Practice Set 3

Robotics & Automation
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Using your textbook and what we covered in lecture, try solving the following problems. For some problems you may find it convenient to use Matlab (or another programming language of your choice). The solutions are on the next page.

Problem 1

Program the following functions. Here `rotx(`θ`)` means we rotate around the x-axis by θ radians. You will find these functions helpful in future assignments:

- `R = rotx(`θ`)`
- `R = roty(`θ`)`
- `R = rotz(`θ`)`

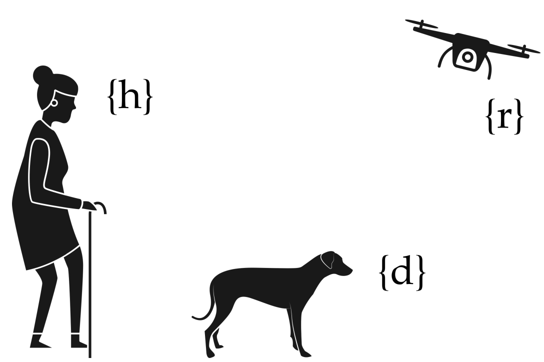
Problem 2

Use your functions to multiply the following rotation matrices:

$$\texttt{rotx}(1.8)*\texttt{roty}(0.3)*\texttt{rotz}(-2.1) \tag{1}$$

Double check that the result is a rotation matrix.

Problem 3



We know the orientation of the dog relative to the human, R_{hd}, and the orientation of the robot relative to the human, R_{hr}.

- Find the orientation of the dog relative to the robot using R_{hd} and R_{hr}.

Problem 1

Here are my implementations in Matlab:

```
function R = rotx(theta)

    R = [1 0 0;
        0 cos(theta) -sin(theta);
        0 sin(theta) cos(theta)];

end
```

```
function R = roty(theta)

    R = [cos(theta) 0 sin(theta);
        0 1 0;
        -sin(theta) 0 cos(theta)];

end
```

```
function R = rotz(theta)

    R = [cos(theta) -sin(theta) 0;
        sin(theta) cos(theta) 0;
        0 0 1];

end
```

Problem 2

Use your functions to multiply the following rotation matrices:

$$\texttt{rotx}(1.8)*\texttt{roty}(0.3)*\texttt{rotz}(-2.1) \tag{2}$$

Double check that the result is a rotation matrix.

Using the functions implemented above:

$$R = \begin{bmatrix} -0.482 & 0.825 & 0.296 \\ 0.051 & 0.363 & -0.930 \\ -0.875 & -0.434 & -0.217 \end{bmatrix} \tag{3}$$

To double check this, you can show that $R^T R = I$ and $\det(R) = +1$.

Problem 3

We know the orientation of the dog relative to the human, R_{hd}, and the orientation of the robot relative to the human, R_{hr}.

- Find the orientation of the dog relative to the robot using R_{hd} and R_{hr}.

We are given R_{hd} and R_{hr}. We want to find R_{rd}, the orientation of the dog relative to the robot. Using the subscript cancellation rule, we have that:

$$R_{rd} = R_{rh} R_{hd} \tag{4}$$

Although this is correct, we do not have R_{rh}. Remember that $R_{hr}^T = R_{rh}$, i.e., transposing a rotation matrix switches the frame of reference:

$$R_{rd} = R_{hr}^T R_{hd} \tag{5}$$