# Design and Development of 3D Stereoscopic Files Visualization Software

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**Abstract:**

Stereoscopic Visualisation combines latest stereoscopic display technologies with a robust machine which will handle large amount of data and permit it to be manipulated interactively in real time. Stereo lithography machines such as 3D printers which will build any volume shape as a series of slices. Ultimately these machines need a series of closed two dimension contours which are stuffed in with coagulated material because the layers are connected together. The STL file format seems capable of displaying a polyhedron with any polygonal facet, however in real-time it is solely used for triangles, which suggest that abundant of the syntax of the ASCII format is unused. To properly become a 3D volume, the surface pictured by any STL files should be closed and connected, wherever each edge is an element of precisely two triangles, and not self-intersecting. The software documented below imports stl files such that we can visualize that stl file in 3 dimensions on our computer screen. We can perform certain required operations on that stl file and can also export it with an extension .stl .This exported file can again be used in 3d printer to get the desired 3d model.

**Keywords:** Stereoscopic Visualisation; Stereolithography; 3d printer.

## I. INTRODUCTION

Stereoscopy is a method for making or enhancing the illusion of depth in a picture by stereo sis for binocular vision. The word stereoscopic vision derives from Greek στερεός (stereos), which means 'firm, solid', and σκοπέω (skopeō), which means 'to look, to see'. Any stereoscopic image is termed a stereogram. Originally, stereogram is a pair of stereo pictures that can be viewed using a stereoscope .Stereoscopic vision refers to the method of making or enhancing the illusion of depth in a piccture by presenting two offset pictures on an individual basis to the left and right eyes of the viewer. These images are connected together by the visual process system in the human brain to provide the perception of 3D depth. Stereoscopic Visualisation is a manner in which your brain expects to visualize things, with a left eye and a right eye view, and from the minor variations that around 50mm of eye separation creates in these two views, the brain is in a position to measure depth and so able to build and perceive the important world we tend to expertise daily . It's the distinction between viewing at a flat photo or illustration of an object and feeling that you just will reach out and touch the item itself. Stereoscopic vision refers to the method of making or enhancing the illusion of depth in an picture by presenting two offset pictures separately to the left and right eyes of the viewer. These pictures are combined by the visual process system within the human brain to relinquish the perception of 3D depth.

## II. HISTORY

In 1838 the English physicist Sir Charles Wheatstone first defined the concept of stereopsis as the perception of depth that results from slight differences in the visual projection of the world onto the two retinas due to their distinct anatomical positions (Wheatstone, 1838). This phenomenon is commonly referred to as binocular disparity, retinal disparity, or retinal rivalry (Lipton, 1982). Later in the same year, Sir Charles Wheatstone created a device called a "stereoscope," which provides each eye with a distinct picture. Using two angled mirrors, he demonstrated the human brain's tendency to bring together the two images in a manner that yields perception of a 3D visualization (Wheatstone, 1842). Finally, Wilhelm Rollmann, a physicist, built upon this concept to devise the anaglyph, which employs red and green lenses to create a 3D visualization by showing different pictures filtered by red and green lenses to each eye (Rollmann, 1853) STL was invented by the Albert Consulting Group for 3D Systems in 1987. The format was developed for 3D Systems' first commercial 3D printers. Since its initial release, the format remained relatively unchanged for 22 years. In 2009, an update to the format, dubbed STL 2.0, was proposed.

## III. STL (STEREOLITHOGRAPHY)

STL (Stereo Lithography) is a file extension native to the stereo lithography CAD software created by 3D Systems.STL has many acronyms like "Standard Triangle Language" and "Standard Tessellation Language". This file format is supported by several alternative software system packages. It is mostly used for speedy prototyping, 3D printing and computer-aided manufacturing. STL files describe solely the surface geometry of a three-dimensional object with none illustration of color, texture or alternative common CAD model attributes. The STL format specifies each ASCII and binary representations. Binary files are mostly used, since they are more compact.

