MEC4204
Final Year Project

Design and Construction of an Automated Multipurpose Distiller

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Introduction

- Steam distillation is the widely used method for the extraction of essential oil
- Currently, only few industries produce bio-ethanol fuel largely because of the cost of importing a sophisticated distiller

Problem Statement

The seasonal fluctuating markets of both ethanol and essential oil demands

Current small scale steam distillation technologies are very laborious, have very high startup costs

Main Objective

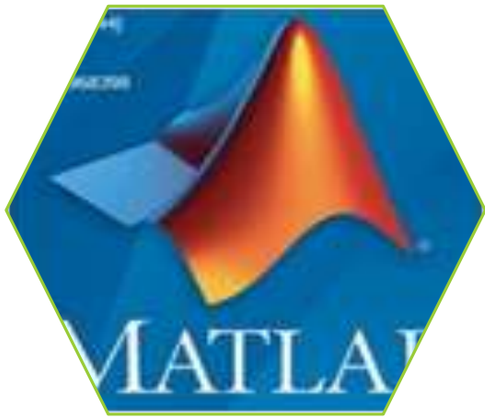
To design and construct a cost-effective multipurpose automated distiller technology of essential oils and ethanol

Specific Objectives

To determine the design requirements

To design hardware controller software for optimal energy-efficiency distillation

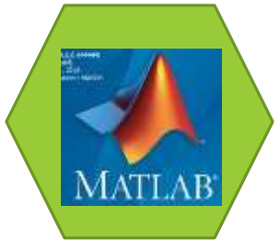
To develop conceptual and detailed designs of a less laborious distiller



To construct and test the prototype

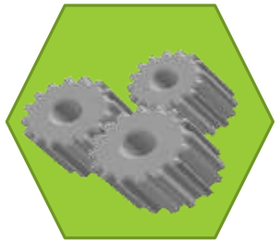
Scope

Design, analysis, validation



Hardware controller software

Optimal automation and *hybridization*



Construction of the *feasibility incremental* prototype

Justification

The inflexibility of the current small scale steam distillation technologies with the nature of the distillation process

Current small scale steam distillation technologies are very energy-inefficient, laborious and have very high startup costs

Methodology

Specific Objective	Method
Determining the design specifications	**Literature review, Benchmarking and Analytical machine design**
Developing of a conceptual and detailed designs of a less laborious distiller	**Axiomatic Design Theory (ADT)** ▪ Functional Requirements (FRs), Design Solutions (DSs), and Performance Metrics (PMs)
Designing the hardware controller software for optimal energy-efficiency distillation	**Program flowcharts, Pseudo -code algorithms and IDEs**
Construction and testing of the feasibility incremental prototype	**Incremental prototyping, field testing**

