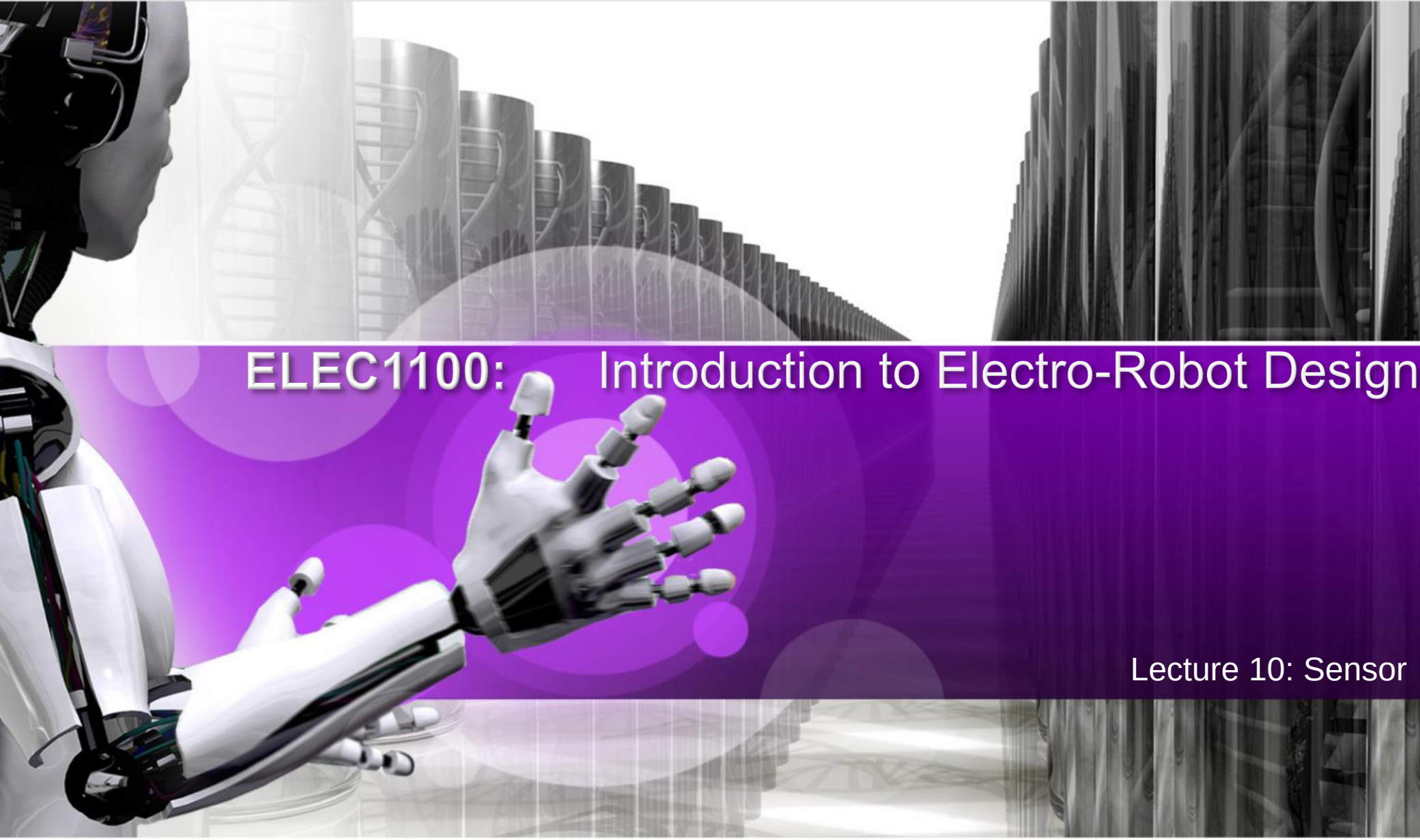
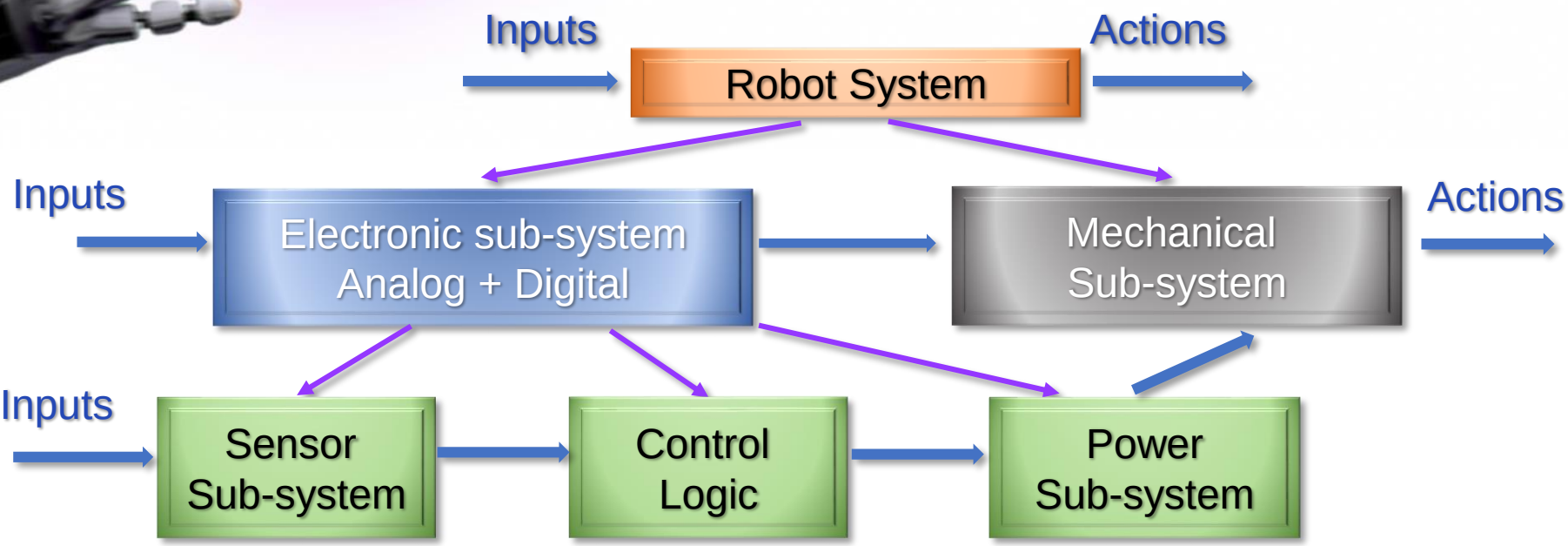


