Jordan University of Science and Technology
Software Engineering Department
SE321: Software Requirements Engineering
First Semester 2022

Hydroponics Agriculture

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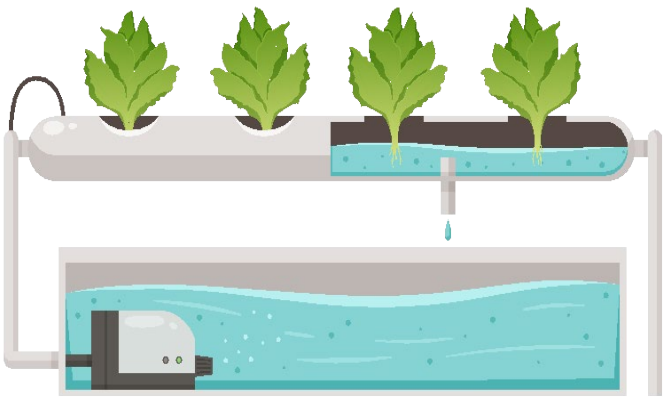
"When tillage begins, other arts follow.
The farmers, therefore, are the founders of human civilization."



Phase 1

What is the problem?

During the evolution of the human, agriculture and land utilization was inevitably connected with survival in nature. The urbanization phenomenon ultimately caused, during the last few decades, the degradation of our natural environment. As a result, the quality (and quantity) of produced food we consume has significantly decreased. The need for the evolution of alternative methods of cultivation is constant and always a hot topic, especially in order to confront the multiple problems that conventional agriculture has. Hydroponics, is the technique of growing plants using a water-based nutrient solution rather than soil, comes to solve many of these problems.

On the other hand, hydroponics is accompanied by several problems, including:

1. Plants need watering and fertilization frequently.
2. Incorrect Lighting: difficulty controlling the suitable light levels for plant.
3. Not monitoring the quality of water: any negative changes on water properties causes complete failure on the hydroponics system.
4. Not Monitoring the Health of Your Plants: do not monitor your plants frequently cause many diseases.
5. Using Hard Water in Your Hydroponics System: The pH can change considerably over hours or days due to a range of factors including temperature, rate of absorption of nutrients by your plants, presence of disease, excess evaporation etc.
6. Blocked Or Broken Pumps: Hydroponics systems rely on constant or very frequent delivery of water and nutrients to your plants; **blocked pumps leads plants wilting and dying very quickly.**
7. Need to maintaining hydroponic solution temperature(Root zone temperature is one of the major factors that affect root health and plant growth. The temperature of the nutrient solution is generally optimum between 60° F and 75° F.)

Solution

Although they are small problems, we cannot deny their impact on the performance of hydroponics, so we must solve them through designing a smart monitor and controlling system, which can make it easy to implement the connection of a monitoring field and to remote monitoring centers. This system can monitor the sensors feedback accurately, automatically transmit the data of humidity, light intensity, water level, nutrients contained in water and pH in real time access on a mobile application . Moreover, the farmer has detailed access to the information, the basic process will take place automatically without any intervention from him.

1. Sensor for each group of plants which is in the same line, to measure the humidity to decide whether to start the water cycle or not.
2. Before and after the water cycle, no changes in humidity means that there’s a problem in the pumps.

(If any problem happened the system will notify the farmer);
(cycle duration determine manually by the AE and farmer or auto form the system)

3. The farmer and the ENG can determine the schedule for exposure of the plant to light, depending on the type of plant, by specifying the hours of exposure to the sun, the percentage of radiation allowed, and the hours of shade.
4. The system must determine the light source to achieve the required light level , whether it is direct sunlight, LED or both, depending on the weather sensor readings:
   - Decrease the intensity of the sun's rays by increasing glass shade.
   - Using LED when sun's rays is not enough .

In accordance with all previous conditions

5. Before every water cycle the system uses probes to measure your nutrient reservoir's pH (to avoid the damages caused by the hard water), EC levels, water temperature ,and any microbes which is the main factor for the success or failure of the system. then uses this information to dose your plants with the correct amount of nutrients and supplements.
6. Design and control system of water level in hydroponic plants.

Objectives

1) Make the continuous observation process easier .
2) Decrease the user involvement(To maintain sterilized water).
3) Increase the success chance.
4) Increasing the accuracy of the information, which reduces the error rates caused by human.
5) Guess the problems before they happen by analyzing the collected data.

Phase 2

Jordan University of Science and Technology
Software Engineering Department
SE321: Software Requirements Engineering
First Semester 2022
Software Requirements Specification (SRS) Template

2.1 Software Requirements Specification (SRS)

Hydroponics Agriculture

Version: (1) **Date: (1/12/2022)**

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1. INTRODUCTION

Purpose

The purpose of the following SRS document (Software Requirements Specification) is to clarify the developments that we will make on the hydroponic system, through the automation of manual processes, which improves the results of the process and reduces the costs of the existing system.
By explaining the purpose and features of the system, both farmer and AE will simplify their functionality, and rise efficiency.

1.2 Scope

The HAS will decrease the user involvement by designing a smart monitor and controlling system, which can make it easy to implement the connection of a monitoring field and to remote monitoring centers.
Most specifically This system can monitor the sensors feedback accurately, automatically transmit the data of field humidity, light system and temperature, level, properties, and pH of water tank in real time access on a mobile application. Moreover, the users have access to the information.

1.3 Definitions, Acronyms, and Abbreviations

Term	Definition
SRS	Software Requirements Specification
HAS	Hydroponics Agriculture System
FR	Functional requirement

NFR	NON - Functional requirement
Cams	Cameras
AEs	Agricultural Engineers

1.4 References

Requirements engineering from system goals to UML models to software specifications are obtained and worked through Conducting interviews with officials in the Faculty of Agriculture at the University of Science and Technology.

https://makehorticulturalknowledgework.com/projects/hydroponics-agriculture-and-employment-development-project

SRS Template
https://press.rebus.community/requirementsengineering/back-matter/appendix-c-ieee-830-template/

1.5 Overview

In the following pages you will find two main points first one is The Overall Description which talks about the general factors that affect the hydroponic system like assumptions, constraints. And you will get a summary and general knowledge about hydroponic system requirements and functionality.

Second point is Specific Requirements in this point you will find functional requirements; requirements that define the fundamental actions the system will provide, then you will find External Interfaces; contains a detailed description of all inputs and outputs from the software system, followed by Performance Requirements “nonfunctional requirements” , then Design Constraints which talks about design constraints that can be imposed by other standards, hardware limitations, etc.. , at the end you will find Software System Attributes; a number of attributes of software that can serve as requirements.

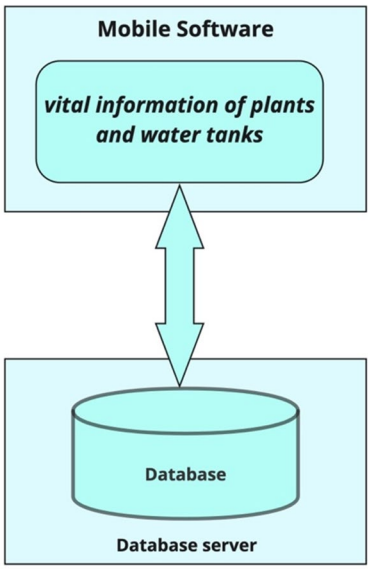
2. General Description

2.1 Product Perspective BACK, PIC

This system will consist of a mobile application. The mobile application will be used to monitor and know the vital information of plants and water tanks and get alerts in the event of any problem.

The farmer and the agricultural engineer can edit the vital information of the plant and water tanks (knowing that the engineer has more access in editing plant and water info).

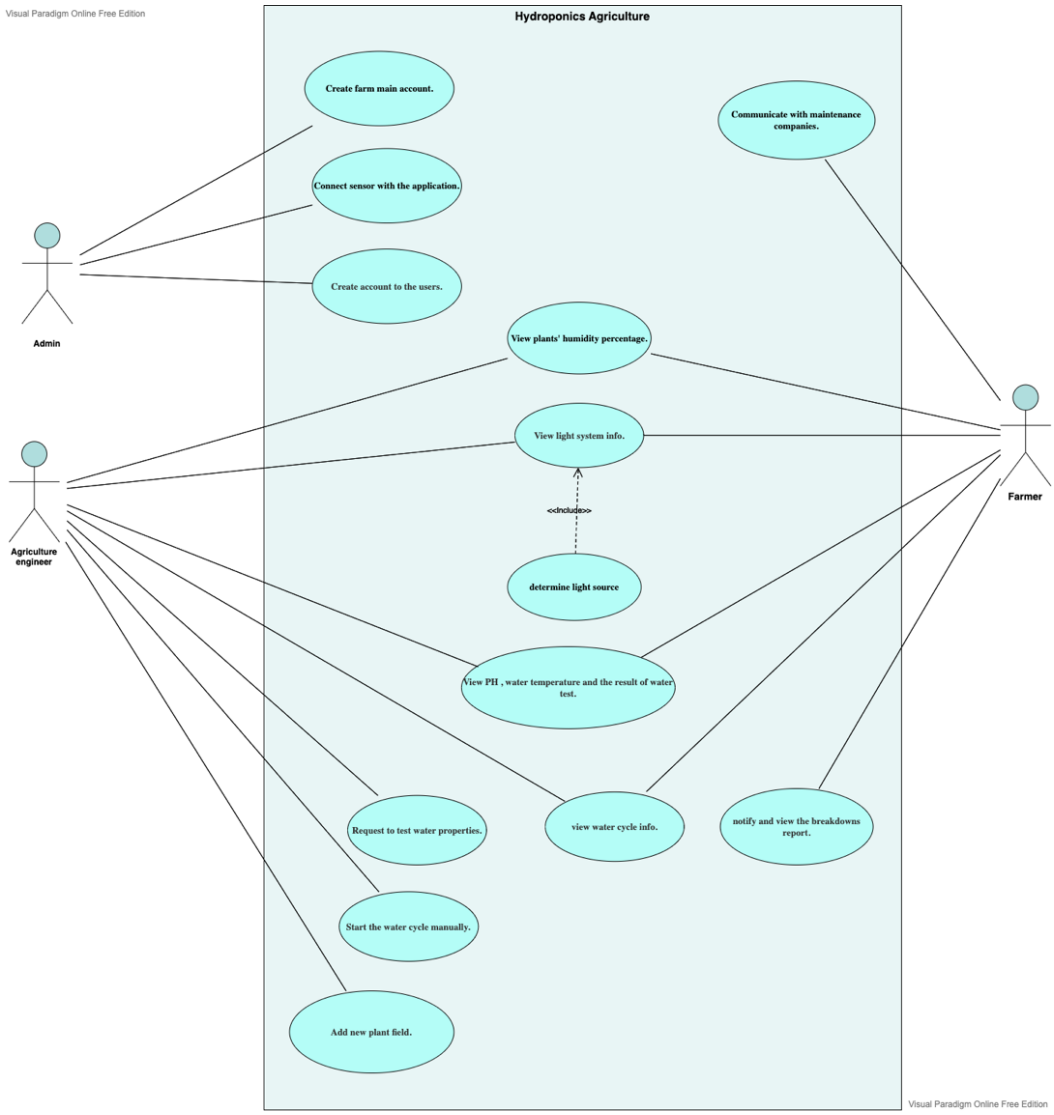
Data from current plant information will be stored and organized in a database system.



