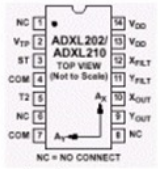
EXPLORE ROBOTICS – CISC 1003

EXPLORING ROBOTICS – UNIT C

Sensors

Sensors



Accelerometer


Gyro

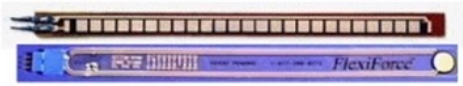

Pendulum Resistive Tilt Sensors


Piezo Bend Sensor


Metal Detector


Digital Infrared Ranging


CDS Cell
Resistive Light Sensor



Resistive Bend Sensors

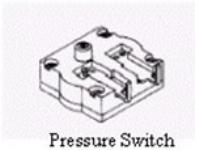

UV Detector

Py

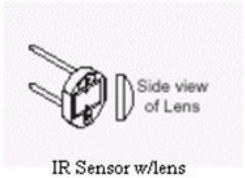

Limit Switch


Mechanical Tilt Sensors


Touch Switch


Pressure Switch


IR Pin
Diode



IR Sensor w/lens


Thyristor


Magnetic Sensor


Hall Effect
Magnetic Field
Sensors


IR Reflection
Sensor


IR Amplifier Sensor

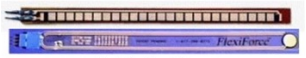

IRDA Transceiver


Magnetic Reed Switch

Sensors are for Perception


Pendulum Resistive Tilt Sensors


Piezo Bend Sensor

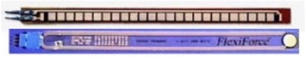

Resistive Bend Sensors

- Sensors are physical devices that measure physical quantities.
  - Such as light, temperature, pressure
- Perceptual system of a robot includes:
  - ***Proprioception*** (internal) system
  - ***Exteroception*** (external) system
- Sensors produce uncertainty challenge
  - Sensor noise and errors are inherent in physical measurement

Sensors are for Perception


Pendulum Resistive Tilt Sensors


Piezo Bend Sensor

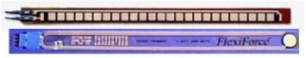

Resistive Bend Sensors

- Issues with Sensors:
  - Sensors produce signals, not symbols.
- May be continuous or multi-dimensional
- Signal-to-symbol problem:
  - How to form an intelligent response from sensor input when system requires a symbolic input form.
    - Such as a camera waiting for a person to smile (symbol) before taking a photo (response).

Sensors are for Perception


Pendulum Resistive Tilt Sensors


Piezo Bend Sensor


Resistive Bend Sensors

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- Sensor Fusion: Combining multiple sensors to get better information about the world.

Switches

- Switches measure current to detect an open or closed circuit.

Lightobject.com
Annex Depot Inc.

Levels of Processing

- Electronics (low level): such as measuring voltages
- Signal processing (medium level): such as separating voice from noise
- Computation (high level): such as recognizing an object from an image

Levels of Processing

- Examples:
  - Bump Sensors (low)
  - Odometer (low)
  - Sonar (medium)
  - Speech (medium)
  - Vision (high)

Levels of Processing

- Given the sensor input:
  - Both simple and complex sensors can be used to answer the question:
    What should a robot do? (action in the world)
  - Complex sensors can also be used to answer the question:
    What was the world like? (reconstruction of the world)

Locating People

- What kind of sensor would you use to locate people in a room?

