

Exploring with Autonomous Vehicles

October 10th - November 14th, 2020

FEMMES & MEGC Workshop

University of Michigan, Ann Arbor

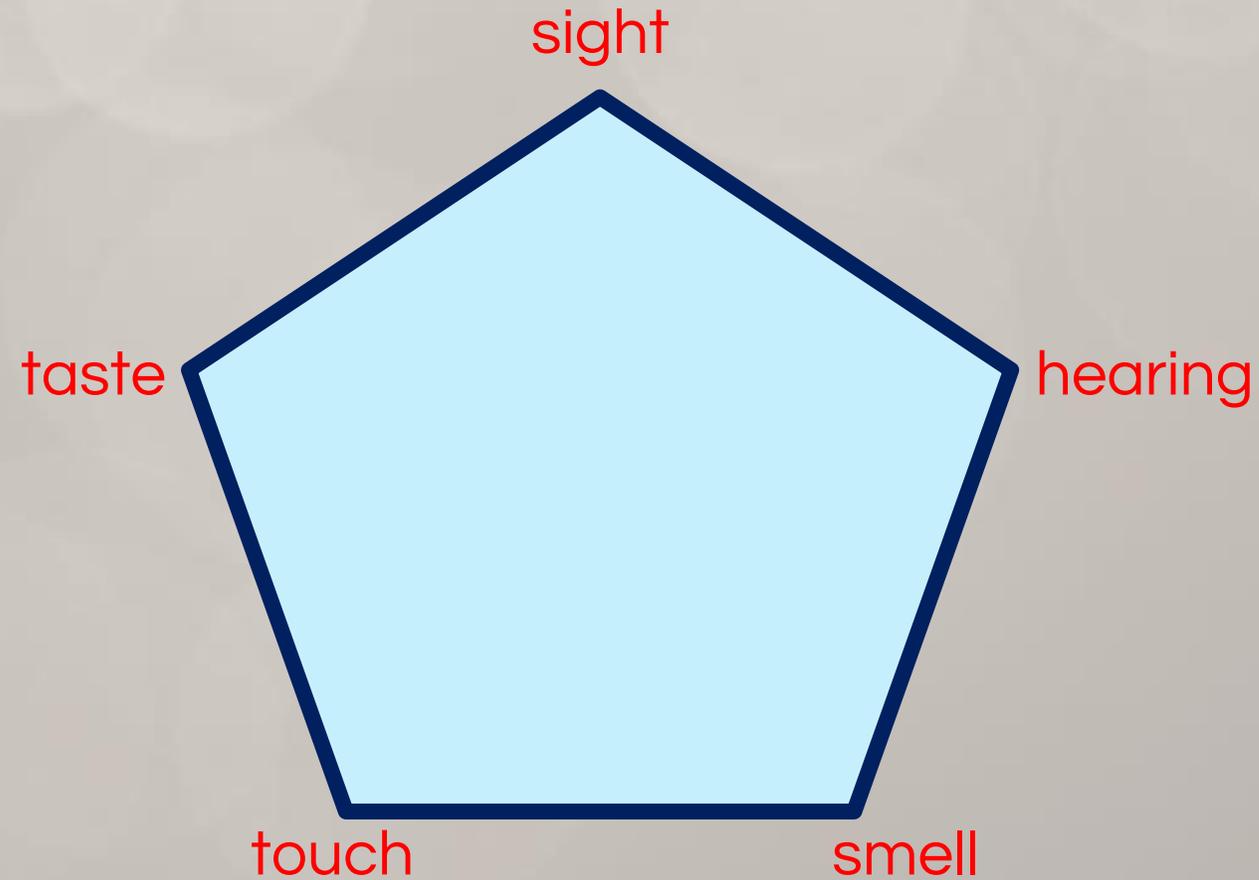


**How do humans
drive cars?**



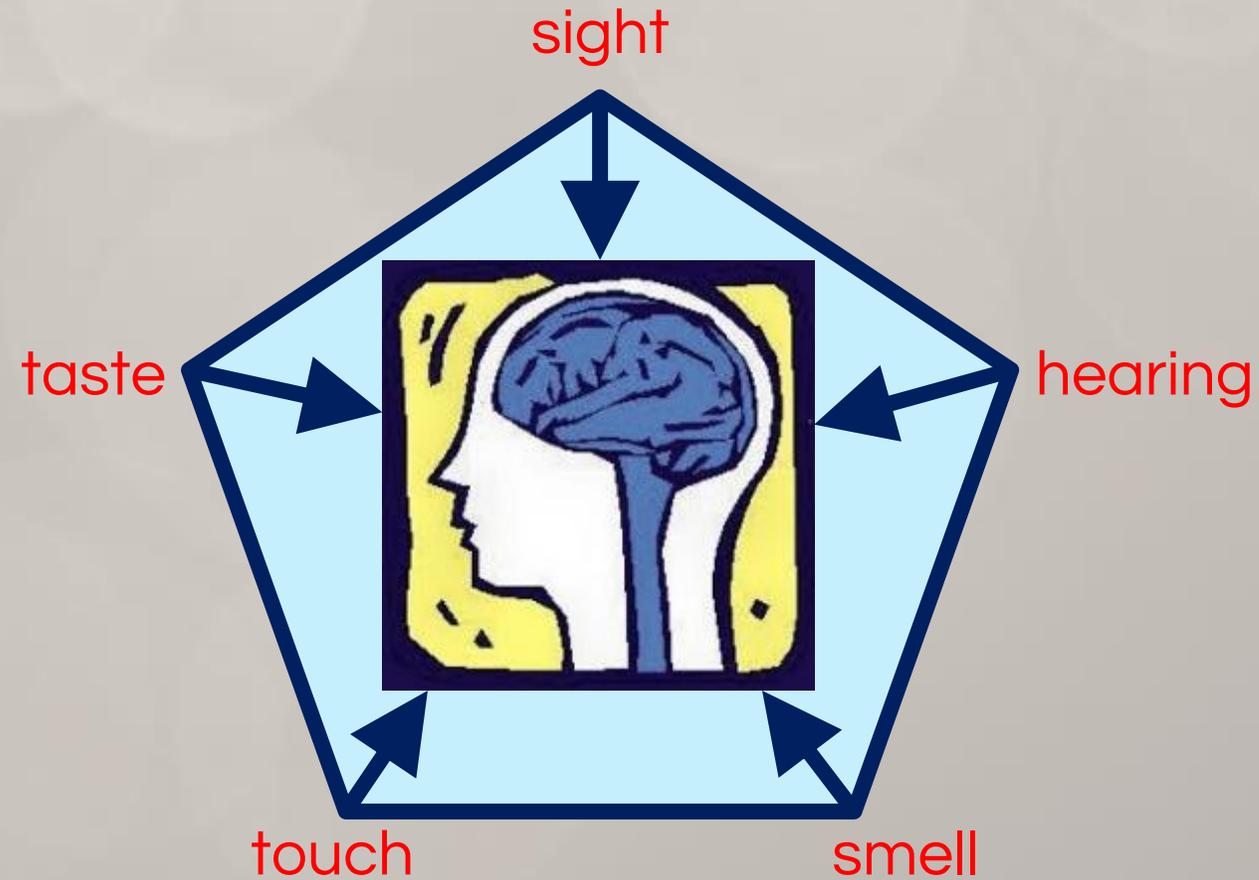
Sensing

5 senses in the human body



Sensing and perceiving

5 senses in the human body + *one computer*



Sensing and perceiving

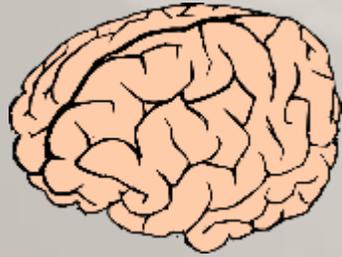
Sensing is taking in information about the world
size, shape, hue, range, texture, brightness, intensity

Perceiving is understanding that information
“red apple”, “moving car”, “fluffy dog”

