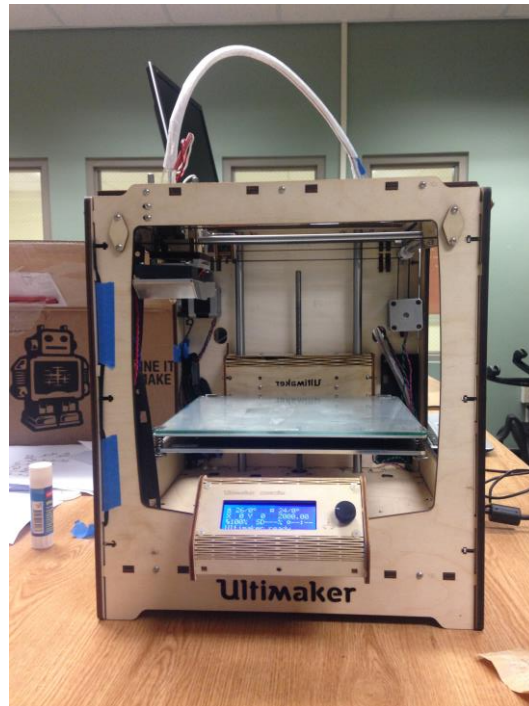


Project Report

Ultimaker Original +

COSC 5340:Embedded Systems

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Team Members

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Abstract

This paper describes how we implemented and examined the development of an embedded system, namely the Ultimaker Original +. Ultimaker, a company specialized in designing 3D printers. Ultimaker 3D printers are designed and built for fused deposition modeling for various high quality plastics like PLA, ABS, CPE within a commercial/business environment. While this printer is delivered as a DIY-kit it is suitable for the education of 3D-printing. The purpose of this project is to implement an autonomous 3D printer , from assembling, programming and testing. This document will give overview of how to assemble the Ultimaker original + 3D printer, Issues the team faced while building it. The tasks had been distributed in four different group. Phase I of the project was to assemble the hardware components of the printer analyse it, Go through the manual and decide the steps to do. The assembly of small parts from the given kit is done and then we started connecting the parts to the bigger components. Upon successful completion of the assemble of the robot hardwares,the software component was upload to the microcontroller while other groups designed the project's website, the remaining group's responsibility was to work on the report as the task progressed. While working on this project, our team experienced certain challenges during implementation . But the team was able to successfully overcome those challenges with proper execution of tasks and collaboration.

1. Introduction

An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular function. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys are among the myriad possible hosts of an embedded system. Embedded systems that are programmable are provided with programming interfaces, and embedded systems programming is a specialized occupation.

Because an embedded system is engineered to perform certain tasks only, design engineers may optimize size, cost, power consumption, reliability and performance. Embedded systems are typically produced on broad scales and share functionalities across a variety of environments and applications. The application of Embedded Systems is all around us; from watches, household appliances, Cameras to Airplanes, Avionics Systems are among the myriad possible hosts of an embedded system. Embedded systems are managed by single or multiple processing cores in the form of microcontrollers or digital signal processors (DSP), field-programmable gate arrays (FPGA), application-specific integrated circuits (ASIC) and gate arrays. These processing components are integrated with components dedicated to handling electric and/or mechanical interfacing.

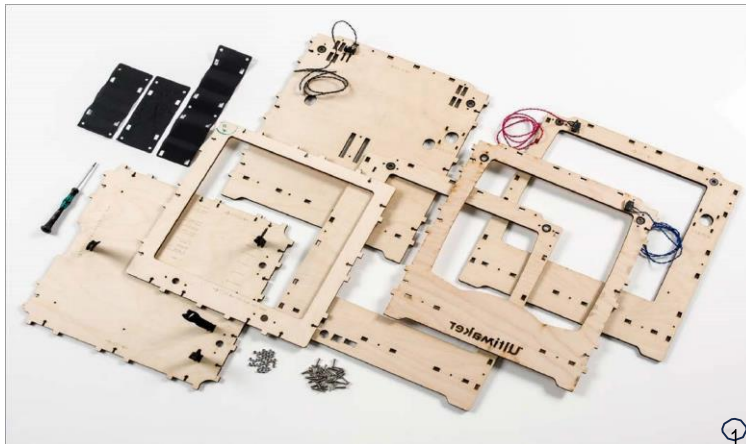
3D printing and embedded computing are emerging technologies showing potential to reach new markets and create new jobs. One can Demonstrate the viability of utilizing 3D printing technology to develop product prototypes

2. Hardware Specifications

The Ultimaker Original + consists of following hardware.

