EXPLORE ROBOTICS – CISC 1003

EXPLORING ROBOTICS – UNIT C
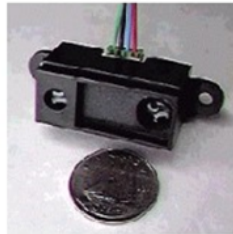
Sensors

Sensors

Accelerometer

Gyro

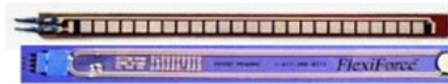Pendulum Resistive Tilt Sensors

Piezo Bend Sensor
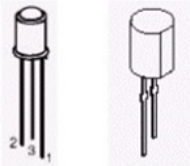
Metal Detector

Digital Infrared Ranging

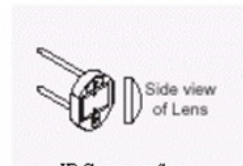CDS Cell Resistive Light Sensor

Resistive Bend Sensors

UV Detector

Py

IR Pin Diode

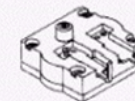IR Sensor w/lens

Side view of Lens

Limit Switch

Mechanical Tilt Sensors

Touch Switch

Pressure Switch

IR Reflection Sensor

IR Amplifier Sensor

Thyristor

Magnetic Sensor
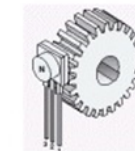
Hall Effect Magnetic Field Sensors

IRDA Transceiver

Magnetic Reed Switch

Sensors are for Perception

- 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

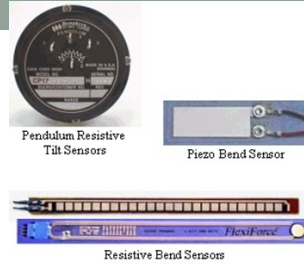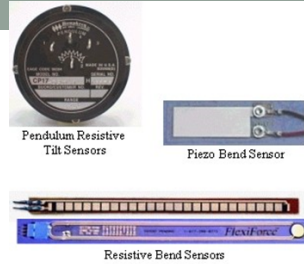# Sensors are for Perception

- 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
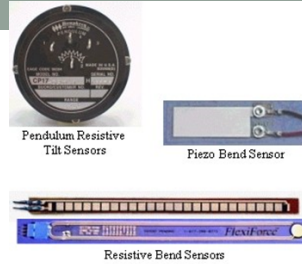
- Issues with Sensors:
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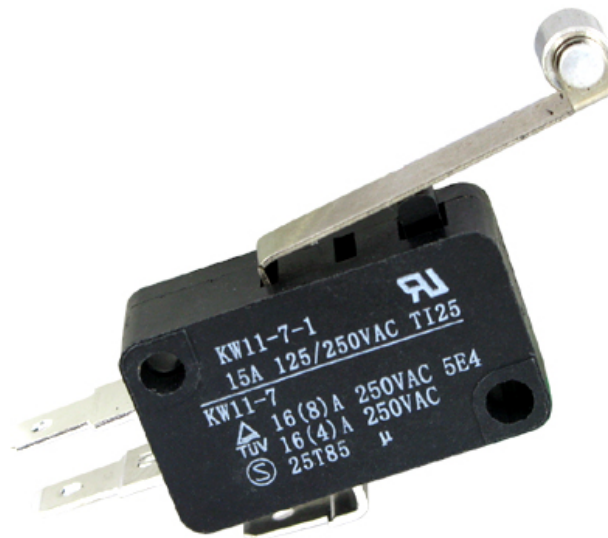   - Such as a camera waiting for a person to smile (symbol) before taking a photo (response).
- Sensor Fusion: Combining multiple sensors to get better information about the world.