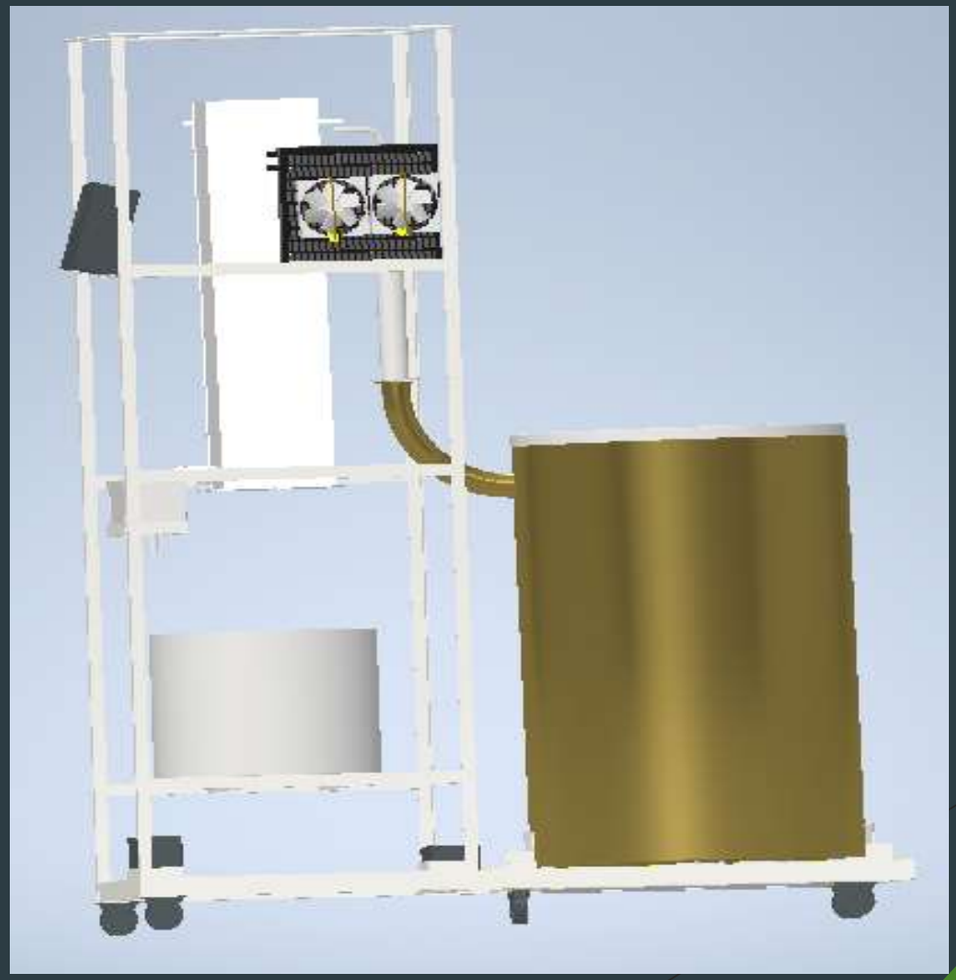
Limitations

- Scarcity of open-source technical content
- Scarcity of firsthand experimental data
- Theoretical nature of the computer-aided Design simulations