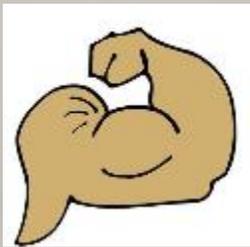


How Humans Navigate

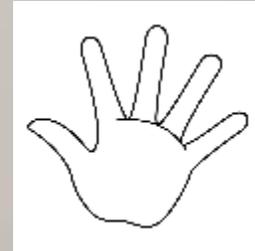
Computer



Muscles



Sensors



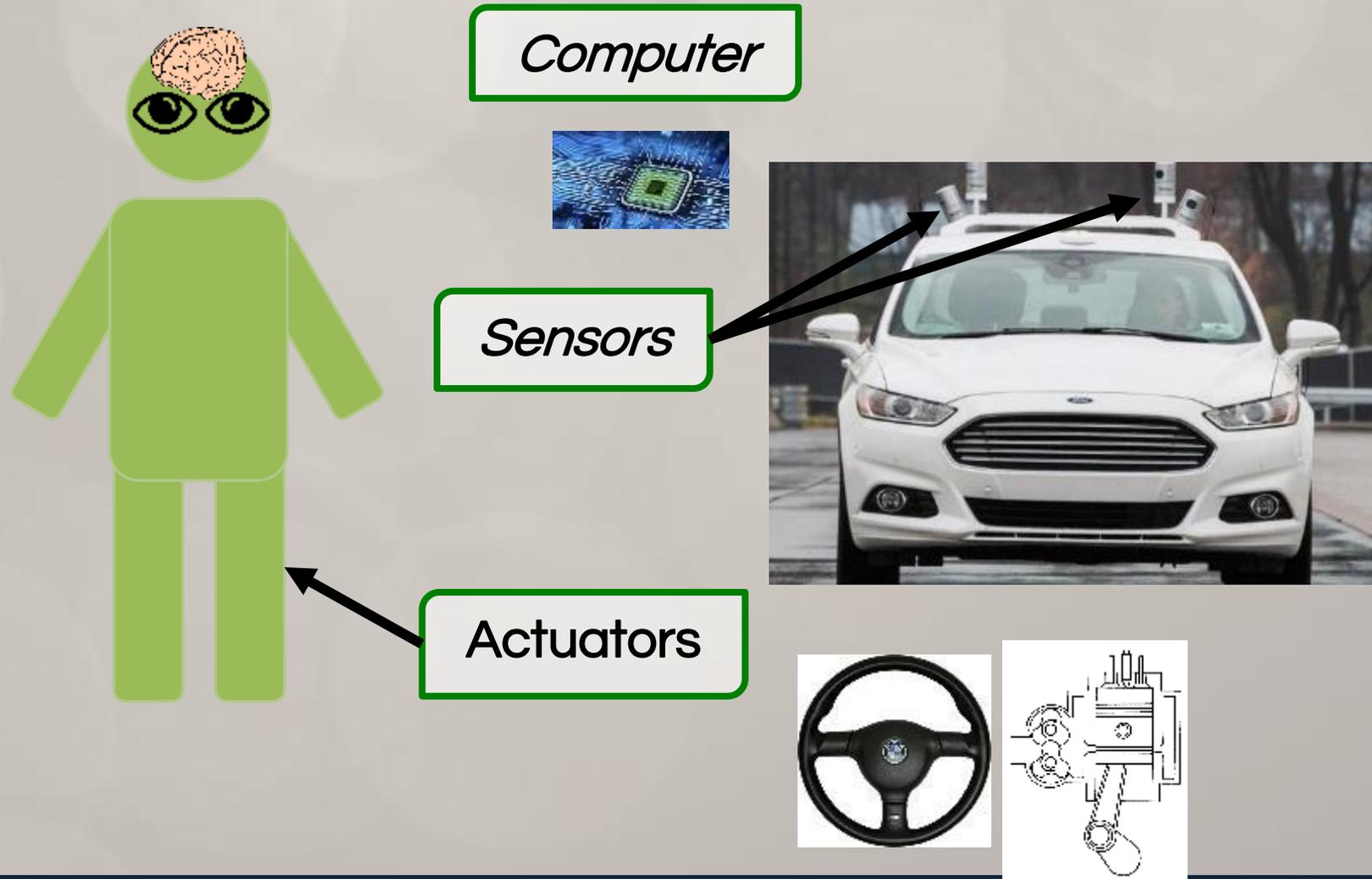
How can cars
drive themselves?