ELEC1100: Introduction to Electro-Robot Design

Lecture 10: Sensor

SONG Shenghui and MURCH Ross, Dept. of ECE, HKUST

ELEC1100 ROADMAP



Sensor Basics:

Wk5: Sensor Basic – Sensor/Line/ADC

Basic electronics:

Wk1: Basic Electronics - Charge/Current/Voltage/Resistor

Wk2: Energy/Power and DC Sources

Motor Power Supply:

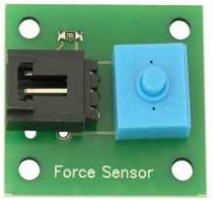
Wk3: Pulse Signal and PWM Control

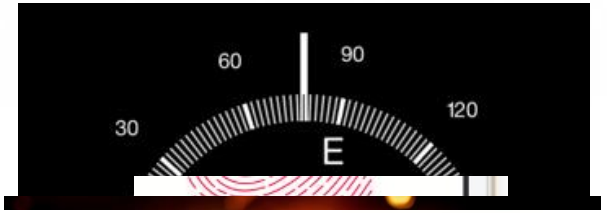
Wk4: Transistor and H-Bridge

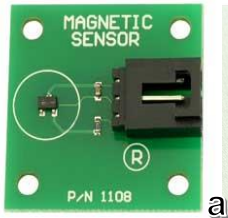
WHAT IS A SENSOR?

- A device that measures or detects a real-world condition, such as motion, heat or light and converts the condition into an analog or digital representation
- It is the equivalent of eyes, ears and skin of a Robot to found out the environment it is situated
- Make up of camera, microphone, gyroscope etc.