2.2 Product Functions

The hydroponic system consists of several features that make the process more successful in easier way such as:

- Independent access for all users to manage the system.
- Input data by AE and admin only.
- Viewing data in simple ways to analyze, understand, and track by all users.
- Although the system is automatically works, but AE has full control at any time.
- Improve maintaining processes by view breakdowns reports continuously.
- Highly protected water health.



2.3 User Characteristics

The System contain three main members, admin, farmer and AE.
The admin became responsible once he/she creates farm main account of registering other users accounts, also connecting system sensors.

The **AE** creates new plant field and specify each field information such as (the vital information and values of plant in addition to preparing the water tank from water temperature, water level and adding water cycle period).
AE have manual control on all system automated actions.

Farmer can view all fields information and breakdowns reports.

2.4 General Constraints

Performance Requirements

- **Static**
  1. System shall not access users to the system before admin register them.
  2. System shall monitor all the vital information of plants field at the same time.
  3. System shall contain several specific information for each group of plants without mix them up.
  4. Highly protected water health by testing water after (number of water cycles / 3).
- **Dynamic**
  1. The process of notifying the farmer and sending the report if any problem happened shall be processed in less than 10 seconds.
  2. The process of updating plant information shall processed in less than 1 second.

Design Constraints

1. System shall be compatible on android and IOS operating systems.
2. System shall support the last 4 versions of mobile OS as a minimum.
3. System shall run via Internet Connection.

System attributes

- **Reliability**
  1. System shall not crash during usage .
- **Availability**
  1. System shall work all the time.
  2. A notification is sent to the farmer If any problem happened
- **Portability**
  1. System should be written in Swift using X Code.
  2. System should be written in Java or Kotlin using android studio SDK for android applications.

2.5 Assumptions and Dependencies

- *HAS is a mobile application that can be accessed from anywhere with an internet connection.*
- *A farmer and AE can access the application if and only if the admin give them permission.*
- *A farmer and AE both can monitor multiple fields at the same time.*
- Plant information should be updated continuously.
- *It is assumed that users are familiar with how to use a mobile application and the main functionality of HAS.*

2.6 Apportioning of Requirements

- *Integrate AI with the system.*

- *Add a new feature like live monitor plant via cams.*
- *Add a new feature such as chatting between farmer and AE.*

3. Specific Requirements

3.1 External Interface Requirements

This section provides a detailed description of all inputs into and outputs from the system. It also gives a description of the hardware, software and communication interfaces and provides basic prototypes of the user interface.

3.1.1 User Interfaces

Figure 0 shows the application icon.

Figure 1 shows the start page for the user who is using the mobile application for the first time. The start page will be displayed, containing three options. The user must specify his identity (User Type).

Figure 2 In the next stage, the login page will appear for the admin, where he must enter the serial number of the farm, he is responsible for in addition to the password. If it is his first time and he does not have an account, he must move to the page of Figure 3.

Figure 0 – App icon

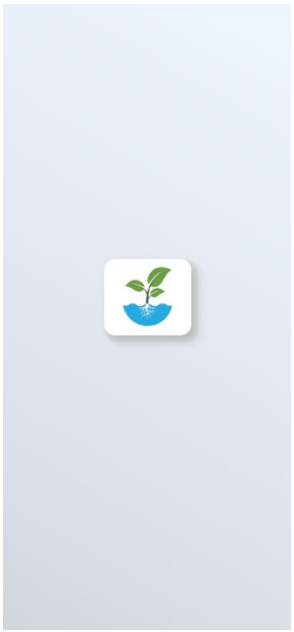


Figure 1 – Get started page

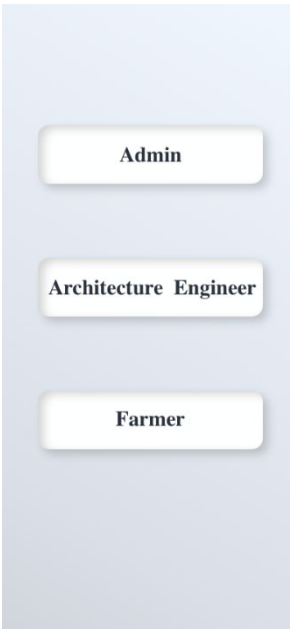


Figure 2 –Admin login & registratio

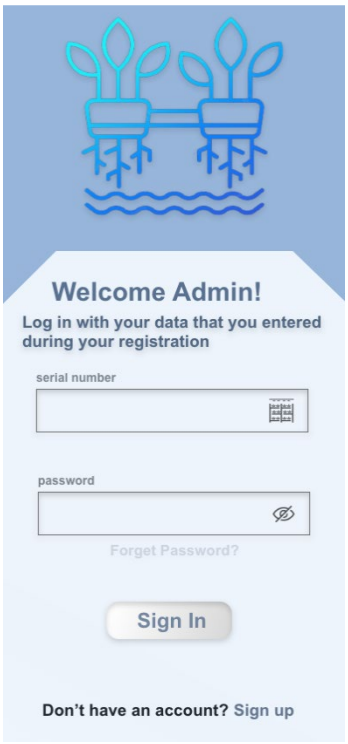


Figure 3 -New account for Admi

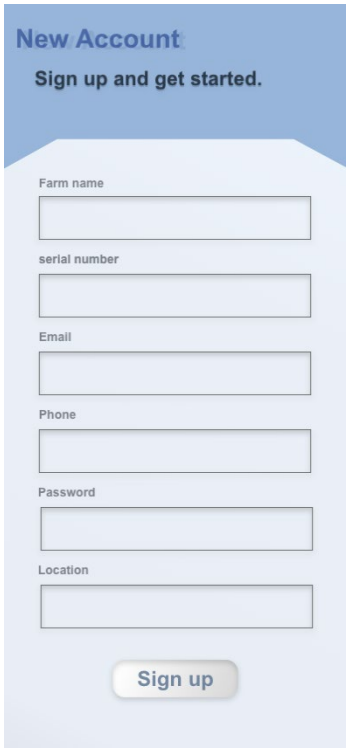


Figure 4 -Admin home

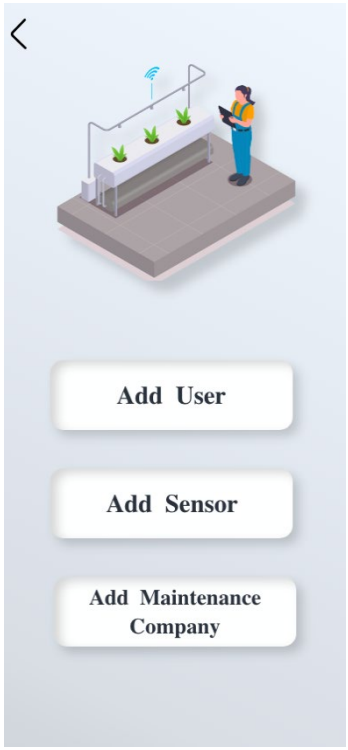


Figure 5 -Add user

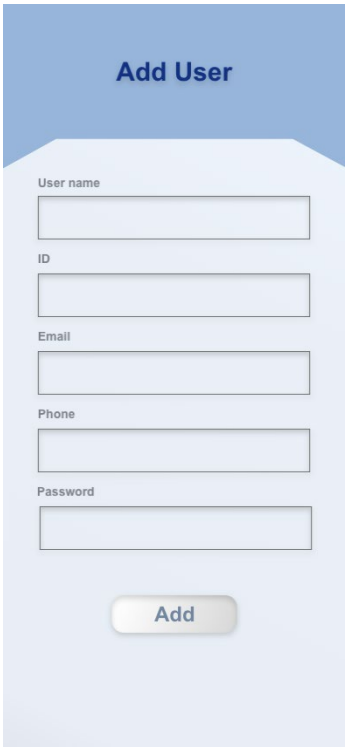


Figure 3 In the event that he does not have an account, he must create one for the farm that he is responsible for by entering the name of the farm, its location, its serial number, his email, and phone number, assigning a new password to him, and then signing up. Where the home page will appear

Figure 4 Three boxes will appear on the home page, where he is responsible for adding user and sensor devices to the system, as well as the companies responsible for maintenance.

Figure 5 This page is to add the user and his information (create an account for him). The user's name and ID, email, phone number, and password are entered.

Figure 6 This page is to add the sensor to the system by specifying its type and adding the MAC address.