Switches

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

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?
  - 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.
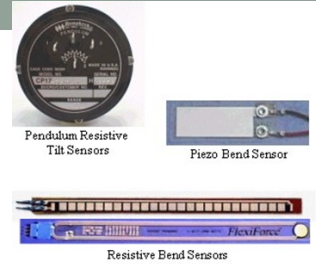 - Distance: locate objects that block a previously open area

Locating People

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

Finding Distance using Sonar
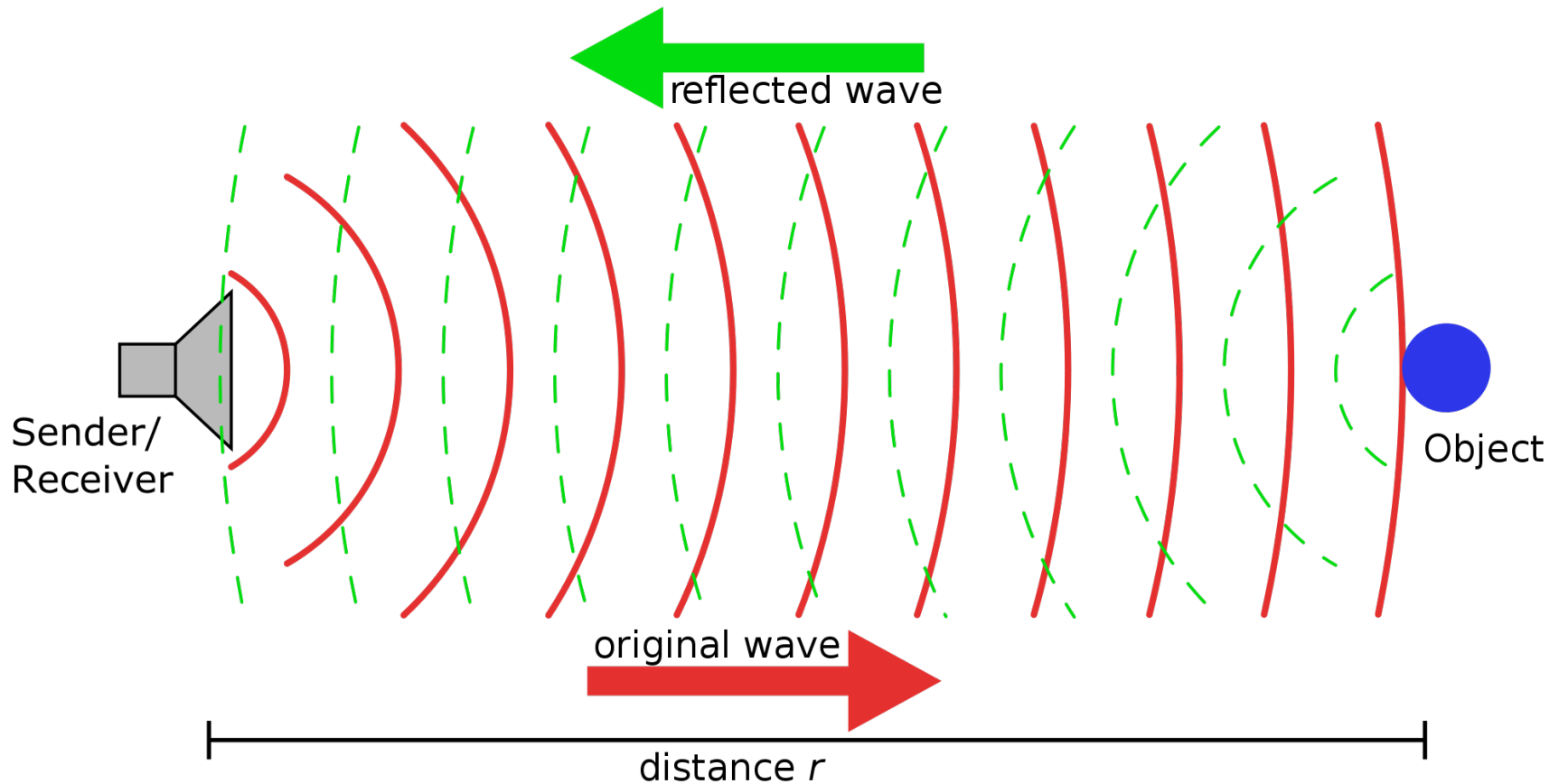
Sensor Types

