The GLU library is available in all OpenGL implementations; functions in the GLUlibrary begin with letters glu.

To interface with the window system and to get input from external devices into our programs, we need at least one more system-specific library that provides the “glue” between the window system and OpenGL. For the X window system, this library is functionality that should be expected in any modern windowing system.

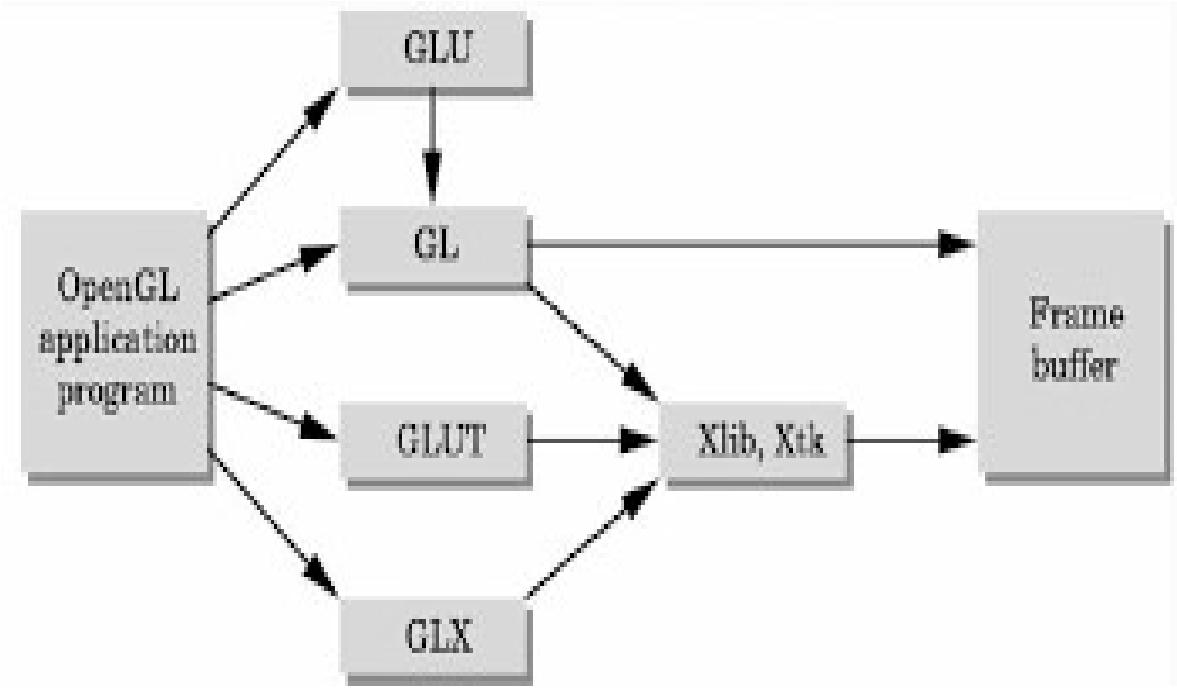

Fig 1.3.1 Library organization

Fig1.3.1 shows the organization of the libraries for an X Window System environment. For this window system, GLUT will use GLX and the X libraries. The application program, however, can use only GLUT functions and thus can be recompiled with the GLUT library for other window system.

1.4 OPENGL ARCHITECTURE:

1.4.1 Pipeline Architectures

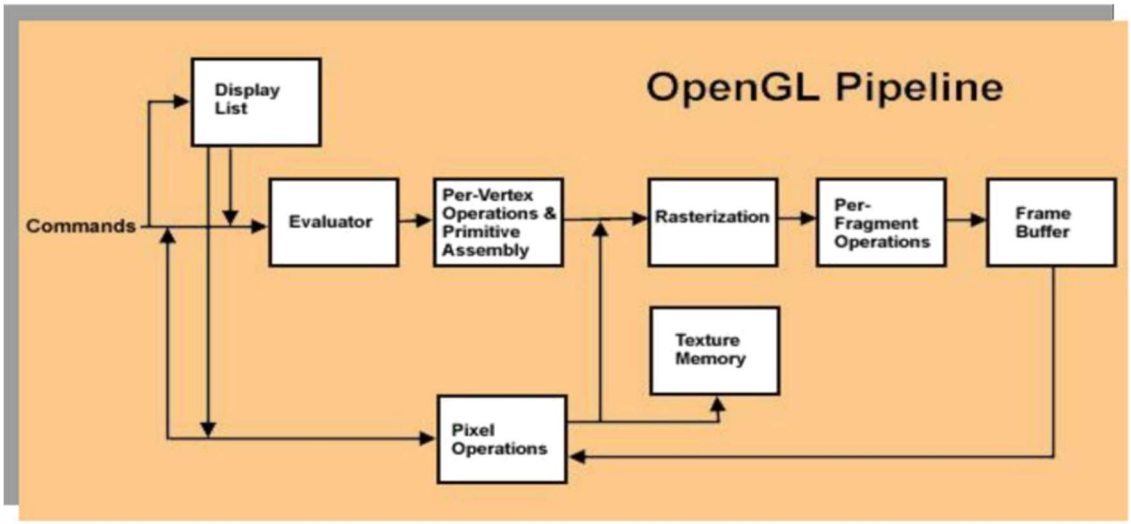

FIG:1.4.1 OPENGL PIPELINE ARCHITECTURE

Display Lists:

All data, whether it describes geometry or pixels, can be saved in a display list for current or later use. (1 alternative to retaining data in a displaylist is processing the data immediately - also known as immediate mode.) When a display list is executed, the retained data is sent from the display list just as if it were sent by the application in immediate mode.