Figure 7 Add a maintenance company (pipes, sensors, all the electric parts)

Figure 6 -Add sensor

Figure 7 -Add Maintenance Company

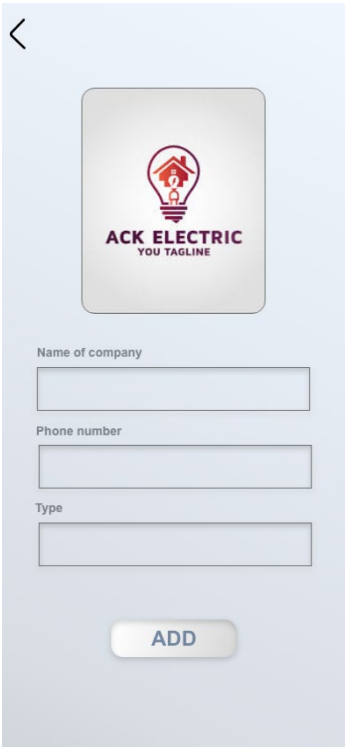


Figure 8 - AE &Farmer Login

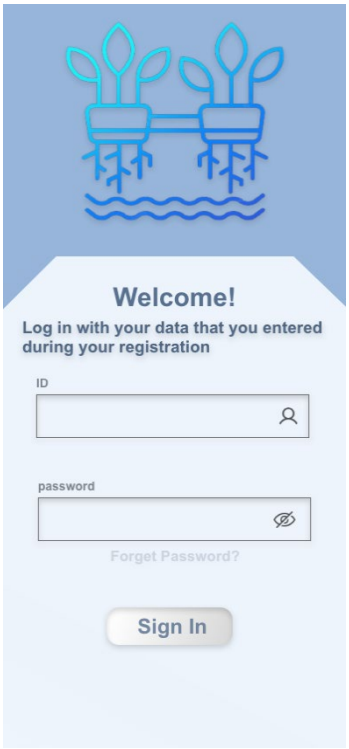


Figure 9-AE Home

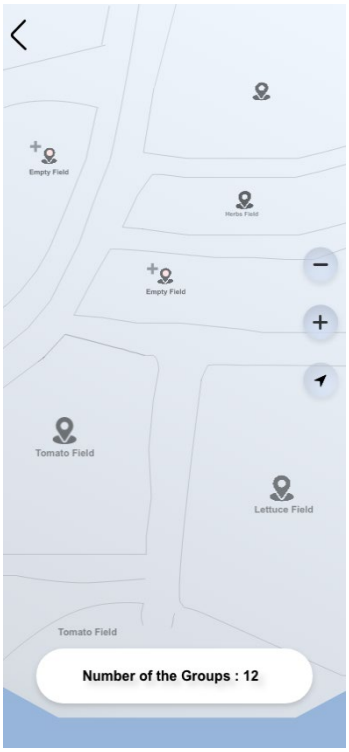


Figure 10-Add new Field

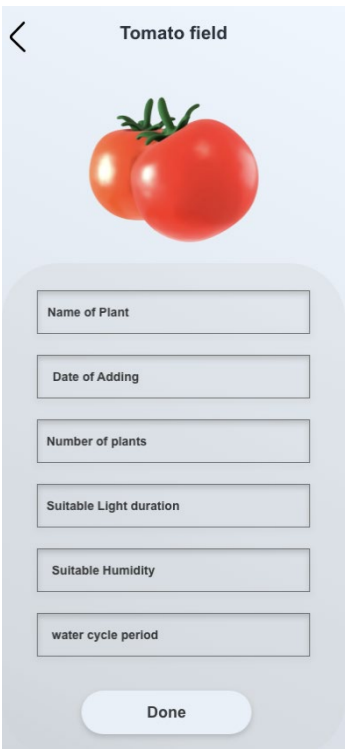


Figure 11-AE view Filed

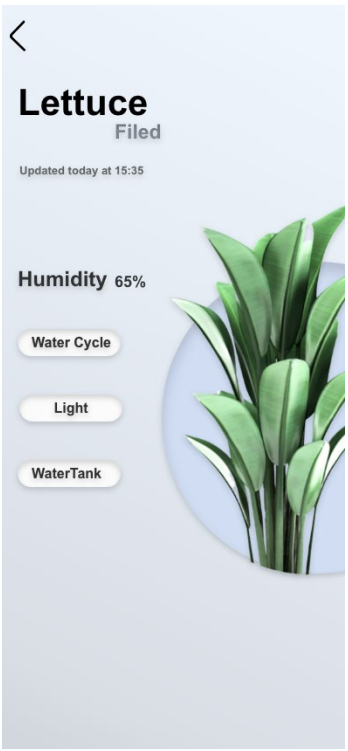


Figure 8 Each AE and farmer has a ready account, where he must only enter the information, he obtained from the admin of each of them (his ID in addition to the password), and in case he forgets the password, he can retrieve it via e-mail or phone number.

Figure 9 The engineer's home page, where he can see all of the plant fields on the farm, their numbers, and which are empty for new plants to be added.

Figure 10 If the empty field is selected, this page appears, where he must specify the name of the plants in this field (type) and the date they were added, as well as the number of plants in each field, the duration of lighting for this plant, the humidity, and the duration of the water cycle.

Figure 11 If a specific plant is selected from the home page, this page appears, displaying vital plant information such as humidity in addition to three buttons (lighting, water cycle, and water tank).

Figure 12-AE water cycle

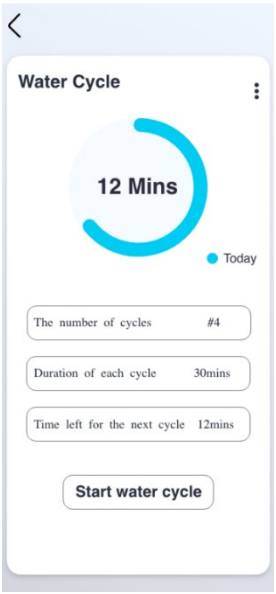


Figure 12 After clicking on the water cycle button, this page appears showing the number of cycles and the duration of each cycle.
the time left for the next cycle
In addition, he can start a new water cycle any time he wants.

Figure 13- AE light LED

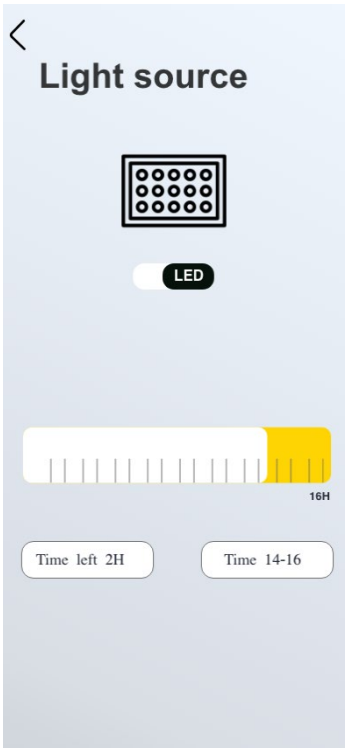


Figure 14- AE light SUN

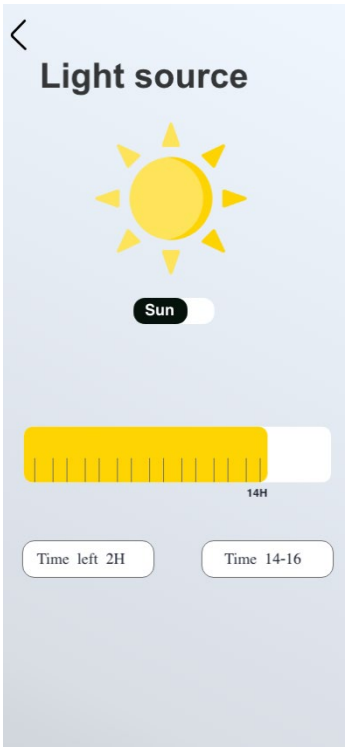


Figure 15- AE water Tank

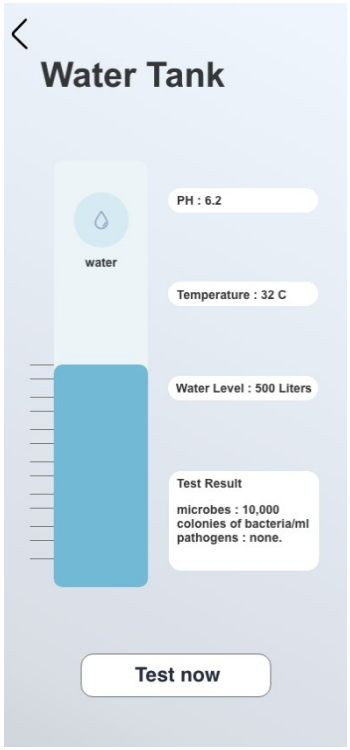


Figure 16- Farmer Home page

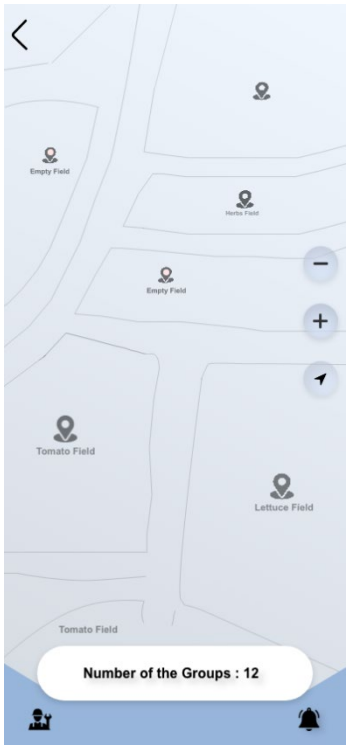


Figure 13 This page appears after you click the "light" button. The system determines the light source, but AE and the farmer (both) can control it manually. Figure 14 appears after you click the switch button (Figure 13 depicts LED lighting, Figure 14 SUN lighting.) The page displays the total amount of light required for plants during the day (total) and the time they are exposed to sunlight and the time remaining until the end of the exposure.

Figure 15 The page displays water information such as PH, temperature, water level, and test water information. The AE engineer is available to conduct tests at any time.

Figure 16 The Farmer's home page, where he can see all of the plant fields on the farm, their numbers, At the end of the page, 2 icons appear: one to choose a maintenance company and communicate with them, and the other to show notifications and alert the farmer in the event of any malfunction.