- 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

Passive Remote Sensing | Active Remote Sensing
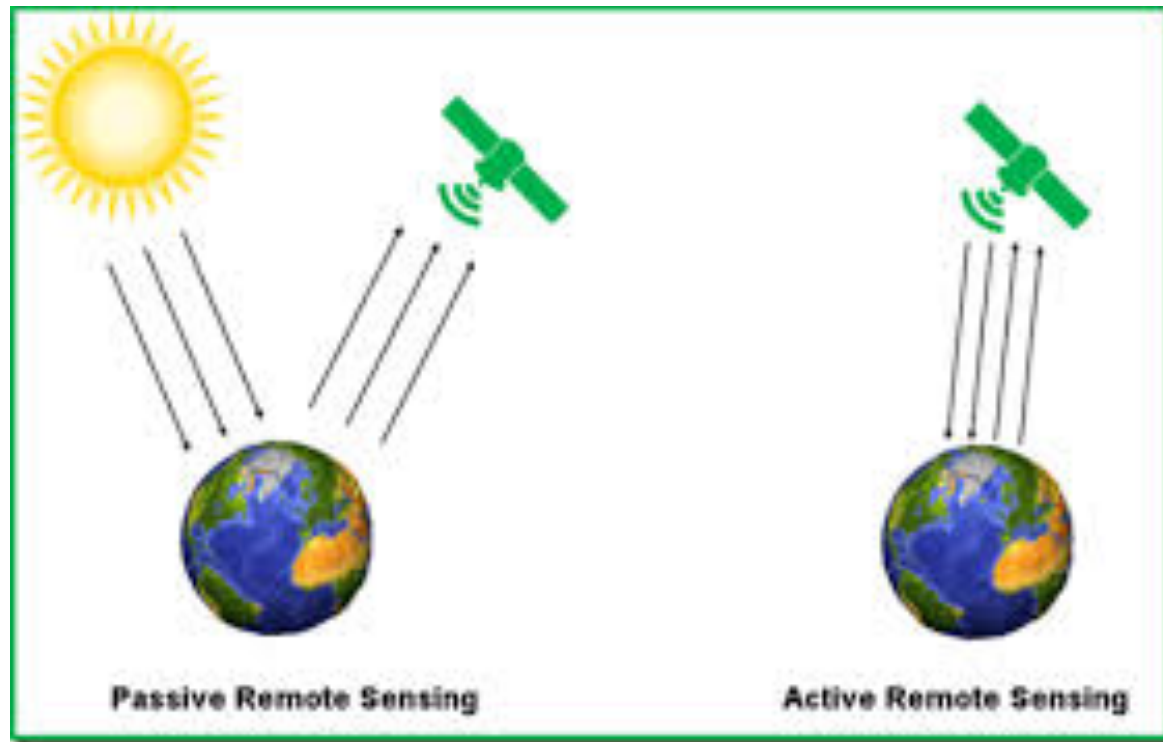
Global satellite system

- 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.)

Sensor cover

Sensor rod

★The figures are in see-through drawings.

OFF ON ON OFF

≪When the sensor rod is free≫
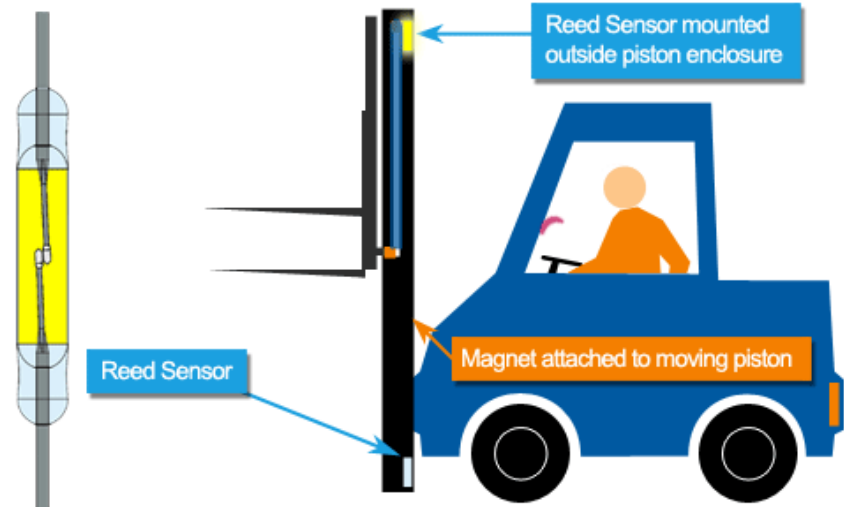
≪When the sensor rod is in contact≫