To make decisions about the world, driverless cars need to know what's around them



Driverless Cars are (sort of) like you and me...



Sensing and perceiving

Driverless Cars *sense* with laser, radar, sonar, and cameras



They *perceive* thanks to complex algorithms that allow their "brains" to understand input from the sensors

[Autonomous cars in action!](#)

Meet Edison

Edison has sensors to help it see and actuators to help it move

Computer
(Brain)



Wheels
(Muscles)

Line
Tracking
Sensor

Our job is to teach the brain!



Introduction to EdScratch

Programming with EdScratch is how we tell Edison what to do
Follow along at edscratchapp.com

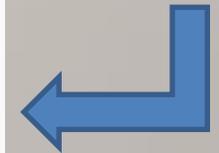
Block
Categories



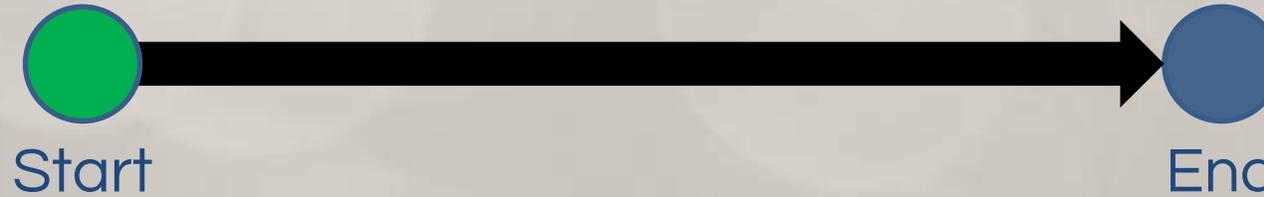
Blocks
(Drag and drop)

The screenshot shows the EdScratch programming environment. At the top, there is an orange header with a 'Menu' icon and a 'Save' button. Below the header, the interface is divided into three main sections. On the left is a 'Block Categories' sidebar with a grid of colored circles and labels: Drive (blue), LEDs (purple), Sound (pink), Data (orange), Events (yellow), Control (orange), Sensing (light blue), Operators (green), and Comment (pink). Below this grid is a 'Blocks' section containing two blue blocks: 'forwards for 1 cm at speed 5' and 'backwards for 1 cm at speed 5'. The central workspace shows a 'Start' block (yellow) followed by a 'forwards for 10 cm at speed 5' block (blue). On the right side, there is a 'Program' label with a blue arrow pointing to the workspace.

Program



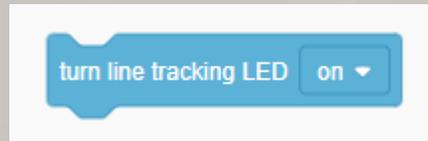
First activity: Line Following



Helpful Code Blocks:



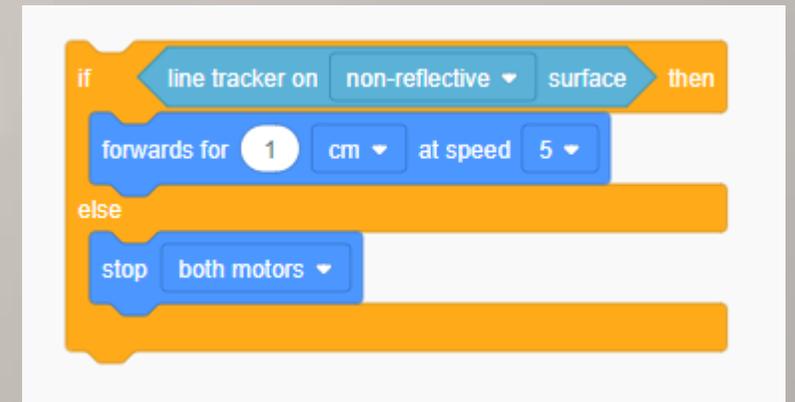
Start block



Turn on line sensor (Sensing category)