TYPES OF SENSOR

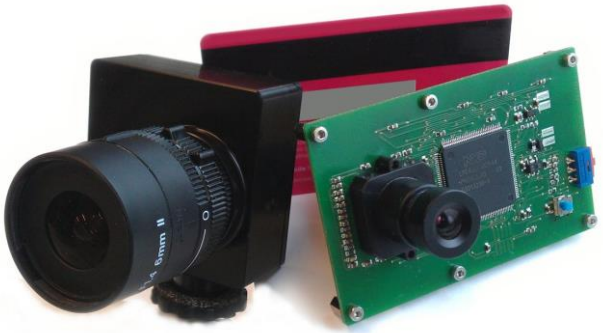


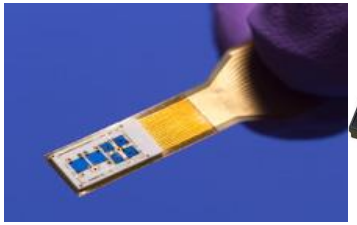




accelerometer

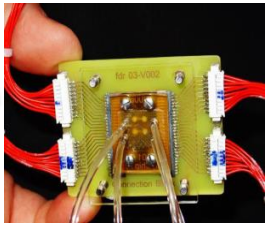
microphone





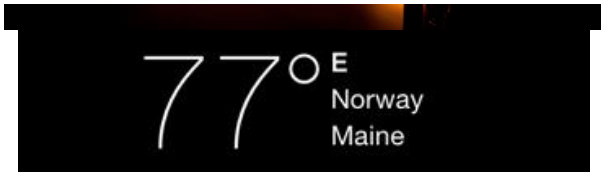
chemical sensor

image sensor



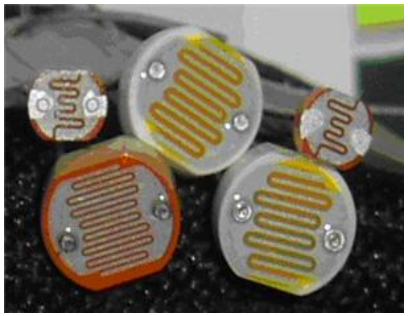
biosensor

gyroscope



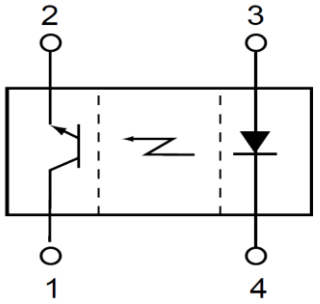
OPTICAL SENSORS

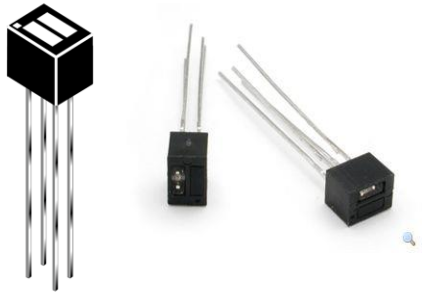
- Example of common optical sensors are light sensitive resistor (CdS) and photodiode
- Optical sensors can be combined with light sources to produce line sensors to detect position