Sensor rod

Switch lever

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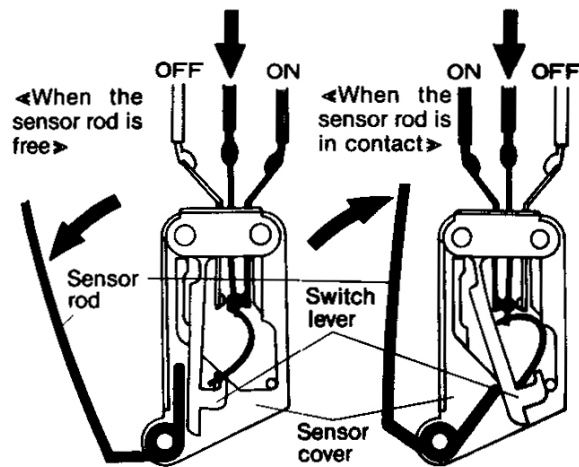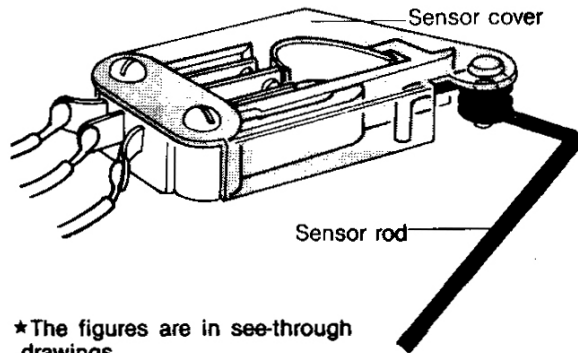
≪About the sensor≫
The sensor rod will activate the switch lever for turning on and off one of the two motors.

Contact Sensor

Reed Sensor mounted outside piston enclosure

Reed Sensor

Magnet attached to moving piston
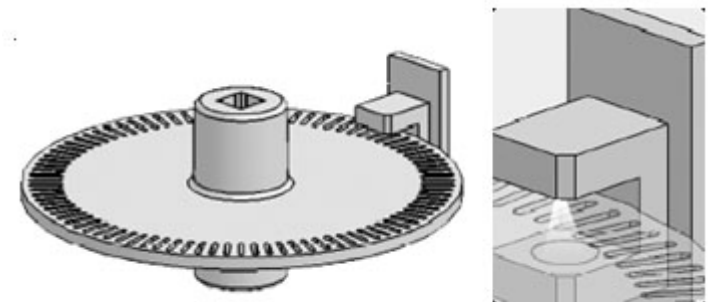
Limit sensor

Figure 2. Optical shaft encoder disk

Shaft encoder sensor

Light Sensors

- Photocells convert light intensity to resista[nce in] the circuit
  - Work even with invisible light (such as infrare[d])
  - Could be used for measuring intensity, differe[nce in] intensity or break in continuity
- Reflectance sensors: active sensors with emitter and detector side by side
- Break beam sensors: emitter and detector face each other

