3D SLA Printer v2.0

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Goals

- To learn the engineering design process
- To modify and improve upon previous designs, including our own
- To build a functional, repeatable, and cost-effective DLP 3D SLA printer

Issues with v1.0

- Vat and build plate not parallel
- Unstable and imprecise wooden frame
- Vat L-arms not stable
- Failed peeling system
- Warped build plate
- Build plate support too large
- Projector/mirror offset
- No UV shielding
- No projector/electronics cover
- Lead rods too long
- No pause/abort ability

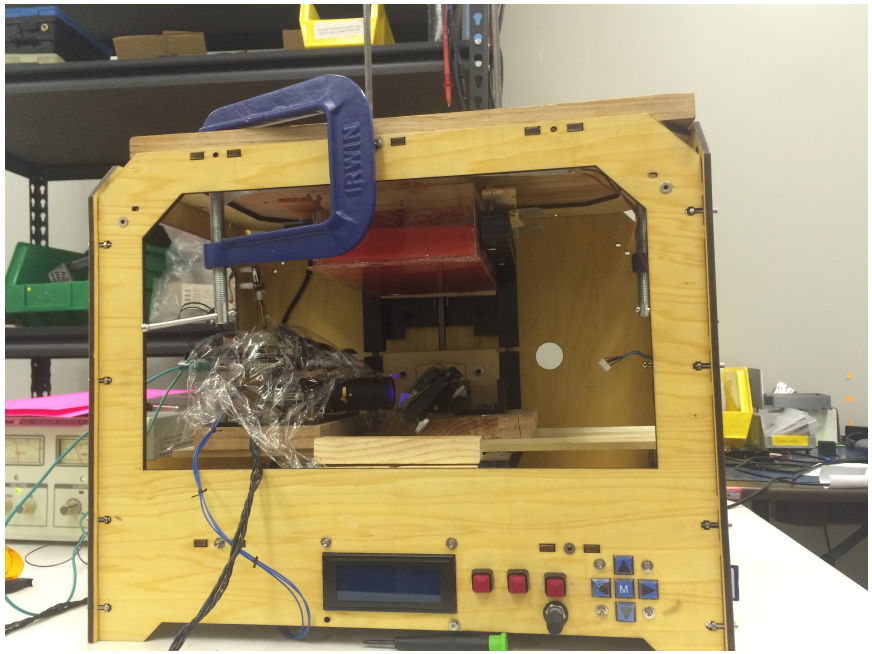

Figure 1. v1.0 Printer

Design Improvements

Requirement	Action
Mechanical stability	Extruded aluminum frame supports vat
Consistent separation of build from vat	Hinge peeling system with active tilt system
Print surface parallel to vat	Three lead rods paired with support rods
Reliable reference to projector	Projector slides into the frame and projects onto a mirror

Active Tilt System

- The gear pushes a gear rack as the build plate moves up.
- The hinge attaching the opposite edge of the Vat to the frame allows a tilting motion to occur.
- When the build is peeled off the build plate, the Vat will fall back on the gear rack and be lowered back down to the starting position.

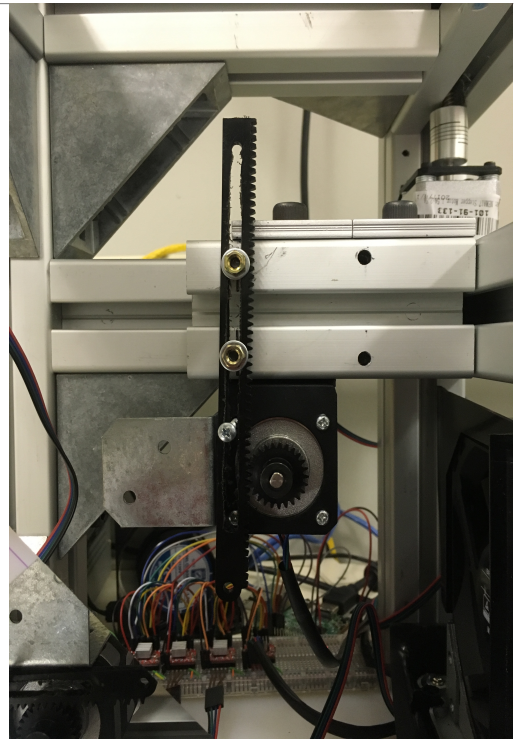

Figure 2. Active Tilt System

The Printing Process

- Create an STL file
- Send STL file through slicing program, outputting series of PNG images
- Power up the RPi and start the printer application
- Run the GUI and connect to the RPi
- Upload PNG folder to the GUI using a thumb drive or the GUI
- Configure the printer settings (ex: cure time, layer image source, layer size, peel distance, motor speed, and motor step size)
- Ensure the build platform and vat are parallel and fill vat with resin
- Press Start
- Once the print concludes, remove the resulting object and press Reset Build Plate to move the build plate back down to the starting position.