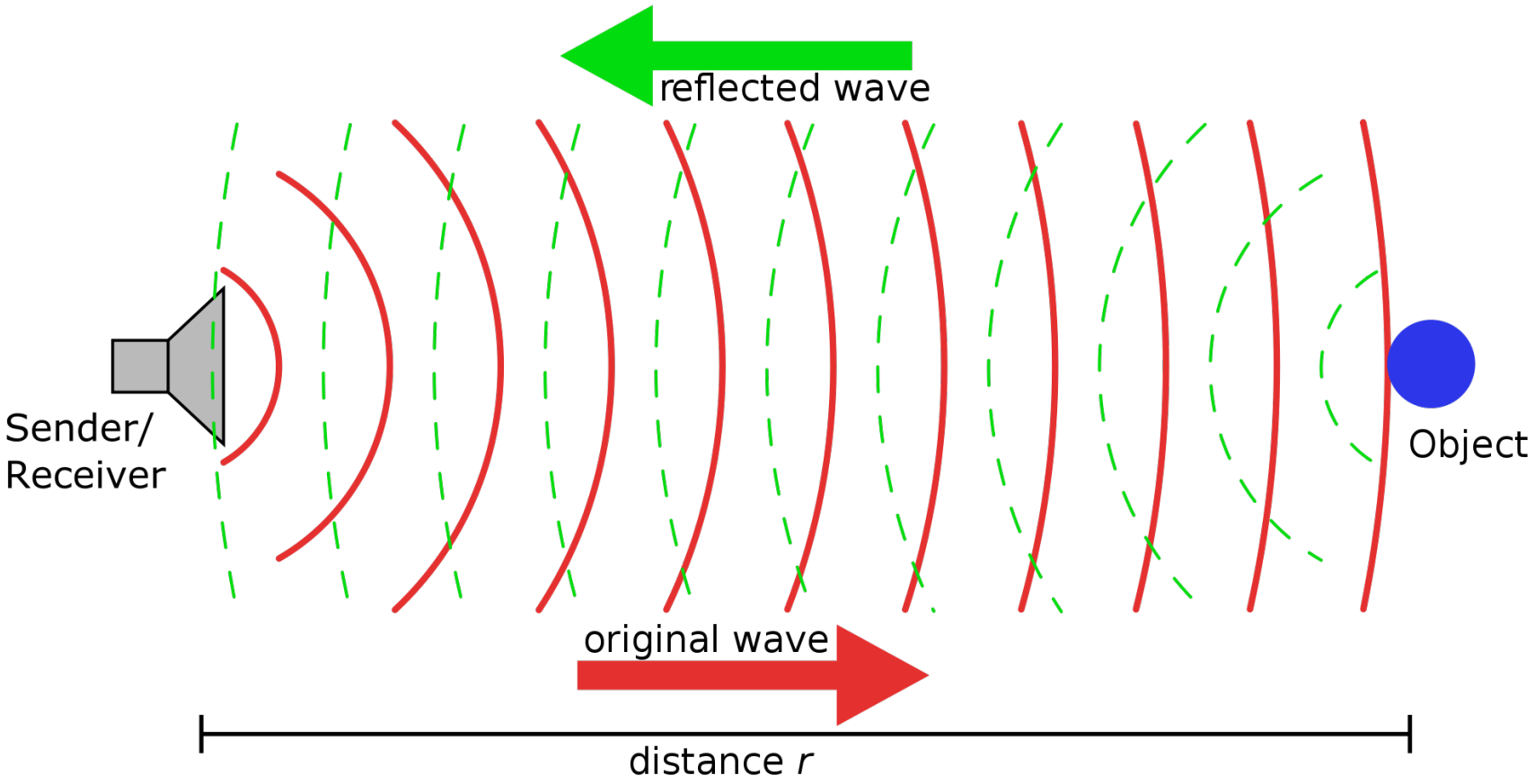
Locating People

- What kind of sensor would you use to locate people in a room?
  - *Camera*: most obvious,
    - but the most complex to process the signal.
  - *Temperature*: locate objects within human body temperature.
  - *Motion Detector*: locate objects moving that are a certain size.
  - *Color Detector*: locate objects of skin color, or human clothes.
  - *Distance*: locate objects that block a previously open area

Locating People

- The sensors will need to be calibrated before use in the robot.
  - To help achieve accurate readings