CdS

Photodiode

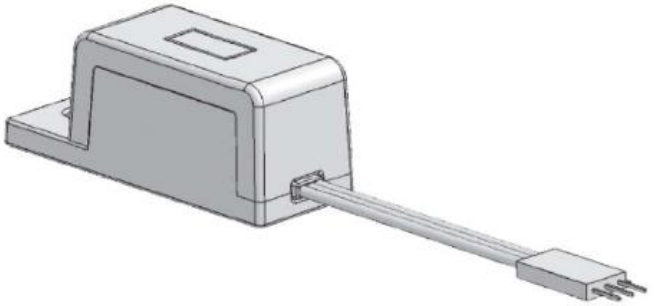




Line Sensor

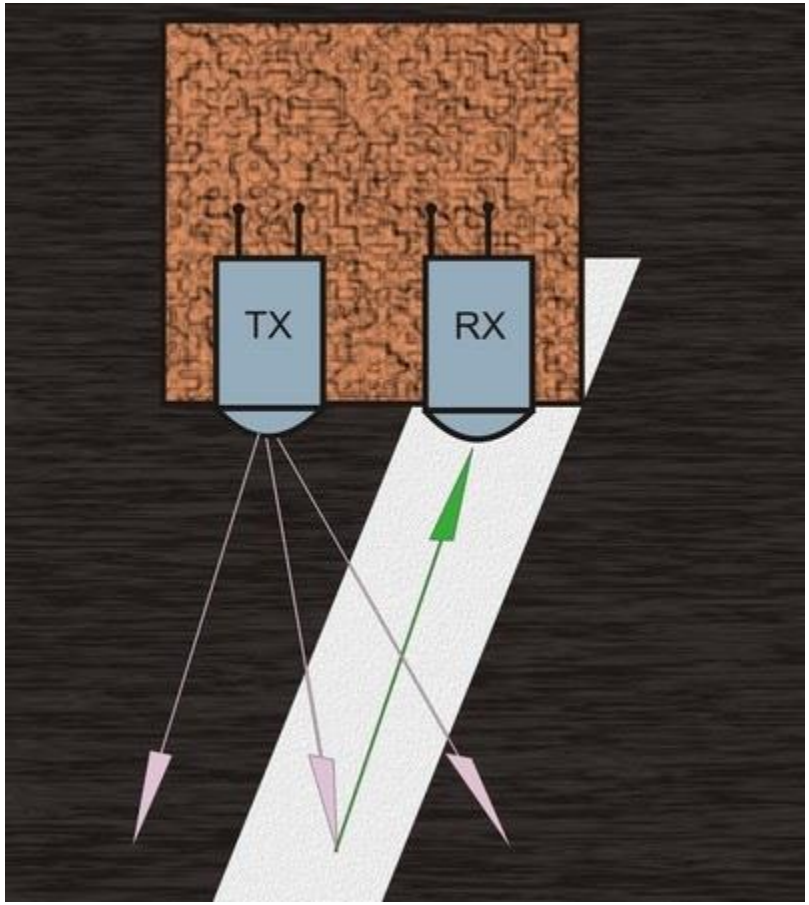
LINE SENSORS

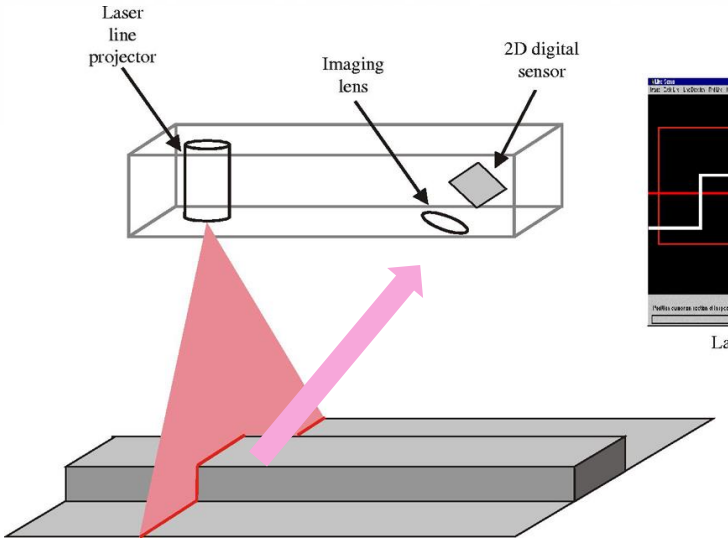
- The Navidroid include an infrared light sensor and an infrared LED
- The LED illuminates the surface and the light sensor picks up the infrared radiation

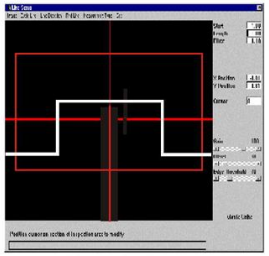


- Light-colored surface will reflect more light than dark surface
- Therefore a dark line in a pale surface or a pale line in a dark surface can be detected

