

# Contour Scanning with 3D Printers

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**Abstract**— 3D printing has become the defacto standard for rapid prototyping and research. However, the ability to quickly copy existing designs via scanning is not yet common. This paper looks at some inexpensive methods to enable a 3D printer to perform object scanning.

## I. INTRODUCTION

In recent years, 3D printing has become a common household term, and has provided affordable avenues for researchers, students, and even the everyday consumer to design and build otherwise unobtainable components for an affordable cost. Fused Deposition Modeling (FDM) printers provide a sturdy and expandable platform; they also provide a micro-controller that can be flashed with different firmware to allow for additional drivers and features to be developed in order to work with more advanced sensor devices.

## II. IMPLEMENTATION

The most important component for object scanning is the range sensor(s). Many different types exist, each with their respective advantages and disadvantages. Time of flight or infrared sensors are most common for inexpensive designs and provide a reasonable degree of accuracy. A time of flight sensor measures how long its laser light has taken to bounce back instead of how an infrared sensor measures how much light is reflected back; this results in a much more accurate reading. For this project, a ST microelectronics VL6180X is chosen for its small size, affordability and performance; a mount is fabricated in SolidWorks shown in Figure 1 and fixed to the print head shown in Figure 2

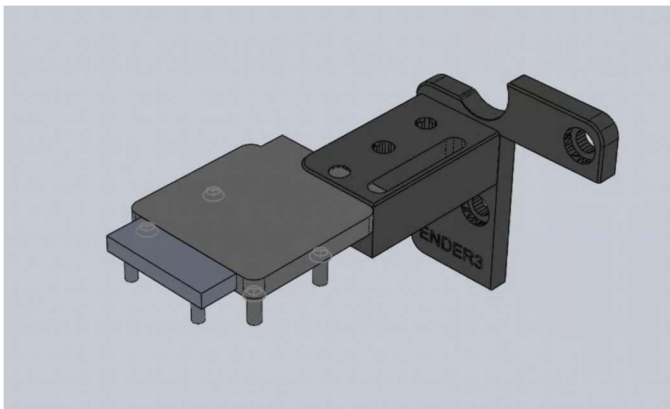


Figure 1

## III. IMPLEMENTATION (CONTINUED)

The Marlin firmware needs additions to allow the use of a TOF sensor. Marlin's Gcode interpreter has a set list of commands, however, this "list" can be expanded. We designate the new Gcode command "G2001" to return the averaged distance from the object to the TOF sensor; averaging helps reduce noise and provide a better contour. Additions added to Marlin are tracked as git commits in order to increase productiveness. The host computer runs a C++ driver program which controls the 3D printer via serial (UART) and the TOF values are stored in a csv file and then plotted. Consequently, this data can be imported into SolidWorks.

## IV. IMPLEMENTATION (CONTINUED)

A common Cartesian 3D printer contains a movable bed (y axis) along with a gantry (x axis) and screw drive (z axis); these components provide a high amount of accuracy of around 0.1 millimeters or better. Mounting a ranging sensor to the print head allows for a top down view of the object. More sophisticated designs can be employed to give a 3-dimensional view of the object... looked upon in a future white-paper. The object is scanned according to a user defined rectangle and resolution; the data is then fed to a processing program to a connected computer. A mesh grid can be generated for use in computer modeling programs such as SolidWorks.

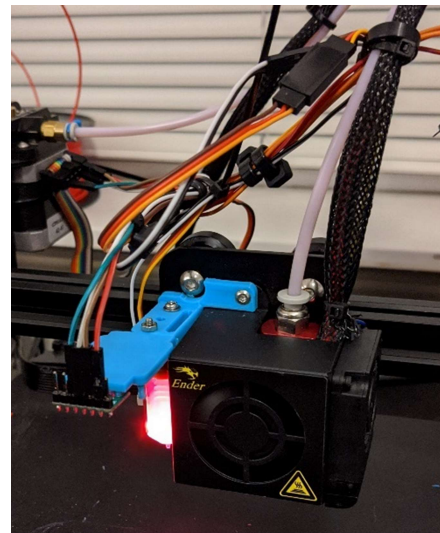
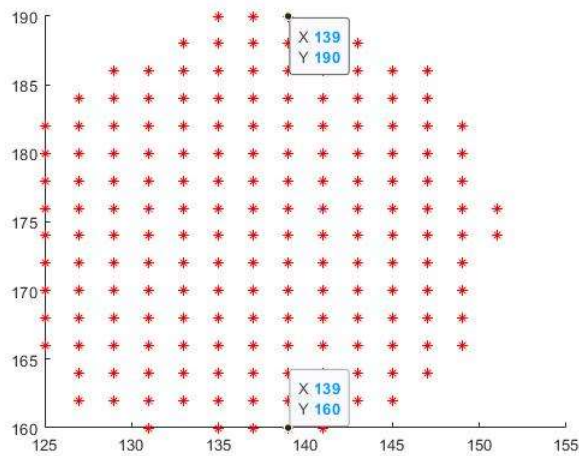


Figure 2

## V. TESTING

Many hours of testing have led to positive conclusions regarding the effectiveness of TOF contour scanning. This section aims to analyze measured data and its error against known object dimensions. In Figure 3, a scan of a nickel wrapped in tape (diameter = 21.21mm) is presented; with a mesh resolution of 2.0 mm. The diameter is determined to be around 30 mm; this result can be refined with a higher mesh resolution of 0.1mm – 0.5mm for example. Figure 3 is a “quick scan”, done in about 2 minutes, whereas a 1.0mm scan is lengthier at around 25-30 minutes. The ST TOF chip being used was designed to be used in an application for rough measurements; the sensor performed well for its price point and ease of use.



**Figure 3**

## VI. CONCLUSION

Overall, the end expectations for this project were vague; not much information is available regarding retrofitting scanning hardware to 3D printers. However, the results from this project have given a “green light” to further proceed with experimentation. The next iteration will include more sensors and a mechanism to rotate an object and employ spherical coordinates to get more complete object data in 3D.