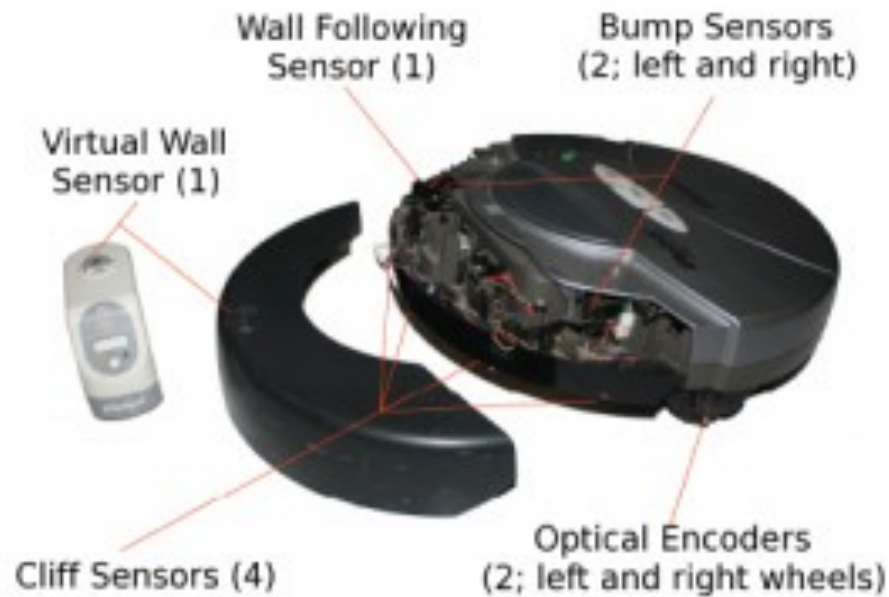- Calibration is used to reduce noise

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
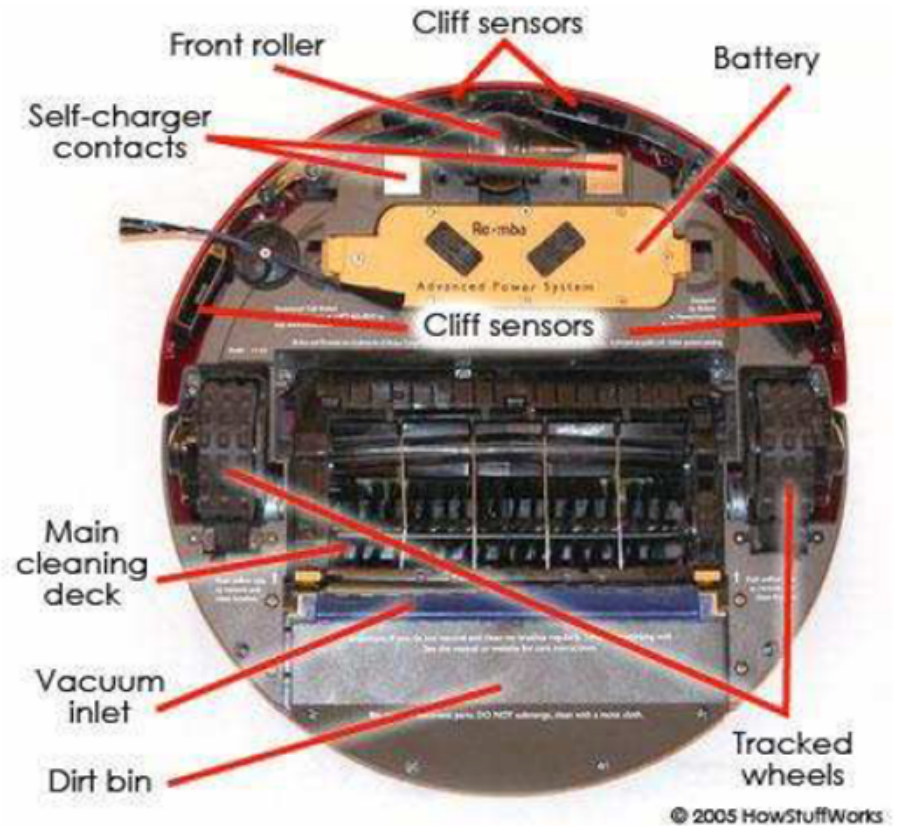   - Sends infra-red signals that cause robot to turn

How Roomba works

- The Roomba (sage) contains 10 sensors

Top and bottom views

Infrared sensor
Bumper
Handle
Roomba
Spot cleaning-mode button
spot clean
Power button
iRobot
Standard cleaning-mode button
Dirt bin

Front roller
Cliff sensors
Battery
Self-charger contacts
Cliff sensors
Main cleaning deck
Vacuum inlet
Dirt bin
Tracked wheels