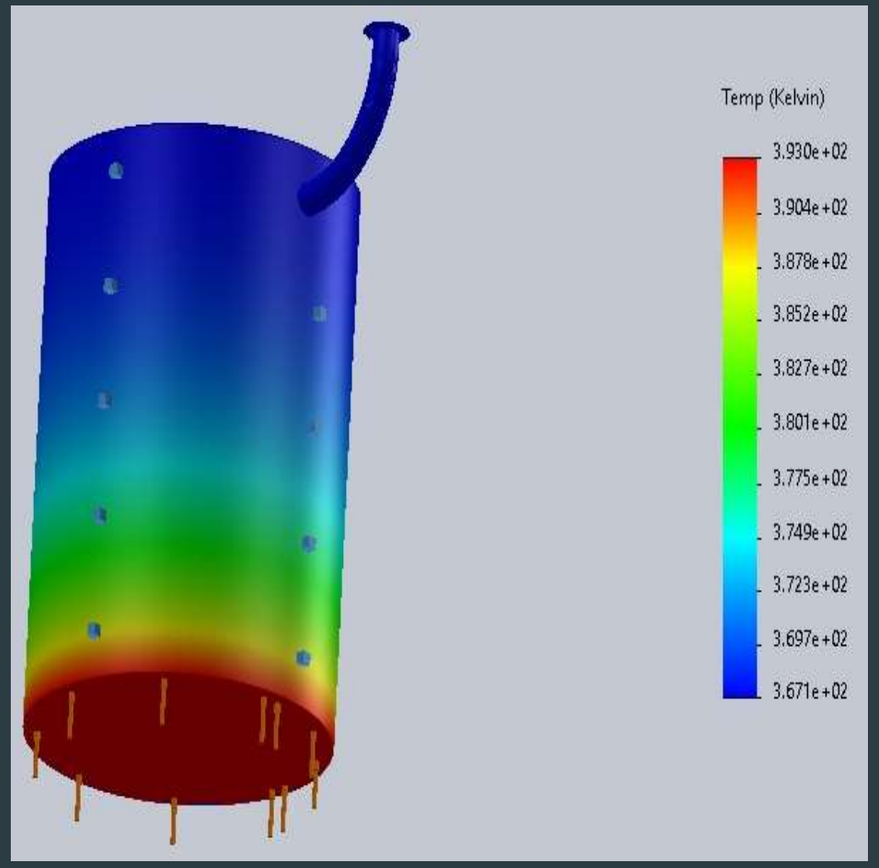
Product Specifications

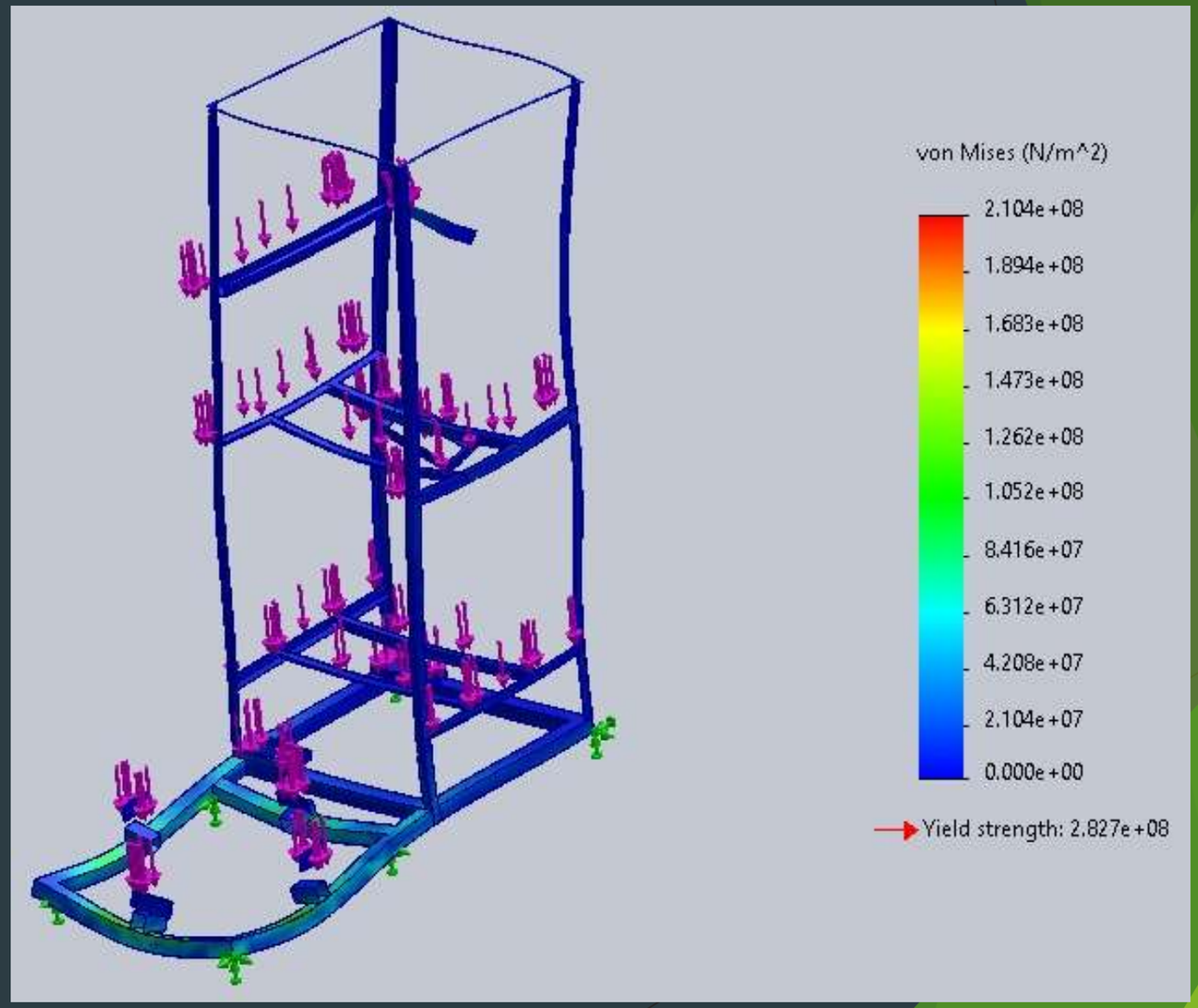
Part	Parameter	Designed Value	Marginal Value
Still	Threshold still volume	200Ltrs	226Ltrs
Condenser	Distillate Temperature	30^0C	27^0C
Heater primer	Distillate yield loss	1g/s	1.1g/s
Holistic Device	Cost Price	UGX 3,000,000	UGX 1,500,000
Process controller	Maximum controller loop overshoot error	10%	5%
Process vessel	Energy efficiency rate per distillate volume	7.2kJ/Ltr	6kJ/Ltr