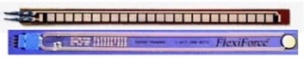
Finding Distance using Sonar



Sensor Types


Pendulum Resistive Tilt Sensors


Piezo Bend Sensor

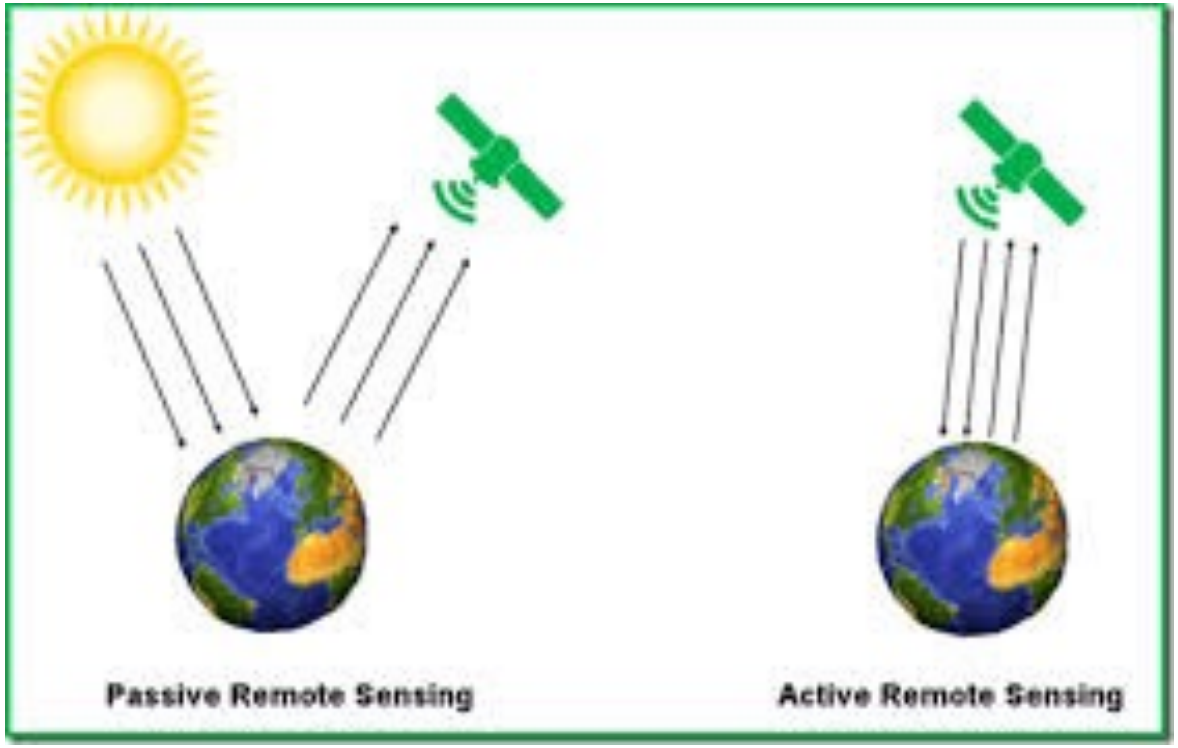


Resistive Bend Sensors

- Simple Sensors: sensors that don't require a lot of processing.
- Passive vs. Active (both simple or complex):
  - ***Passive***: measures a physical property only, with a detector
    Ex: switches, resistive light sensors, cameras
  - ***Active***: provides own signal/stimulus, with both an emitter and a detector
    Ex: reflectance and break beam, ultrasound and laser.

Passive vs. Active Sensors

- Global satellite system

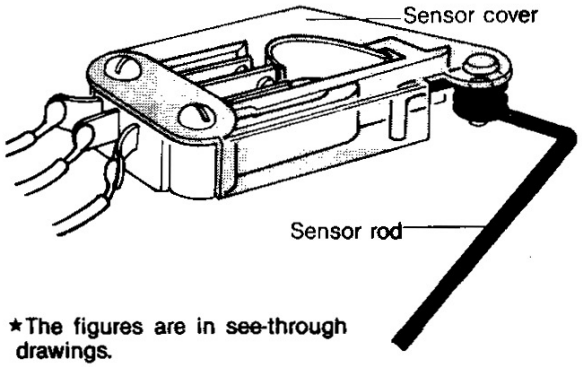


http://grindgis.com/remote-sensing/active-and-passive-remote-sensing

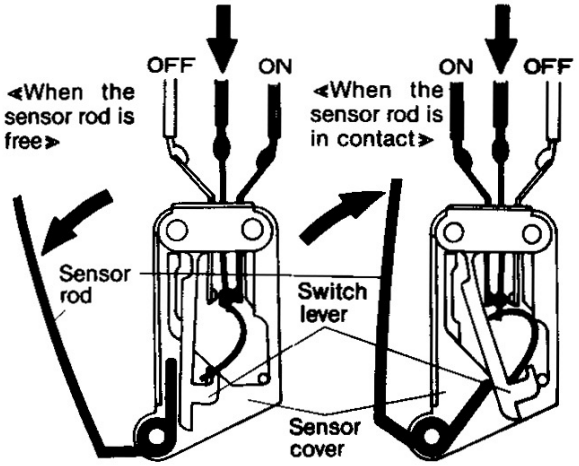
Global satellite system

- Sun constantly emits light energy and is only source of natural light for earth
  - earth's surface produce natural emissions
- Passive sensors measure this energy or power
    - as a function of physical temperature, roughness and other physical characteristics related to earth
- Active sensors throw their own energy source towards earth
  - Energy reflected from earth's surface
  - Measured by active sensors

Sensor Types (cont.)

