

# Exploring with Autonomous Vehicles

October 10<sup>th</sup> - November 14<sup>th</sup>, 2020  
FEMMES & MEGC Workshop  
University of Michigan, Ann Arbor

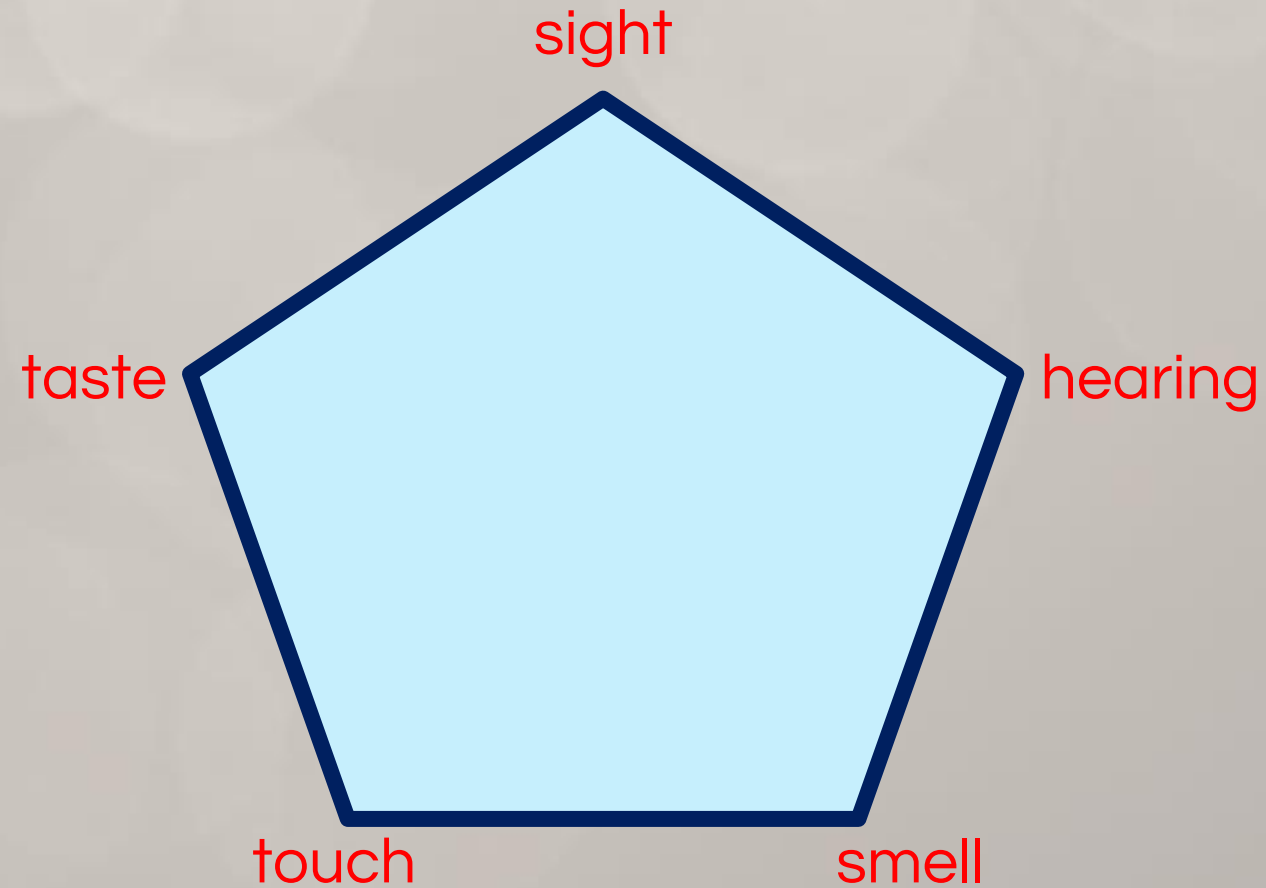


**How do humans  
drive cars?**



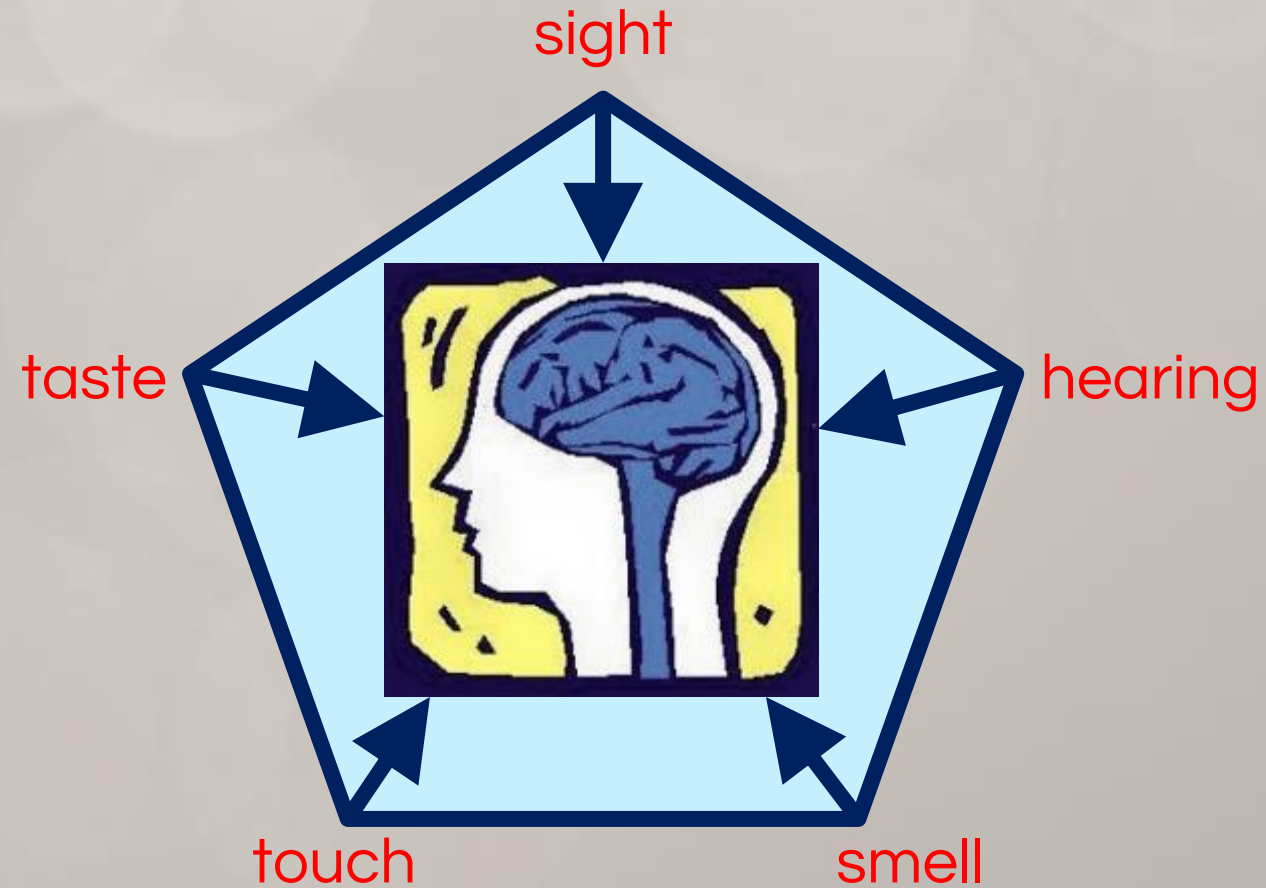
# Sensing

5 senses in the human body



# Sensing and perceiving

5 senses in the human body + *one computer*



## Sensing and perceiving

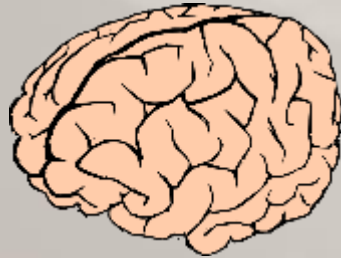
**Sensing is taking in information about the world**  
*size, shape, hue, range, texture, brightness, intensity*

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



# How Humans Navigate

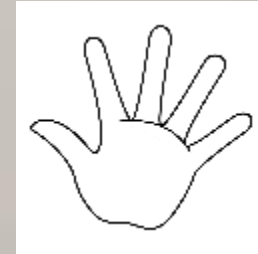
*Computer*



*Muscles*



*Sensors*



How can cars  
drive themselves?