Product Design | Hardware Design

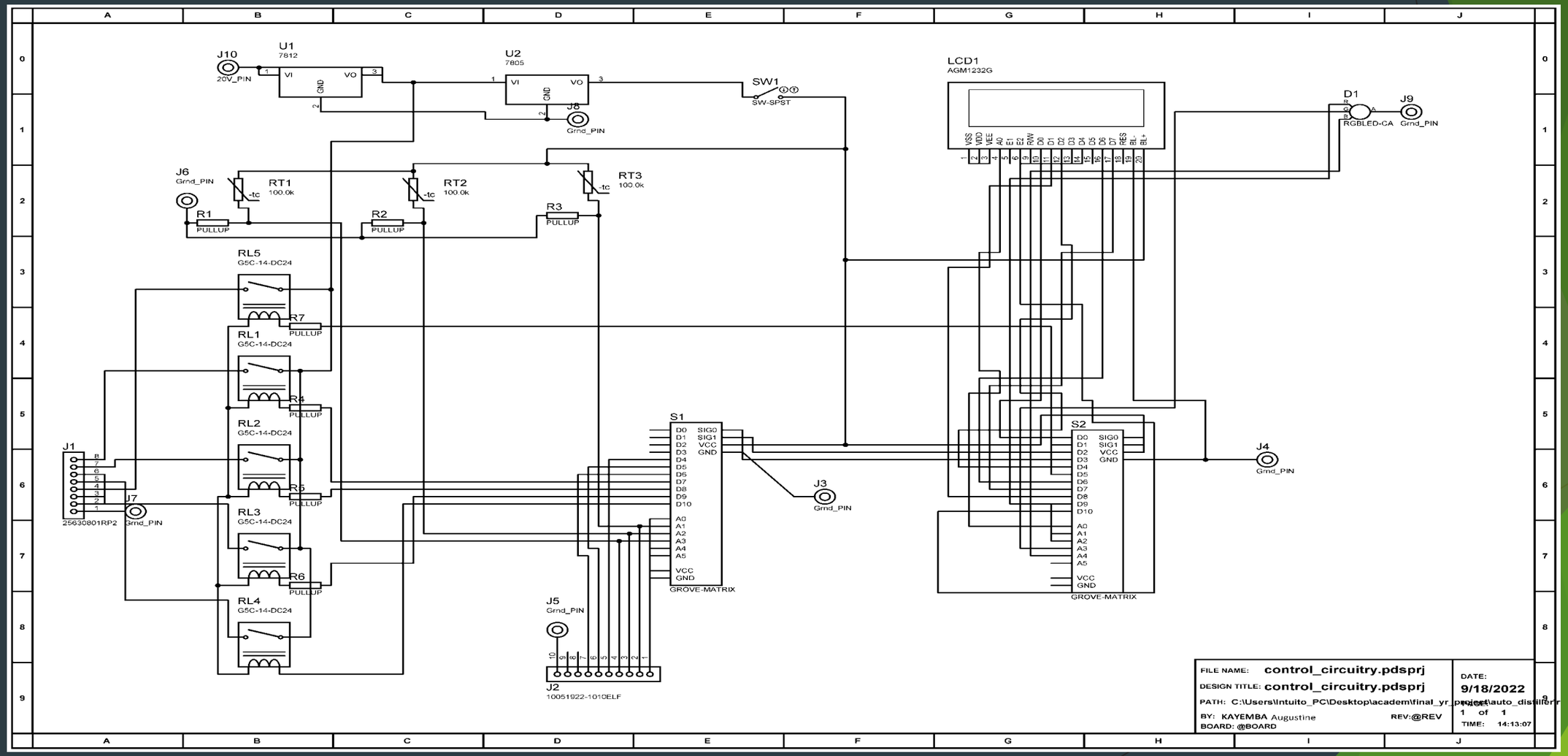


Product Design | Hardware Design Validation