Evaluators:

All geometric primitives are eventually described by vertices. Parametric curves and surfaces may be initially described by control points and polynomial functions called basis functions. Evaluators provide a method to derive the vertices used to represent the surface from the control points. The method is a polynomial mapping, which can produce surface normal, texture coordinates, colors, and spatial coordinate values from the control points.

Per-Vertex Operations:

For vertex data, next is the "per-vertex operations" stage, which converts. The vertices into primitives. Some vertex data (for example, spatial coordinates) are transformed by 4 x 4 floating-point matrices. Spatial coordinates are projected from a position in the 3D world to a position on your screen. If advanced features are enabled, this stage is even busier. If texturing is used, texture coordinates may be generated and transformed here. If lighting is enabled, the lighting calculations are performed using the transformed vertex, surface normal, light source position, material properties, and other lighting information to produce a color value.

Primitive Assembly:

Clipping, a major part of primitive assembly, is the elimination of portions of geometry which fall outside a half-space, defined by a plane. Point clipping simply passes or rejects vertices; line or polygon clipping can add additional vertices depending upon how the line or polygon is clipped.

In some cases, this is followed by perspective division, which makes distant geometric objects appear smaller than closer objects. Then view port and depth (z coordinate) operations are applied. If culling is enabled and the primitive is a polygon, it then may be rejected by a culling test. Depending upon the polygon mode, a polygon may be drawn as points or lines. The results or this stage are complete geometric primitives, which are the transformed and clipped vertices with related color, depth, and sometimes texture-coordinate values and guidelines for the rasterization step.

Pixel Operations:

While geometric data takes one path through the OpenGL rendering pipeline, pixel data takes a different route. Pixels from an array in system memory are first unpacked from one of a variety of formats into the proper number of components. Next the data is scaled, biased, and processed by a pixel map. The results are clamped and then either written into texture memory or sent to the rasterization step. If pixel data is read from the frame buffer, pixel-transfer operations (scale, bias, mapping, and clamping) are performed. Then these results are packed into an appropriate format and returned to an array in system memory. There are special pixel copy operations to copy data in the frame buffer to other parts of the frame buffer or to the texture memory. A single pass is made through the pixel transfer operations before the data is written to the texture memory or back to the frame buffer

Texture Assembly:

An OpenGL application may wish to apply texture images onto geometric objects to make them look more realistic. If several texture images are used, it's wise to put them into texture objects so that you can easily switch among them. Some OpenGL implementations may have special resources to accelerate texture performance. There may be specialized, high-performance texture memory. If this memory is available, the texture objects may be prioritized to control the use of this limited and valuable resource.

Rasterization:

Rasterization is the conversion of both geometric and pixel data into fragments. Each fragment square corresponds to a pixel in the frame buffer. Line and polygon stipples, line width, point size, shading model, and coverage calculations to support ant aliasing are taken into consideration as vertices are connected into lines or the interior pixels are calculated for a filled polygon. Color and depth values are assigned for each fragment square.