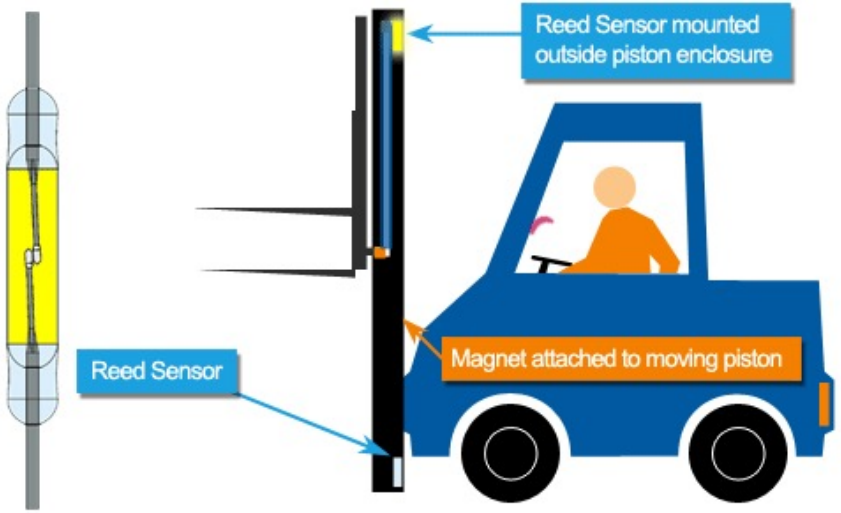


★The figures are in see-through drawings.



≪About the sensor≫
The sensor rod will activate the switch lever for turning on and off one of the two motors.

Contact Sensor



Limit sensor

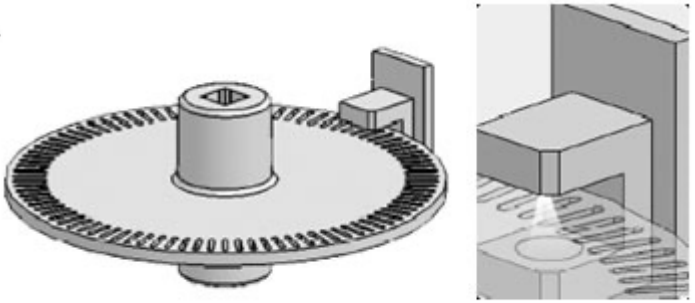


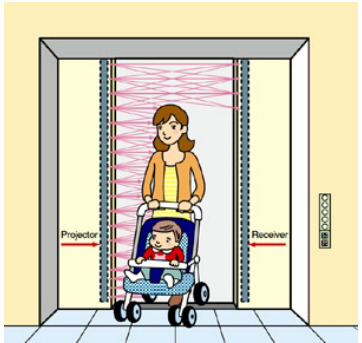
Figure 2. Optical shaft encoder disk

Shaft encoder sensor

Light Sensors

- Photocells convert light intensity to resista
  the circuit
  - Work even with invisible light (such as infrare
  - Could be used for measuring intensity, differ
    intensity or break in continuity

- Reflectance sensors: active sensors witn emitter and detector side by side
- Break beam sensors: emitter and detector face each other



- Calibration is used to reduce noise

ROOMBA

iRobot ROOMBA

- The Roomba vacuums your floors and rugs at the press of a button, helping to maintain a cleaner home.
  - Self-navigation around corners and doors.
    - Combines input from smart sensors
    - Requires minimal human input
    - System Includes virtual wall units
      - Sends infra-red signals that cause robot to turn

Roomba Parts

- There are a few main parts to Roomba:
  - Sensors:
    - including infrared, photocell and bump sensors
  - wheels, and brushes

Roomba Parts

- Roomba uses infrared and photocell **sensors** to navigate around a room.
  - Cliff sensors let the vacuum know when it's near a "cliff," such as stairs or a balcony.
    - If it senses this, the vacuum will back away from the ledge.
  - Wall sensors let the vacuum know a wall is nearby
    - Roomba will follow the path of the wall
- If the robot bumps into something, the force of impact causes the bump sensor to trigger
  - sending the robot in a different direction

Roomba Parts

- The Roomba wheels contain optical encoders,
  - The encoders use a light sensor to determine how far the Roomba has traveled.