**ASCII STL:**
An American Standard Code for Information Interchange (ASCII) STL file start with solid name where name is not compulsory string (though if name is omitted there must still be a space after solid). The file continues with many triangles, each represented as follows:

Facet normal ni nj nk
   Outer loop
      Vertex v1x v1y v1z
      Vertex v2x v2y v2z
      Vertex v3x v3y v3z
   End loop
End facet

where every n or v is a floating-point number in sign-mantissa-"e"-sign-exponent format, e.g., "3.570000e-009" (every v must be positive). The file concludes with endsolid name The structure of the format suggests that alternative possibilities exist (e.g., facets with more than one "loop", or loops with more than three vertices). In realtime, all facets are simple triangles. White space (spaces, tabs, newlines) is also used at anyplace within the file except inside numbers or words. The spaces between "facet" and "normal" and between "outer" and "loop" are needed.

**Binary STL:**
Because American Standard Code for Information Interchange STL files can become terribly big, a binary version of STL exists. A binary STL file has associate 80-character header (which is which is usually neglected, however ought to ne'er begin with "solid" as a result of which will lead most software systems to suppose that this is an ASCII STL file). The header must be a 4-byte unsigned whole number indicating the amount of triangular sides within the file. Following that's information describing every triangle successively. Every triangle in binary format is given by 12, 32-bit floating- point numbers: three for the normal and then three for the X/Y/Z coordinate of every vertex – just as with the ASCII version of STL. After this, a 2-byte ("short") unsigned whole number that is the "attribute byte count" –within the normal format, this could be zero as a result most software system doesn't perceive anything..[6] Floating-point numbers are described as IEEE floating-point numbers and are assumed to be little-endian, though this is often not expressed in documentation.

UINT8[80] – Header
UINT32 – Number of triangles
     foreach triangle
REAL32[3] – Normal vector
REAL32[3] – Vertex 1
REAL32[3] – Vertex 2
REAL32[3] – Vertex 3
UINT16 – Attribute byte count
End

## IV. WORKING

### 1. Import STL file:

The stl file which is to be visualized is taken as a input to the software .We can select any one stl file at a time from multiple stl files available in the particular folder. The stl files are represented as combinations of triangles. Sometimes in such files any data could be missing such as missing coordinates of a vertex or some spelling mistake or also extra spaces may occur. Such files are called corrupt files or damaged files .We have to make sure such damaged files should not be selected as a input to this software.

### 2. Recognize file:
We can use both ASCII as well as binary file as a input to the software. Both this file formats are explained in detail in

Introduction chapter. After importing a stl file software firstly recognizes whether the file is ASCII or binary. Depending on the file format further process is done.

### 3. Data extraction:-

Data extraction is the process of analyzing data in order to retrieve important or needful information from the data source available. In this system our data source is the stl file from which the data is to be retrieved. The data to be retrieved is the x, y, z coordinates of the 3 vertices and normal of each triangle in the stl file irrespective of the file format. After retrieving of data each vertex x, y and z coordinates are stored in a separate database variables so that we can use that variables in further process of this software.

### 4. Data patching:

In order to visualize the particular stl file we have to patch the triangles together. The patching is done with the help of the extracted vertices and facet normal. After patching the data we can see a figure on axis of our matlab software. This figure is the required visualization of the respective stl file.

### 5. Draw an axis:-

In order to do surgery a orthopedic surgeon needs to select a specific axis through which he could insert the rod . So the line of axis is determined by selecting two points on the stl figure displayed in the software .

### 6. Draw a cylinder:-

After selecting two points a line is drawn on the surface of the stl figure . This line can be used as an central axis to the cylinder i.e rod to be drawn. With the help of the two points selected on the stl figure and a specific radius a cylinder is drawn representing a rod on the stl surface.

### 7. Functions :

Additional functions such as zoom in or zoom out, pan and also 3d rotation of the displayed stl file can also be performed.

### 8. Boolean Operations:

Boolean operations such as Boolean add and subtract is also performed.

**Boolean add:-** Boolean add operation combines the cylindrical surface and the stl surface together and gives out the combined stl file as a output.

