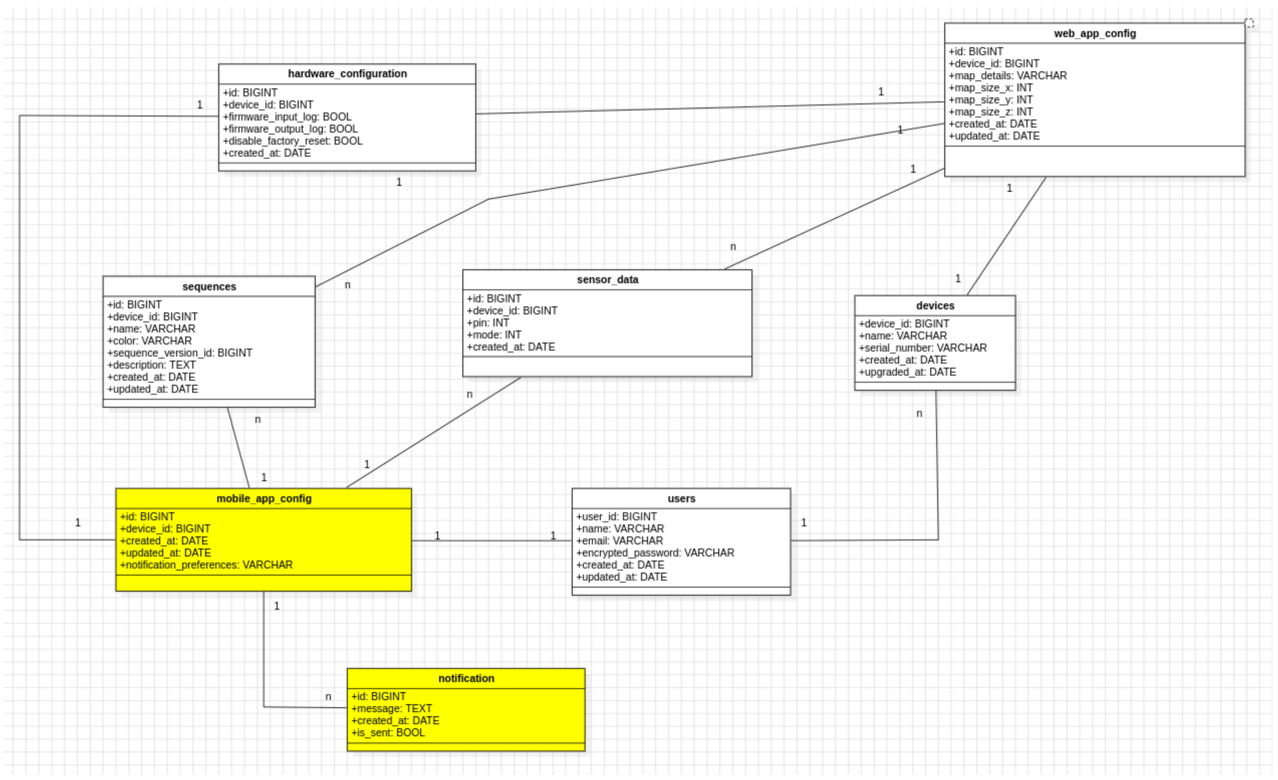


Figure 20: Logical Database Requirements Class Diagram for improved system

4.5. Design Constraints

Constraints for web application is persistent in this case with additional constraints that may occure due to the nature of mobile platform such as OS version and device configuration.

4.6. System Attributes

Mobile applications share the same attributes as web application. However, decreases the unnecessary details of the web application and more appropriate to mobile usage.