|  |
| --- |
| http://4vector.com/i/free-vector-uppsala-universitet_061927_uppsala-universitet.png |
| Electron gun vacuum system control |
| Project in Embedded Systems |
|  |
| **Simon Gollbo** |
| **3/9/2017** |

|  |
| --- |
|  |

# Abstract

Short summary of the project, communicating the most important results.

Contents

[Abstract 2](#_Toc476739879)

[1. Introduction 2](#_Toc476739880)

[1.1. Background 2](#_Toc476739881)

[1.2. Purpose of the project 2](#_Toc476739882)

[1.3. Project specifications 2](#_Toc476739883)

[1.4. Project planning 2](#_Toc476739884)

[2. Working principles 3](#_Toc476739885)

[3. Implementation 4](#_Toc476739886)

[3.1. Overview of the system 4](#_Toc476739887)

[3.2. Hardware and components 4](#_Toc476739888)

[3.3. Integrated Development Environment (IDE) 4](#_Toc476739889)

[3.4. Development tools 4](#_Toc476739890)

[3.5. Implementation 4](#_Toc476739891)

[4. Results and discussion 5](#_Toc476739892)

[5. Conclusions 6](#_Toc476739893)

[6. References 7](#_Toc476739894)

[7. Appendix 8](#_Toc476739895)

# Introduction

## Background

Some background for the project

Electron gun vacuum system, 5 kW, 10 kV, accelerate electrons and bend path to heat metal to be deposited onto substrate

In the clean room of the Ångström Laboratory there is an electron gun system which is used to deposit thin films of metal onto a substrate. The electron gun uses an electric field to accelerate electrons which form an electron beam of high power. The electron beam is then directed using magnetic fields into a crucible that holds the metal to be deposited. The high energy of the electron beam vaporizes the metal and the metal vapor shoots upwards toward the substrate target.

To avoid oxidation and contamination of the samples, the process needs to be carried out in a vacuum chamber. The vacuum chamber for the system at the Ångström Laboratory utilizes two pumps, an air pump and a cryo pump. The air pump is able to bring the chamber from atmospheric pressure down to 10^-2 mbar. At this pressure, the air pump is unable to lower the pressure further and the cryo pump is used. The cryo pump works by moving a portion of gas from the chamber to a separate chamber. The separate chamber is then cooled down using liquid helium, which compresses the gas inside. The compressed gas is then moved to a storage tank. The cryo pump is able to bring the pressure in the vacuum chamber down to 10^-8 mbar. The air pump is required due to the limited volume of the cryo pump storage tank. The cryo pump storage tank fills quickly if the cryo pump is used at atmospheric pressure.

## Purpose of the project

The purpose of the project

Upgrade control system for vacuum system, design from scratch using microcontroller and touch screen

Also implement PID-controller

The purpose for this project is to upgrade the control system for the vacuum system. Currently, there is no mechanism for ensuring that the user performs the correct sequence of actions to utilize the vacuum system. An example of erroneous usage is incorrectly turning on the cryo pump at atmospheric pressure which leads to the cryo pump storage tank filling up. If this were to happen, the cooling of the system has to be turned off and the gas has to be allowed to heat up before being ventilated. The system then has to cool back down. This entire process takes several days to complete during which time the electron gun cannot be used.

Also, the current control system is spread out over several controls. This project also aims to gather all controls in a single control device.

The project also aims to implement a universal PID-controller. The scope of the project does not include implementing the PID-controller in the vacuum system, but control of the metal crucible could be controlled using this type of controller. As such, the universal PID-controller enables further work on the control system in the future.

## Project specifications

Specifications for the project

Graphical user interface for controlling the various valves and pumps in the system, interfacing the microcontroller with the industrial grade electronics, system logic to disallow or warn user when action taken is not appropriate (opening a bad combination of valves for example)

Universal PID-controller, customizable gains

## Project planning

Planning for the work to be performed

Get software, microcontroller programming

Get the screen to draw stuff

Get the touch interface to output values and correct these to get accurate screen coordinates as compared to the drawing of the graphics

Mechanical relays for digital outputs and optocouplers for digital inputs to interface with industrial grade electronics

Draw PCB, order and hand solder components

Test PCB

# Working principles

How the touch screen works

How the microcontroller works

How the vacuum system + electron gun works

How the PID-controller works

# Implementation

## Overview of the system

Overview of the system

Touch screen

Microcontroller

MC to industrial grade electronics interface

PID-regulator

## Hardware and components

Microcontroller

PCB

Relays

Optocouplers

Touch screen

## Integrated Development Environment (IDE)

AtmelStudio

## Development tools

Sublime text

Git

USBasp programmer

AVRDUDESS

## Implementation

Present setups and source codes, discuss problems faced and how they were solved

# Results and discussion

Present the results with specific parameters and performance values associated with the specifications and discuss how well the results fulfill the specifications, what problems you encountered and how you found solutions and solved the problems.

# Conclusions

Conclude how well the project has been done and how well the system/project performs (in other words how well the finished system/project performs fulfill the specification). Summarize how the knowledge you’ve learned is applied to the project.

# References

References to code that was used as inspiration

# Appendix

Perhaps some code can be put here