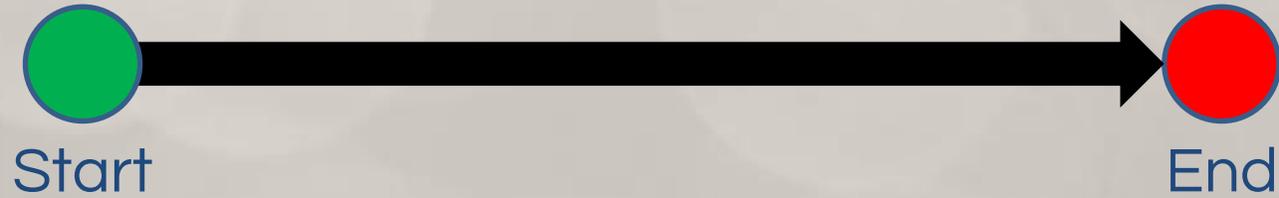


Repeat block (Control category)



Move one step forward along line

First activity: Line Following



One Solution

```
Start
turn line tracking LED on
forever
  if line tracker on non-reflective surface then
    forwards for 1 cm at speed 5
  else
    stop both motors
```

The code block is a Scratch script for line following. It begins with a "Start" block, followed by a "turn line tracking LED on" block. A "forever" loop contains an "if-then-else" structure. The "if" condition is "line tracker on non-reflective surface". If true, the robot moves "forwards for 1 cm at speed 5". If false, the robot "stop both motors".

Second activity: Obstacle Avoidance



Helpful Code Blocks:

```
turn obstacle detection beam on
clear obstacle detector sensor data
turn line tracking LED on
```

Turn on line and obstacle sensors

```
if obstacle detected ahead then
else
```

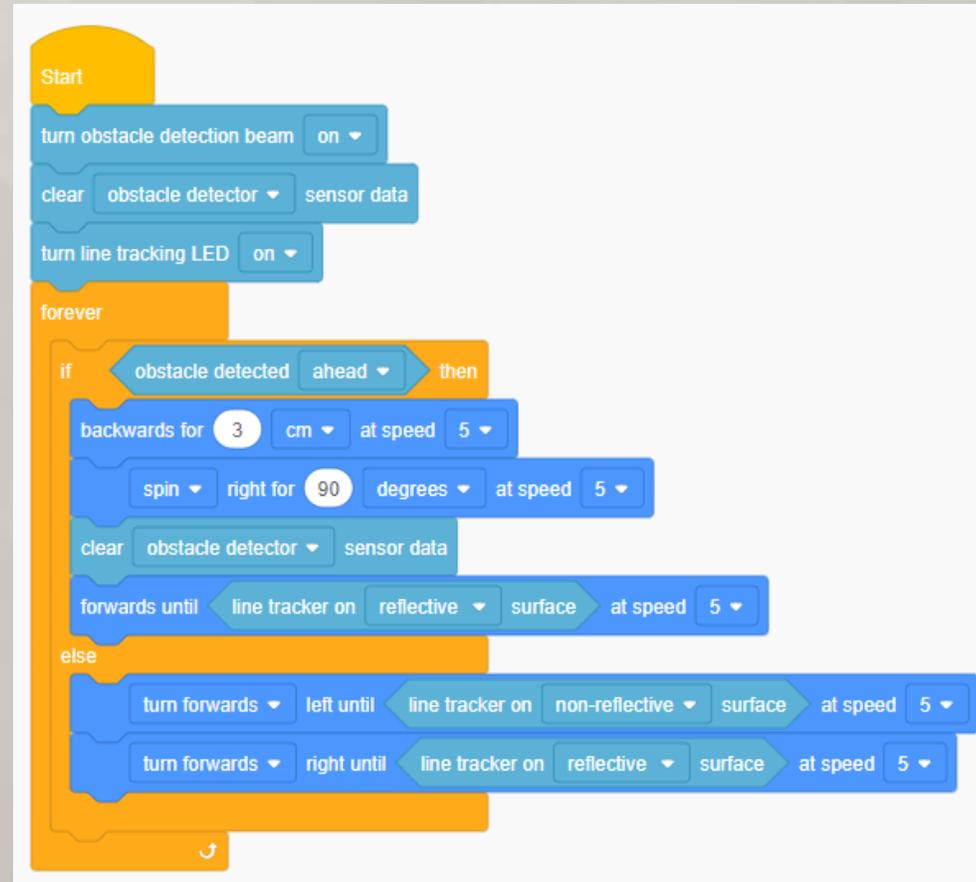
Check for obstacles

```
spin right for 90 degrees at speed 5
clear obstacle detector sensor data
forwards until line tracker on reflective surface at speed 5
```

Change into right lane

Second activity: Obstacle Avoidance

One Solution



Thank You!
Questions?



