Image Processing Tecniques for Masked Stereolithography(MSLA) Addative Manufacturing

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***Abstract*—Over the past few years additive manufacturing has made a big leap in usage. Recently Masked Stereolithography (MSLA) has made the fastest acceleration in technology due to the pervious processes. However, MSLA additive manufacturing is still a relatively new field for consumer grade machines. These machines use a photopolymer, UV light, and an LCD to create a three-dimensional object in a relatively short period of time. Due to the recent advancement in this technology in the past two years not much has been done with image processing. Using image processing, the machine can do higher detailed prints without the need for much post processing of the object. By using multiple techniques used in image processing and convert it over to a three dimensional uses this additive manufacturing processes could increase quality without an increase in cost to the relatively inexpensive consumer-based machines.**
(*Abstract*)

I. Masked Stereolithography(MSLA)

Masked Stereolithography (MSLA) is a newer type of additive manufacturing process. This process uses an LED or LED array designed to output a 405nm wavelength. The light used is projected on to a liquid crystal display, which is used to mask of the light from the LED/LED array. This LCD is similar to a phone LCD; however, the backlight is replaced with the LED/LED array. The light that passes through the LCD then goes through a clear film, commonly used Fluorinated ethylene propylene (FEP). This film is the bottom of a VAT, the film is used to hold the photopolymer. This photopolymer is engineered to be cured using the 405nm spectrum of light, allowing for a controlled curing of this resin. The resin is cured between two surfaces, the FEP film at the bottom of the VAT and the build plate which is moved is the Z axis to control the layer height of the print. By curing the photopolymer in between the two surfaces and controlling which pixels the light can pass through, then a layer of voxels, three dimensional pixels, is made. By slowly creating this voxel layers an object can appear due to the change in voxel placement.

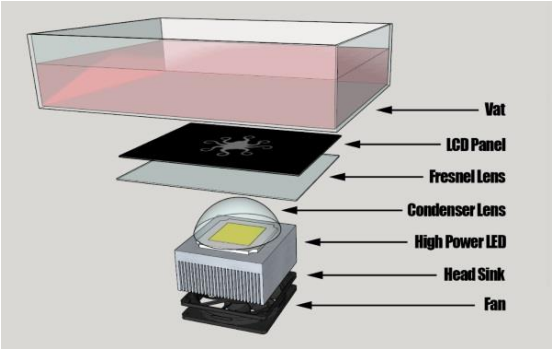

Fig. 1 Exploded view an MSLA machine

Fig. 2 Printed object using voxels and a photopolymer

In the masking of the light and polymerization of the photopolymer in those specified regions allow for the voxel layer to be made. These layers can sometimes be seen by the human eye or can be felt. This voxel layering is called the voxel effect, seen in “Fig. 3”. The voxel effect can be bad for high detail prints which can lose detail. The purpose of the paper is to compare open slicing software of the voxel images to different types of image processing techniques.

Fig. 3 Voxel Effect and Voxel Side Profile

II. Previous Work

This field is such relatively new, with only having two companies have open source software. Chitubox, a slicing software from the company CBD,

is the oldest free MSLA slicing software available. However, just recently they added anti-aliasing to their software and does still have a few bugs in it. The slicer works by taking in the STL file, which is a triangular mesh of an object. This mesh is then sliced at a certain height specified on the Z axis, allowing for an image of the mesh slice of the XY plane to be made "Fig. 4". In Chitubox the program then takes the images and adds anti-aliasing to each image layer. The anti-aliasing part can be chosen as 0,2,4, and 8.

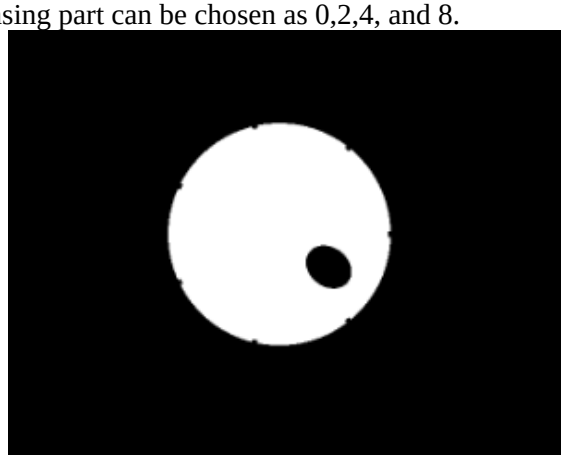

Fig. 4 XY axis slice

The method of blurring the edge of the object works fine in Chitubox, however the voxel layer lines are still prominent if the gradient of the object was low is the XZ or YZ planes, as seen in "Fig 3" in the voxel side profile.