Roomba Sensors

- Infrared-sensor:
  - Infrared waves, A.K.A. infrared (IR) light, are a part of the electromagnetic spectrum
  - humans can’t see IR light
    - but can sense it as heat.
  - infrared can be used for night vision
    - the ability to detect objects in dark environments
    - Also, for predicting weather patterns, tracking technology, etc.

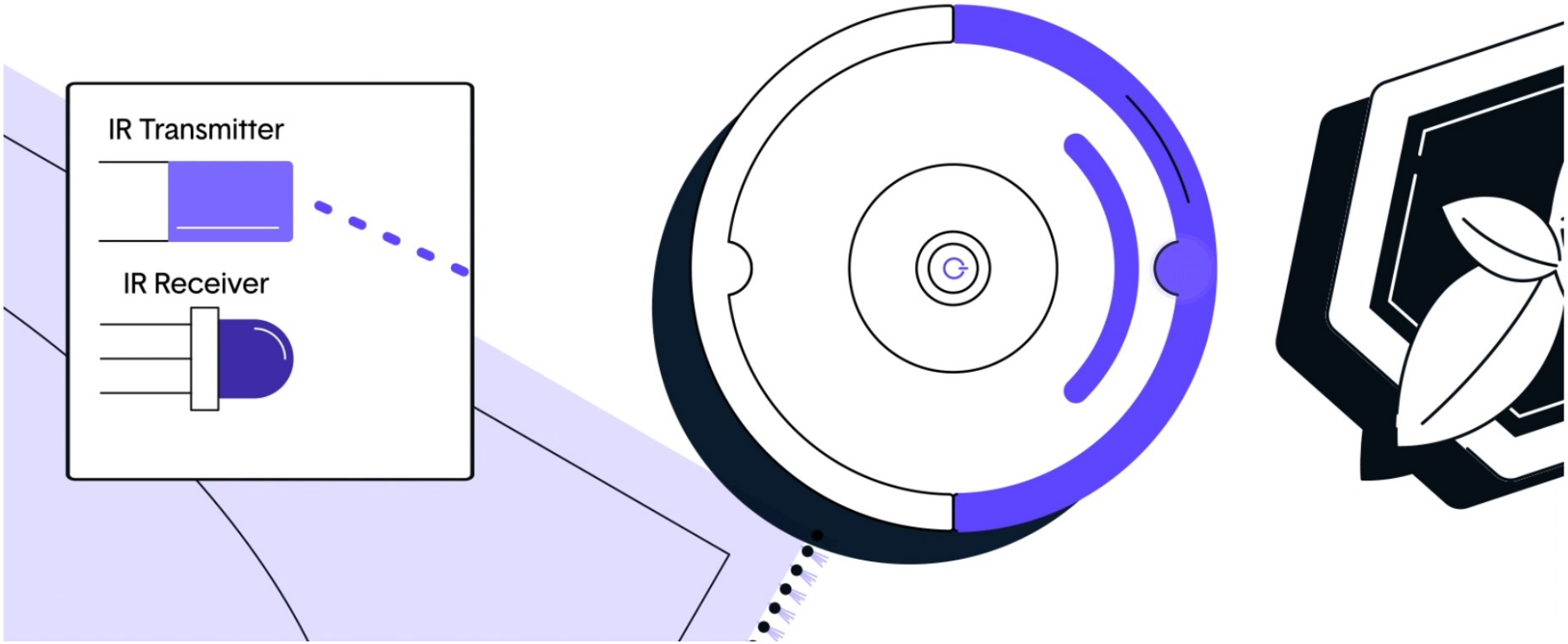
Roomba Sensors

- A photoelectric cell emits a visible or infrared light beam from its light-emitting element
  - A reflective-type photoelectric sensor can then detect the light beam that the target reflects.
  - Another sensor measures the change in light quality

Roomba Sensors

- A Roomba contains both infrared sensors and photocell sensors
  - Roomba can use the infrared sensor on the front to bounce light off an object to detect its presence
    - even if it's cleaning after dark and there's limited natural light
  - A Roomba measures how long it takes for an emitted infrared beam to bounce back to the photocell sensors
    - which provides more precise object detection.
  - The photocells measure changes in light levels, while the infrared sensors can detect changes in motion.

