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EXP NO : 1

Aim : Implementation of Coordinate system conversion 1: Cartesian to Cylindrical, Cartesian to Spherical 2: Cylindrical to Cartesian, Cylindrical to Spherical. 3: Spherical to Cartesian, Spherical to Cylindrical

Software used : MATLAB

Theory : Cartesian Coordinates : Cartesian coordinates are a system used to uniquely determine the position of a point in space. In a 2-dimensional space, it is defined by two axes: the x-axis (horizontal) and the y-axis (vertical). The position of any point in this plane is determined by a pair of numerical coordinates (x,y)(x, y)(x,y). Each coordinate represents the distance of the point from the respective axis.

In a 3-dimensional space, an additional z-axis (perpendicular to both the x and y axes) is introduced, and a point is represented by a triplet (x,y,z)(x, y, z)(x,y,z), where:

• x is the distance from the yz-plane.

• y is the distance from the xz-plane.

• z is the distance from the xy-plane.

Spherical Coordinates : Spherical coordinates provide a different method to locate a point in space using three parameters: radius rrr, polar angle θ\thetaθ (often called colatitude), and azimuthal angle :

• r: The distance from the origin to the point.

• θ: The angle between the positive z-axis and the line formed between the origin and the point (0 ≤ θ\thetaθ ≤ π).

• : The angle between the positive x-axis and the projection of the point onto the xy-plane (0 ≤ < 2π).

Cylindrical Coordinates : Cylindrical Coordinates are a hybrid between Cartesian and spherical systems. They use three parameters: radius r, azimuthal angle , and height z:

• r: The radial distance from the origin to the projection of the point onto the xy-plane.

• : The same as in spherical coordinates, representing the angle between the positive x-axis and the projection of the point onto the xy-plane.

• z: The height of the point above the xy-plane, similar to the z-coordinate in Cartesian coordinates.

• A point in cylindrical coordinates is represented as (r,,z)

Pointwise Comparison

• In Cartesian Coordinates: A point is expressed as (x,y,z) with each value representing a linear distance along a principal axis.

• In Spherical Coordinates: A point is expressed as (r,θ,) with r indicating the radial distance, θ\thetaθ the angle from the z-axis, and the angle in the xy-plane.

• In Cylindrical Coordinates: A point is expressed as (r,,z) combining the radial distance and angular position from spherical coordinates with the height from Cartesian coordinates.

1.1 Cartesian to Cylindrical Co-ordinate

```
%Declaration of the variables :
x=35;
y=50;
z=10;
fprintf("The cartesian coordinates are: ");
```

```
The cartesian coordinates are:
```

```
fprintf("x");disp(x);
```

```
x    35
```

```
fprintf("y");disp(y);
```

```
y    50
```

```
fprintf("z");disp(z);
```

```
z    10
```

```
%Conversion of Cartesian to Cylindrical
m= x^2 + y^2 ;
rho= sqrt(m);
phi = atan(y/x);
z=z;

fprintf("the cylindrical cordinates are ");
```

```
the cylindrical cordinates are
```

```
fprintf("the radial distance :");disp( rho);
```

```
the radial distance :   61.0328
```

```
fprintf("the angle with the x axis is :");disp(phi);
```

```
the angle with the x axis is :    0.9601
```

```
fprintf("the height of the cylinder :");disp(z);
```

```
the height of the cylinder :    10
```

1.2 Cartesian to Spherical Co-ordinate

```
%Conversion of Cartesian to Spherical
n= x^2 + y^2 + z^2;
r= sqrt(n);
theta = acos(z/r);
phi = atan(y/x);
fprintf("The spherical coordinates are: ");
```

```
The spherical coordinates are:
```

```
fprintf("The radial distance is: ");disp(r);
```

```
The radial distance is:    61.8466
```

```
fprintf("The angle with z axis is: ");disp(theta);
```

```
The angle with z axis is:     1.4084
```

```
fprintf("The angle with x axis is: ");disp(phi);
```

```
The angle with x axis is:     0.9601
```

2.1 Cylindrical to Cartesian Co-ordinate

```
%%Declaration of the variables :
rho=25;
phi=0.4;
z=35;
fprintf("The cylindrical coordinates are: ");
```

```
The cylindrical coordinates are:
```

```
fprintf("rho=");disp(rho);
```

```
rho=    25
```

```
fprintf("phi=");disp(phi);
```

```
phi=    0.4000
```

```
fprintf("z=");disp(z);
```

```
z=    35
```

```
%Conversion 2.1: Cylindrical to cartesian
```

```
x= rho*cos(phi);
y=rho*sin(phi);
z=z;
fprintf("The cartesian coordinates are: ");
```

```
The cartesian coordinates are:
```

```
fprintf("x");disp(x);
```

```
x   23.0265
```

```
fprintf("y");disp(y);
```

```
y    9.7355
```

```
fprintf("z");disp(z);
```

```
z    35
```