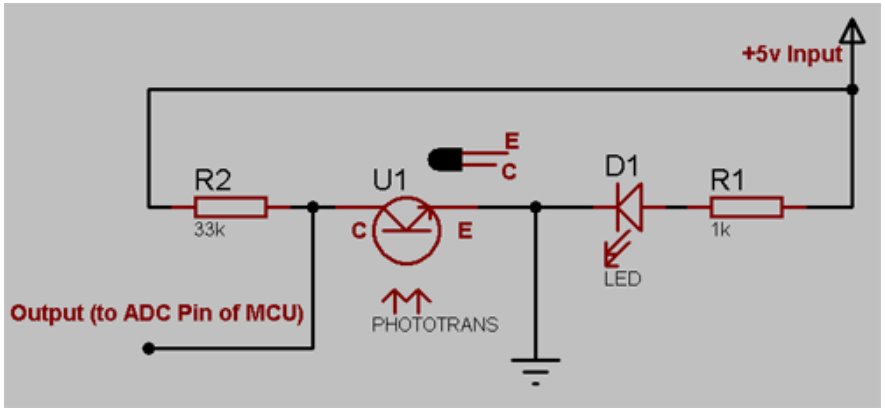
LINE SENSORS





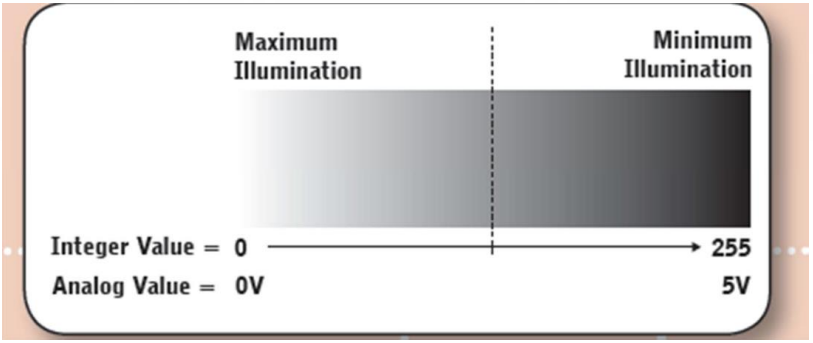


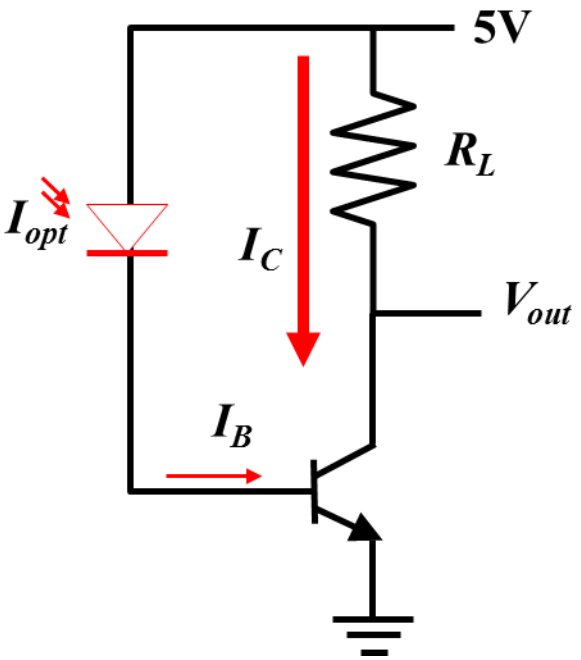
Laser line image



SENSOR OUTPUT

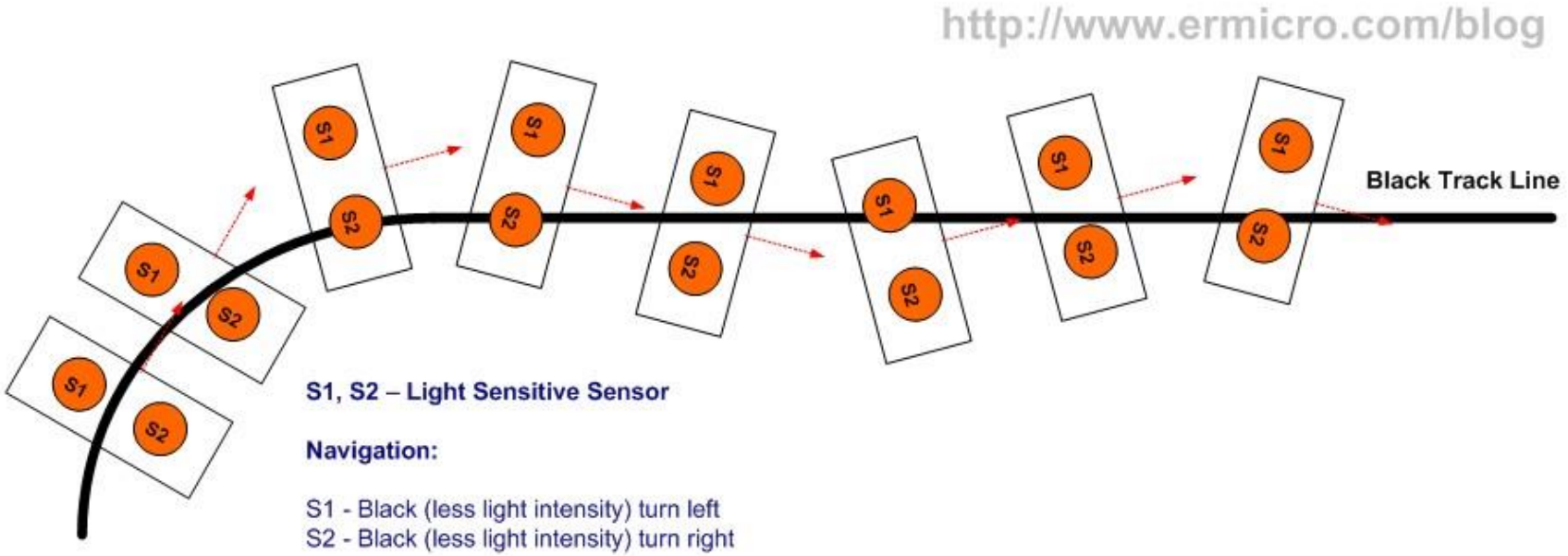
- The sensor output will be around 0V when the surface is pale or highly reflective
- When the reflected light is lower than a certain reference value, the output will be close to 5V
- By adjusting the reference value, you will be able to distinguish a pale or a dark surface





