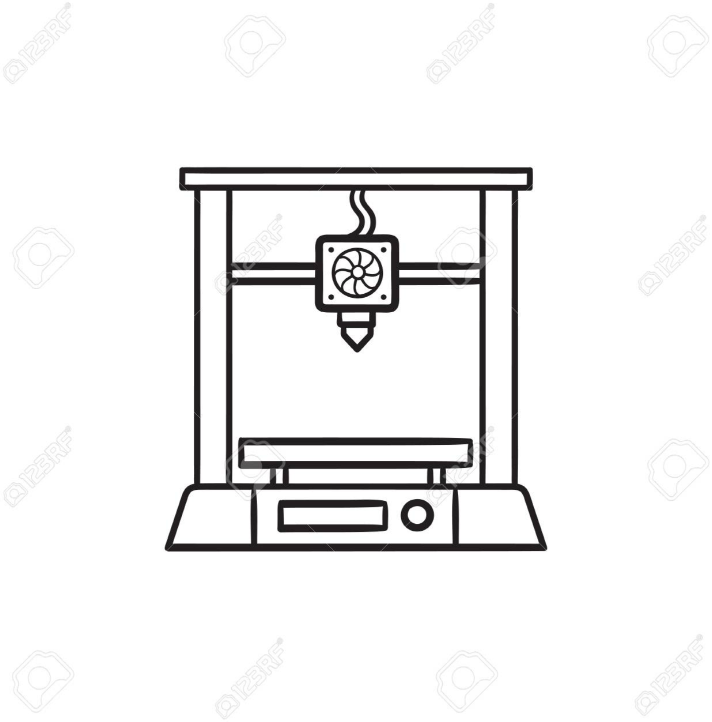
Department of Computer Science & Engineering
The University of Texas at Arlington

Detailed Design Specification
CSE 4317: Senior Design II
Spring 2020



Craft Printers
Outreach Robot

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REVISION HISTORY

Revision	Date	Author(s)	Description
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1 Introduction

This product's main concept can be broken down into the following main layers: the tablet's application along with it's communication modules and the Monoprice 3d printer. This document will lay out the path itself the drawing takes from the tablet to the 3d printer within a certain specified time, along with details of the subsystems in each level.

2 System Overview

The overall structure of the project consists of two main layers. The main path the drawing takes is from the application to the 3d printer is the following: The user has to first make the drawing itself in the Inkscape application on the tablet which upon saving would saved as an SVG, which would be transferred to a certain folder from where a certain path would be scripted where the 3d printer may retrieve its images. The SVG file retrieved from that folder would be converted to G-code instructions for the 3d printer to mimic the drawing.

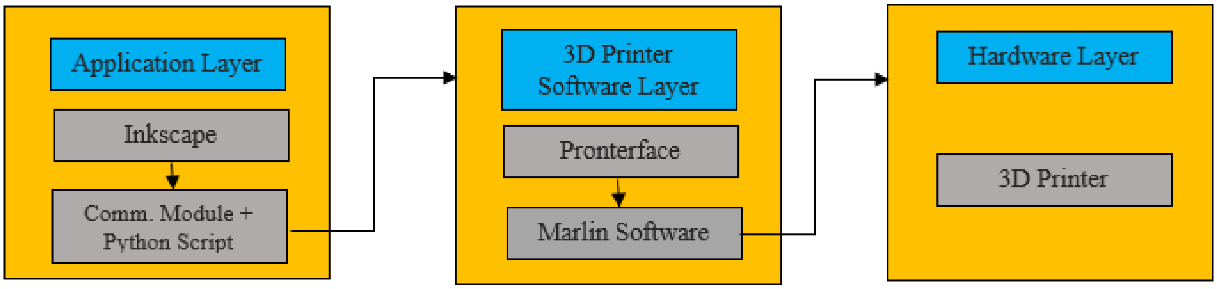

Figure 1: System architecture

3 Application Layer Subsystems

In the Application layer, two main modules exist which interact with each other. First comes the software the students use to make their drawings in the first place, Inkscape. Second interacting module is the Python Script which deals with the g-code produced by the drawings.

3.1 Layer Details

Inkscape is the first component in this layer. The students make the drawing directly on the graphics tablet provided in Inkscape, which is connected to the computer. As the students make the drawings on the Inkscape software with a stylus, it would be saved as an SVG image onto a specific directory where all images are stored. Using a plugin provided in Inkscape, it generates g-code for the drawings done after which a Python script is run on the g-code files. This whole processes was originally intended to be automated with a single Python script).

3.2 Layer Operating System

The first component in this layer is Inkscape: a vector graphics software which is compatible with Windows 10, Mac OS X, and Linux. It's installed on the Windows 10 computer provided to us in the labs for us in the Senior Design course.

3.3 Layer Software Dependencies

The python script is pretty simple and straight forward. For the G-code generated by the Revetier tool (plugin installed in Inkscape), it goes and modifies the G-code to eliminate instances of where the 3d printer moves or drags itself across the drawing paper/board. This happens when it goes from one object to another in the same drawing, so a set amount of distance is scripted in the G-code for the printer to lift in the Z-direction to give smoother and cleaner drawings.