Hardware

The fundamental hardware design remains the same as in the previous prototype:

- A microcontroller controls the stepper motor driver boards, which control the stepper motors.
- In this prototype, the Arduino is replaced by the RPi, the number of motors has been increased to four, and we've added a breadboard to keep all the boards and wires organized.
- When the 3D printer application runs, it toggles various GPIO pins which are connected to the stepper motor drivers.
- The RPi handles all the timing; the drivers simply interpret these GPIO signals and tell the motors to move.

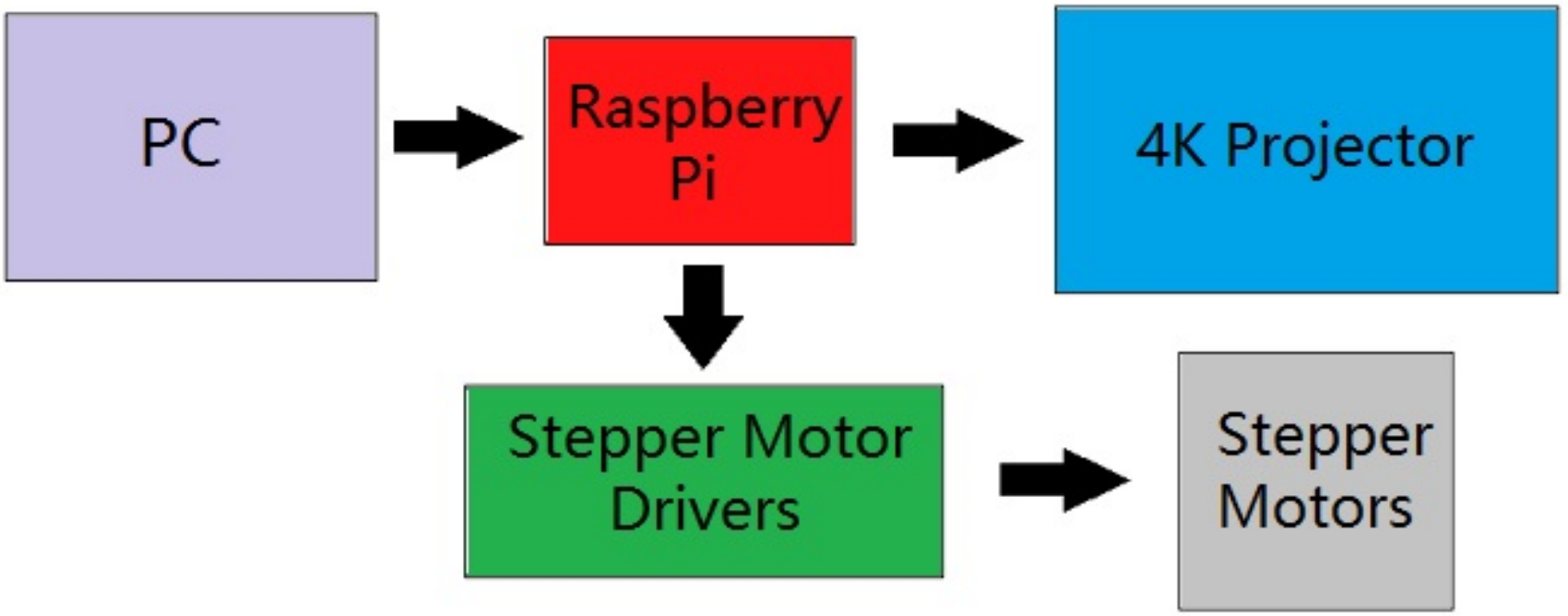

Figure 4. Software Block Diagram

Software

- The v2.0 prototype uses a 4k projector that cannot be controlled using the LC4500-PEM GUI. The curing patterns must be streamed to the projector over HDMI.
- RPi offers many advantages, including extra storage capacity, a faster processor, more accurate timing, more GPIO pins, and a desktop development environment
- The cure patterns can be uploaded to the RPi using a thumb drive or by using the GUI
- The GUI allows the user to:
  - Upload cure patterns
  - Customize printer settings
  - Control print process