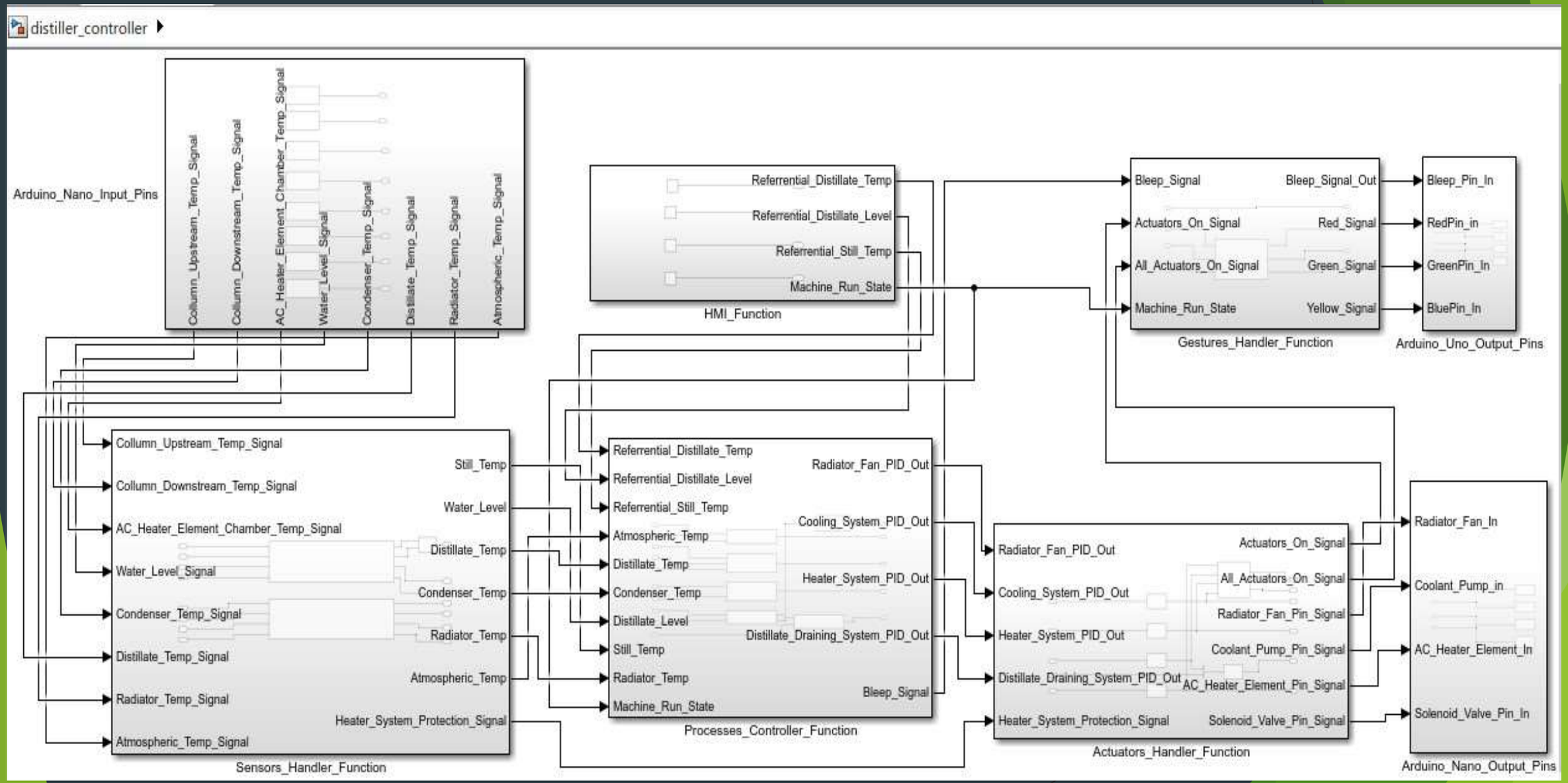




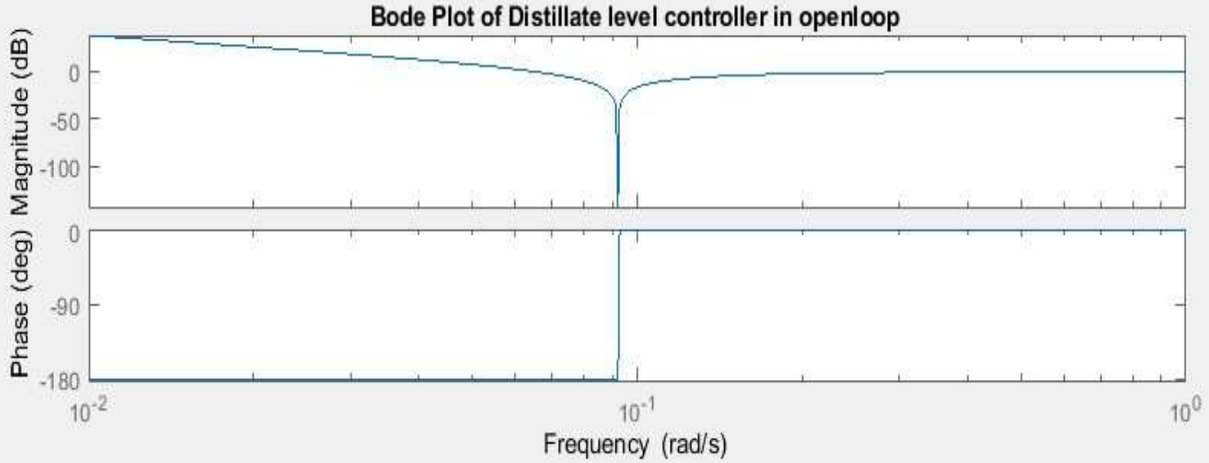
Product Design | Hardware Controller Circuitry Design