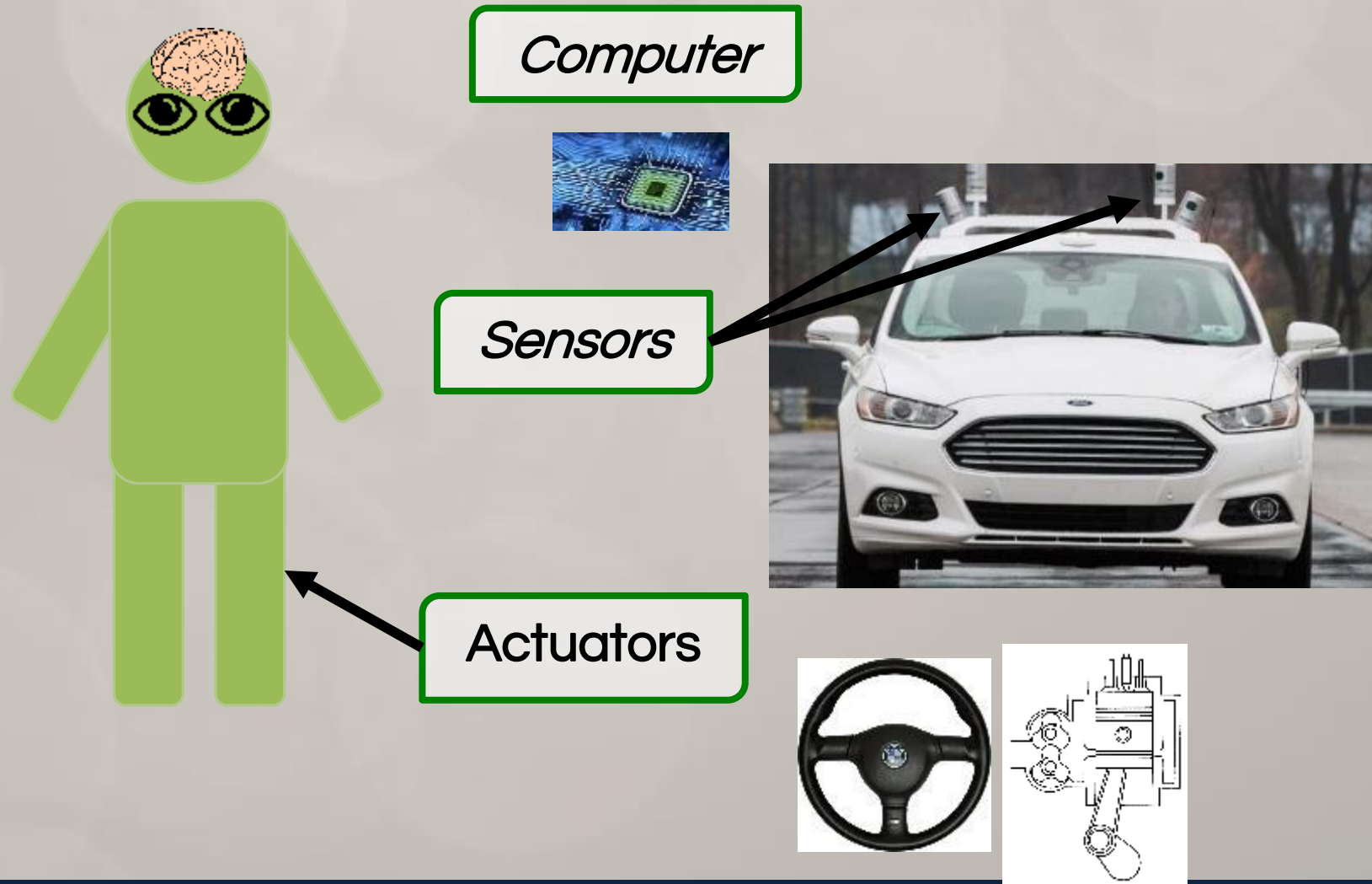


To make decisions about the world, driverless cars need to know what's around them





# 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

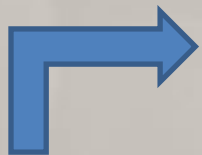
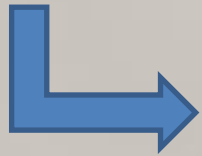
Our job is to teach the brain!