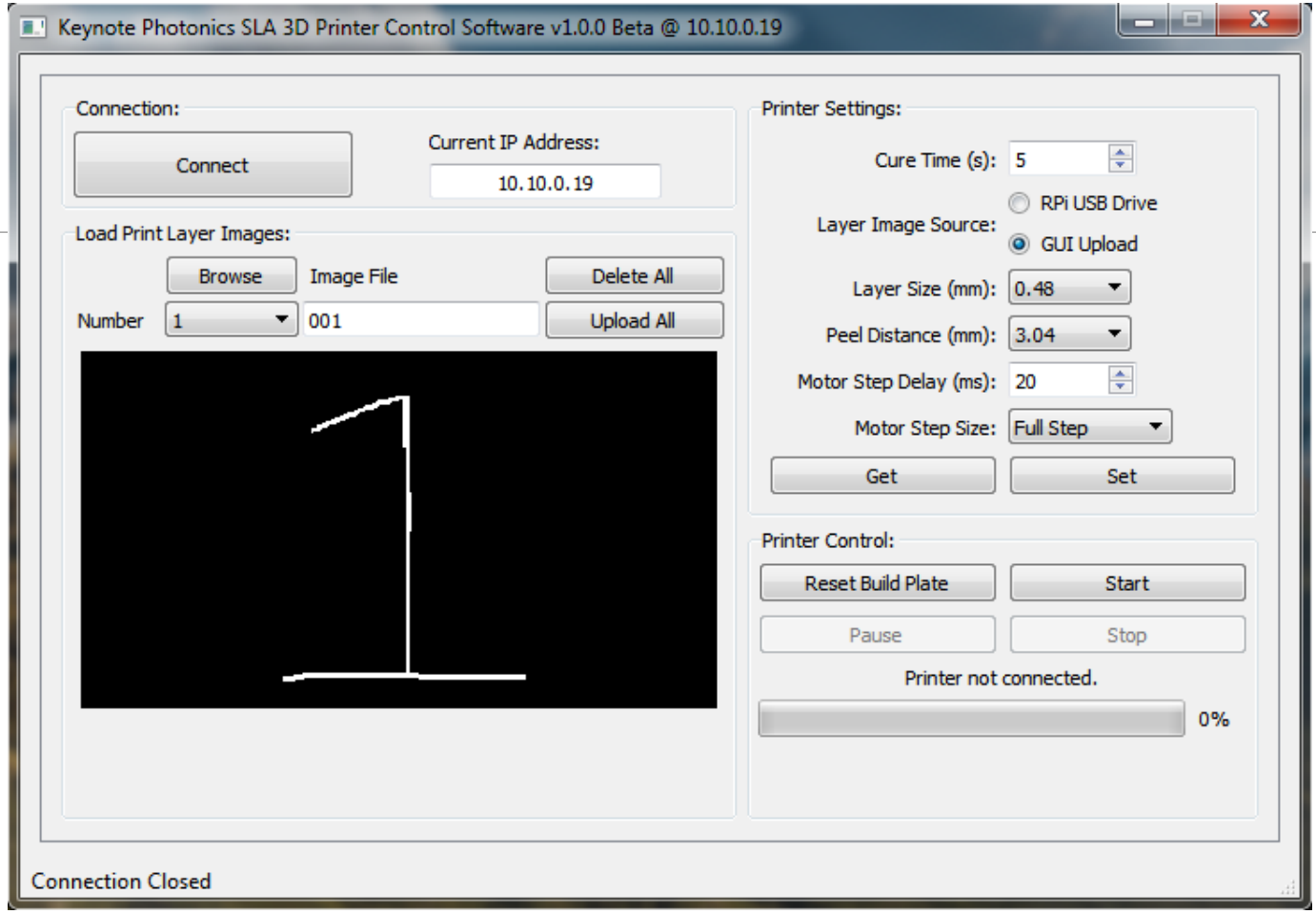

Figure 3. The GUI

Results

- Active tilt system is working better than v1.0
- Improved performance due to more parallel Vat/plate (more repeatable, greater adhesion, consistent thickness across print)
- Print speed has increased (4 sec exposure time, ~15 sec/layer)

Lessons Learned

- Vat floor-build plate parallel is highly important
- Design will change as prototype is built
- Communication is key, especially during the design process
- Take precise measurements
- It is important to do things right the first time
- Be decisive
- Think through all the implications of your decisions
- Don’t expect it to be perfect, but still strive for perfection
- Steel is a heavy material

Next Steps

- Move to aluminum top plate
- Add set screws and leveling feet to structure
- Gear rack design improvements
- Optimize peeling and print plate movement