Figure 17- Farmer Home page

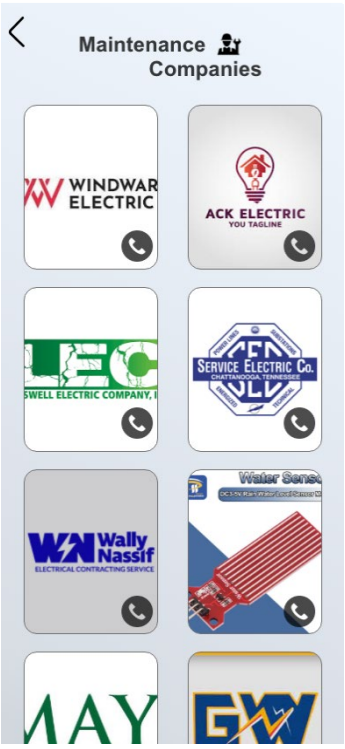


Figure 18- plant Field for farmer

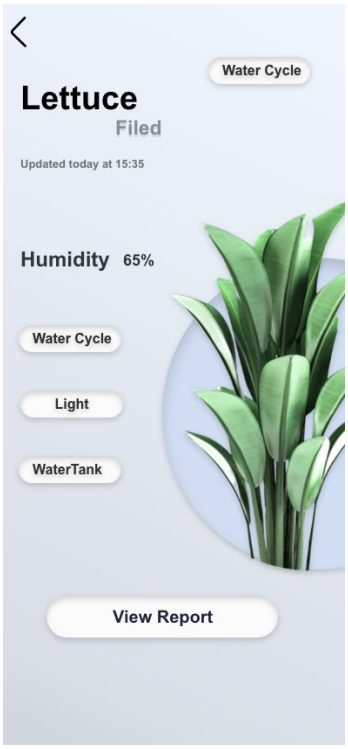


Figure 19- Farmer Home page

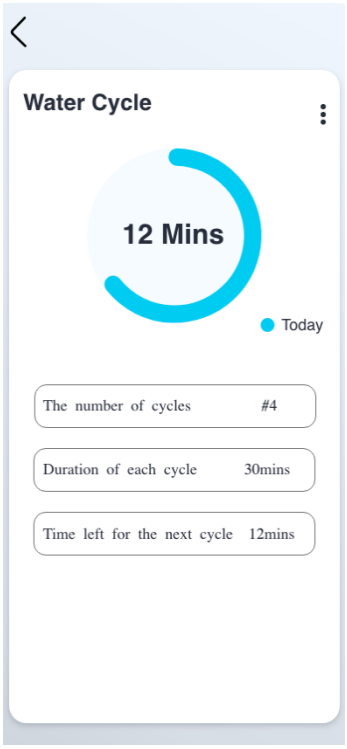


Figure 20- Farmer Home page

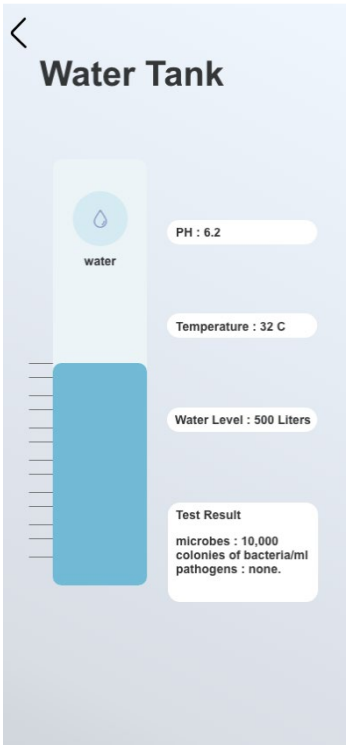


Figure 17 This page appears after clicking on the maintenance icon on the farmer's home page, where he can choose any company to communicate with.

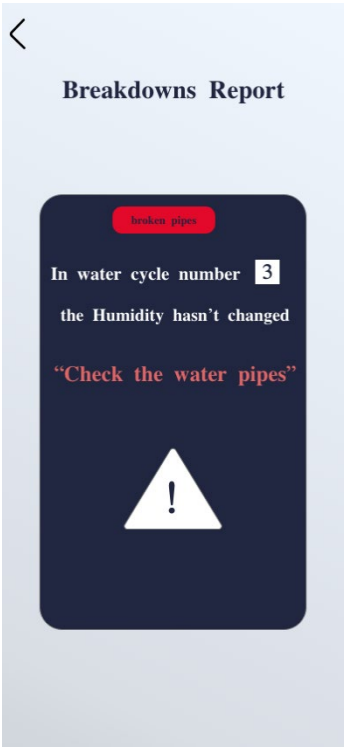
Figure 18 If the farmer selects a specific plant from the home page, this page appears, displaying vital plant information such as humidity in addition to three buttons (lighting, water cycle, and water tank), and if there is any problem in the system, the farmer can view the report to see more details about this problem.

Figure 19 After the framer click on the water cycle button, this page appears showing the number of cycles and the duration of each cycle.
the time left for the next cycle
In addition,

Figure 20 The page displays water information such as PH, temperature, water level, and test water information.

Figure 21 IF there is any problem in the system, the farmer can view the report to see more details about this problem.

Figure 21- Report page



3.2 Functional Requirements

3.2.1 The system shall allow the admin to create farm main account.

Identifier	F1
Category	Functional Requirement
Specification	Creating an account for the first time as admin to the system will create by default a farm account. Admin need to fill all farm info such as location and name.
Fit criterion	None
Source	Admin
Rationale	We need this requirement to make the system organized and independent.
Interaction	None
Priority	High
Stability, Commonality	More stable

3.2.2 The system shall allow only admin to add accounts for other users.

Identifier	F2
Category	Functional Requirement
Specification	Admin give access to other users by create accounts to them, required info are name, serial number, phone, and password.
Fit criterion	None
Source	Admin
Rationale	We need this requirement to give users permissions to access the specific farm system in legal way, without any overlaps.
Interaction	F1
Priority	High
Stability, Commonality	More stable

3.2.3 The system shall allow the admin to connect sensors with the application.

Identifier	F3
Category	Functional Requirement
Specification	Light and humidity sensors should be connected to the system to get reads, admin will pair sensors using mac address, system will display connectivity process.
Fit criterion	None
Source	Admin
Rationale	We need this requirement to make sure that system works effectively using sensors readings.
Interaction	F1
Priority	High
Stability, Commonality	More stable

3.2.4 The system shall allow the AE request to test water tank properties.

Identifier	F4
Category	Functional Requirement
Specification	Although system do this process automatically, AE can request it at any time. Test should contains PH, temperature, level, microbes and pathogens.
Fit criterion	None
Source	Agriculture engineer
Rationale	We need this requirement to control HS without user involvement at the same water tank place. Also this FR helps AE to interact with HS even when the automated process are not working as required .
Interaction	F2, F3
Priority	Medium
Stability, Commonality	More stable

3.2.5 The system shall allow AE to add new field.

Identifier	F5
Category	Functional Requirement
Specification	IFF the farm has empty places AE can add new flied. Adding new field consist these information: Filed plants name, adding date, number of plants, water cycle period, humidity and light duration, that will be saved in the database later for analysis..
Fit criterion	None
Source	AE
Rationale	We need this requirement to input data to the system to make decision based on them.
Interaction	F2
Priority	High
Stability, Commonality	More stable

3.2.6 The system shall allow the AE start water cycle manually.

Identifier	F6
Category	Functional Requirement
Specification	Although system do this process automatically, AE can request it at any time.
Fit criterion	None

Source	AE
Rationale	We need this requirement to help AE to interact with HS even when the automated process is not working as required.
Interaction	F2
Priority	Medium
Stability, Commonality	More stable

3.2.7 The system shall allow the AE and farmers to view plants light system info.
(Sub functions)
The system shall allow the AE and farmers to determine the light source
(Sun light or LED).

Identifier	F7
Category	Functional Requirement
Specification	Light sensors record sun light time, then the system view difference between target light duration and sensor reads continually as timeline. System should complete the time using LED. Both AE and farmer can choose the light source manually.
Fit criterion	None
Source	Agriculture engineer and farmers
Rationale	We need this requirement to monitor for the most important component of HS. And Be flexible on light daily changes by the free options.
Interaction	F2, F5
Priority	High
Stability, Commonality	More stable

3.2.8 The system shall allow the AE and farmers to view PH, water temperature and the result of water test

Identifier	F8
Category	Functional Requirement
Specification	Test should contain PH, temperature, level, microbes and pathogens.
Fit criterion	None
Source	Agriculture engineer and farmers
Rationale	We need this requirement to avoid starting water cycle with unhealthy water .
Interaction	F2, F3
Priority	High
Stability, Commonality	More stable

3.2.9 The system shall allow the AE and farmers to view field plants humidity.

Identifier	F9
Category	Functional Requirement
Specification	Humidity sensor shows that water cycle is working and all plants get enough water every cycle.
Fit criterion	None
Source	Agriculture engineer, farmer
Rationale	We need this requirement to avoid plant desiccation.
Interaction	F2, F3
Priority	High
Stability, Commonality	More stable

3.2.10 The system shall allow the AE and farmers to view water cycle info.

Identifier	F9
Category	Functional Requirement
Specification	Water cycle info are: 1.Number of cycles 2. Water cycle period of time 3. Time left for the left cycle
Fit criterion	None
Source	Agriculture engineer, farmer
Rationale	We need this requirement to avoid human involvement in regular monitoring.
Interaction	F2, F3
Priority	Medium
Stability, Commonality	More stable

3.2.11 The system shall allow the farmers to communicate with maintenance companies.

Identifier	F11
Category	Functional Requirement
Specification	If any problems happened ,farmer will be able to communicate maintenance companies throw their phone numbers**.**
Fit criterion	None
Source	Farmer
Rationale	We need this requirement to communicate as fast as possible if any breakdowns happened with trusted companies.
Interaction	F2,F3,F12,F13
Priority	High
Stability, Commonality	More stable

3.2.12 The system shall notify the farmers to view breakdowns report.

Identifier	F12
Category	Functional Requirement
Specification	Under specific conditions system will notify farmer to check the breakdowns report .

