

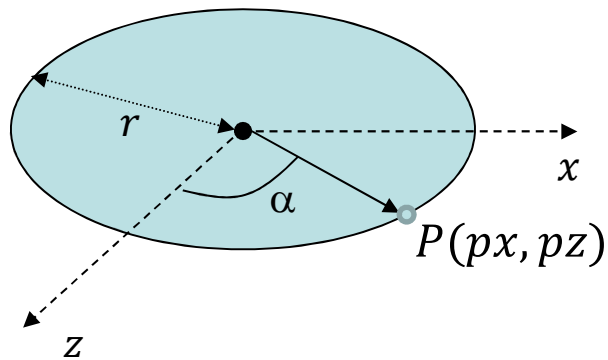


Camera Motion Drawing a Cylinder



Polar Coordinates

- Polar coordinates specify points based on an angle and a radius.



Polar Coordinates
 (α, r)

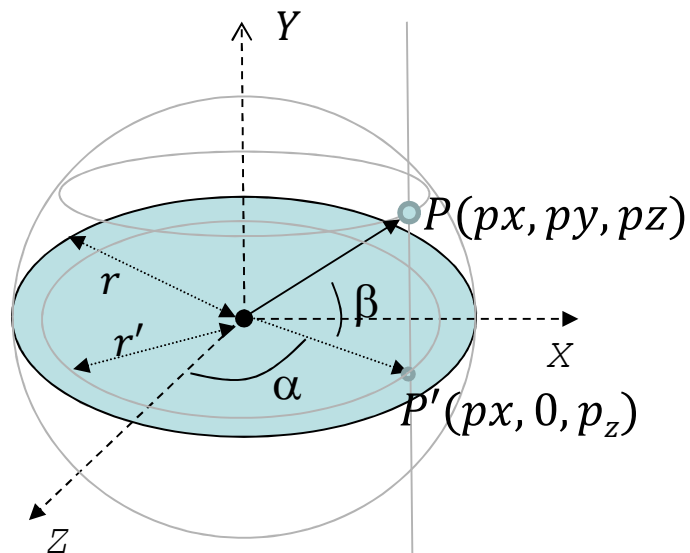


Cartesian Coordinates
 $px = r * \sin(\alpha);$
 $pz = r * \cos(\alpha);$



Spherical Coordinates

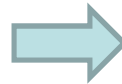
- Specify a point on the surface of a sphere



$$r' = r \times \cos(\beta)$$

Spherical Coordinates

$$(\alpha, \beta, r)$$
$$-90 < \beta < 90$$



Cartesian Coordinates

$$z = r \times \cos(\beta) \times \cos(\alpha);$$
$$x = r \times \cos(\beta) \times \sin(\alpha);$$
$$y = r \times \sin(\beta);$$



Explorer Mode Camera

- The camera moves in the surface of a sphere, always looking at the centre of the sphere.
- Don't allow the camera to be upside down.

```
gluLookAt( px, py, pz,    // camera position
           lx, ly, lz,    // look at point
           ux, uy, uz)    // "up vector" (0.0f, 1.0f, 0.0f)
```

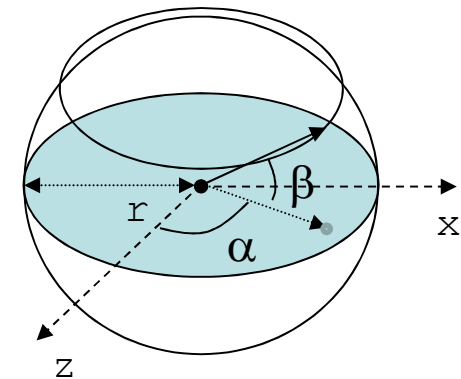
- The look at point is constant (0.0f, 0.0f, 0.0f)
- The camera position is defined based on spherical coordinates (*alpha*, *beta*, *radius*) that must be converted to Cartesian coordinates (p_x , p_y , p_z)
 - (*alpha*, *beta*) determine the position of the camera in a sphere of radius *r*. Limit $|beta| < 1.5$ (radians)
 - *radius* determines the distance of the camera to the look at point



FPS Camera

- Camera Orientation
- The view direction is obtained using spherical coordinates. The look at point is defined based on the view direction and the actual camera position.
- The view direction is a vector D computed based on the two angles (α and β) that define the horizontal and vertical orientation respectively.
- Considering $P = (p_x, p_y, p_z)$, the camera position, and $D = (d_x, d_y, d_z)$, the view direction:

```
gluLookAt(px,py,pz,  
          px+dx, py+dy, pz+dz,  
          ux, uy, uz);
```

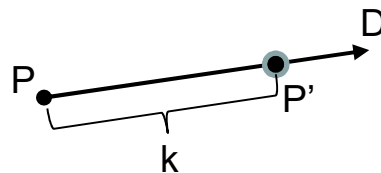




FPS Camera

- Camera Motion
- Forward and backward movement is achieved using vector D
- D should be normalized
- To move the camera k units forward, and considering D to be a unit vector, implies recomputing the camera position as follows:

$$P' = P + k \times D$$

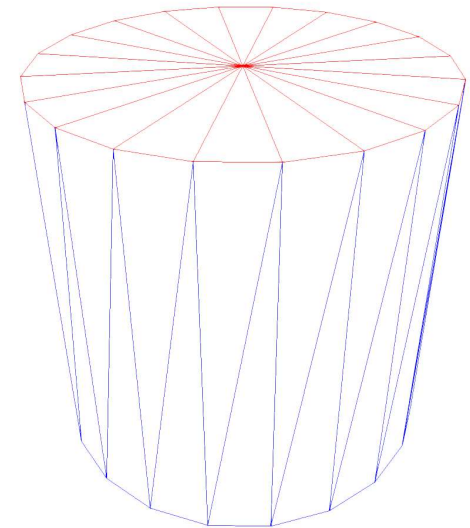


- Note: the look at point must also be displaced.



Practical Assignment

- Build a cylinder using triangles defining the vertices based on polar coordinates
 - function `drawCylinder(float radius, float height, int slices)`
- Complete the code skeleton to build an interactive application using the keyboard to move the camera up/down and left/right (explorer mode) using spherical coordinates.
 - function `processKeys` and `processSpecialKeys`





π and math.h

- A value for PI is defined in constant `M_PI` in `math.h`
- To have this constant available we should write:

```
#define _USE_MATH_DEFINES // always before the include
#include <math.h>
```

- Usage example:

```
float x = M_PI / n;
```




Useful functions

- Set a color:

```
glColor3f(r,g,b)
```

- note: call the function before sending the vertices to the GPU

- Change drawing mode:

```
glPolygonMode(faces, mode);
```

- **faces:** GL_FRONT, GL_BACK, GL_FRONT_AND_BACK
- **mode:** GL_FILL, GL_LINE, GL_POINT