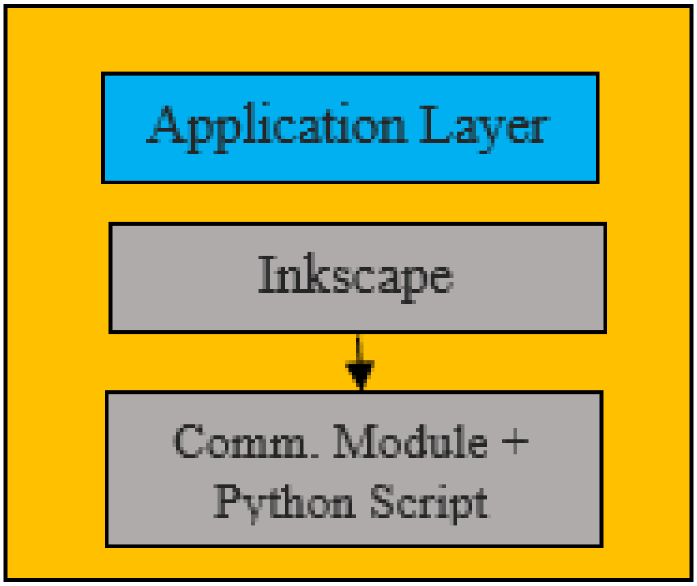

Figure 2: The Application Layer System

3.3.1 Subsystem Data Processing

Inkscape's plugin generates the G-code which in which a few modifications are made to lift the printer's nozzle upwards in Z-direction. Two calls are made first in the code to open the file, and a loop is used to write something on the file based on what position it's at. If the g-code line contains: "G0 F100.000000", it will add in the lines zdown, G1 Z-75. If the g-code line contains: "G0 F200", then it writes zup,G1 Z-23. Then it closes the files.

4 3D Printer Software Layer Subsystems

The 3D Printer Software Layer contains the software ran on the 3D printer and the Marlin software which controls the drivers and movement for the printer. This system runs on the components within the Hardware system and maintains a connection to the Application system.

4.1 Layer Hardware

8-bit Atmel AVR micro-controller - This is the chip that the Marlin firmware will communicate with. This controls the motors of either the 3D printer or the robotic arm.

4.2 Layer Operating System

Operating systems not required by this layer. This software can be run using MacOS, Windows, and most Linux distributions excluding Ubuntu/Lubuntu.

4.3 Layer Software Dependencies

Python and G Code. The more specific dependencies are listed below in the subset dependencies.

4.4 Pronterface Software Subsystem

This subsystem consists of the pronterface software which generates a user interface to control the 3D printer. This software we used provided the GUI and the overarching functionality of the printer.

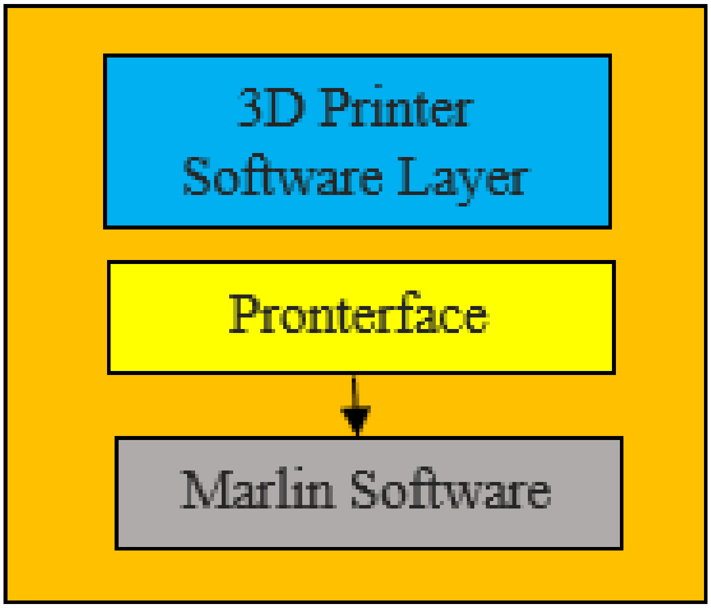

Figure 3: The Pronterface Software Subsystem

4.4.1 Subsystem Hardware

Purely Software

4.4.2 Subsystem Operating System

Operating systems not required by this layer. This software can be run using MacOS, Windows, and most Linux distributions excluding Ubuntu/Lubuntu.