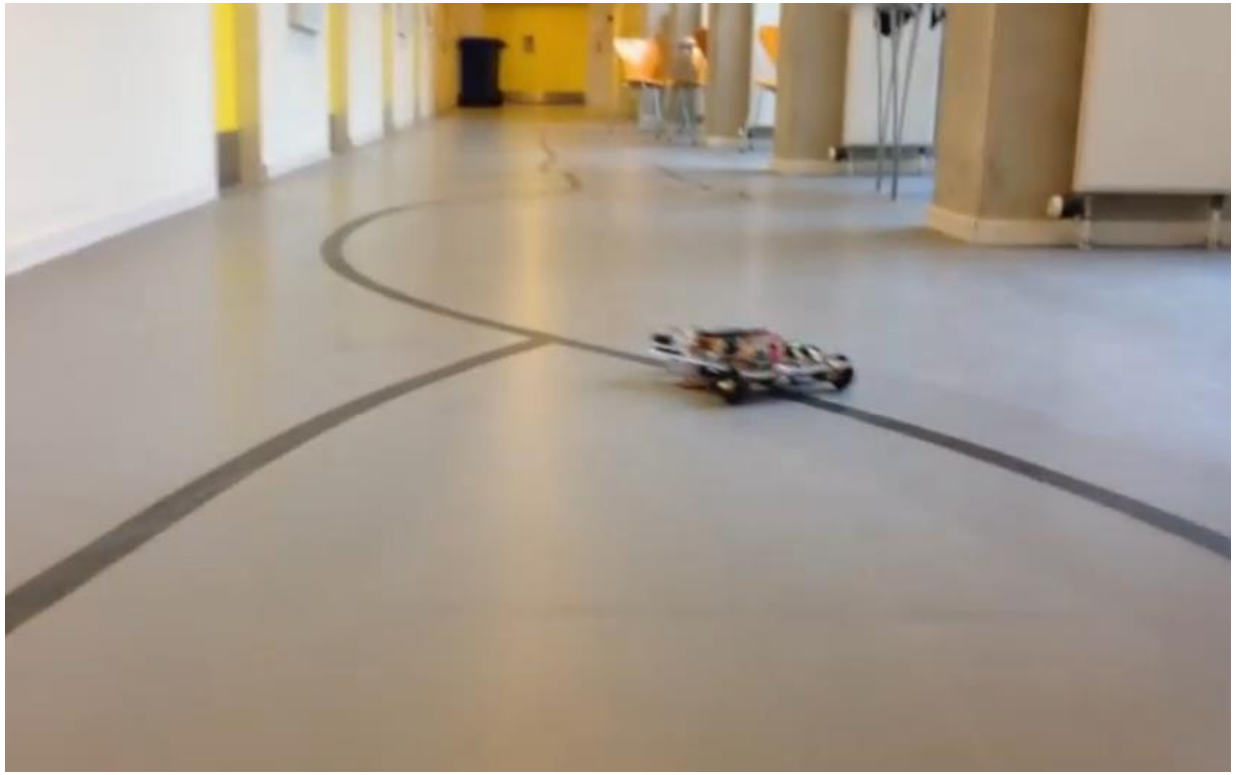
LINE SENSORS IN YOUR ROBOT

- Example: Two line sensors are used together



Example of Line tracking navigation on the Line Follower Robot (LFR)

https://www.youtube.com/watch?v=Cf-V-giXiRw



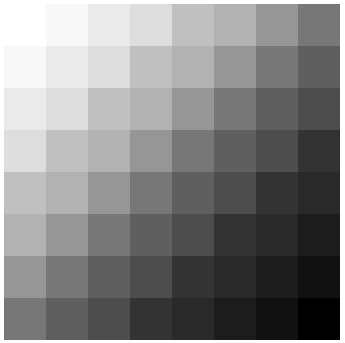
ANALOG AND DIGITAL REPRESENTATION OF CURRENT