# Introduction to EdScratch

Programming with EdScratch is how we tell Edison what to do  
Follow along at [edscratchapp.com](https://edscratchapp.com)

Block  
Categories



Blocks

(Drag and drop)

Menu Save

Drive LEDs Sound Data Events Control Sensing Operators Comment

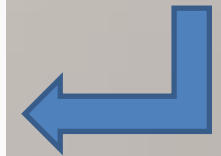
forwards for 1 cm at speed 5

backwards for 1 cm at speed 5

Start

forwards for 10 cm at speed 5

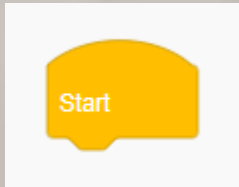
Program



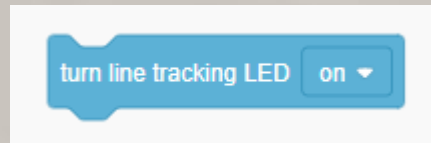
# First activity: Line Following



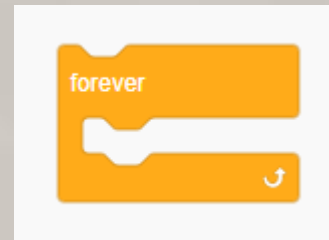
## Helpful Code Blocks:



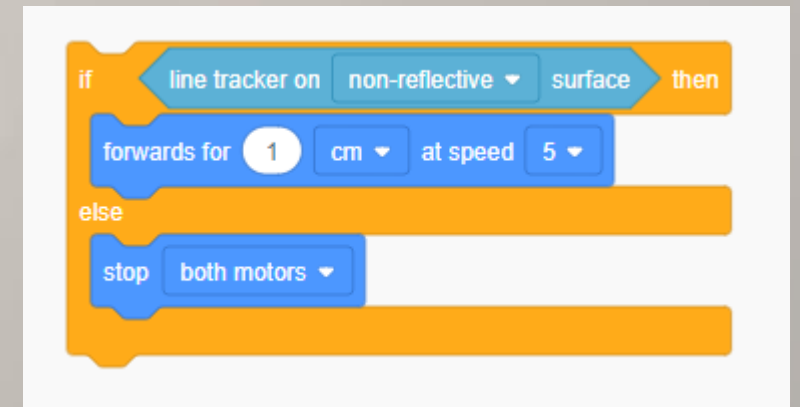
Start block



Turn on line sensor (Sensing category)

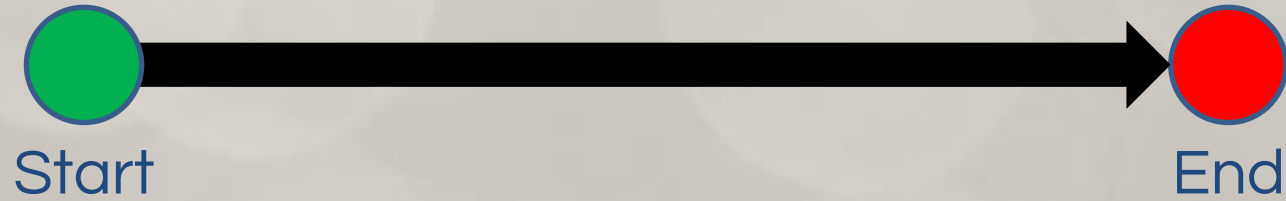


Repeat block (Control category)