1. Frame :

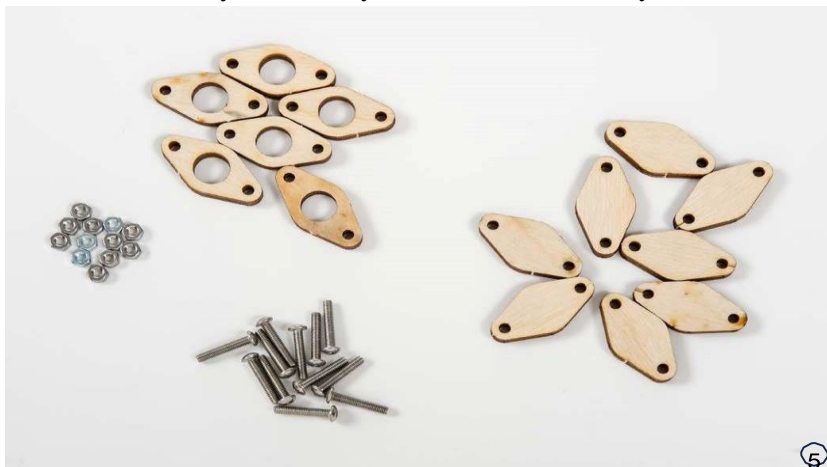
The frame contains Panel and other parts First prepare all the panels by attaching the necessary parts. This makes it much easier to put the frame together later. Before start, take the panels and remove all other wooden parts from them. It Contains Front, Back , Right ,Left and bottom Panel



2. Sliding blocks

Once the frame is assembled, the X and Y axles can be put in the frame. Therefore you will first assemble the sliding blocks and attach the wooden caps to the frame. When this is done, the X and Y axles can be placed in the frame with pulleys, belts and sliding blocks around them.

For the X/Y axles you will only need the 2 mm hex key.



3. Build volume

210 x 210 x 205 mm

4. Layer resolution

Up to 20 micron

5. Speed

30 mm/s - 300 mm/s

6. Nozzle temperature

180° - 260° C

7. Nozzle / filament diameter

0.4 mm / 2.85 mm

8. File transfer

Stand alone SD card printing

9. Print technology

Fused Filament Fabrication

3. ASSEMBLY

For the Ultimaker to function well, it is very important to implement the hardware properly. We followed various steps to assemble the hardware components. They are as follows:

Step 1: we assemble the **frame** of the Ultimaker Original+ as stated in manual. We prepared the panel then assemble the frame and as last step attached various parts to frame.

Step 2: Once the frame is assembled, the **X and Y axles** can be put in the frame. We first assemble the sliding blocks and attach the wooden caps to the frame. When as this is done, we put the X and Y axles in the frame with pulleys, belts and sliding blocks around them.

Step 3: Assembly of the **Z stage** consists of several parts. preparing the aluminium base plate and heated bed, that together form the Z stage. After this, the Z stage cap is assembled and the Z stage can be installed in the Ultimaker.

We require the following tools : hex key 2 mm, hex key 2.5 mm, flat screw driver and socket wrench or pliers.

Step 4: The **print head** exists of several parts that must be assembled: the housing, hot end and fan. When the print head is assembled it can be placed in the frame and can be aligned.

For the print head assembly we need the 2 mm hex key and crosshead screwdriver.

Step 5: The **feeder** consists of three parts that must be assembled before the feeder can be placed on the Ultimaker: the main feeder housing, clamp and drive bolt. Once the feeder is placed on the Ultimaker, the bowden tube and spool holder will be connected as well.

For this part the 2 mm hex key and socket wrench or pliers were needed

Step 6 : The **UltiController** is the display and control panel of your Ultimaker Original+. We assemble it and place it on the front panel.

For the assembly of the UltiController we use the 2 mm hex key and crosshead screwdriver.

Step 7 : The last step of the assembly process is connecting the electronics. We first mount the main board to the bottom side of the Ultimaker Original+ and then connect all the wires to it.

We use the 2 mm hex key and flat screwdriver to mount and connect the electronics.

4. Software Specifications

Basic Cura Software and Blender is used

Cura :

The type of software you use when 3d printing can be just as important as the type of 3d printer and the brand of filaments you are using. Cura is probably one of the best 3d Printing software.

Cura can be used on many machines, as it's open source, if you don't have an ultimaker 3d printer than there is the feature to add your own printer. Adding a printer is pretty simple as there are over 19 profiles already installed in Cura. You can even add your own custom rep rap printer by adding the build volume along with the nozzle size.

- To start the installation of Cura, download it first.
- After downloading, open the installer and run the installation wizard to complete the installation.
- To make sure Cura can run on your computer, we recommend to check the system requirements described below.
- Accepted platforms
 - Windows Vista or higher
 - Mac OSX 10.7 or higher
 - Ubuntu 14.04 or higher - Only 64-bit versions
- System requirements
 - OpenGL 2 compatible graphics chip
 - Intel Core 2 or AMD Athlon 64 or newer

Blender:

Blender is a professional free and open-source 3D computer graphics software product used for creating animated films, visual effects, art, 3D printed models, interactive 3D applications and video games. Blender's features include 3D modeling, UV unwrapping, texturing, raster graphics editing, rigging and skinning, fluid and smoke simulation, particle simulation, soft body simulation, sculpting, animating, match moving, camera tracking, rendering, video editing and compositing. It further features an integrated game engine

Blender is cross-platform and runs equally well on Linux, Windows and Macintosh computers. Its interface uses OpenGL to provide a consistent experience. To confirm specific compatibility, the list of supported platforms indicates those regularly tested by the development team.

