Lab1 - FoMAR

Finding angles

First of all, er have our rotation matrix. I'm calling it "my_R".

```
my_R = [0.5363 -0.3020 0.7881;0.6830 0.7039 -0.1951;-0.4958 0.6429 0.5838]
```

```
my_R = 3×3
    0.5363   -0.3020    0.7881
    0.6830    0.7039   -0.1951
   -0.4958    0.6429    0.5838
```

Now, we have to know which are the angles that meet the following equation: my_R == R1*R2*R3, being R1 for z, R2 for y, and R3 for x.

For each angle, alpha (in R1), beta (in R2) and gamma (in R3), let's find out thir values.

```
syms a a alpha; syms b a beta; syms c a gamma;

R1 = [cos(alpha) -sin(alpha) 0; sin(alpha) cos(alpha) 0; 0 0 1];
R2 = [cos(beta) 0 sin(beta); 0 1 0; -sin(beta) 0 cos(beta)];
R3 = [1 0 0; 0 cos(gamma) -sin(gamma); 0 sin(gamma) cos(gamma)];

my_R_with_angles = R1*R2*R3
```

my_R_with_angles =

$$\begin{pmatrix} \cos(\alpha)\cos(\beta) & \cos(\alpha)\sin(\beta)\sin(\gamma)-\cos(\gamma)\sin(\alpha) & \sin(\alpha)\sin(\gamma)+\cos(\alpha)\cos(\gamma)\sin(\beta) \\ \cos(\beta)\sin(\alpha) & \cos(\alpha)\cos(\gamma)+\sin(\alpha)\sin(\beta)\sin(\gamma) & \cos(\gamma)\sin(\alpha)\sin(\beta)-\cos(\alpha)\sin(\gamma) \\ -\sin(\beta) & \cos(\beta)\sin(\gamma) & \cos(\beta)\cos(\gamma) \end{pmatrix}$$

Finding β (beta)

- **For our ecuation `-sin(beta)=-0.4958`**

```
B = solve(-sin(beta) == -0.4958);
```

We see that beta can be b1 or b2

```
b1 = B(1);
b2 = B(2);
```

Conclusion: possibles values for beta

```
double(b1)
```

```
ans = 0.5188
```

```
double(b2)
```

```
ans = 2.6228
```

Finding α (alpha)

- **For our ecuation `cos(alpha)*cos(beta) == 0.5363`**

If beta is b1

We see that alfa can be b1_a1 or b1_a2

```
b1_A = solve(cos(alpha)*cos(b1) == 0.5363);
b1_a1 = b1_A(1);
b1_a2 = b1_A(2);
```

If beta is b2

We see that alfa can be b2_a1 or b2_a2

```
b2_A = solve(cos(alpha)*cos(b2) == 0.5363);
b2_a1 = b2_A(1);
b2_a2 = b2_A(2);
```

- **For our ecuation `cos(beta)*sin(alpha) == 0.6830`**

If beta is b1

We see that alfa can be b1_aa1 or b1_aa2

```
b1_AA = solve(cos(b1)*sin(alpha) == 0.6830);
b1_aa1 = b1_AA(1);
b1_aa2 = b1_AA(2);
```

If beta is b2

We see that alfa can be b2_aa1 or b2_aa2

```
b2_AA = solve(cos(b2)*sin(alpha) == 0.6830);
b2_aa1 = b2_AA(1);
b2_aa2 = b2_AA(2);
```

Conclusion: possibles values for alpha

first value:

```
b1_a1; double(b1_a1)
```

```
ans = 0.9052
```

```
b1_aa1; double(b1_aa1)
```

```
ans = 0.9051
```

second value:

```
b1_a2; double(b1_a2)
```

```
ans = -0.9052
```

```
b2_aa1; double(b2_aa1)
```

```
ans = -0.9051
```

third value:

```
b2_a1; double(b2_a1)
```

```
ans = 2.2364
```

```
b1_aa2; double(b1_aa2)
```

```
ans = 2.2365
```

forth value:

```
b2_a2; double(b2_a2)
```

```
ans = 4.0468
```

```
b2_aa1; double(b2_aa2)
```

```
ans = 4.0467
```

Then, we will be using

- b1_a1
- b1_a2
- b2_a1
- b2_a2

Finding ɣ (gamma)

```
my_R_with_angles
```

my_R_with_angles =

$$\begin{pmatrix} \cos(\alpha)\cos(\beta) & \cos(\alpha)\sin(\beta)\sin(\gamma)-\cos(\gamma)\sin(\alpha) & \sin(\alpha)\sin(\gamma)+\cos(\alpha)\cos(\gamma)\sin(\beta) \\ \cos(\beta)\sin(\alpha) & \cos(\alpha)\cos(\gamma)+\sin(\alpha)\sin(\beta)\sin(\gamma) & \cos(\gamma)\sin(\alpha)\sin(\beta)-\cos(\alpha)\sin(\gamma) \\ -\sin(\beta) & \cos(\beta)\sin(\gamma) & \cos(\beta)\cos(\gamma) \end{pmatrix}$$

```
my_R
```

```
my_R = 3×3
    0.5363   -0.3020    0.7881
    0.6830    0.7039   -0.1951
   -0.4958    0.6429    0.5838
```