- After sensor detects the signal, it has to be represented and stored some where

Analog representation

Stored as voltage or current value

Digital representation

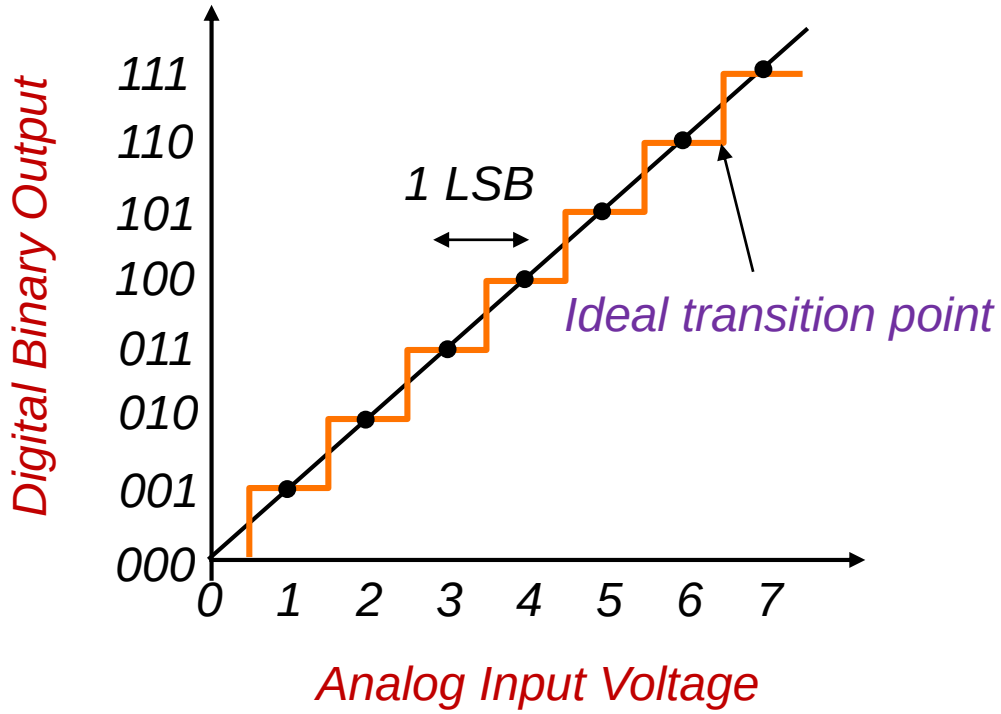


Stored as pulses or numbers

- Some data loss in digital representation, but more easy to store and duplicate

ANALOG TO DIGITAL CONVERSION

- Converting a voltage level to binary number and store as 1/0



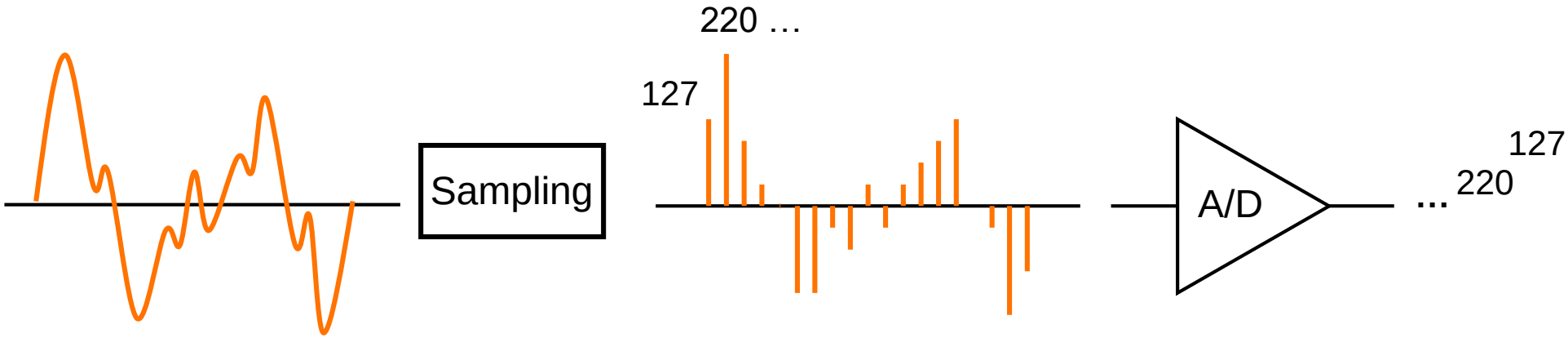
LSB = Least Significant Bit

$$1\ LSB = \frac{\text{maximum voltage range}}{\text{number of binary levels}}$$

- The smaller the LSB, the more accurate the conversion and the smaller the quantization error