Blender is available for Windows Vista and above, Mac OSX 10.6 and above, and Linux. Blender 2.76b is the last supported release for Windows XP.

5.Configuration Checks

After having installed the latest firmware some default checks will be done on the Ultimaker Original+. Cura will try to connect to the Ultimaker Original+ over USB, will heat up the nozzle a bit and the limit switches will be checked.

Before running the checks, make sure that the print head is placed in the middle of the Ultimaker Original+ and that there is some distance (minimal 3 cm) between the nozzle and build plate. If not, move them manually to the correct position.

Firmware

The first step of setting up your Ultimaker Original+ is making sure that the latest firmware is installed. Therefore, please take the following steps.

Connect your Ultimaker Original+ with the USB cable to your computer.

Also attach the power supply and turn the Ultimaker Original+ on.

Select “Upgrade to Marlin firmware” and Cura will automatically install the latest firmware.

Limit switches

For checking the limit switches, it is advised to follow the steps described below.

When Cura asks you to check to press the left X endstop, gently move the print head towards the front left corner until you hear a click and Cura give you a next command. This means that the limit switch is working correctly.

6. Calibration: Bed leveling

In the last step of the “configuration wizard” Cura will guide you through some steps in order to calibrate the build plate. For printing it is very important that the first layer is nicely squished into the glass plate and sticks well to it. If the distance between the nozzle and build plate is too big, your print won't stick properly to the glass plate. On the other hand, if the nozzle is too close to the build plate it can prevent the filament from extruding from the nozzle.

Before the bed leveling can be done, the Ultimaker Original+ will first do the "homing". This means that it will move the print head to the left back corner and the build plate will move up. After this, you can follow the steps below for leveling the build plate.

Setting the height

Use the up/down control buttons until the nozzle just touches the glass plate and check if the Z limit switch is triggered. If not, you may have to adjust the height of the Z limit switch.

Adjusting the build plate

The next step is to adjust the build plate screw in the front left corner of the build plate for setting the correct height (the nozzle should just be touching the build plate). Turning the build plate screw to the left means that the platform will get closer to the nozzle.

When finished with this corner press “Resume” and the print head will move to the next point. Repeat these steps for all points.

Check the bed calibration

During the last step, the Ultimaker Original+ will print a square on the build plate in order to check if the build plate has been properly calibrated. For this step, make sure that filament has been loaded!

Tip: For accurate bed leveling it is advised to use a piece of paper. Slide the piece of paper between the nozzle and build plate at each point and make sure that you feel slight friction when moving the piece of paper.

Successful first layer

When 3D printing, it's very important that the first layer is nicely pressed onto the glass plate with flat lines of filament and no gaps in between. Check out the below images to see a successful first layer and two unsuccessful ones.

6 Loading Filament

After bed leveling it is time to further prepare the Ultimaker Original+ for the first print by loading filament.

Preparing

Before loading the filament, the filament spool itself has to be placed on the spool holder. Make sure to put it with the filament in clockwise direction, so that the filament can enter the material feeder from the bottom.

Next, heat up the nozzle with the UltiController by navigating to Prepare > Preheat > PLA 1. Wait a

minute while the print head is heating up. This way we ensure that the filament is being melted when it goes through the nozzle.

Insert the filament

Before being able to insert the filament, the material feeder has to be opened first. In order to do this you have to loosen the pressure from the material feeder by turning the lever vertically and pulling it all the way up. Next, you can open up the material feeder by pulling out the black plastic part.

Now you can take the end of the filament and guide it through the material feeder. Push it all the way along the bowden tube until the filament has reached the print head and can't move any further.

7. Conclusion and Future Works

In this project, our team went through the whole process of implementing an autonomous Ultimaker original +, starting with the assembly, and finishing with the programming and testing of the printer .

We faced main issue

Ultimaker 3D printers are designed and built for fused deposition modeling for various high quality plastics like PLA, ABS, CPE within a commercial/business environment. While this printer is delivered as a DIY-kit it is suitable for the education of 3D-printing. How does it work, what does the printer do?

The multiplex housing is ideal for making all kind of adjustments. Although we achieved a very high standard in the reproduction of 3D-models with the usage of Cura, the user remains responsible to qualify and validate the application of the printed object for it's intended use. While being an open filament platform the best results will be achieved with Ultimaker certified filament, while effort has been made in order to match material properties with machine settings.

Mintemp or Maxtemp error and Mintemp or Maxtemp error bed are the main problem we faced while making the printer work.It was happening due to loose connection of the sensors to the heating board.

By overcoming all the issues we successfully completed the assembly and make the 3D printer work.

Ultimaker can be mainly used for education purpose , to help blind and visually impaired people , breaking barriers in education, making prototype , and ultimate games , toys and many more one can imagine.

8. References

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