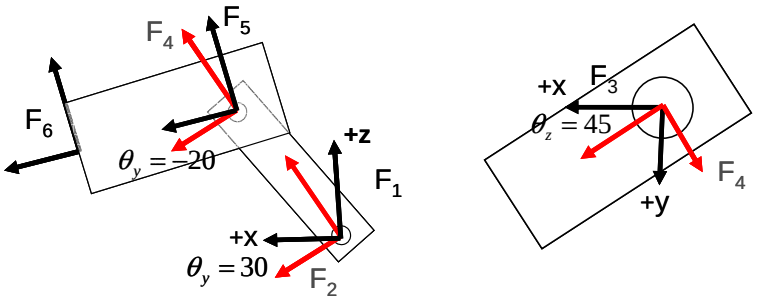
CSE 398/498 Robocup

Solutions to Homework 1:

I have decomposed the problem into 6 coordinate frames. You may have combined translations and rotations. That is fine, but I am going for as clear a presentation as possible. Hopefully this helps. My body coordinate frame is with respect to the axes labeled +x,+y,+z. The red is just for legibility.



Side View Top View

The camera frame is the 6th frame, in which the coordinates of the ball (with units as cm) are

$$ {}^{6}p = \begin{bmatrix} 100 \\ 0 \\ 0 \\ 1 \end{bmatrix} $$

We first write the transformation for the translation along the head 8 cm

$$ {}^{5}A_{6} = \begin{bmatrix} 1 & 0 & 0 & 8 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

Going from the head joints to the head frame we have

$$ {}^{4}A_{5} = \begin{bmatrix} \cos(-20) & 0 & \sin(-20) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(-20) & 0 & \cos(-20) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

for the head nod and

$$ {}^{3}A_{4} = \begin{bmatrix} \cos(45) & -\sin(45) & 0 & 0 \\ \sin(45) & \cos(45) & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

for the head pan. Next we add in the translation for the neck

$$ {}^{3}A_{2} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

and the rotation of the neck joint

$$ {}^{1}A_{2} = \begin{bmatrix} \cos(30) & 0 & \sin(30) & 0 \\ 0 & 1 & 0 & 0 \\ -\sin(30) & 0 & \cos(30) & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

We can now compose all of these frames to get the position of the ball in the camera frame

$$ {}^{1}p = {}^{1}A_{2}\,{}^{2}A_{3}\,{}^{3}A_{4}\,{}^{4}A_{5}\,{}^{5}A_{6}\,{}^{6}p $$

which according to my Matlab run yields:

```
>> A5_6 = homogTrans([0 0 0],[8 0 0])

A5_6 =

    1    0    0    8
    0    1    0    0
    0    0    1    0
    0    0    0    1

>> A4_5 = homogTrans([0 -pi/9 0],[0 0 0])

A4_5 =

    0.9397         0   -0.3420         0
         0    1.0000         0         0
    0.3420         0    0.9397         0
```

```
         0         0         0    1.0000
```

```
>> A3_4 = homogTrans([0 0 pi/4],[0 0 0])

A3_4 =

    0.7071   -0.7071         0         0
    0.7071    0.7071         0         0
         0         0    1.0000         0
         0         0         0    1.0000
```

```
>> A2_3 = homogTrans([0 0 0],[0 0 8])

A2_3 =

     1     0     0     0
     0     1     0     0
     0     0     1     8
     0     0     0     1
```

```
>> A1_2 = homogTrans([0 pi/6 0],[0 0 0])

A1_2 =

    0.8660         0    0.5000         0
         0    1.0000         0         0
   -0.5000         0    0.8660         0
         0         0         0    1.0000
```

```
>> p6 = [100 0 0 1]'

p6 =

   100
     0
     0
     1
```

```
>> p1 = A1_2*A2_3*A3_4*A4_5*A5_6*p6

p1 =

   84.6168
   71.7620
    3.0366
    1.0000
```