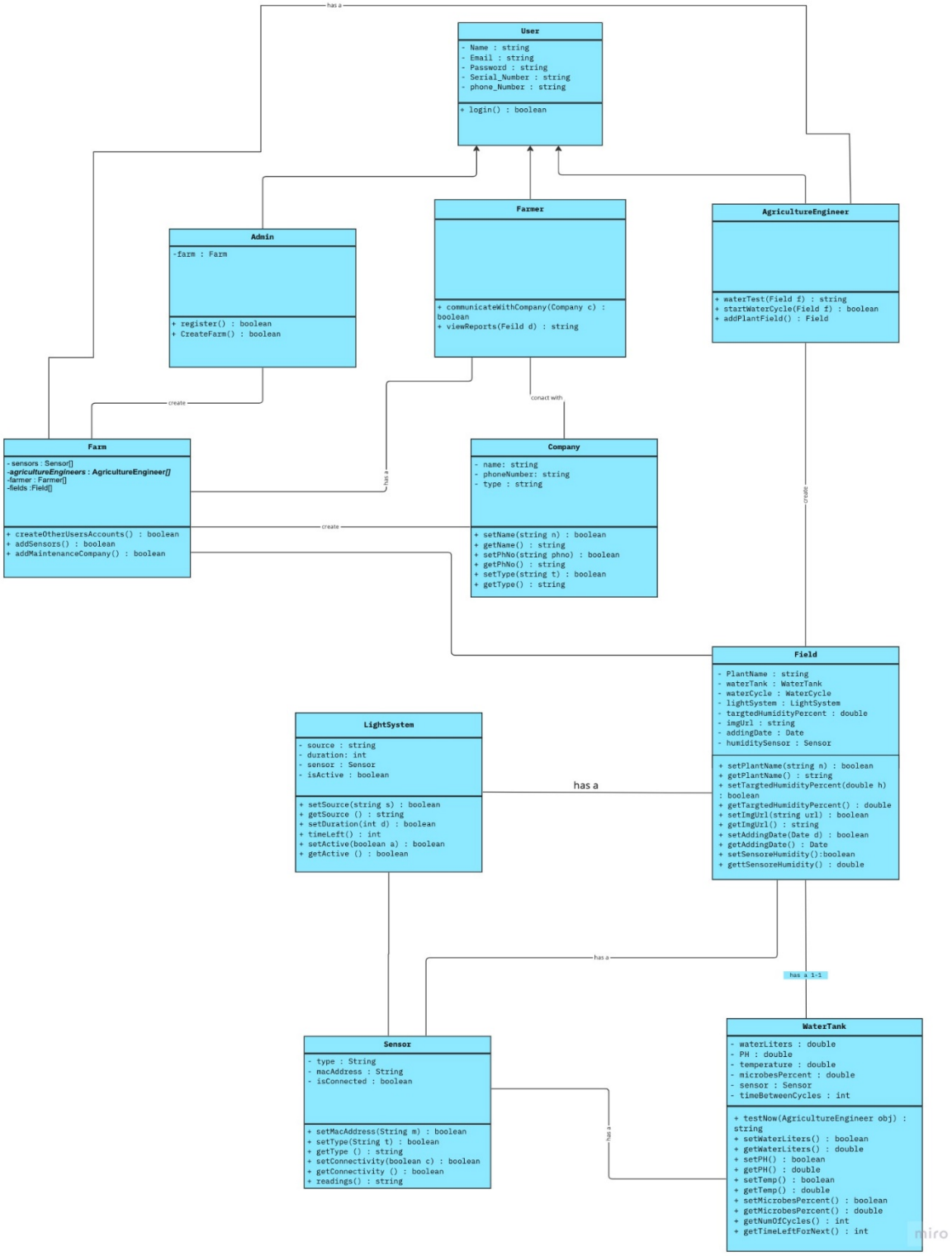
Fit criterion	None
Source	Farmer
Rationale	We need this requirement to keep HS working as fast as possible if any breakdowns happened.
Interaction	F2,F3
Priority	High
Stability, Commonality	More stable

3.2.13 The system shall allow admin to add companies contact info.

Identifier	F13
Category	Functional Requirement
Specification	Admin can add company info: Company name ,contact number ,specialization.
Fit criterion	None
Source	Admin
Rationale	We need this requirement to make contract with trusted companies.
Interaction	none
Priority	High
Stability, Commonality	More stable

3.3 Use case diagram – see in 2.2

3.4 Class diagram



3.5 Non-Functional Requirements

3.5.1 Performance

ID	NFR1
Title	Performance
Category	Non-Functional requirement
Specification	System shall handle multiple users at the same time. System shall update monitored data frequently.
Fit Criterion	After three months of adding plant fields, plants health should not decreased more than 0.6% . Note : usually plant health decreased by 3%.
Source	AE
Rationale	In order to increase HS performance
Interaction	None
Priority level	High
Stability, Communality level	Stable

3.5.2 Usability

ID	NFR2
Title	Usability
Category	Non-Functional requirement
Specification	The design of UI reflects the usability of the system, Each user has separate pages to define responsibilities in easy way. every action has its own page to avoid the overlap that affects the real HS.
Fit Criterion	Get feedback from user by prototype.
Source	AE, Farmer, and Admin.
Rationale	To make the application easy to use.
Interaction	None
Priority level	Medium
Stability, Communality level	Stable

3.5.3 Efficiency

ID	NFR3
Title	Efficiency

Category	Non-Functional requirement
Specification	Fast inserting data from sensors readings to system throw the database to process it ,real live retrieving data from database.
Fit Criterion	Get feedback from user by acceptance test.
Source	Team members
Rationale	In order to improve the quality of service that is provided to the user.
Interaction	AE, Farmer and Admin.
Priority level	High
Stability, Communality level	Stable

3.5.4 Maintainability

ID	NFR4
Title	Maintainability
Category	Non-Functional requirement
Specification	Integrate AI with the system. Add a new feature like live monitor plant via cams. Add a new feature such as chatting between farmer and AE. Make the application easy to update and fast to implement new services in the future.
Fit Criterion	Test the independency of the system.
Source	Admin
Rationale	In order to update the system services.
Interaction	None
Priority level	Medium
Stability, Communality level	Stable

3.5.5 Reliability

ID	NFR5
Title	Reliability
Category	Non-Functional requirement
Specification	system give a accurate result for all system services

Fit Criterion	Compare between the result of the system and the expected result .
Source	AE ,Farmer
Rationale	In order to make the system result more accurate.
Interaction	None
Priority level	High
Stability, Communality level	Stable

3.5.6 Security and Safety

ID	NFR6
Title	Security and Safety
Category	Non-Functional requirement
Specification	The system must protect all the information of farms and the other users.
Fit Criterion	Make sure that no one can access the accounts and the information of another users.
Source	Admin
Rationale	In order to make the user account and information more protected.
Interaction	None
Priority level	Low
Stability, Communality level	Stable

3.5.7 Availability

ID	NFR7
Title	Availability
Category	Non-Functional requirement
Specification	The system must be available to users 99.5 percent of the time. The total downtime for the system over a year shall not exceed 0.3 percent.
Fit Criterion	Try to enter to the system and test it services at any time.
Source	AE, Farmer and Admin .

Rationale	In order to make the system more available for the users
Interaction	None
Priority level	High
Stability, Communality level	Stable

3.5.8 portability

ID	NFR8
Title	portability
Category	Non Functional requirement
Specification	The application works cross platforms.
Fit Criterion	Make sure that the servers afford a high users load
Source	AE ,Farmer and Admin.
Rationale	In order to make the application more adaptable platform to run on.
Interaction	None
Priority level	medium
Stability, Communality level	Stable

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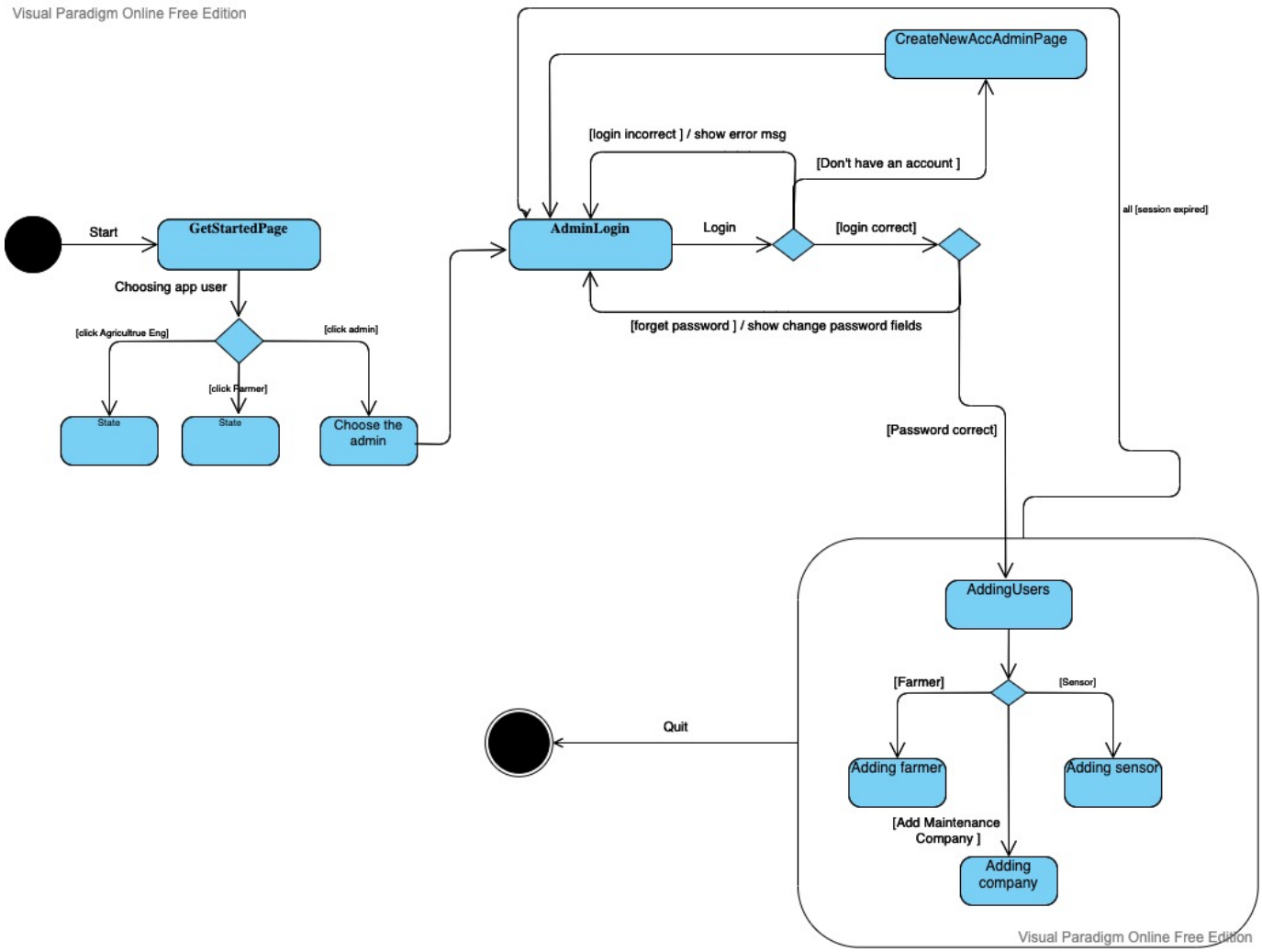
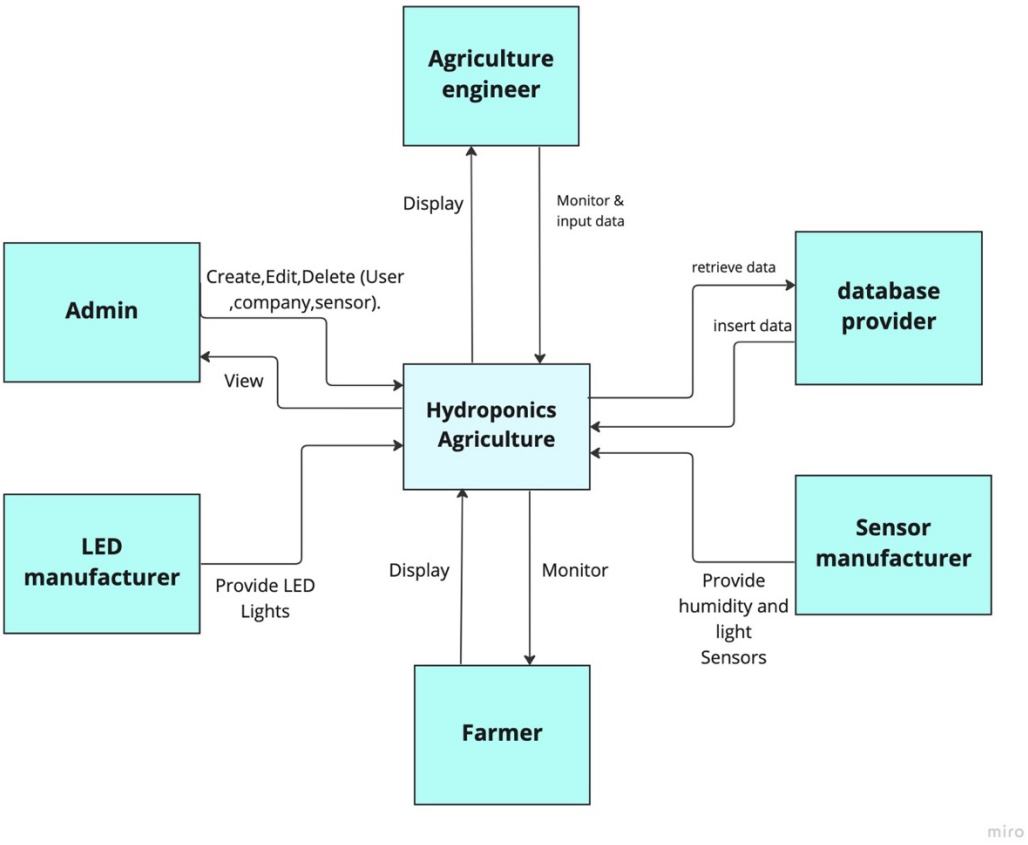
4. Analysis Models