1.4.2 OpenGL Engine And Drivers:

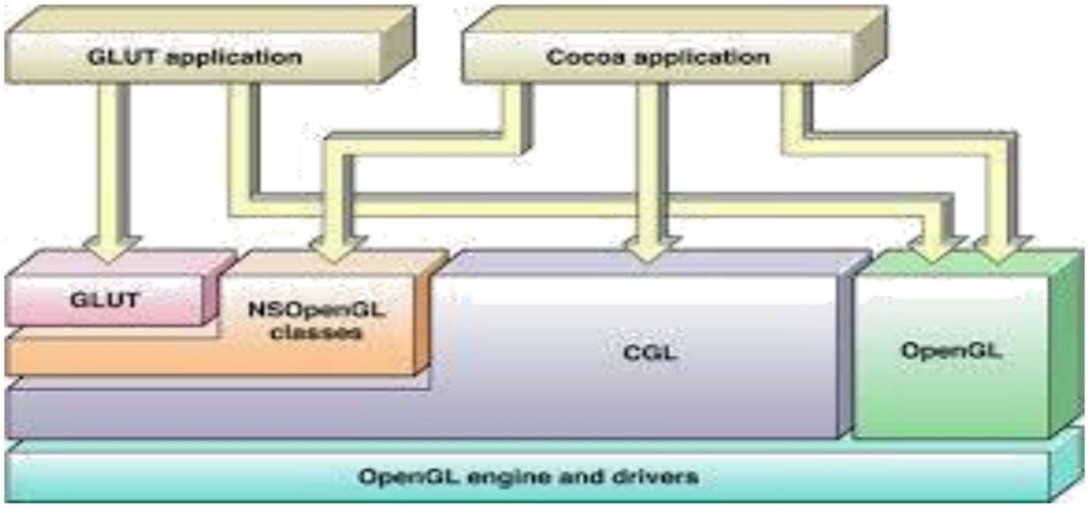

FIG:1.4.2 OPENGL ENGINE AND DRIVERS

1.4.3 Application Development-API's

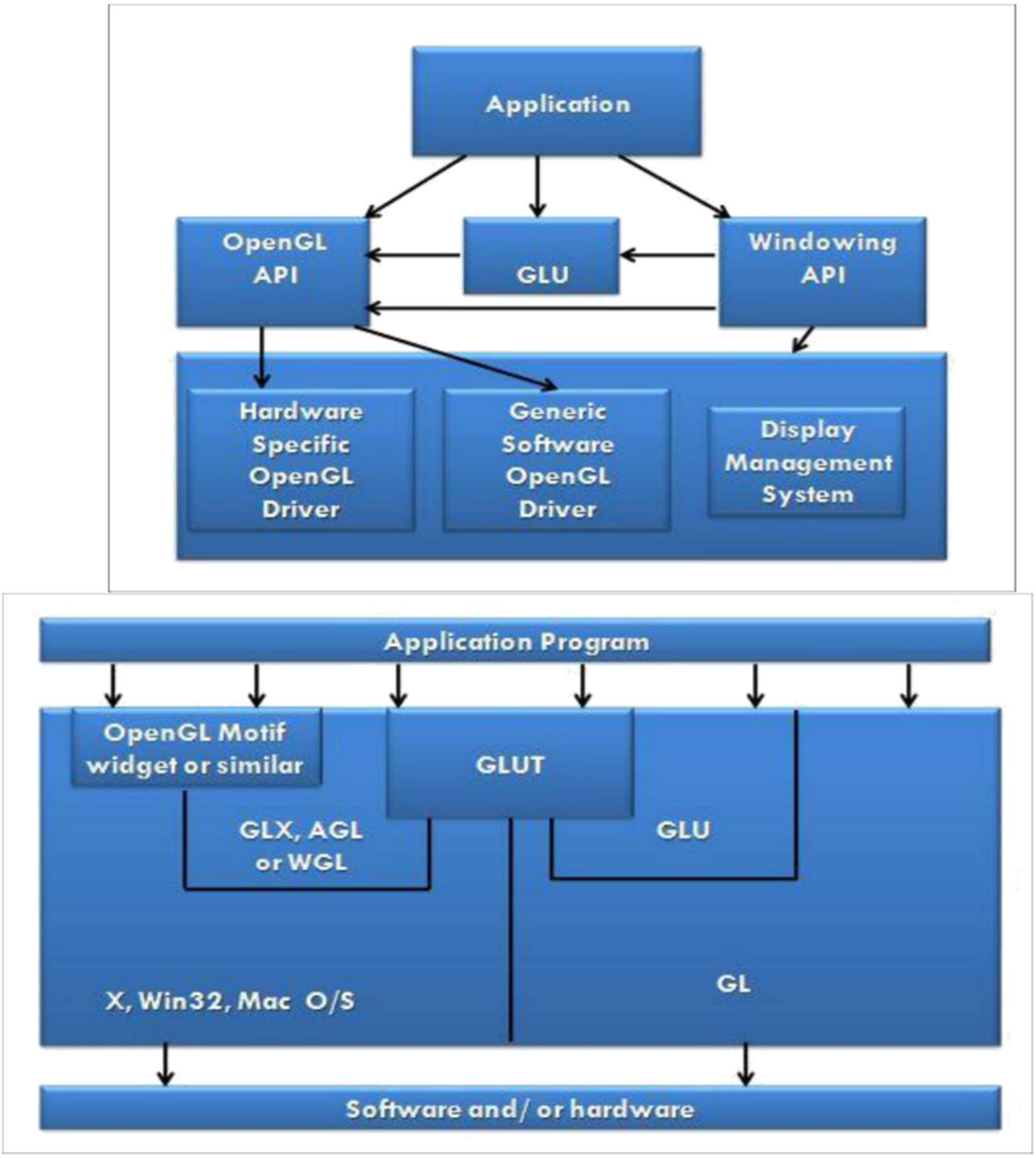

Fig 1.4.3 Application Development API's

The above diagram illustrates the relationship of the various libraries and window system components. Generally, applications which require more user interface support will use a library designed to support those types of features (i.e. buttons, menu and scroll bars, etc.) such as Motif or the Win32 API. Prototype applications, or ones which do not require all the bells and whistles of a full GUI, may choose to use GLUT instead because of its simplified programming model and window system independence.