**Boolean subtract:-** Boolean subtract operation removes the vertices which is inside that cylindrical surface i.e rod and gives us the remaining stl file as output. The obtained stl file contains a hollow portion of the shape of cylinder in which the particular rod can be inserted. Thus reducing the hard work of the orthopedic surgeon at the time of surgery .This process also increases the accuracy of the surgery.

### 9. Exporting:-

After performing operations on the selected stl surface the changed stl surface need to be saved and exported. So export function can be used to again save the changed stl surface with

.stl file extension. This exported .stl file can be further given as a input to the 3d printed if suggested by orthopedic surgeon. Sample References Section
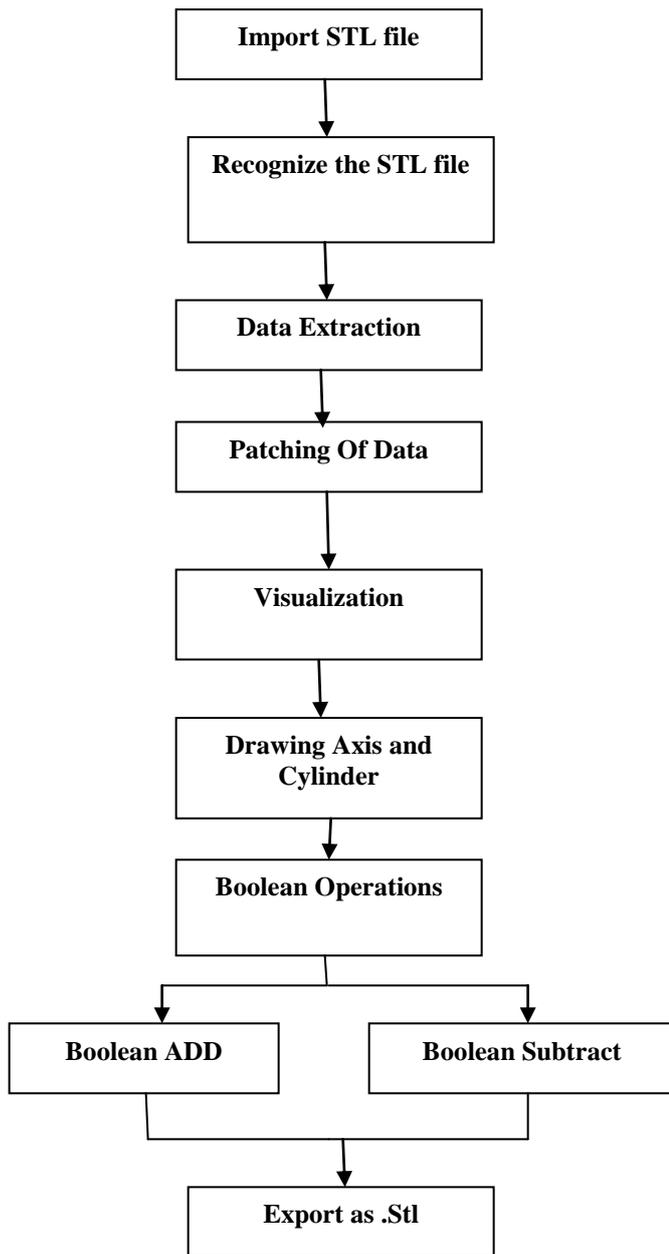
## V.  SYSTEM FLOW

```
┌─────────────────────────┐
│     Import STL file      │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│   Recognize the STL file │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│     Data Extraction      │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│     Patching Of Data     │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│      Visualization       │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│    Drawing Axis and      │
│       Cylinder           │
└─────────────────────────┘
            │
            ▼
┌─────────────────────────┐
│    Boolean Operations    │
└─────────────────────────┘
       │           │
       ▼           ▼
┌──────────┐  ┌──────────────┐
│ Boolean  │  │   Boolean    │
│   ADD    │  │   Subtract   │
└──────────┘  └──────────────┘
       │           │
       └─────┬─────┘
             ▼
    ┌──────────────────┐
    │  Export as .Stl  │
    └──────────────────┘
```