List all analysis models used in developing specific requirements previously given in this SRS. Each model should include an introduction and a narrative description. Furthermore, each model should be traceable the SRS's requirements.

4.1 State-Transition Diagrams (STD)

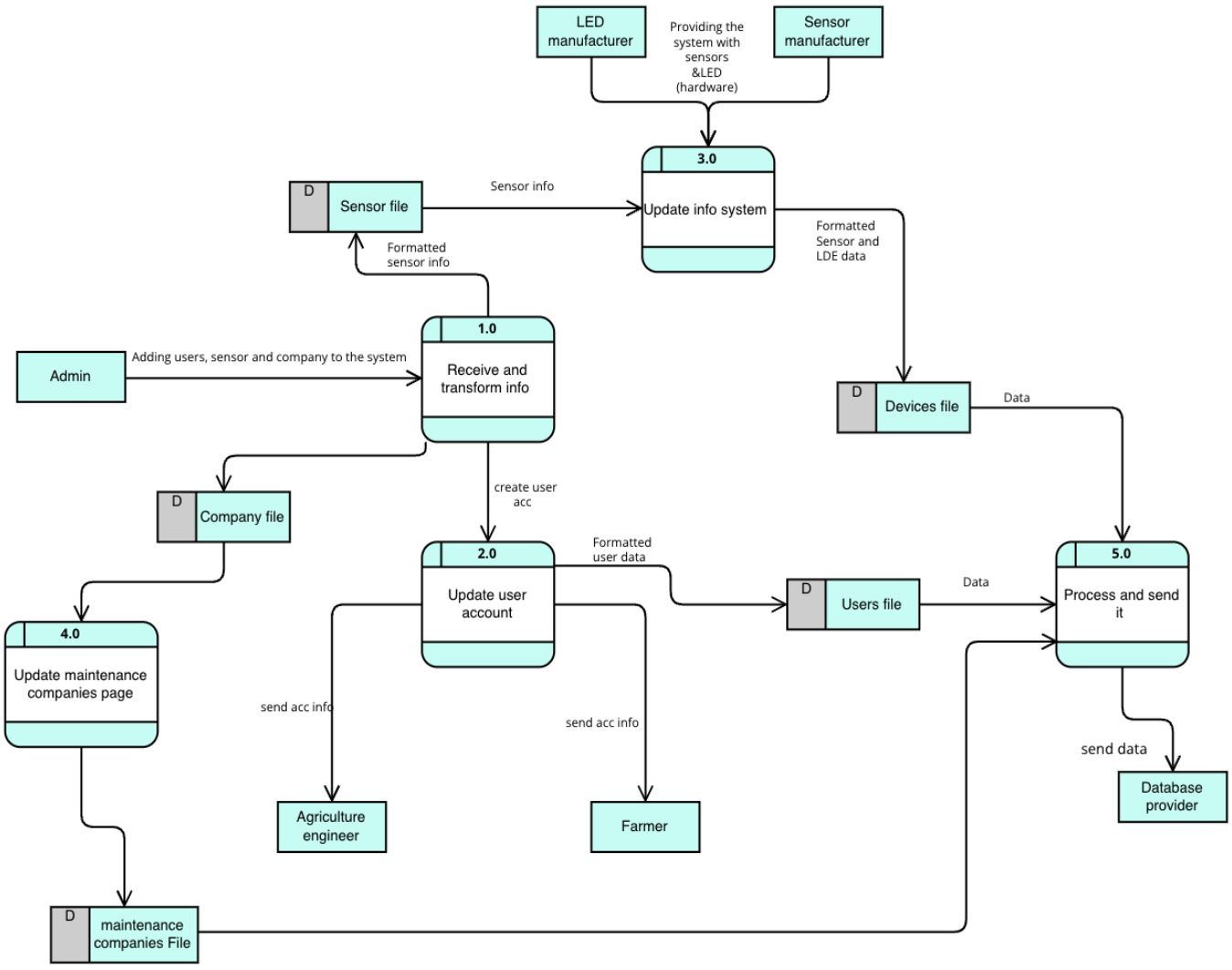


4.2 Context Diagram

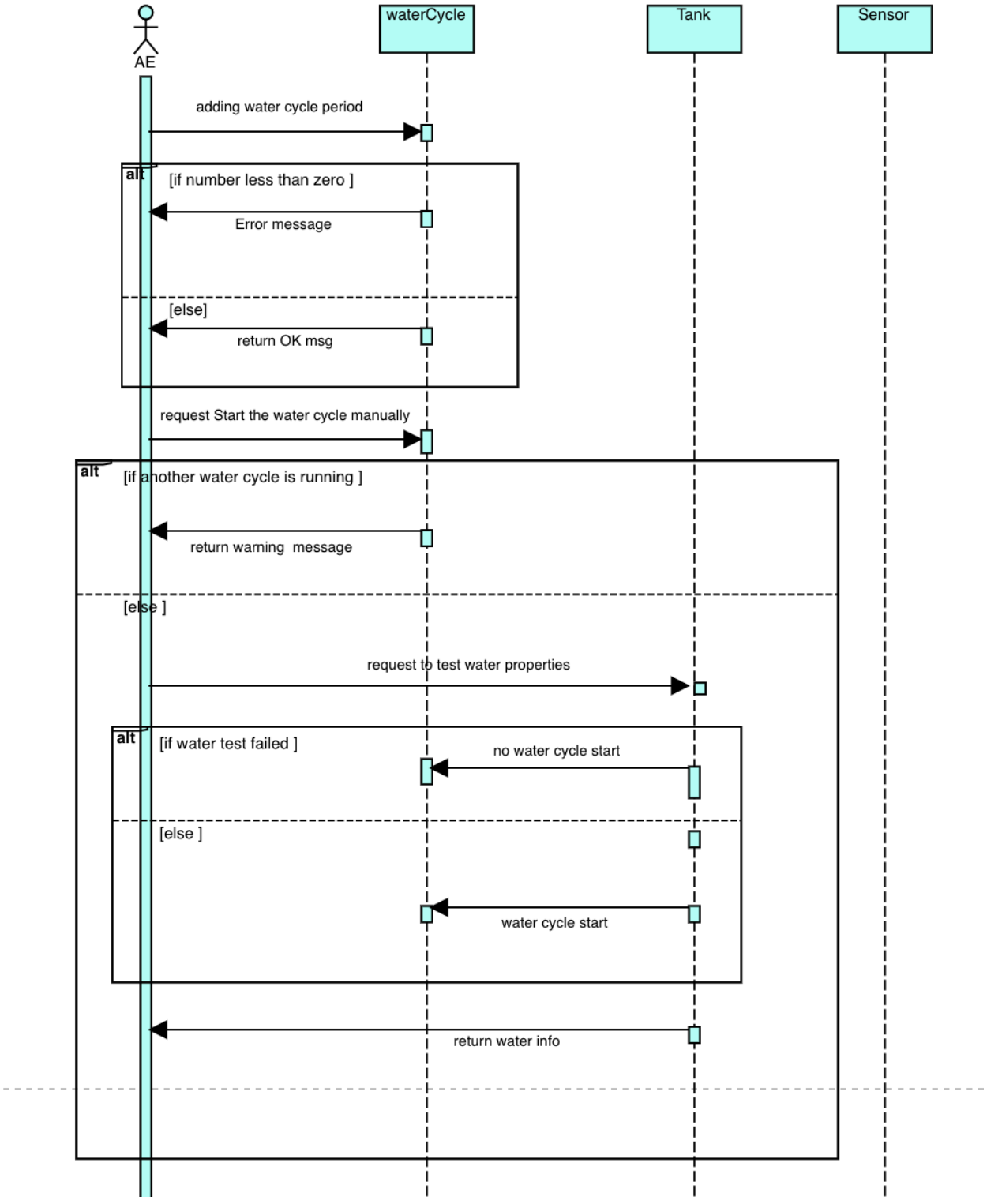


4.3 Data Flow Diagrams (DFD)

A) Level 0



4.4 Sequence Diagrams



2.2 Inconsistency management

2.2.1 Types of inconsistency

Terminology clash:
e.g. farmer: “user” vs. “employee”
e.g. percent of water int plant: “humidity” vs. “moisture”