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
```

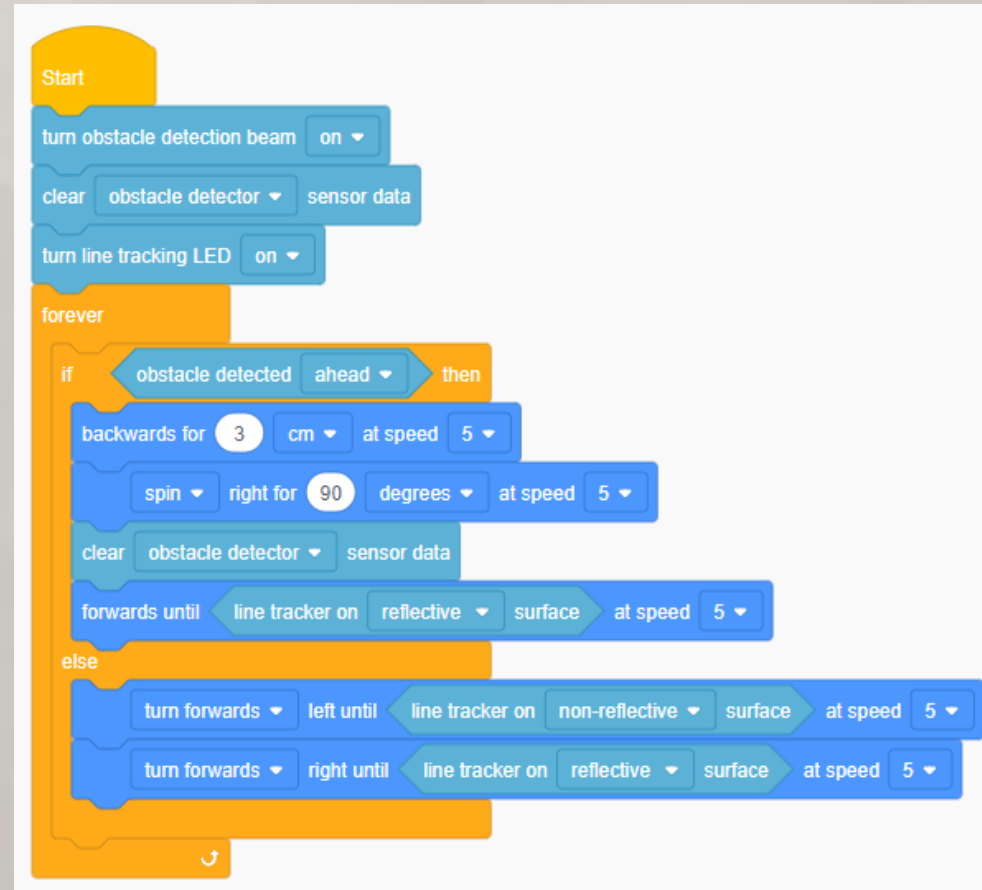
Check for obstacles

```
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

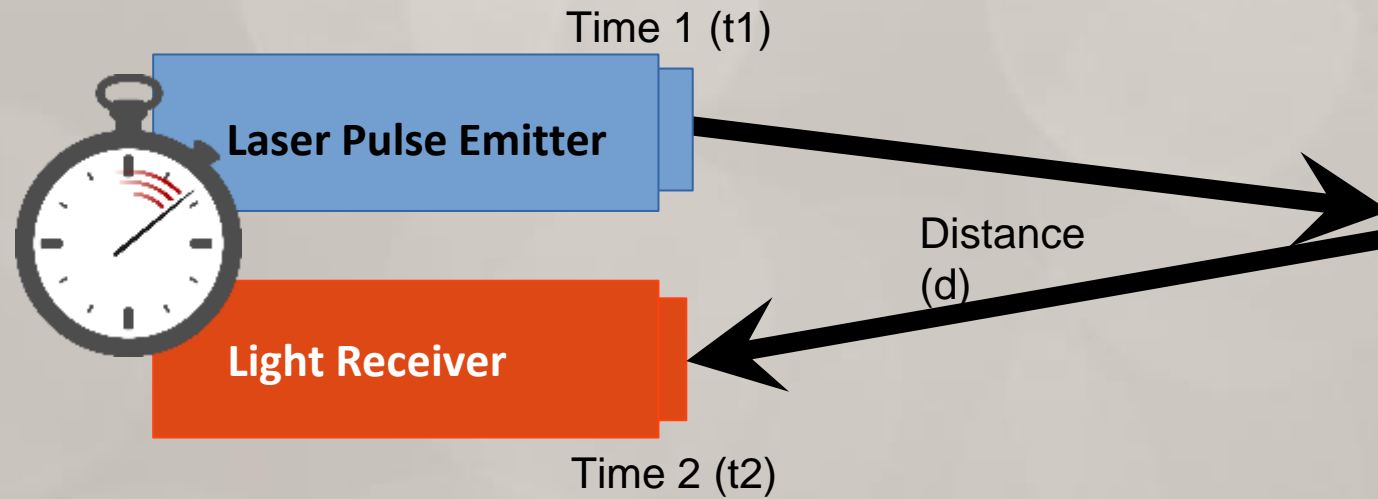
Engineers use simple algorithms as building blocks for more complicated programs