**Figure.1. System Flow Diagram**

## VI.  FUNCTIONS USED:

**1. For Import:-**
**a.For selecting a particular stl file from number of stl files following function is used:--**

*[File Name, Path Name] = uiget file('*.stl',' Select the stl file');*

**b. For reading the selected file following function is used**
         *READ_ stl(File Name);*

**2. For Recognize** :-
For recognizing whether the selected stl file is ASCII or binary following code is used:-
*Function [stlFORMAT] = IDENTIFY_ stl_format (stl FILE NAME)*

*Fid IN = f open (stl FILE NAME);*

*Fseek (fidIN,0,1);        % Go to the end of the file*
*Fid SIZE = ftell (fidIN);   % Check the size of the file*

*if rem(fidSIZE-84,50) > 0*
   *stl FORMAT = 'ascii';*
 *else*

 *f seek (fidIN,0,-1);        % Go to the start of the file*
 *firsteighty = char(fread(fidIN,80,'uchar')');*

 *% Trim leading and trailing spaces:*
 *first eighty = strtrim (first eighty);*

 *% Take the first five remaining characters, and check if these are 'solid':*
 *First five = first eighty(1:min(5,length(first eighty)));*

 *if strcmp (firstfive,'solid')*

  *fseek(fidIN,-80,1);        % Go to the end of the file minus 80 characters*
  *lasteighty = char(fread(fidIN,80,'uchar')');*

  *if findstr(lasteighty,'endsolid')*
   *stlFORMAT = 'ascii';*
  *else*
   *stlFORMAT = 'binary';*
  *end*

  *else*
   *st lFORMAT = 'binary';*
  *end*

*end*

*% Close the file*
*fclose(fidIN);*

**3. for Data Extraction:-**
After Selecting a particular file format i.e ASCII or binary we have to read the coordinates of the vertices of all the triangles Following code stores x ,y and z coordinates of all the triangles in xco , yco and zco variables respectively.
         *xco =squeeze( stlcoords(:,1,:) )'*
         *yco =squeeze(stlcoords(:,2,:) )';*
         *zco =squeeze( stlcoords(:,3,:) )';*

**4. for patching**:-
After selecting a particular stl file and extracting data from it, we have to patch the obtained coordinates so that a stl file is visualized.

Following function is used for patching:-
 *[hpat] = patch(xco,yco,zco,'b');*
Patch function is used to create one or more filled polygons according to the parameter provided in the function call. Matlab automatically detect the current axis being used in our gui to display the patched data.

**5. for visualization:-**
Matlab automatically detect the current axis being used in our gui to display the patched data. Once we use this above patch function the stl file is displayed on in the current axis .
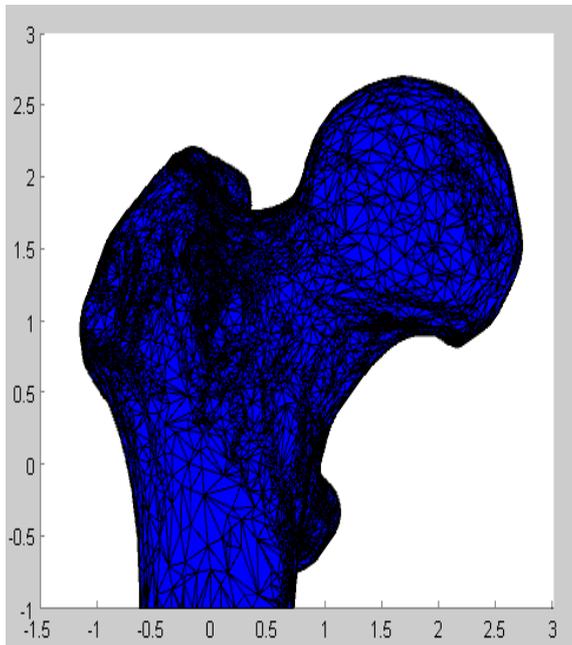
**Figure.2. Visualization of stl file.**

## 6.Function for drawing Axis:-

For drawing axis across the displayed stl surface we have to select two distinct points on the stl surface. We can select any point on the surface of stl file by just left clicking on the stl surface and the pressing enter. Pressing Enter confirms the point you have selected. By this process you have two select two points and as soon as you press enter for the second point the line is been drawn. This line can be used as an axis to draw a cylinder.