Designation clash:
e.g. “user” for “farmer” *vs.* “Agriculture Engineer”

Structure clash
e.g. “microbes test result” as percentage (e.g. 0.2%) *vs.* ratio(e.g. 10.000 bacteria/ml).

strong conflict
e.g. Only AE controls all automated process.
Vs Admin can request for test water at any time.
e.g. Only admin can add sensors
vs User who can add field can add sensors

weak conflict
e.g. AE can start a water cycle at any time
vs while water cycle is running , no request is accepted.
e.g. AE and farmer can determine light source
vs If sensors reading shows night time , light source should be LED.

2.2.2 Handling Conflict

S1 All process that need decision will be part of AE responsibilities .
S2 Adding new hard ware to the existing system will be Admin’s job.
W1 At the time water cycle is running , start new cycle button will be disabled .
W2 when sensors reading shows that no enough sunlight,
LED is not an option, it’s mandatory.

2.2.3 Managing conflicts: a systematic process

S1: The system shall allow the admin to connect sensors with the application.
S2: The system shall allow AE to add new field.
S3: The system shall allow admin to add hardware providers contact info.
#Conflicts(S_1) = remainderOf (1001 div 1000)= 1
#nonConflictingOverlaps(S_1) = quotientOf (1001 div 1000)= 1
#Conflicts(S_2) = remainderOf (1 div 1000)= 1
#nonConflictingOverlaps(S_2) = quotientOf (1 div 1000)= 0
#Conflicts(S_3) = remainderOf (1000 div 1000)= 0
#nonConflictingOverlaps(S_3) = quotientOf (1000 div 1000)= 1
#Conflicts(total) = remainderOf (2002 div 1000)= 2
#nonConflictingOverlaps(total) = quotientOf (2002 div 1000)= 2

Statement	S1	S2	S3	Total
S1	0	1	1000	1001
S2	1	0	0	1
S3	1000	0	0	1000
Total	1001	1	1000	2002

S1: The system shall allow the AE and farmers to view plants light system info.
S2: The system shall allow the AE and farmers to determine the light source(Sun light or LED).
S3: If sensors reading shows that sun light is not enough, light source must be LED.
S4: LED is not an option when they are broken based on breakdowns test report.

Statement	S1	S2	S3	S4	Total
S1	0	1000	0	0	1000
S2	1000	0	1	1	1002
S3	0	1	0	1	2
S4	0	1	1	0	2
Total	1000	1002	2	2	2006

#Conflicts(S_1) = remainderOf (1000 **div** 1000)= 0
#nonConflictingOverlaps(S_1) = quotientOf (1000 **div** 1000)= 1
#Conflicts(S_2) = remainderOf (1002 **div** 1000)= 2
#nonConflictingOverlaps(S_2) = quotientOf (1002 **div** 1000)= 1
#Conflicts(S_3) = remainderOf (2 **div** 1000)= 2
#nonConflictingOverlaps(S_3) = quotientOf (2 **div** 1000)= 0
#Conflicts(S_4) = remainderOf (2 **div** 1000)= 2
#nonConflictingOverlaps(S_4) = quotientOf (2 **div** 1000)= 0
#Conflicts(total) = remainderOf (2006 **div** 1000)= 6
#nonConflictingOverlaps(total) = quotientOf (2006 **div** 1000)= 2

Conflict resolution tactics

- Avoid boundary condition

e.g. “All process that need decision will be part of AE responsibilities only”

- Restore conflicting statements

e.g. “At the time water cycle is running , start new cycle button will be disabled .”

- Drop lower-priority statements

e.g. drop --> User who can add field can add sensors

- Specialize conflict source or target

e.g. “Adding new hardware to the existing system will be Admin’s job only.”

2.3 Risk Analysis

2.3.1 Types of risk

Product-related: e.g.

- Under abnormal conditions sensors wrong reads (weather conditions).
- database Server down → not real live retrieving
- AE wrong input
- Users prefer manual agriculture on using phone (trust issues)
- ignore breakdowns notifications
- admin connects sensors wrongly (cause fields sensors overlap)

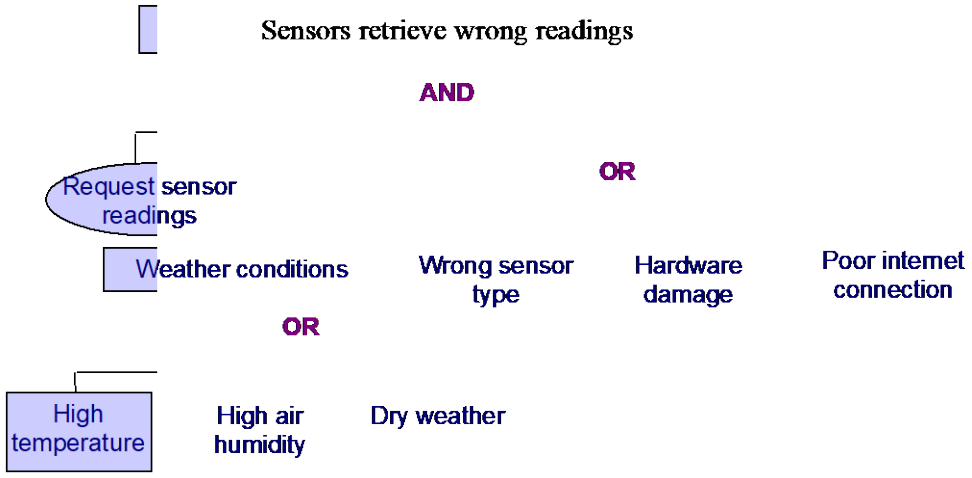
Process-related risks:

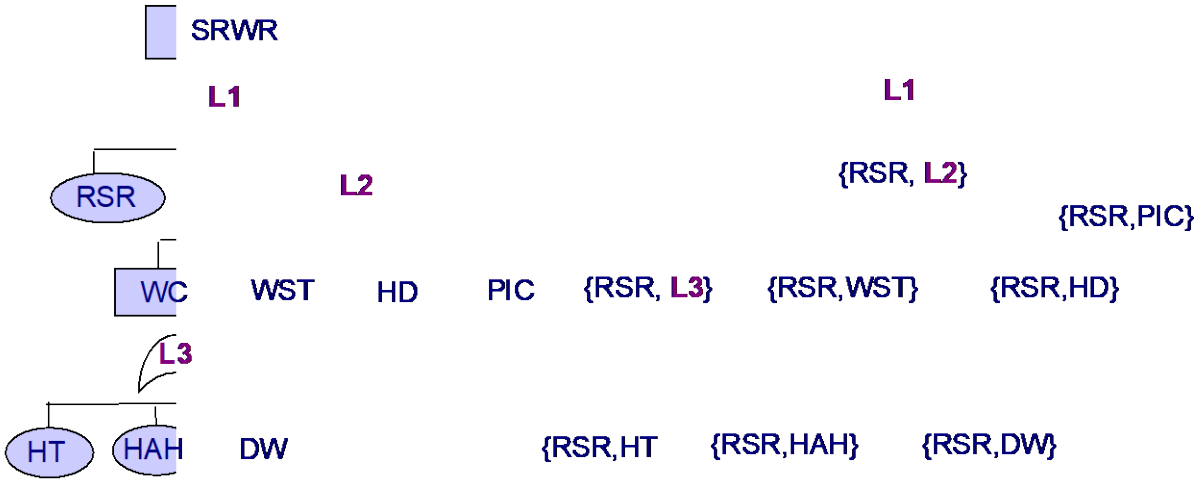
- human risk : developers can’t integrate HS with the mobile app
- cost issues (manual tools agriculture lower cost)
- Tight deadline, that made us work in a rush and commit more mistakes.