DATA SAMPLING

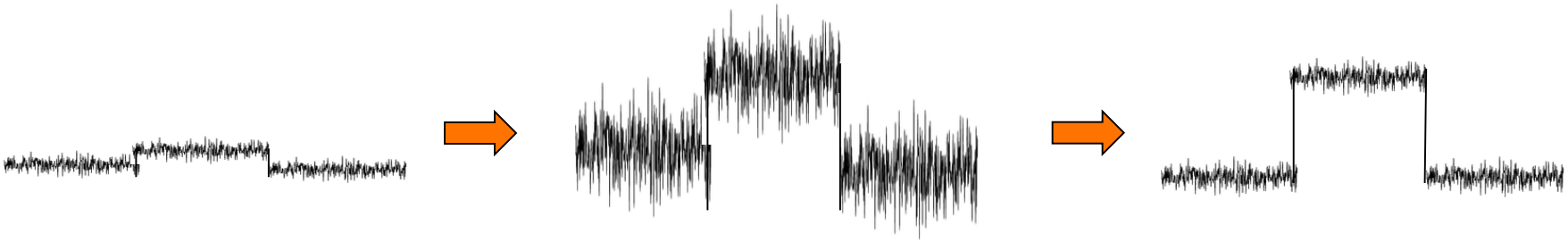
- Actual A/D process involve sampling, which represents the time domain resolution of the analog signal



- The more often you sample, the more accurate the data, but the more storage space required
- For example, CD music is sampled at 44.1kHz

SIGNAL LEVEL AND NOISE

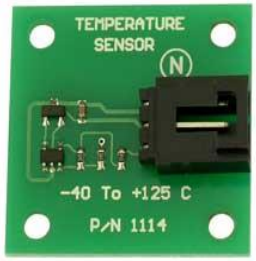
- Signal coming out directly from a sensor is usually very small and need to be amplified
- All signals contain noise that set the minimum detectable level

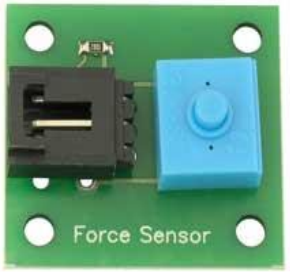


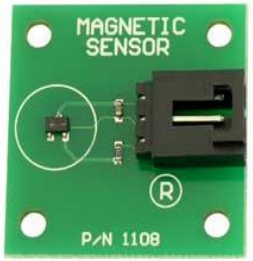
barely detectable | after amplification | averaging

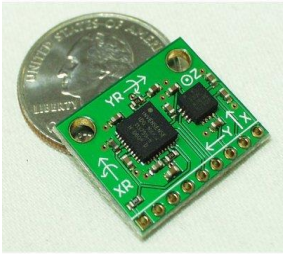
- Most signal from the sensor needs to be amplified
- For example, your line sensor composed of a sensor and a switch

LECTURE SUMMARY

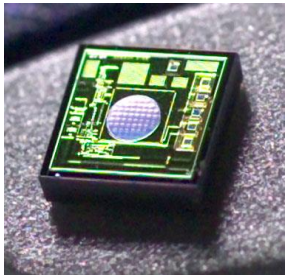








accelerometer



microphone

chemical sensor

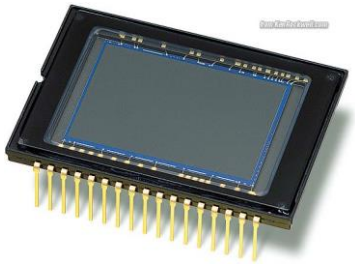
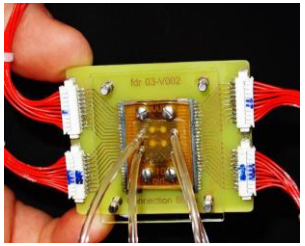


image sensor



biosensor

gyroscope

- Sensor signal is usually very small and need to be amplified
- Analog data is converted to digital data through sampling and A/D conversion
- After A/D, sensor data are digitally represented and stored

NEXT LECTURE

- Logic basics

QUESTIONS?