EECS 442 Discussion

Arash Ushani

September 16, 2015

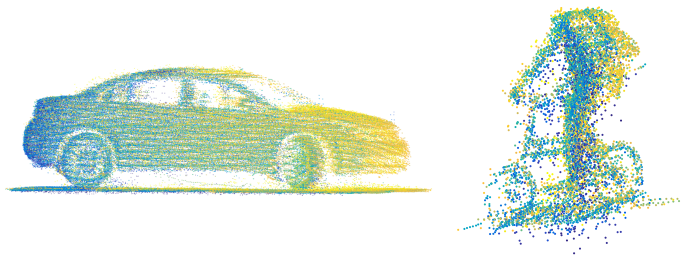# About Me

- GSI: Arash Ushani (aushani@umich.edu)
- 3rd year PhD student in Perceptual Robotics Lab (PeRL)
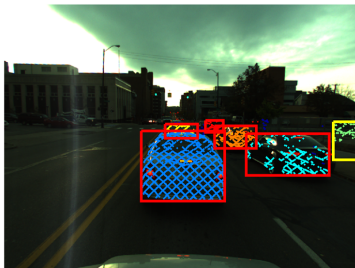- `http://robots.engin.umich.edu`

Autonomous Cars!

My Research

- Autonomous vehicles
- Obstacle detection and tracking

My 442 Project

- Turn signal and stop light detection aided by LIDAR point clouds
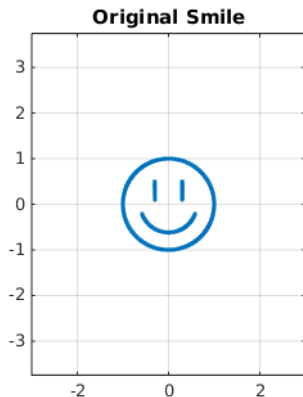
Logistics

- Please use Piazza for questions regarding the course or material (no technical questions via email)
- If you have topics/questions you want to go over in discussion, please post them in Piazza
- Professor Office Hours Mondays 3-4 PM in NAME 201
- GSI Office Hours Tuesdays 2-3 PM in EECS 2420

Rigid Body Transform (RBT)

- What is a rigid body transform?
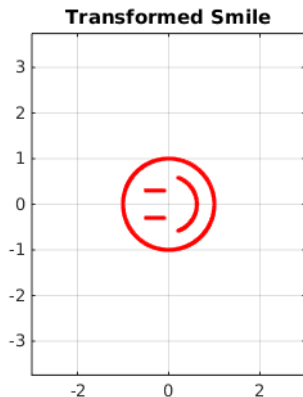
Scaling

- How do we scale a vector?

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Example: scale vector by 2

$$x = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$\mathbf{T} = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

$$\mathbf{T}x = \begin{bmatrix} 2 \\ 4 \end{bmatrix}$$

Rotation

- How do we rotate a vector?

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Example: rotate vector by $90°$

$$x = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$\mathbf{T} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$

$$\mathbf{T}x = \begin{bmatrix} -2 \\ 1 \end{bmatrix}$$

Translation

- How do we translate a vector?

Translation

- How do we translate a vector?
- Need to use homogeneous coordinates!

- $\begin{bmatrix} x \\ y \end{bmatrix}$ is represented by $\begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$

- $\begin{bmatrix} x \\ y \\ z \end{bmatrix}$ is converted back by doing $\begin{bmatrix} x/z \\ y/z \end{bmatrix}$

Translation

- How do we translate a vector?
- Need to use homogeneous coordinates!
- $\begin{bmatrix} x \\ y \end{bmatrix}$ is represented by $\begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$
- $\begin{bmatrix} x \\ y \\ z \end{bmatrix}$ is converted back by doing $\begin{bmatrix} x/z \\ y/z \end{bmatrix}$
- $\mathbf{T} = \begin{bmatrix} 1 & 0 & t_x \\ 0 & 1 & t_y \\ 0 & 0 & 1 \end{bmatrix}$

Translation

Example: translate vector by $(3, 4)$

$$x = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \tilde{x} = \begin{bmatrix} 1 \\ 2 \\ 1 \end{bmatrix}$$

$$\mathbf{T} = \begin{bmatrix} 1 & 0 & 3 \\ 0 & 1 & 4 \\ 0 & 0 & 1 \end{bmatrix}$$

$$\mathbf{T}\tilde{x} = \begin{bmatrix} 4 \\ 6 \\ 1 \end{bmatrix}$$

Combinations

- Let's rotate and scale

Example: scale vector by 2 and then rotate by $90°$

$$x = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$$

$$\mathbf{R} = \begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$$

$$\mathbf{S} = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}$$

$$\mathbf{T} = \mathbf{RS}$$

$$\mathbf{T}x = \mathbf{RS}x = \begin{bmatrix} -4 \\ 2 \end{bmatrix}$$

MATLAB Exercise

- Go to CTools → Resources → Discussion → 09-16_matlab.zip