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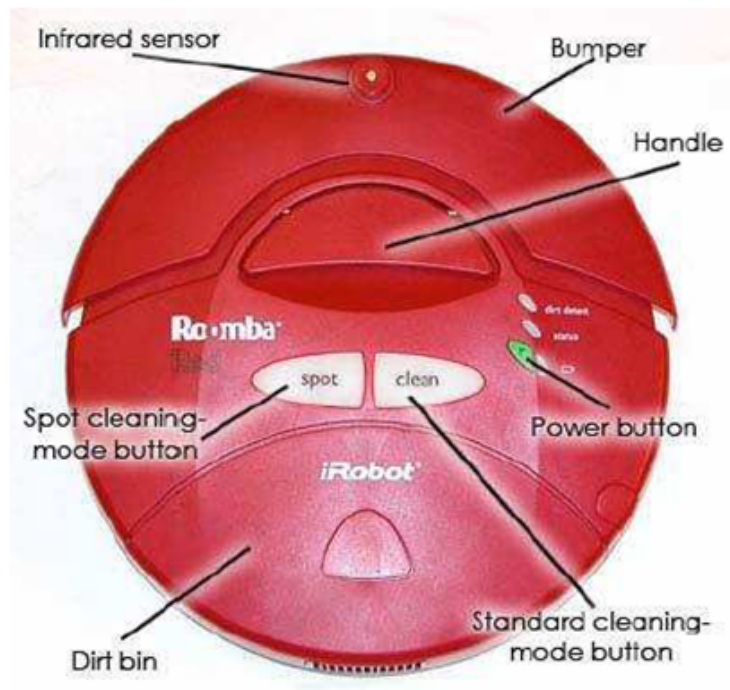
Roomba Sensors

- 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

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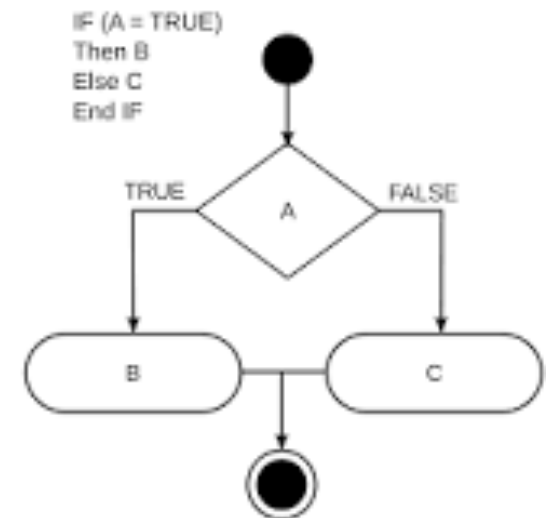
Conditional Execution
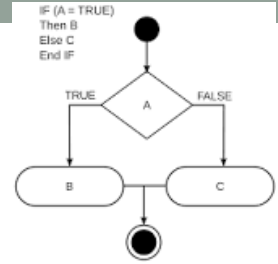
- Basic structure of if-then else construct:
  - If (boolean condition) Then
    - (consequent)
  - Else
    - (alternative)
  - End If

Conditional Execution

- In MindStorms, implemented by Conditional Constructs (if-then-else)
  - allows programs to behave differently based on different values of sensor inputs.

NXT Touch Sensor

The NXT Touch sensor's configuration panel is shown in Figure 9-1.
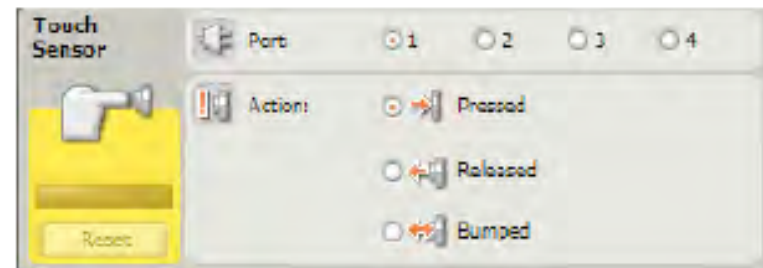
Figure 9-1. The NXT Touch sensor's configuration panel

LAB

- Let's start working with robots!