Back Up Slides:
But...How do real Driverless
Cars do it?



Decision-making and actuation

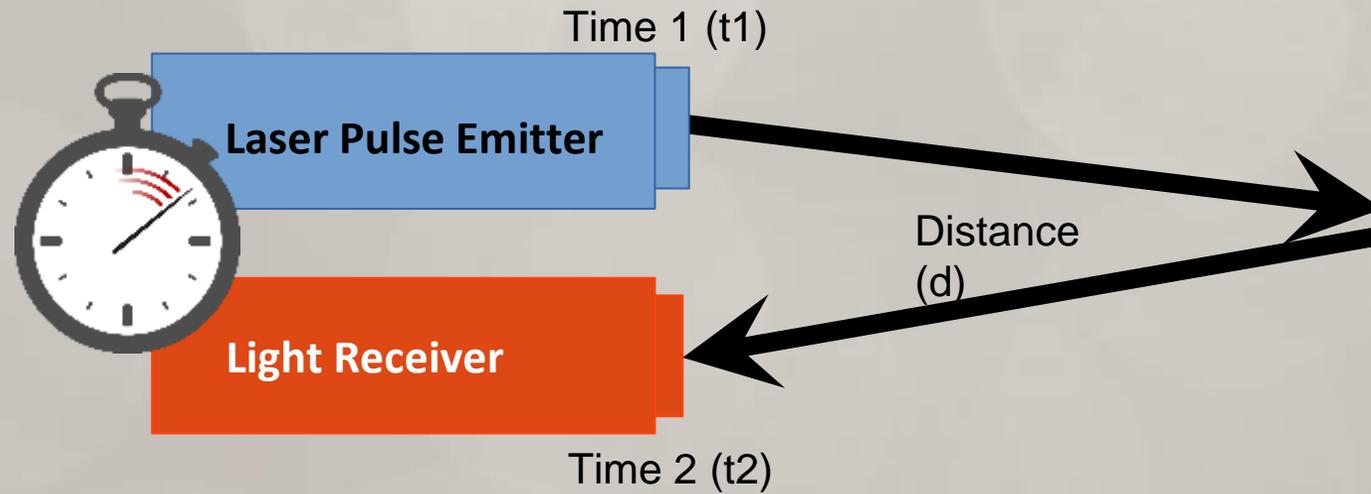
Engineers use simple algorithms as building blocks for more complicated programs