III. Recreation of Chitubox's Anti-Aliasing

For the first part of the experiment was to recreate what the free slicer, Chitubox has done. By using OpenGL, a 3D and 2D modeling and viewing library, the slices of the STL file was created. OpenGL allowed for an easy way of making the slices due to the multiple language and how old the library is. OpenGL was used to import the STL first and made sure the mesh of the file was correct. By taking the mesh and then orientating a camera of the XY plane, the images of the slices could be made. The software was told the size of the image, 2560x1440 pixels, and the placement of the object in space. Then the thickness of the object was told by a user input and the slices where made and saved into a separate folder for use later.

After all the slices were cut the next step was using OpenCV, an image processing library, to recreate the anti-aliasing from Chitubox. By using multiple edge blurring techniques, as seen in "Fig. 5", and comparing them to Chitubox's version of anti-aliasing of 2, "Fig. 6". The types of blurring techniques used are averaging [5x5], Gaussian [5x5], and averaging[2x2]. Compared to Chitubox's anti-aliasing of 2, the averaging[2x2] was the closest one.

Fig. 5 OpenCV Edge Blur

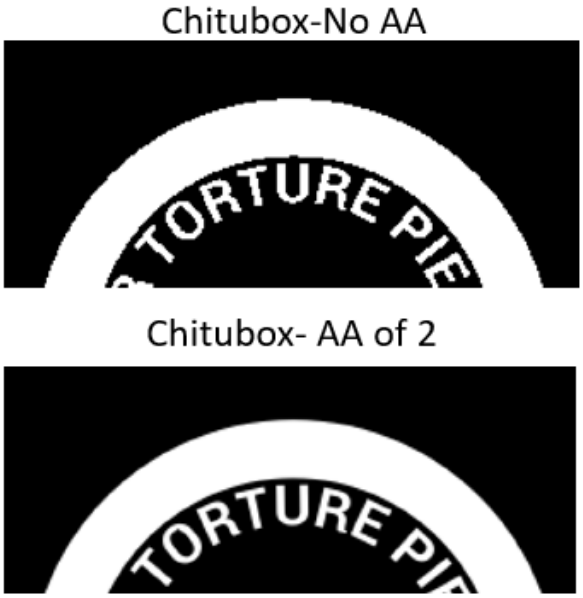

Fig. 6 Chitubox Anti-aliasing

IV. Improvements To Anti-Aliasing

While testing the XY axis edge blur techniques and comparing the to Chitubox's, the XZ and YZ axis images slices of the object were also created and had the edges blurred. This blurring allowed for a smoother transition between layers allowing for a better looking and feeling part. By taking XY, XZ and YZ axis slices and combining them the 3D object can be shown in a voxelated format. By taking each voxel and averaging them with the other axis' voxel you can smooth out the part and lower the layer line amounts. Then by taking the Image slices of the XY plane the object can be printed using those slices.

V. Morthology Techniques

Another way of using image processing in additive manufacturing is by using morphology on the slices. Before using anti-aliasing of the object, the parts could be put through an ellipse, gradient or rectangle morphology techniques, "Fig. 7".

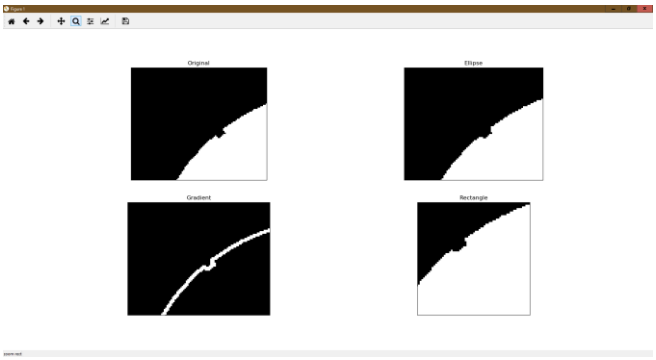

Fig. 7 Ellipse, Gradient, and Rectangle Morphology

One of the uses for morphology in additive manufacturing is gradient, this technique can be used for hollowed out parts. The hollowing of the part can be used to get rid of extra material on the inside of the part that is not needed in a specific application, “Fig. 8”.

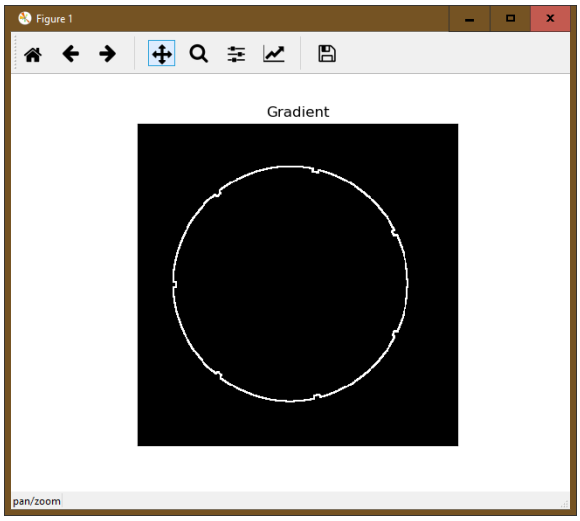

Fig. 8 Gradient of an Object for Hollowing

VI. Future Work

References

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