2.2 Cylindrical to spherical Co-ordinate

```
%2.2.Conversion of Cylindrical to Spherical
r= sqrt(rho^2+z^2);
theta=atan(rho/z);
phi=phi;
fprintf("The Spherical coordinates are: ");
```

```
The Spherical coordinates are:
```

```
fprintf("The radial distance ");disp(r);
```

```
The radial distance    43.0116
```

```
fprintf("The angle with z axis ");disp(theta);
```

```
The angle with z axis     0.6202
```

```
fprintf("The angle with x axis");disp(phi);
```

```
The angle with x axis    0.4000
```

3.1 Spherical to Cartesian Co-ordinate

```
%%Declaration of the variables :
r=30;
phi=0.4;
theta=0.8;
fprintf("The spherical coordinates are: ");
```

```
The spherical coordinates are:
```

```
fprintf("r=");disp(r);
```

```
r=    30
```

```
fprintf("phi=");disp(phi);
```

```
phi=    0.4000
```

```
fprintf("theta=");disp(theta);
```

```
theta=    0.8000
```

```
%Conversion 3.1: Spherical to cartesian
x=r*cos(phi)*sin(theta);
y=r*sin(phi)*sin(theta);
z=r*cos(theta);
fprintf("The cartesian coordinates are: ");
```

```
The cartesian coordinates are:
```

```
fprintf("x");disp(x);
```

```
x   19.8219
```

```
fprintf("y");disp(y);
```

```
y    8.3805
```

```
fprintf("z");disp(z);
```

```
z   20.9012
```

3.2 Spherical to Cylindrical Co-ordinate

```
%Conversion 3.2: Spherical to cylindrical
rho=r*sin(theta);
phi=phi;
z=r*cos(theta);
fprintf("The cylindrical coordinates are: ");
```

```
The cylindrical coordinates are:
```

```
fprintf("rho");disp(rho);
```

```
rho   21.5207
```

```
fprintf("phi");disp(phi);
```

```
phi    0.4000
```

```
fprintf("z");disp(z);
```

```
z   20.9012
```

Manual Solutions :

Manual Solutions

1] 1.1] Cartesian to Polar coordinates

$x = 35m$ $y = 50m$ $z = 10m$ (given)

Formulae for conversion:

$$\rho = \sqrt{x^2+y^2} \quad \phi = \tan^{-1}(y/x) \quad z = z$$

Applying,

$$\rho = \sqrt{35^2+50^2} = 61.0328\ m$$

$$\phi = \tan^{-1}\left(\frac{50}{35}\right) = 0.9601\ rad$$

$$z = 10m = 10\ m$$

1.2] Cartesian to spherical coordinates.

Formulae

$$r = \sqrt{x^2+y^2+z^2}$$

$$\theta = \cos^{-1}\left(\frac{z}{\sqrt{x^2+y^2+z^2}}\right)$$

$$\phi = \tan^{-1}\left(\frac{y}{x}\right)$$

Applying,

$$r = \sqrt{35^2+50^2+10^2} = 61.8466m$$

$$\theta = \cos^{-1}\left(\frac{10}{61.8466}\right) = 1.4084\ rad$$

$$\phi = \tan^{-1}\left(\frac{50}{35}\right) = 0.9601\ rad.$$

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2] 2.1] Cylindrical to Cartesian

$p = 25$, $\phi = 0.4$, $z = 35$ (given)

Formulae:

$x = p\cos\phi$, $y = p\sin\phi$, $z = z$

Applying,

$x = 25\cos(0.4) = 23.0265\ m$

$y = 25\sin(0.4) = 9.7355\ m$

$z = 35 = 35\ m$

2.2] Cylindrical to spherical

Formulae:

$r = \sqrt{p^2 + z^2}$

$\theta = \tan^{-1}\left(\frac{p}{z}\right)$

$\phi = \phi$

Applying,

$r = \sqrt{25^2 + 35^2} = 43.0116\ m$

$\theta = \tan^{-1}\left(\frac{25}{35}\right) = 0.6202\ rad$

$\phi = 0.4 = 0.4\ rad.$

3] · 3.1] Spherical to cylindrical

$r = 30$
$\theta = 0.8$ rad
$\phi = 0.4$ rad
(given)

Formulae:

$x = r\cos\phi\sin\theta$, $y = r\sin\phi\sin\theta$, $z = r\cos\theta$

Applying,

$x = 30\cos(0.8)\sin(0.4) = 19.8219\,m$

$y = 30\sin(0.8)\sin(0.4) = 8.3805\,m$

$z = 30\cos(0.4) = 20.9012\,m$

3.2] spherical to cylindrical

Formulae:

$p = r\sin\theta$, $\phi = \phi$, $z = r\cos\theta$

Applying,

$p = 30\sin(0.4) = 21.5207\,m$

$\phi = 0.8 = 0.8$ rad

$z = 30\cos(0.4) = 20.9012\,m$

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Conclusion:

From the given experiment, I was able to gain a comprehensive understanding of the interconversion between cylindrical, cartesian and spherical coordinates. Additionally, I had an opportunity to learn a new software MATLAB, and was also able to get a hands-on experien with it. The experience not only enhanc my theoretical knowledge but also develop d ~~by~~ my practical skills.