6.0 Visualization tool kit.

In order to see how the surface is trimmed and also have a simple means to discern the error between the two surfaces, a visualization tool kit was developed (Figure 6.1). Its capabilities include translation, rotation, zooming and rendering of the surfaces.

The input for the visualization tool kit is two data files. One contains a set of points in 3-D space to be interpolated with a B-spline surface. The other contains a set of points in 2-D parametric space representing the trimming curve. The program interpolates the 3-D data set to obtain a bi-cubic B-spline surface, approximates the trimming curve with a b-spline curve and proceeds to find the resulting trimmed patch. Then both surfaces, the original untrimmed surface and the new trimmed surface patch, are shown on the screen and the user has the capability to visually manipulate them in order to better understand the results. Figure 6.1 shows a screen shot of the interface developed in "C" programming language with the use of OpenGL and X/Motif. The "zoom" slider zooms the object on the screen in and out about the z-axis. The four "arrow buttons" assist in the rotation of the object about the x and y-axes of the screen. The "Exit" button terminates the program.

Theoretically, mapping a trimming curve defined in the parametric space of a surface on

to Cartesian space should result in a curve contained in the surface. In our procedure,
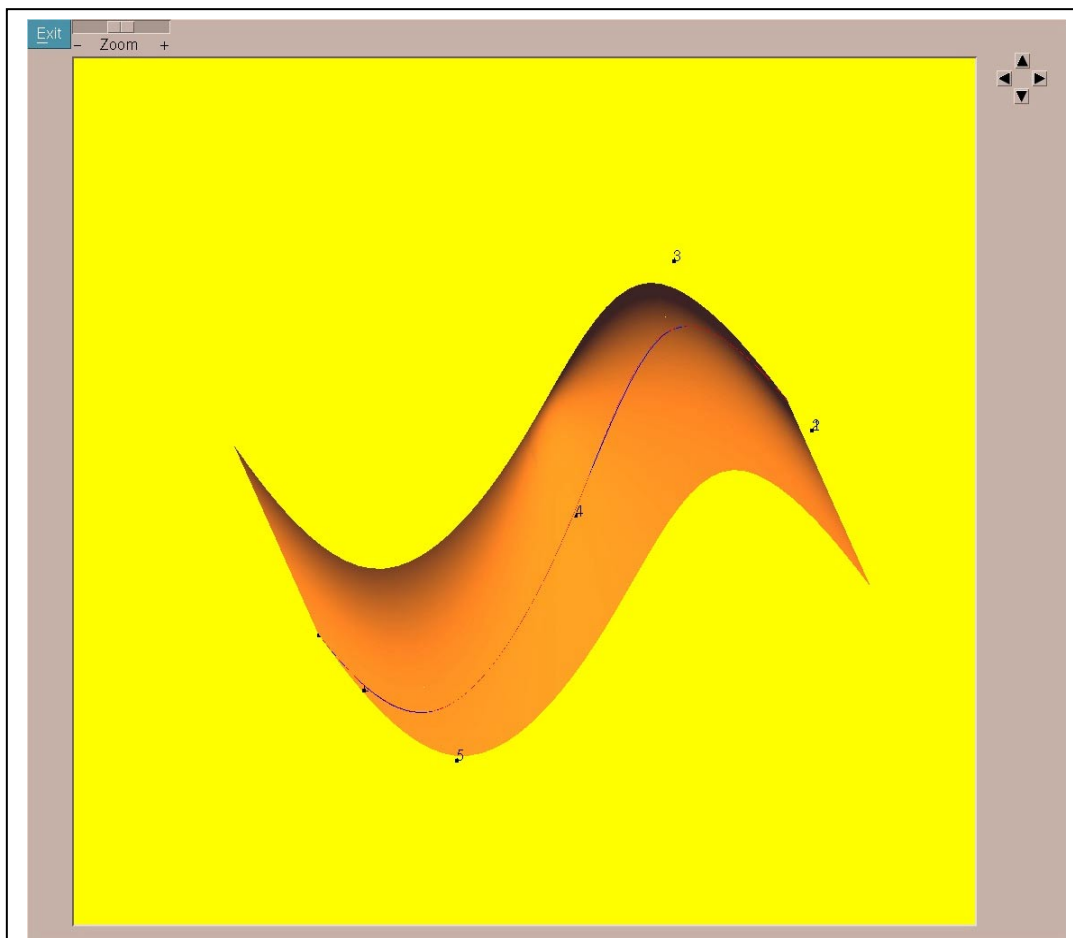

Figure 6.1: A screen shot of the interface developed using X/Motif. An OpenGL context is set to the window to enable OpenGL commands to take effect.

however, a B-spline curve is used to approximate a set of points, which define the

trimming curve mapped from parametric space. Therefore, the resulting B-spline curve

does not have to necessarily lie on the surface, although the results obtained in this study show that visually the deviation is small.

6.1   OpenGL and X/Motif

OpenGL is a software interface to graphics hardware. (The GL stands for Graphics Library). The graphics system is a hardware-independent interface designed to be implemented on many different hardware platforms. The operating system used in this research to implement the results is AIX (IBM UNIX) and the windowing system that the platform supports is the X Window System. The OpenGL Utility Library (GLU) provides many of the modeling features, such as NURBS curves and surfaces. These modeling features have been used in this research to create curves and surfaces.

The NURBS interface is initiated by defining a new NURBS object. Different rendering properties are then set to the NURBS object and the curve or the surface is finally created. Polygonal primitives are used to render a NURBS object. The object is first broken down into small polygons by sampling it at different values of its parameters (u and v) and the resulting polygons are collectively rendered to give a rendered surface. The process of breaking down the NURBS object into polygonal primitives is known as tessellation. Setting a sampling tolerance for the parametric sampling can control the size of the polygons that make up the surface.

In addition to setting the properties directly to the object, OpenGL allows to set general properties to the windowing context that would have an effect on the way any model gets

described within the window. Some of the properties that can be set are shading, surface properties, such as color and reflectivity and lighting. In this research, smooth shading, also called *Gouraud shading* was employed to better visualize the shape of freeform surfaces. The 24-bit RGBA mode was used to specify the lighting characteristics.

OpenGL also has functions that allow performing certain viewing, modeling and projection transformations on the model. These transformations help in a better understanding of the model and its features. The viewing transformation decides the direction in which the model is viewed on the screen. It is analogous to positioning and aiming a camera at the model. The modeling transformations allow the user to rotate, translate or scale the model for better visualization. The projection transformations determine the field of view or the viewing volume and thereby decide what objects are inside it. In addition to the field-of-view considerations, the projection transformation determines how objects are projected onto the screen, as its name suggests. OpenGL provides two basic projection types namely, *perspective* projection, which matches how you see things in daily life and *orthographic* projection, which maps objects directly onto the screen without affecting their relative size.

X/Motif is a library of ready-to-use user-interface elements developed in C programming language that aid in the creation of certain user-interface components like menus, scrollbars, command buttons and so forth for the windows obtained by the default windowing system, the X Window System.