CS 309: Autonomous Robots
FRI I

Eigen

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The Eigen Library

Eigen is a matrix math library

You will use it for

- Matrices
- Quaternions & rotations
- Matrix multiplication and addition

MatrixXd

Eigen provides a very general way to represent matrices

MatrixXd

- The type is Matrix
  - Eigen also supports vectors, quaternions, rotations
- X means that it can have an arbitrary number of rows and columns
- d means that the data is stored as doubles

Let’s make a point!

```
Eigen::MatrixXd p(3,1)


p(0,0) = x;
p(0,1) = y;
p(0,2) = z;
```

Let’s perform a translation

```
Eigen::MatrixXd t(3,1)


t(0,0) = x;
t(0,1) = y;
t(0,2) = z;


Eigen::MatrixXd pTranslated(3,1) = p + t;
```

Rotations using quaternions

```
Eigen::Quaterniond r(w,x,y,z);
Eigen::MatrixXd rotatedP = r.matrix() * p;
```

Note that ROS represents pose and transform quaternions as x,y,z,w

Eigen uses w,x,y,z

If you mess it up on your homework, the result will be incorrect, so double-check!

Rotations using axis and angle

Axis and angle allows us to choose a rotational axis to rotate about

We are not constrained to X, Y, Z

We can choose arbitrary vectors to rotate around

```
Eigen::MatrixXd yAxis(3,1);
yAxis(0,0) = 0;
yAxis(1,0) = 1;
yAxis(2,0) = 0;
Eigen::AngleAxisd rY(angleInRadians, yAxis);
Eigen::MatrixXd rotatedP = rY.toRotationMatrix() * P;
```

Most people find this easier to understand than directly manipulating quaternions, and I would recommend using AngleAxis when possible on your homework.

Do not, however, confuse the axis and angle representation for quaternions. They are different. Always be sure which representation you are using!

Rotating and then rotating

You can compose two rotations together by multiplication, and Eigen will allow you to combine the rotational types.

Eigen::Quaterniond r...
Eigen::AngleAxisd rY…
Eigen::Quaterniond rComposed = rY * r

Note that these multiplications do not commute in the general case!

Order matters!

If your homework does not work as expected, check the order of your operations.

Distal to proximal.