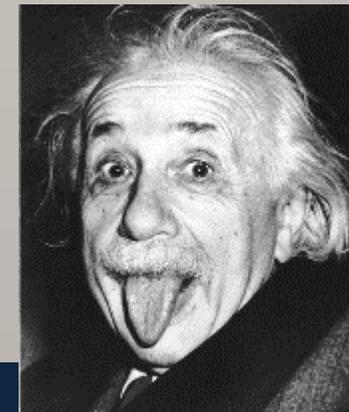
Lasers in the Real World



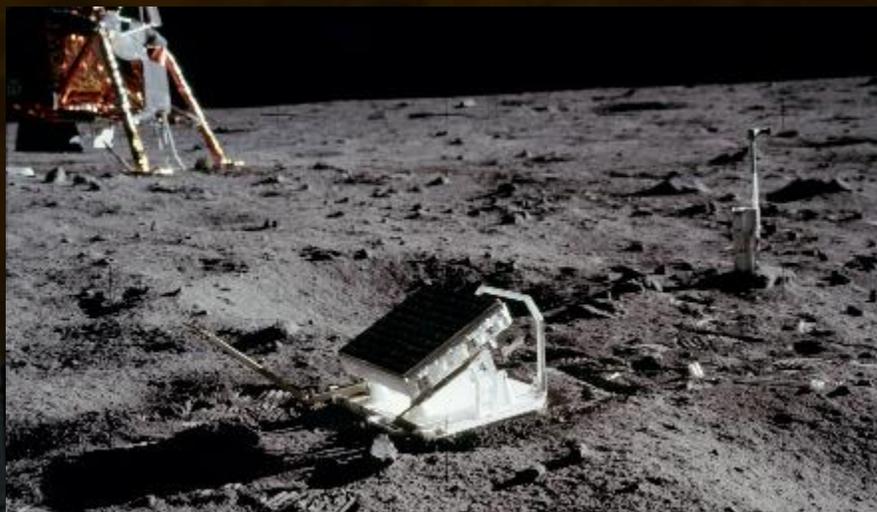
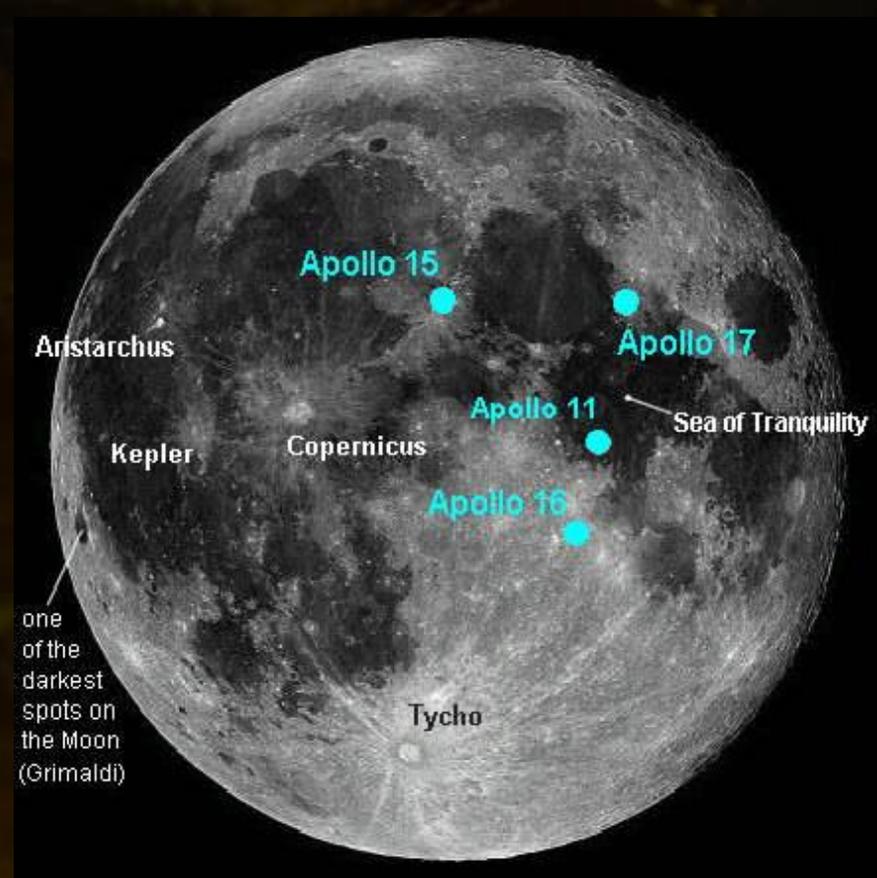
Laser Range Sensors