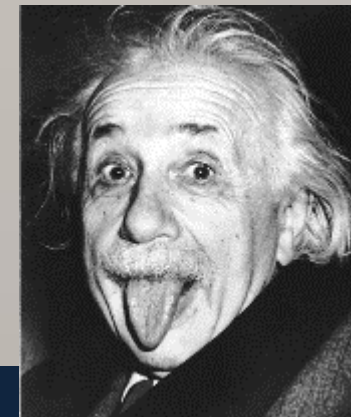
# Lasers in the Real World



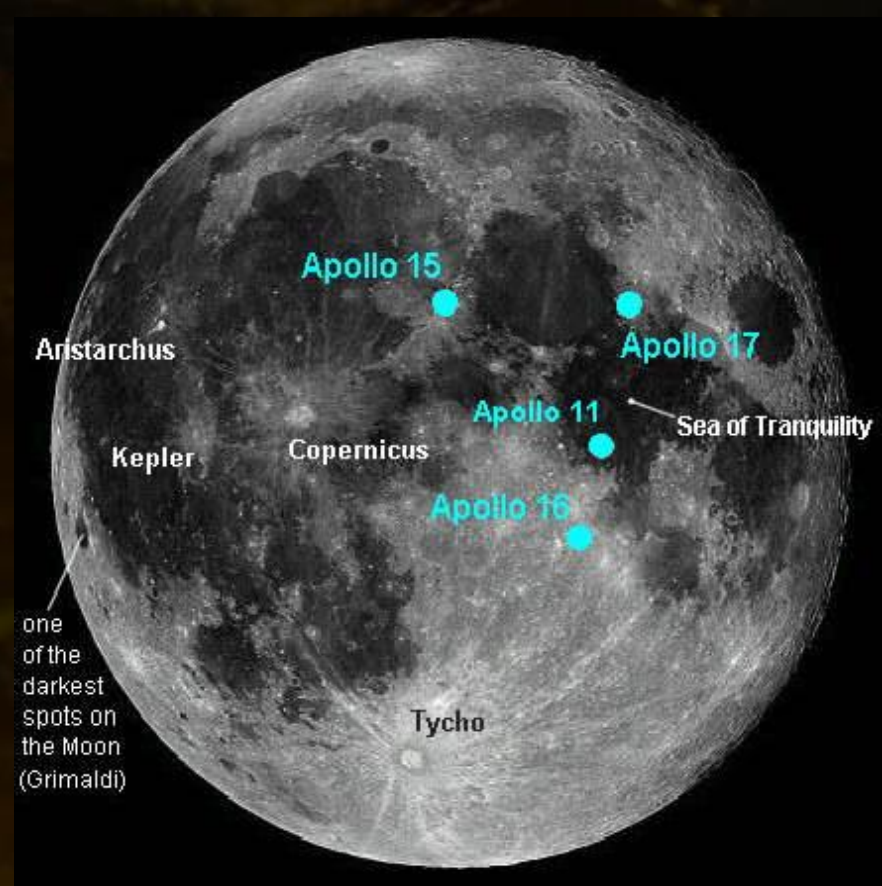
# Laser Range Sensors



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