2.3.2 Risk management

Risk identification :

Risk tree:





Risk assessment:

Qualitative Risk assessment table:

Risk: “Under abnormal conditions sensors retrieve wrong readings”

Consequences	Likely	Possible	Unlikely
Wrong reactions	Catastrophic	Catastrophic	severe
Lose of plants	Catastrophic	High	High
Lose of resources (water – electricity)	Moderate	Moderate	Low
Wrong data analysis	High	Low	Low

***DDP : Quantitative risk management :**

Impact matrix

Objectives	Wrong readings from sensors (likelihood 0.1)	Database Server down (likelihood 0.5)	Wrong Data Input (likelihood 0.3)	trust issues (likelihood 0.1)	Ignore Breakdowns Notifications (likelihood 0.4)	Wrong sensors connection (likelihood 0.5)	Lose obj
Plants health (Weight :0.4)	0.9	0.6	0.7	0.1	0.6	0.6	0.28
Trusted Automated Process (weight :0.2)	0.9	0.8	0.7	0.3	0.5	0.7	0.26
Less of human involvement (weight :0.3)	0.2	0.6	0.8	0.8	0.5	0.1	0.89
Save Natural sources (weight :0.1)	0.8	0.1	0.7	0.3	0.7	0.5	0.09
Risk criticality	0.07	0.30	0.22	0.04	0.22	0.23	

Effectiveness matrix :

Countermeasures	Wrong readings from sensors 0.07	Database Server down 0.30	Wrong Data Input 0.22	trust issues 0.04	Ignore Breakdowns Notifications 0.22	Wrong sensors connection 0.23	Overall effect of countermeasures
Frequent notified test on sensor connectivity, breakdowns.	0.8	0.3	0	0.5	0	0.8	0.35
Contract with Agriculture Analysis company.	0.8	0.2	0.9	0.8	0.1	0.3	0.44
On sensitive cases, send warnings to admin.	0.1	0.6	0.2	0.6	0.9	0.6	0.59
No offline automation data base process.	0.3	0.8	0	0.7	0	0.5	0.40
Combined risk reduction	0.98	0.84	0.92	0.99	0.91	0.97	

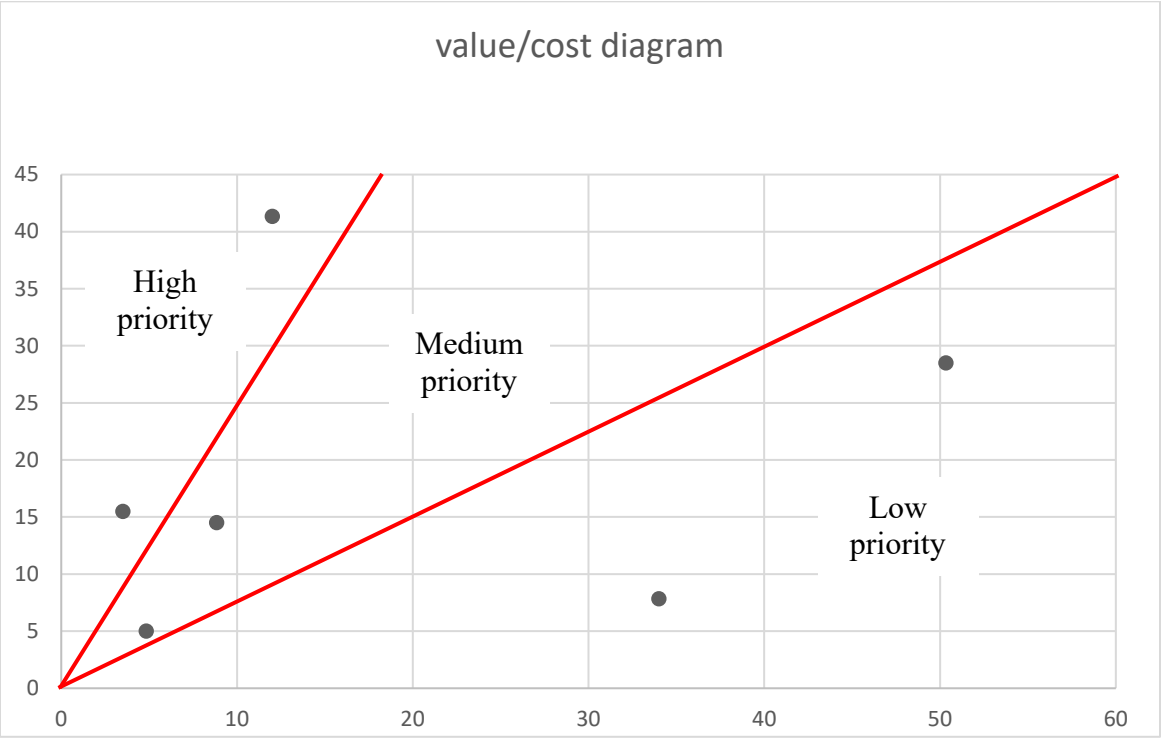
Requirement prioritization

value	Creating Accounts	Manual process control	Adding new components	Display process info	Communicate with maintainec companies	Notification feature
Creating Accounts	1	7	3	5	7	7
Manual process control	1/7	1	1/5	1/7	1/3	5
Adding new components	1/3	5	1	5	7	9
Display process info	1/5	7	1/5	1	5	3
Communicate with maintenance companies	1/7	3	1/7	1/5	1	1/3
Notification feature	1/7	1/5	1/9	1/3	3	1

value	Creating Accounts	Manual process control	Adding new components	Display process info	Communicate with maintainec companies	Notification feature
Creating Accounts	0.51	0.3	0.65	0.43	0.31	0.28
Manual process control	0.17	0,04	0.04	0.01	0.01	0.2
Adding new components	0.17	0.22	0.22	0.43	0.31	0.36
Display process info	0.10	0.30	0.04	0.09	0.22	0.12
Communicate with maintenance companies	0.70	0.13	0,03	0.02	0.04	0.01
Notification feature	0.07	0.01	0.02	0.03	0.13	0.04

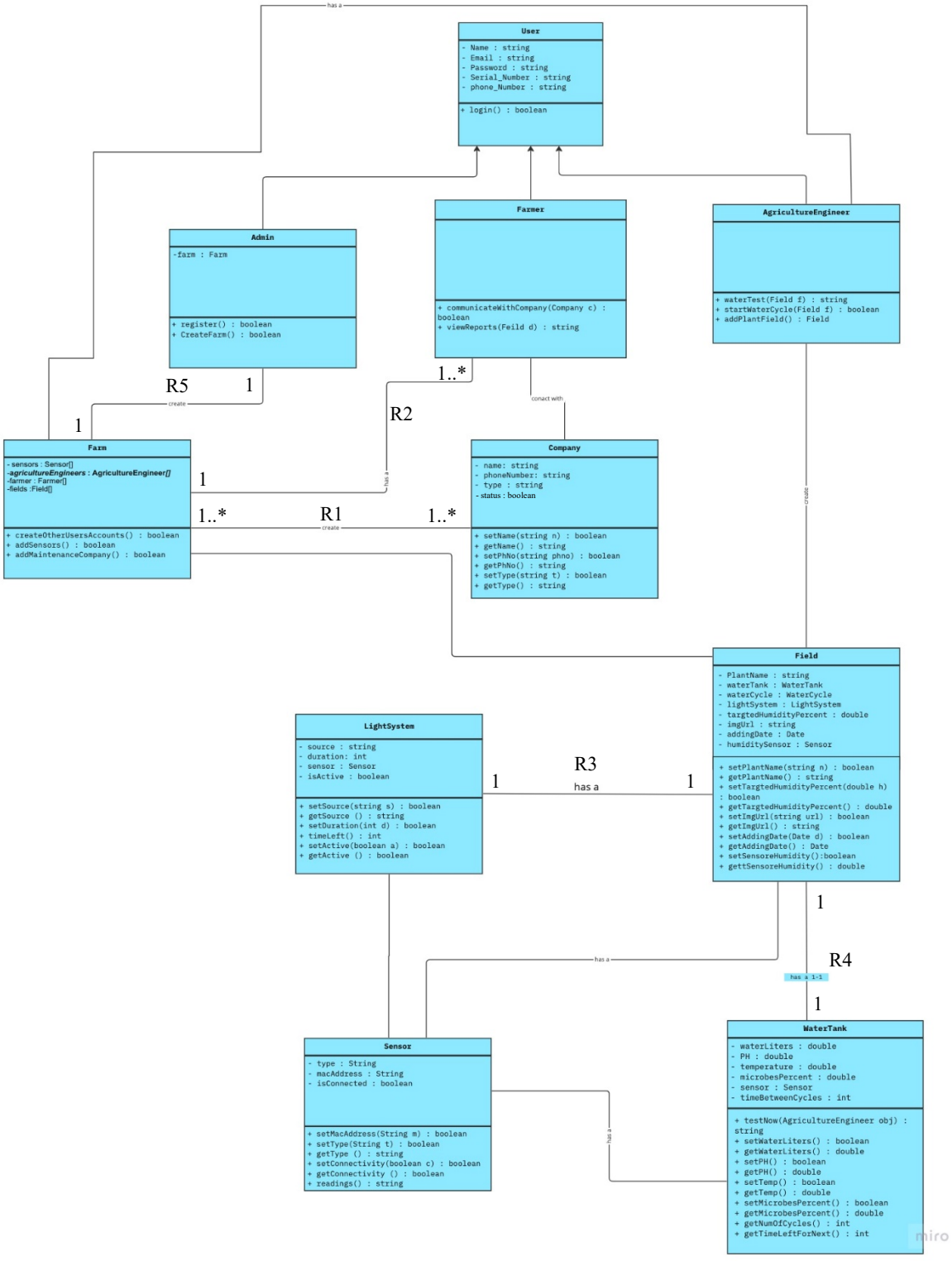
cost	Creating Accounts	Manual process control	Adding new components	Display process info	Communicate with maintainec companies	Notification feature
Creating Accounts	1	1/7	1/7	3	3	5
Manual process control	7	1	1/3	5	7	7
Adding new components	7	3	1	7	7	9
Display process info	1/3	7	1/7	1	5	3
Communicate with maintenance companies	1/3	1/7	1/7	1/5	1	1/3
Notification feature	1/5	1/7	1/9	1/3	3	1

cost	Creating Accounts	Manual process control	Adding new components	Display process info	Communicate with maintainec companies	Notification feature
Creating Accounts	0.11	0.03	0.08	0.18	0.12	0.2
Manual process control	0.79	0.22	0.18	0.30	0.27	0.28
Adding new components	0.79	0.65	0.53	0.42	0.27	0,36
Display process info	0.04	0.04	0.08	0.06	0,19	0.12
Communicate with maintenance companies	0.04	0.03	0.08	0.01	0.04	0.01
Notification feature	0.02	0.03	0.06	0.02	0.12	0.04



Phase 3

3.1 OCL Statement



context Farm
inv: Self.R1 status = true ;

---
context Farm
inv: Self.R2 -> forAll (p1,p2:Farmer | p1<>implies p1.serial_number <> p2.serial_number)

------
context Company
inv: Allinstance () -> select (type = " filterization ")

----
context LightSystem
inv: Self.R3 -> Reject (isconnected = true)

----
context WaterTank
int:self.R4 -> collect (ph=6.6)

----
context Field
inv: Self.R4 -> forAll(timerBetweenCycles=20)

------
context Sensor
Self-> exist (type = 'humidity')

------
context Field
inv:Self.name=AspidistorElatior implies forAll not ocl kind of (lighesystem)

----
context Farm
pre;self.R5->size()=1
------

context : Field
inv:All instance () -> forAll (plantName='potato' AND targetedHumidity = 20)