**Following code is used for drawing an axis throw the stl surface:-**

```
fig=gcf;
dcm_ obj = data cursor mode(fig);
set(dcm_obj,' Display Style', 'data tip',...
   'Snap To Data Vertex', 'off',' Enable',' on')

disp('Click on the figure to display a data tip and select first point, then press Return.')
pause   % Wait while the user does this.

c_info = get Cursor Info(dcm_obj);
x1=c_info. Position;
disp('Click on the figure to display a data tip and select second point, then press Return.')
pause

dcm_1 = data cursor mode (fig);
d_info = get Cursor Info(dcm_1);
x2=d_info. Position;
x=[x2;x1];
hold on;
plot3(x(:,1),x(:,2),x(:,3),'r')

data cursor mode off;
```

## 7.Function for drawing Cylinder:-

For drawing a Cylinder shape i.e a rod which is going to pass through the stl surface , the above  axis is used as a central line passing through the cylindrical surface . The two selected point that has been selected for drawing the line is used as the two ends of the diagonal which is passed through the cylinder.

Now, by just selecting the appropriate radius for the cylinder, a cylindrical shape rod is drawn.

**Following is the code for drawing the cylinder:-**
```
r=.25; // radius of the cylinder
n=10;
cyl_color='w';
closed=1;
[CylinderEndPlate1EndPlate2]=   Cylinder1   (x1,x2,r,n,cyl_color, closed,lines);
```
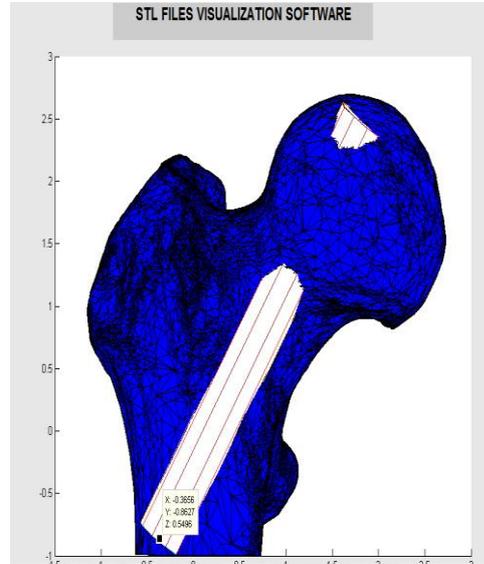

**Figure.3. Femur Stl file with rod Inserted**

## 8. Function For Export :-

After selecting a particular axis, a cylindrical shape rod is being inserted as per the required dimension by orthopedic surgeon. But, if the surgeon want to practically view the object obtained by performing various above operation, he just have to click on export so that the above changed surface is again translated into a .stl file format. 3D printers accept the .stl file format and print the required 3D object. Surftostl function converts surface variables obtained by data extraction i.e xco, yco and zco containing x coordinates, y coordinates and  z coordinates respectively into the group of triangles i.e  the required stl file.

**Function for export:-**
```
[Filexport,pathName]  =  uiputfile('*.stl','STL FILES',' Save as'); surf 2stl(Filexport,xco,yco,zco,'ascii');
```

## VII.   CONCLUSION

Stl file format describes the surface geometry of 3-Dimenssional objects in terms of list of facet data. It is complete listing of x, y, z co-ordinates of normal and vertices of all the triangles. 3D printers use these STL files to build physical 3D models. The proposed system will  be  able  to visualize .stl files  and  we can perform operations on it to get the desired 3d model. This software can be used in biomedical field by orthopedic surgeons. This software can be used in manufacturing industries.  It Opens discipline to new generation of architects.  It's faster and more affordable and effective for the client than ever before.

## VIII.   REFERENCES

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