IR Sensor - Transmitter and receiver



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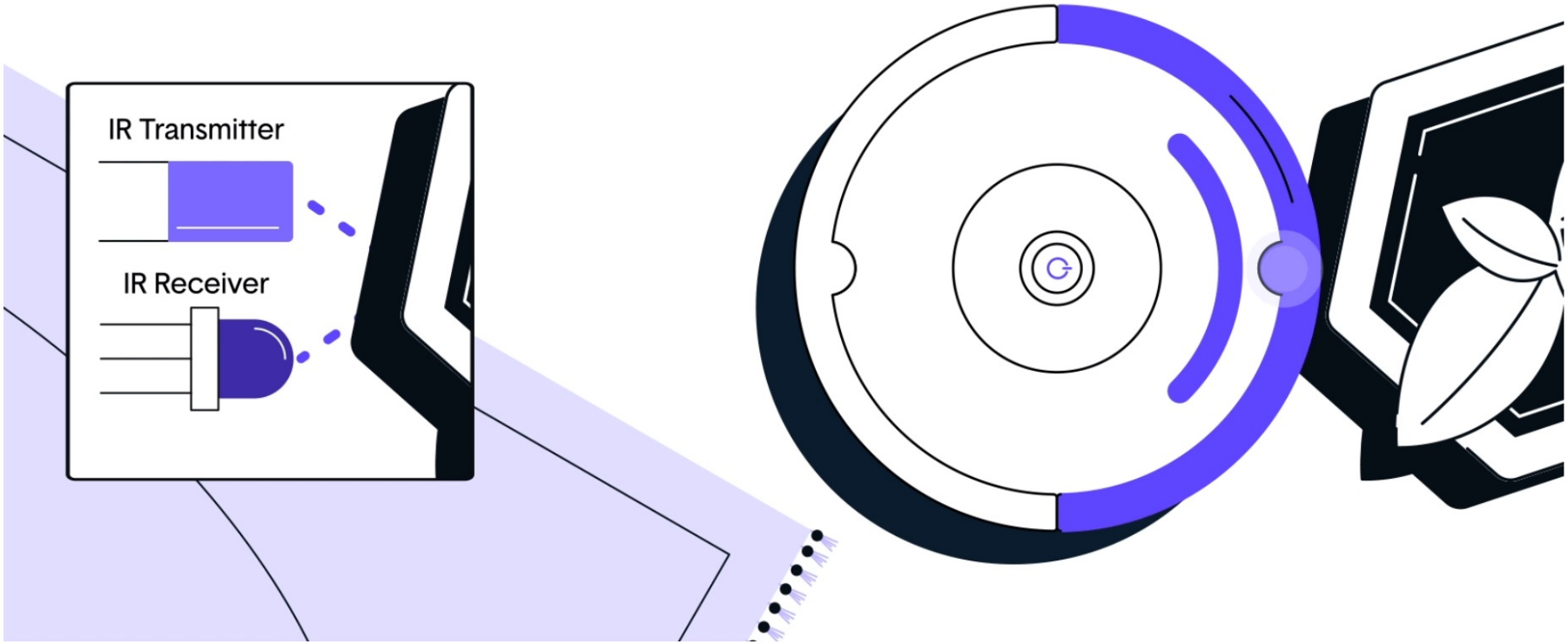


