

***Modern University for Technology & Information***

**Faculty Of Engineering**

**Control Engineering Department**

***SIMACAS***

**A premium project submitted to Control Engineering Department in partial fulfilment of the requirements for the degree of Bachelor of Science in Control Engineering**

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# Executive Summary

# Chapter 1: Introduction

## Project Aim

Irrigation stands as a cornerstone of human civilization, pivotal to its survival and growth throughout history. From ancient times to modern days, the evolution of irrigation has mirrored the progress of civilization itself. Particularly since the Industrial Revolution, and more recently the Data Revolution, advancements in technology have transformed traditional practices. Modern machinery and automation have streamlined many processes that were once labor-intensive, achieving levels of efficiency and precision that were previously unattainable. Despite these advancements, the field of irrigation continues to offer opportunities for innovation, especially in specialized applications.

This project targets one such niche: the development of a small-scale, temporary, automated irrigation system designed for highly controlled environments. These systems are particularly beneficial for specialized agricultural research or the cultivation of rare and exotic plants under precise conditions. The primary goal of this project is to engineer a sophisticated system capable of meticulously monitoring and controlling every aspect of a plant’s environment.

Key features of this innovative system include:

* Comprehensive Monitoring: Utilizing an array of sensors, the system will continuously monitor critical parameters such as temperature, humidity, water levels, and CO2 concentrations. This data-rich approach ensures that all environmental factors affecting plant growth are observed and analyzed.
* Precise Irrigation and Fertilization: The core of the system’s functionality lies in its ability to dispense water and nutrients with pinpoint accuracy. Through the integration of advanced robotics, both the quantity and timing of water and fertilizer application can be precisely controlled, tailored to the plant's specific needs at any growth stage.
* Intelligent Control System: At the heart of the operation is a main Microcontroller Unit (MCU). This MCU is tasked with interpreting sensor data and managing output actions. It is programmed with a sophisticated 'model predictive control' algorithm, which optimizes conditions for maximum plant growth and yield.
* Adaptive Algorithms: The system’s adaptive capabilities allow for real-time adjustments based on immediate environmental feedback, enhancing the efficacy and responsiveness of the irrigation strategy.

By focusing on these advanced technological solutions, this project aims to push the boundaries of what is possible in controlled agricultural systems. It promises not only to enhance the precision of plant cultivation but also to contribute valuable insights into the optimal conditions for plant growth, offering potential applications in both research settings and rare plant cultivation.

Central to achieving this precision is the integration of a model predictive control (MPC) algorithm within the system's main Microcontroller Unit (MCU). The MPC algorithm is crucial for several reasons:

* Anticipatory Adjustments: Unlike conventional control systems that react to changes, MPC predicts future conditions and makes proactive adjustments. This predictive capability allows for the optimization of irrigation and fertilization schedules based on forecasted environmental and plant needs.
* Optimal Resource Utilization: By accurately forecasting future states, the MPC algorithm ensures optimal use of water and nutrients, which is essential for conserving resources while maximizing plant health and productivity.
* Enhanced Growth and Yield: The algorithm continuously refines its predictions and control outputs, adapting to the plant’s growth stages and environmental fluctuations. This adaptability is key to enhancing plant growth rates and maximizing yield.
* Precision and Control: The system's ability to precisely control the delivery of water and nutrients directly addresses the specific needs of each plant, tailored to its particular growth conditions. This level of control is particularly advantageous in research settings or for cultivating plants that require specific care.

The proposed irrigation system not only focuses on the practical aspects of plant cultivation but also embodies a cutting-edge approach to agricultural technology. Through the application of the MPC algorithm, this project aims to set new standards in the precision farming industry, providing insights that could influence broader agricultural practices.

By leveraging such advanced control strategies, this project not only aims to enhance the efficiency and effectiveness of irrigation practices but also to contribute to the broader field of agricultural science, offering scalable solutions that could be adapted for various controlled-environment agriculture applications.