# Lunar Laser Ranging Experiment



# Planar Lidar

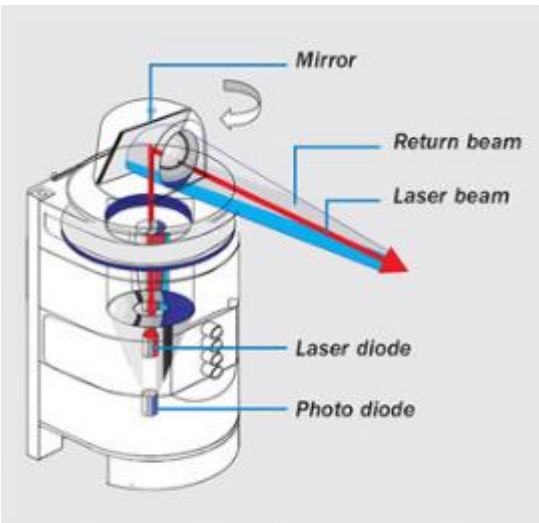
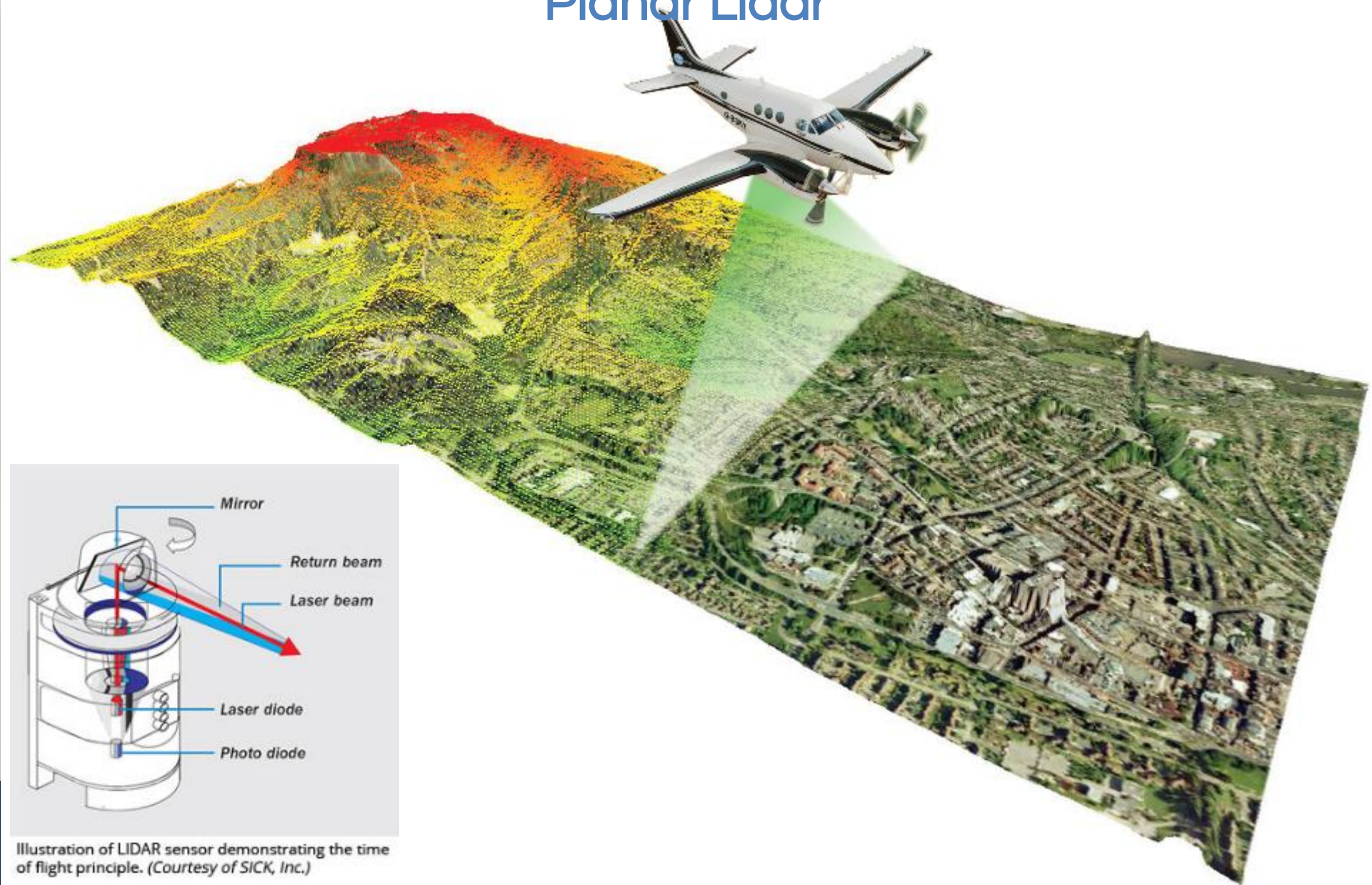


Illustration of LIDAR sensor demonstrating the time of flight principle. (Courtesy of SICK, Inc.)

# 3D Lidar