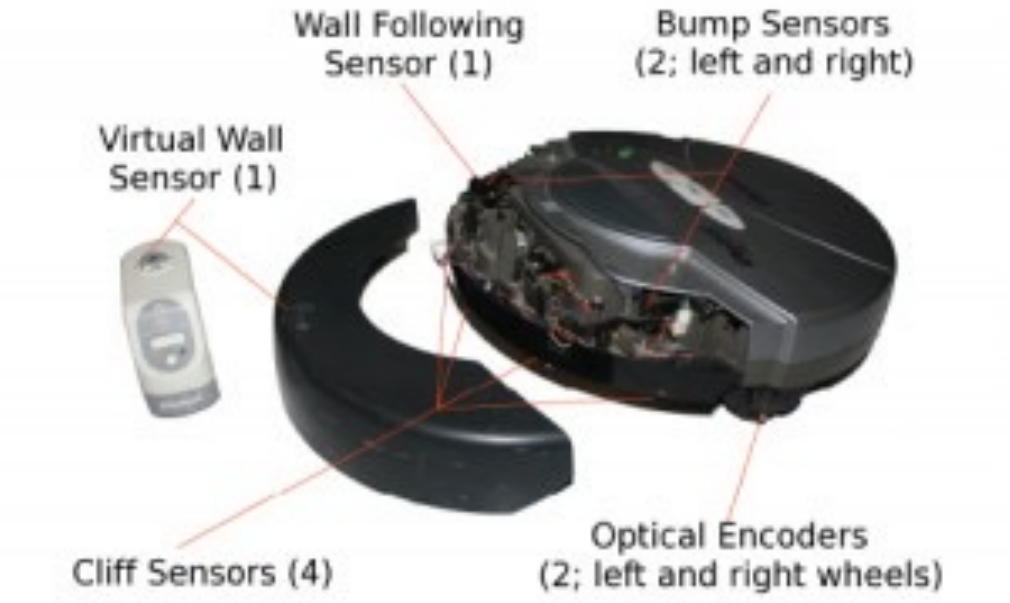
Roomba Sensors

- a Roomba also has a piezoelectric sensor
  - A crystal that measures voltage across its sides
    - Detected when crystal is subject to mechanical stress
      - Such as squeezing or bumping

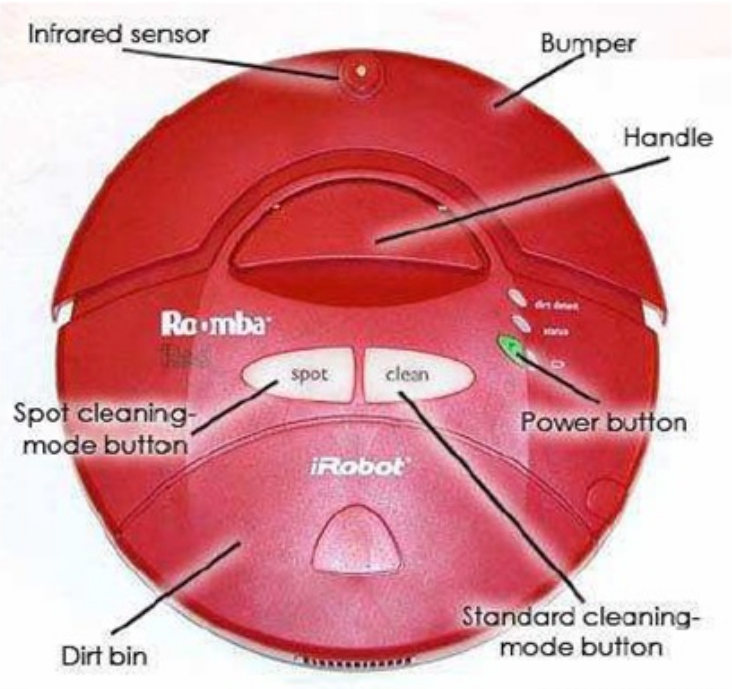
https://www.explainthatstuff.com/piezoelectricity.html