$$d = \frac{1}{2} \frac{t_2 - t_1}{c}$$



Lunar Laser Ranging Experiment



Planar Lidar

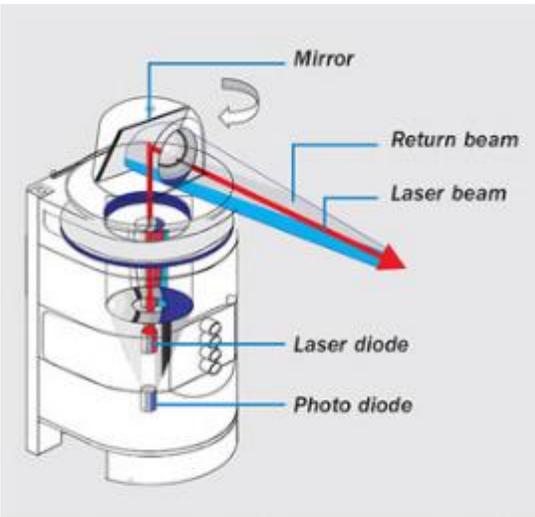
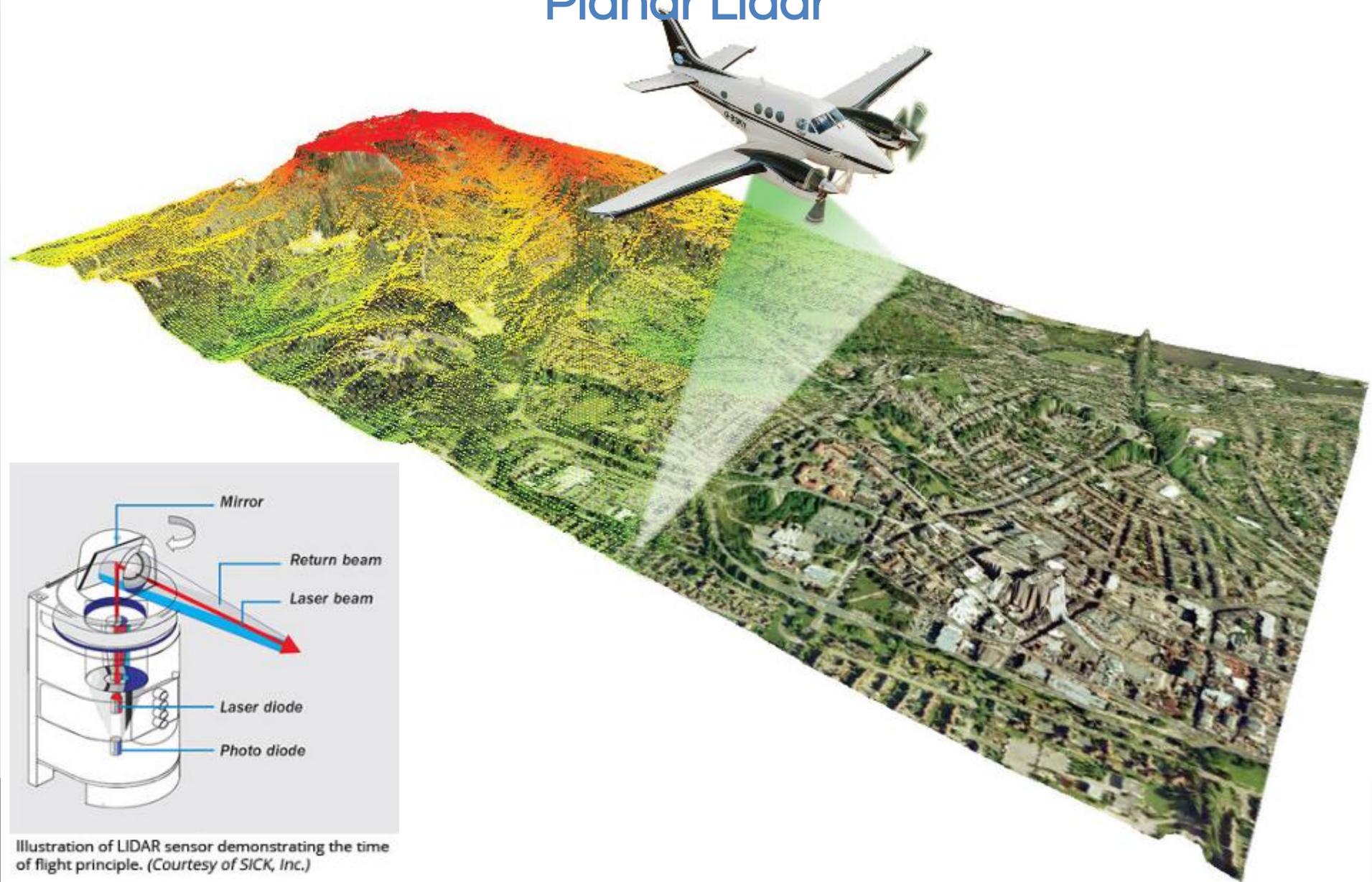


Illustration of LIDAR sensor demonstrating the time of flight principle. (Courtesy of SICK, Inc.)

3D Lidar