4.4.3 Subsystem Software Dependencies

Cython - a superset of python that compiles to C. Allows for communication to Marlin Printcore.py - A library that simplifies writing reprap hosts. This makes working with Marlin (a reprap) easier. pronsole.py - Library that provides load, sleep, print, move, and more functionalities for pronterface. pronterface.py - The encompassing pronterface library pyserial (or python3-serial on ubuntu/debian) - provides support for serial connections of a variety of devices pyreadline (not needed on Linux) - provides functionalities of reading from keyboard, copy, paste and more wxPython 4 - pyglet - Library that fleshes out the GUI of ponterface appdirs - Library that determines platform specific data and directories numpy - Matrix, vector and 3D calculations pycairo - Allows python to use cairo graphics cairosvg - Allows for conversions from SVG to PNG, PDG, etc and vice versa. dbus - allows for simple commuinication between applications

4.4.4 Subsystem Programming Languages

Python 3

4.4.5 Subsystem Data Structures

We have yet to implement specific data structures into the source code.

4.4.6 Subsystem Data Processing

The pronterface software converts inputs into G Code. That data is then given to the Marlin firmware.

4.5 Marlin Software Subsystem

This subsystem consists of the Marlin which is a firmware for controlling 3D Printers. Marlin manages all the real-time functionalities of the 3D printer and coverts G Code into movement for the 3D printer.

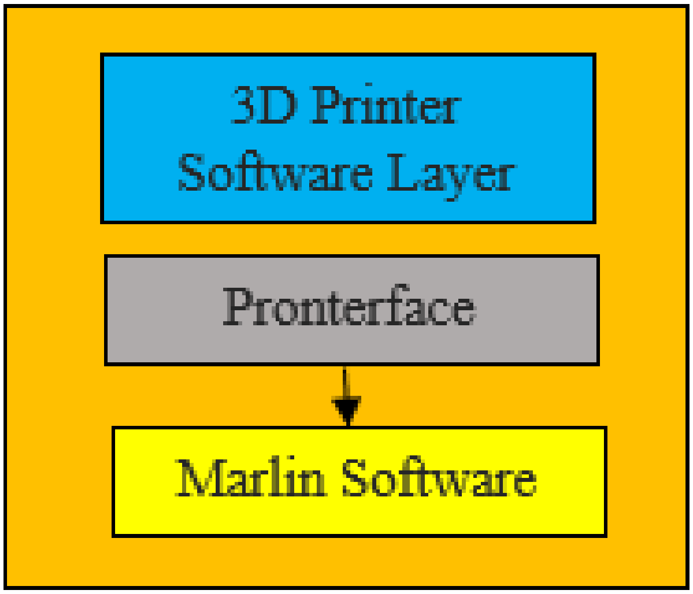

Figure 4: The Marlin Software Subsystem

4.5.1 Subsystem Hardware

8-bit Atmel AVR micro-controllers

4.5.2 Subsystem Operating System

A description of any operating systems required by the subsystem.

4.5.3 Subsystem Software Dependencies

G Code

4.5.4 Subsystem Programming Languages

C/C++

4.5.5 Subsystem Data Structures

We have yet to implement specific data structures into the source code.

4.5.6 Subsystem Data Processing

This firmware takes G Code instructions and converts them to movement for the 3D printer. The Marlin firmware then serially transmits the data to the 8-bit Atmel AVR Micro-Controller via USB.

5 Hardware Layer Subsystems

5.1 Layer Hardware

The hardware layer consists of an Monoprice Maker Select 3D Printer v2 modified to hold a writing utensil.

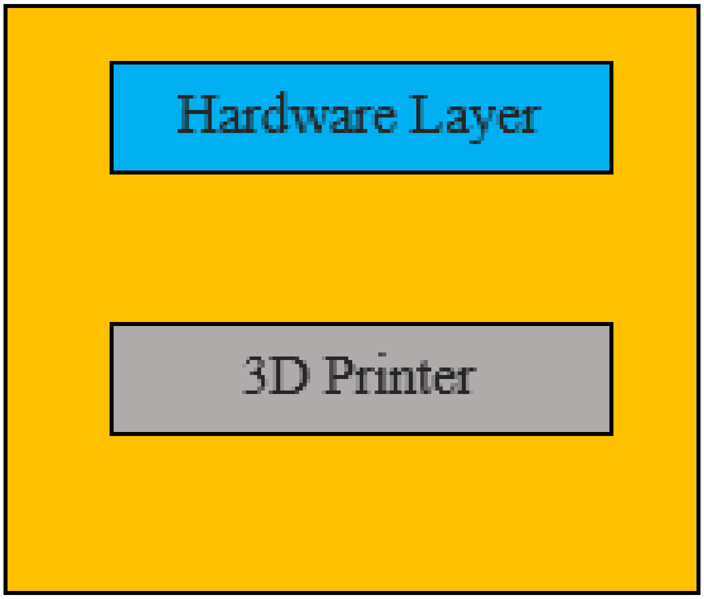

Figure 5: Hardware Layer Diagram

5.2 Layer Operating System

The printer is running factory software and was not changed.

5.3 3D Printer

The purpose of the 3D printer is to receive g code from a computer and move its x, y and z motors in a way to replicate a drawn figure.

6 Appendix A

Include any additional documents (CAD design, circuit schematics, etc) as an appendix as necessary.

REFERENCES