- **For our ecuation `cos(beta)*sin(gamma) == 0.6429`**

If beta is b1

We see that alfa can be b1_a1 or b1_a2

```
b1_G = solve(cos(b1)*sin(gamma) == 0.6429);
b1_g1 = b1_G(1);
b1_g2 = b1_G(2);
```

If beta is b2

We see that alfa can be b2_a1 or b2_a2

```
b2_G = solve(cos(b2)*sin(gamma) == 0.6429);
b2_g1 = b2_G(1);
b2_g2 = b2_G(2);
```

- **For our ecuation `cos(beta)*cos(gamma) == 0.5838`**

If beta is b1

We see that alfa can be b1_aa1 or b1_aa2

```
b1_GG = solve(cos(b1)*cos(gamma) == 0.5838);
b1_gg1 = b1_GG(1);
b1_gg2 = b1_GG(2);
```

If beta is b2

We see that alfa can be b2_aa1 or b2_aa2

```
b2_GG = solve(cos(b2)*cos(gamma) == 0.5838);
b2_gg1 = b2_GG(1);
b2_gg2 = b2_GG(2);
```

Conclusion: possibles values for gamma

First value

```
b1_g1; double(b1_g1)
```

```
ans = 0.8335
```

```
b1_gg1; double(b1_gg1)
```

```
ans = 0.8336
```

Second value

```
b1_g2; double(b1_g2)
```

```
ans = 2.3081
```

```
b2_gg1; double(b2_gg1)
```

```
ans = 2.3080
```

Third value

```
b2_g1; double(b2_g1)
```

```
ans = -0.8335
```

```
b1_gg2; double(b1_gg2)
```

```
ans = -0.8336
```

Forth value

```
b2_g2; double(b2_g2)
```

```
ans = 3.9751
```

```
b2_gg2; double(b2_gg2)
```

```
ans = 3.9752
```

Then, we will be using

- b1_g1
- b1_g2
- b2_g1
- b2_g2

Conclusion

If we use b1

For the value beta =

```
b1
```

```
b1 =
```

$$\mathrm{asin}\left(\frac{2479}{5000}\right)$$

We can use either of these alfas

```
b1_a1
```

```
b1_a1 =
```

$$\mathrm{acos}\left(\frac{5363\,\sqrt{2094951}}{12569706}\right)$$

```
b1_a2
```

```
b1_a2 =
```

$$-\mathrm{acos}\left(\frac{5363\,\sqrt{2094951}}{12569706}\right)$$

and either of this gammas

```
b1_g1
```

b1_g1 =

$$\operatorname{asin}\left(\frac{2143\sqrt{2094951}}{4189902}\right)$$

```
b1_g2
```

b1_g2 =

$$\pi - \operatorname{asin}\left(\frac{2143\sqrt{2094951}}{4189902}\right)$$

If we use b2

For the value beta =

```
b2
```

b2 =

$$\pi - \operatorname{asin}\left(\frac{2479}{5000}\right)$$

We can use either of these alfas

```
b2_a1
```

b2_a1 =

$$\pi - \operatorname{acos}\left(\frac{5363\sqrt{2094951}}{12569706}\right)$$

```
b2_a2
```

b2_a2 =

$$\pi + \operatorname{acos}\left(\frac{5363\sqrt{2094951}}{12569706}\right)$$

and either of this gammas

```
b2_g1
```

b2_g1 =

$$-\operatorname{asin}\left(\frac{2143\sqrt{2094951}}{4189902}\right)$$

```
b2_g2
```

b2_g2 =

$$\pi + \operatorname{asin}\left(\frac{2143\sqrt{2094951}}{4189902}\right)$$

For comodity, we will use these:

- beta

```
b1
```

b1 =

$$\mathrm{asin}\left(\frac{2479}{5000}\right)$$

```
double(b1)
```

ans = 0.5188

- alpha

```
b1_a1
```

b1_a1 =

$$\mathrm{acos}\left(\frac{5363\ \sqrt{2094951}}{12569706}\right)$$

```
double(b1_a1)
```

ans = 0.9052

- gamma

```
b1_g1
```

b1_g1 =

$$\mathrm{asin}\left(\frac{2143\ \sqrt{2094951}}{4189902}\right)$$

```
double(b1_g1)
```

ans = 0.8335