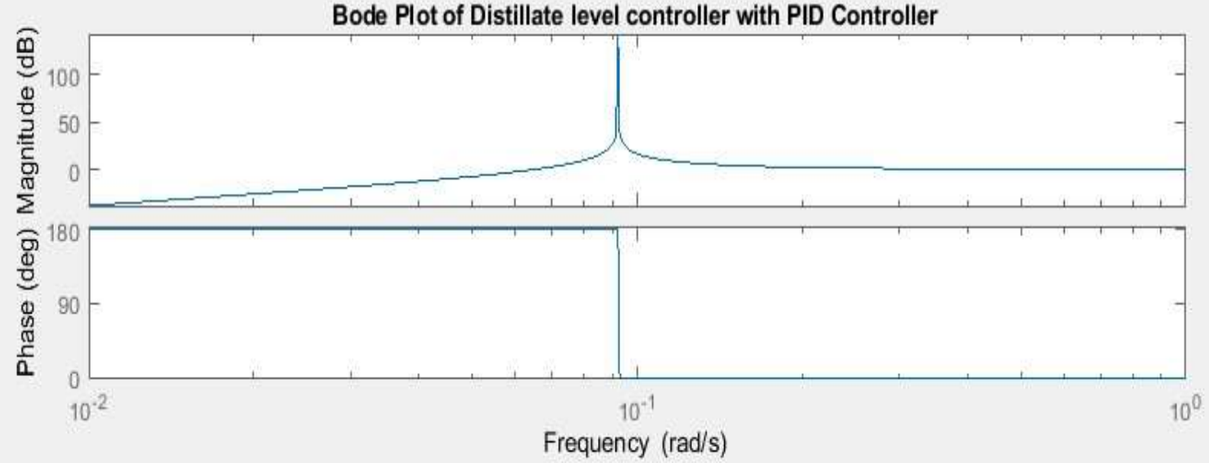


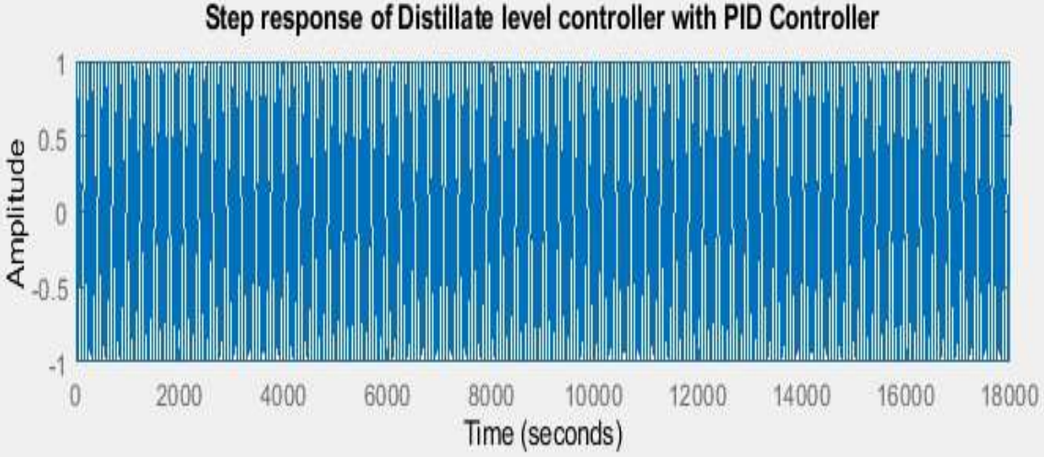
Product Design | Hardware Controller Software Design