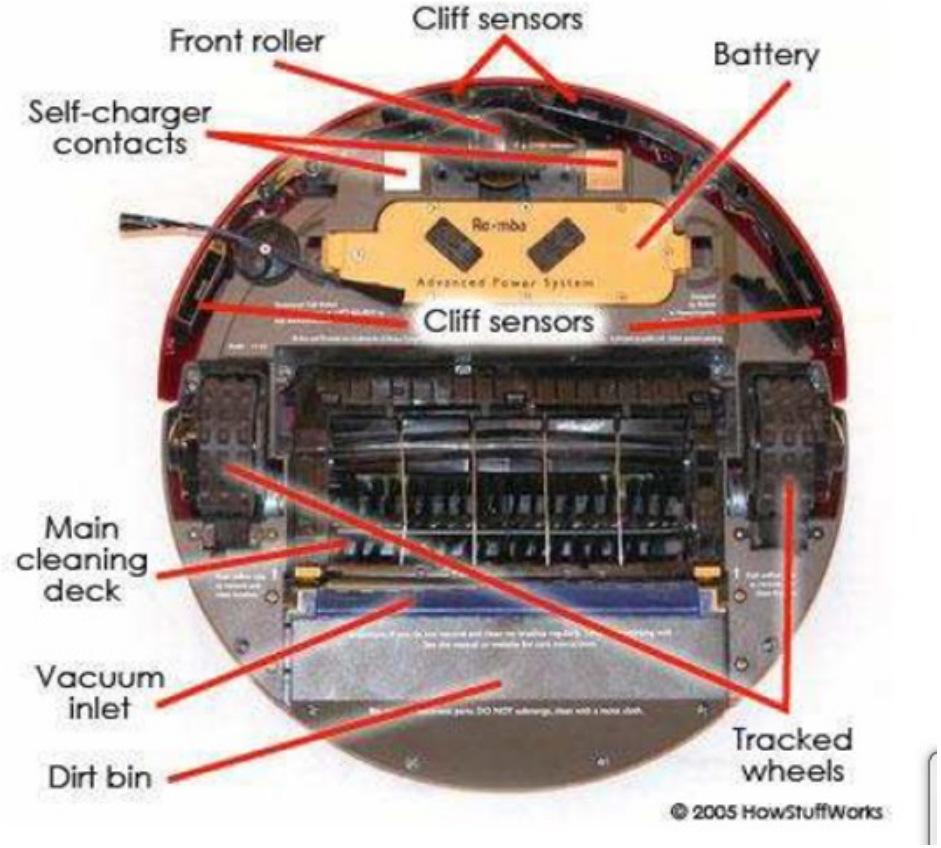
How Roomba works

- The Roomba (sage) contains 10 sensors



Top and bottom views





Roomba Sensors

- The Roomba avoid steps by using cliff sensors.
  - Constantly send out infrared signals
    - Normally immediately bounce back
    - If approaching a cliff, the signals all of a sudden get lost.
- Wall sensor is located on the right side of the bumper
  - Lets Roomba follow very closely along walls and furniture without touching them.

Roomba Sensors

- Object sensors activated when Roomba touches an obstacle
  - It then performs the sequential actions of backing up, rotating and moving forward until it finds a clear path

Roomba Sensors

- A piezoelectric sensor used to detect dirt
  - Crystal that generates electrical impulses when touched
  - causing the robot to retrace its steps, clean a little slower and more thoroughly second time around
- Newer versions use infrared cameras to create a `picture' of the room
  - Result in efficient, less random cleaning paths

Home Robots

- Home Robots

- How Roomba Works

DECISION MAKING

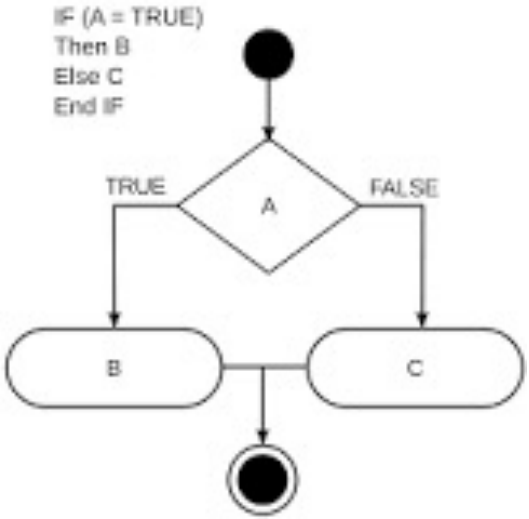
Decision Making

- Sensory inputs will make the robot a little more intelligent
  - such as the value of the light sensor,
- We need a decision-making mechanism
  - To enable robots to react to their environment autonomously (without a human touching it).
- How can we do that?
  - Conditional Execution

https://www.changedlivesnewjourneys.com/decision-making-after-brain-injury/

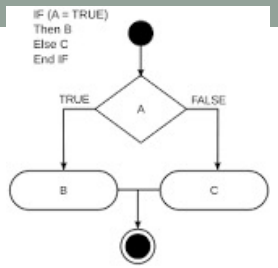
Conditional Execution

- Conditional execution used in decision-making
  - in the programming environment.
  - Widely used in programming languages
  - Common example: If–then(–else)



https://en.wikipedia.org/wiki/Conditional_(computer_programming)

Conditional Execution



- Basic structure of if-then else construct:
  - If (boolean condition) Then
    - (consequent)
  - Else
    - (alternative)
  - End If

LAB

- Let’s start working with our virtual environment!