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Hardware and Software in 3D Printers

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*Abstract*— Current hardware control systems used to manage and synchronize printing operations.

***Index Terms*— Light-curing resins, three dimensional printer, Digital light process.**

# INTRODUCTION

The control hardware and software both determine the precision of the print. The software breaks down the CAD model into slices and generates a series of steps for the hardware controls.

# Discussion

## Video output

Digital Light Processing manufacturing uses a projector to cure a liquid resin. The B9 Creator uses the video output from a dedicated host PC to power the projector. The supported video output for the B9 includes VGA and HDMI. Sedgwick printer supports VGA output only . By using a 1024x768 projector the precision is only slightly hindered by a lower resolution projector. Despite a lower resolution projector than the B9 Creator, Sedgwick can still provide a high quality 3d print.

The EnvisionTEC Perfactory4 printer uses an even higher resolution than the B9 and Sedgwick. Supporting a 1920x1200 resolution, Perfactory4 is extremely precise. The high resolution creates a beautiful print with crisp corners and smooth sides, but at an extremely high cost.

## I/O support

By itself the Arduino is insufficient to power the step motors, fortunately there a number of add on boards(shields) that can provide power to the motors. The Motor Shield V2, by Adafuit, provides a variety of input and output support for servos and motors. It supports up two 5v servos, four bi-directional DC motors, and two stepper motors; additionally you can add support for more motors by "stacking" on another shield.

The B9 Creator is supported by an Arduino controller connected to a dedicated PC via USB . The software running on the PC slices the CAD file and generates a proprietary code to be run on the Arduino. The Arduino interprets the code and send the signals to the corresponding motors/servo/etc. The video output is controlled by the software on the PC, the CAD file is sliced by the program and output to the projector. After each layer of the model is processed the projector to displays the image, allowing the resin to cure. Then a signal from the PC is send to the Arduino to adjust the build table for the next layer. The process is continued until the print is finished or interrupted by the user.

## G-code

Initially used to control machining tools, G-code is a programming language used to interface the controller and hardware. Instructions from the software produce the G-code, which tells the controller what action to execute. Having been used in a variety of machines, G-code has become a ISO standard 6983 in the United States. Having been adapted for use with 3D printers, some of standard controls include setting coordinates, controlled movements, rapid movements, move to origin, arc (counter)clockwise, and more. The syntax for G-code is as follows:

|  |
| --- |
| G1 F1500  G1 X90.6 Y13.8 E22.4 |

**\*\*\*\*\*\*\*Figure: XXX**

This operation instructs the hardware to move to position X-90.6, Y-13.8, extrude resin at a feed rate of 1500mm/minute and extrude 22.4mm of resin. \*\*\*\*\***Figure XXX** is configured for use with a FDM printer, however it can be adapted for a PAM system with software modifications and produce the same print.

## Controller Firmware

There are a few firmware's for the Arduino that interpret the G-code and send the commands to the hardware. A very popular firmware for the Arduino is Sprinter. The supported features of Sprinter include SD card support, extruder speed control, movement speed control, constant and exponential acceleration, and heated build platforms. It is also compatible with a variety of different Arduino shields, but are only used in FDM systems.

Marlin firmware is forked from Sprinter and has the same functionality and more. The functionality added from Sprinter is support for higher step rates, look ahead (for corners), temperature sampling, and EEPROM support for error reporting. Like Sprinter many of the additional features only apply to FDM systems, but it still supports PAM systems as well.

# Acknowledgment

# References

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