## Summarized Methodology

High innovation parts

## Quick Walkthrough

Steps to use the project and quick results

# Chapter 2: Literature Review

# Chapter 3: Methodology

## System Overview

High level system overview with charts of everything

## Mechanical Design

### Intro

What challenges to solve

Brief overview of the innovative solutions

### Aluminum Frame

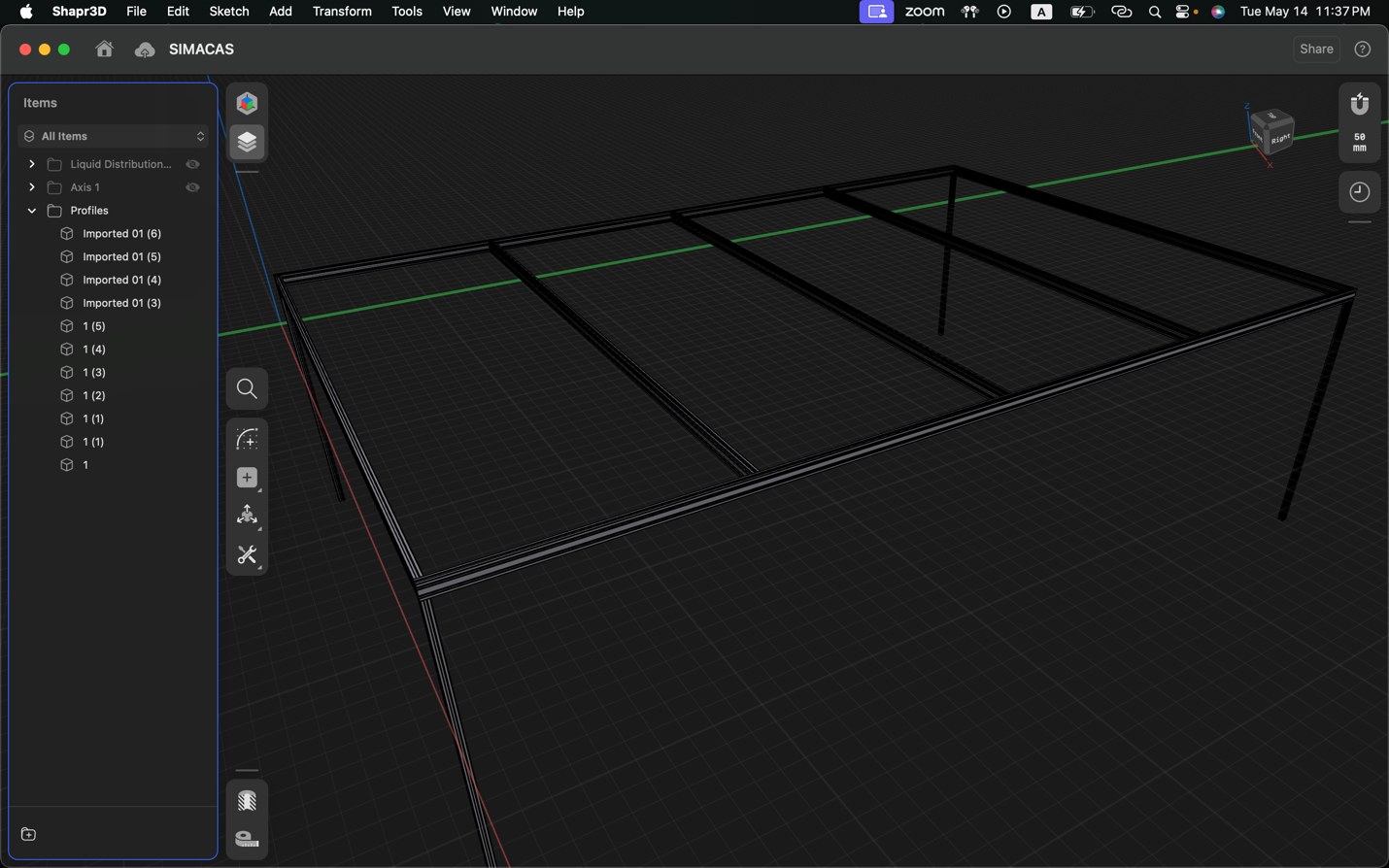
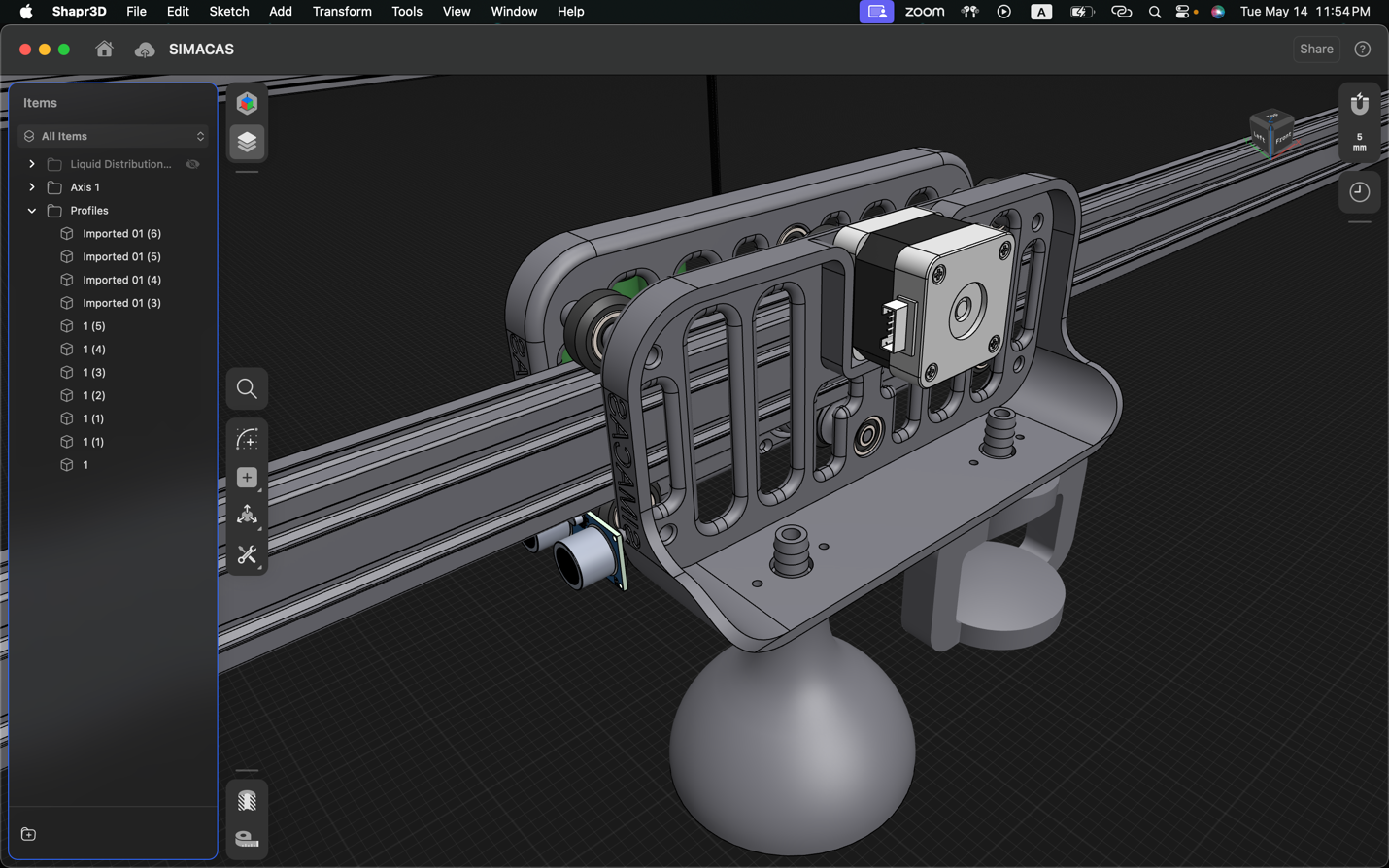
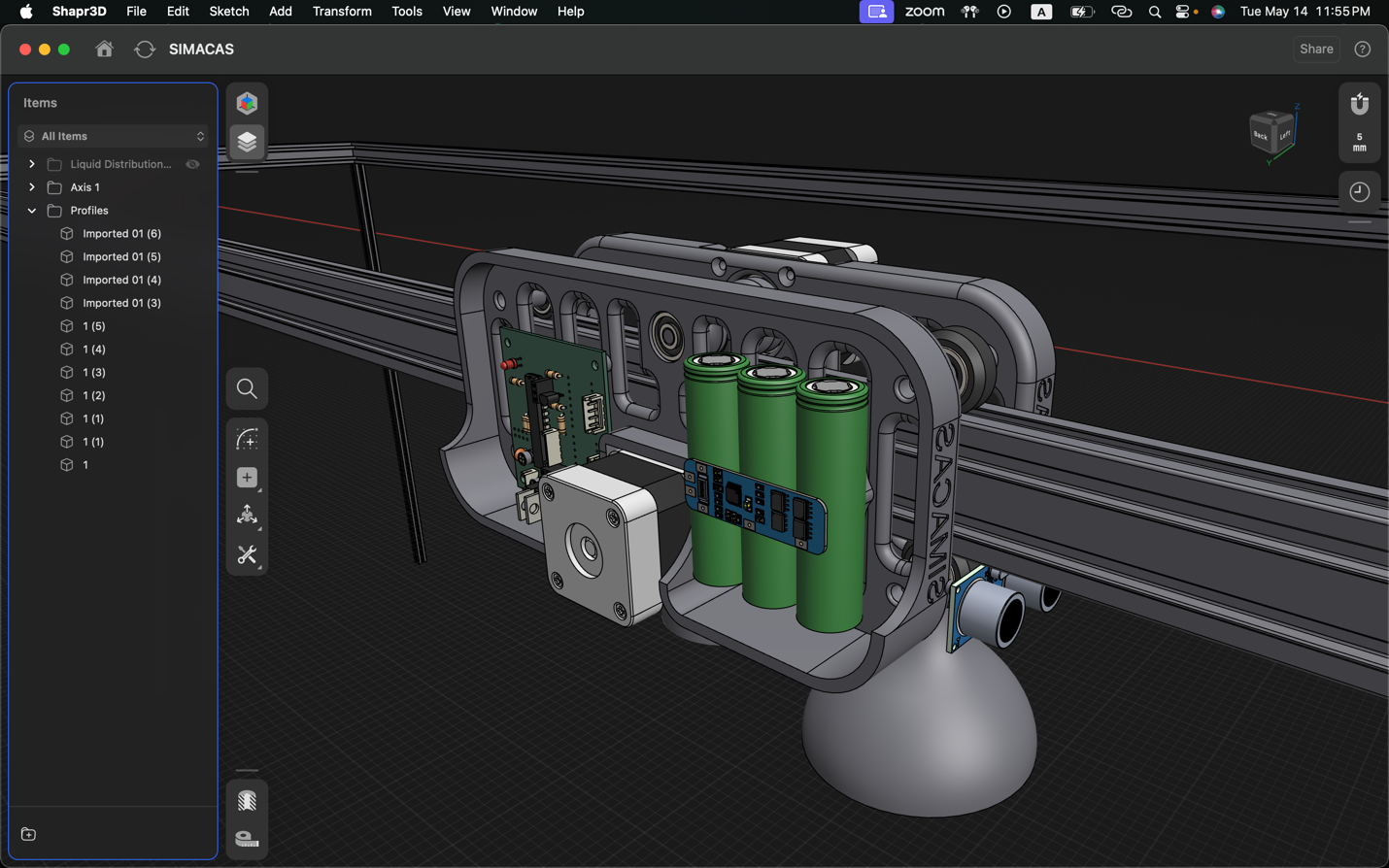


Figure 1: Aluminum Profile Frame 3D model

### Profile Traversal Mechanism





### Water Distribution System

## Electronics

### Intro

### Axis Control

#### Circuit

#### PCB

### Water Distribution Circuit

### Sensor Monitoring

#### Circuit

#### PCB

## Programming

### Intro

### Axis Control

### Sensor Monitoring

### Main Board

#### Interfacing Other Boards

#### Control Algorithms – Model Predictive Control (MPC)

##### Intro to MPC.

##### System Model

##### Implementing the Model

#### Website Control – IOT Application

# Chapter 4: Conclusion

# References