Product Design | Hardware Controller Software Design Validation





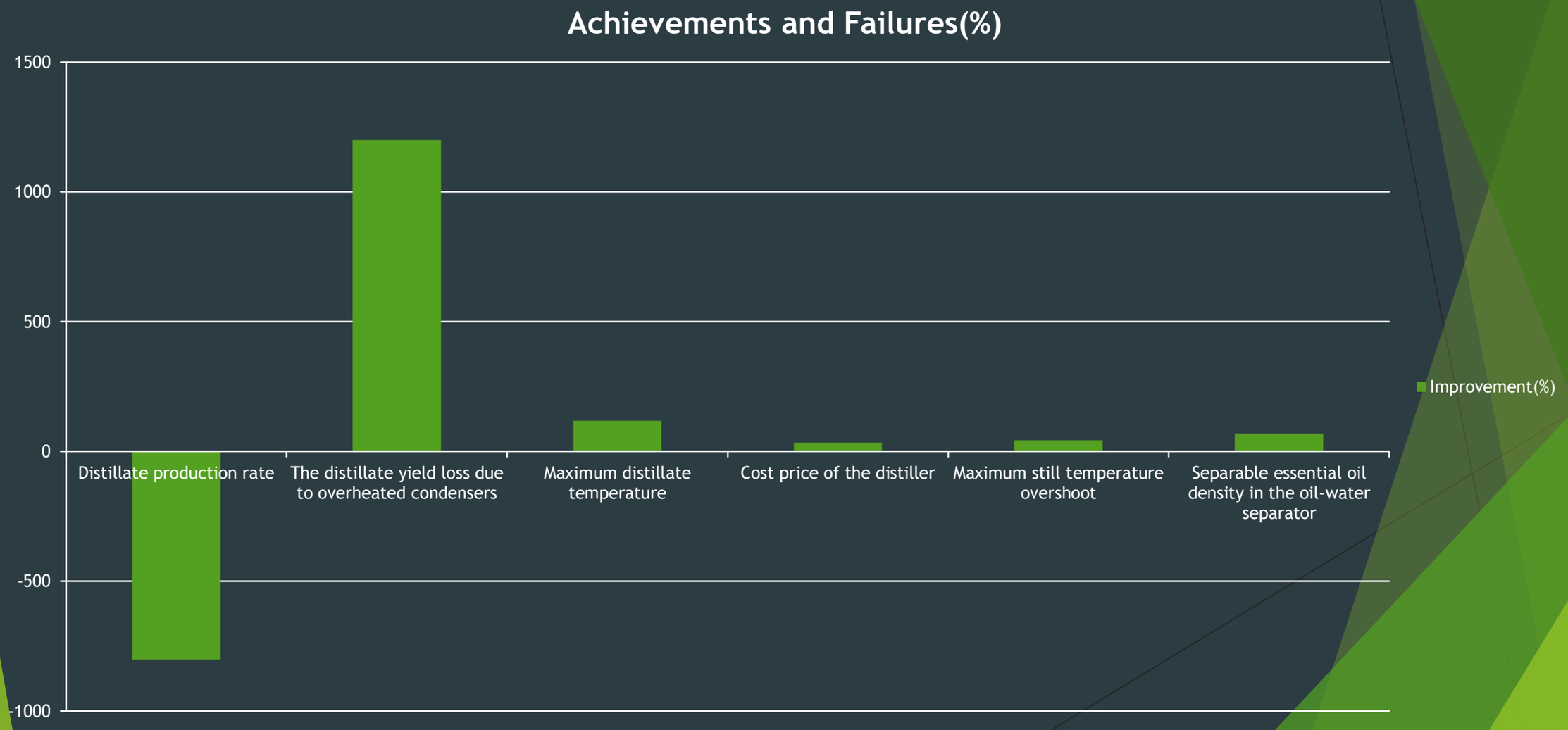


Results

Results | Implementation Timeline

Activity	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8
	Jun-22				Jul-22		Aug-22	
Materials Procurement and Trade-offs								
Structural Frame Fabrication								
Mounting of Sensors and Actuators onto the Machine								
Hardware Control Circuitry Redesign and Assembly								
Hardware Control Program Design and Testing								
Holistic Hardware Functional Tests and Calibrations								
Final Finishing and Touches								
Field Tests								

Results Summary



Results Summary

- 800% reduction from the benchmarked distillate production rate
- 118% reduction in the maximum distillate temperature
- 1200% reduction in the distillate yield loss
- 33.3% reduction in the cost price

Thank You

Q & A