Mechatronics Design I
MSE 110

Instructor

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Teaching Assistants

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What is expected from students ?

➢ Following the laboratory rules:

1. No LEGO parts or components are to be moved outside of the lab.
2. Plagiarism will not be tolerated
3. No food or drinks in the lab
4. Canvas communication not email
5. Office hours will be announced

➢ Professional attitude and communication

➢ Attendance in lectures and tutorial/laboratory sessions

➢ Equal contribution to projects as an active team player

• Respect for assignment deadlines (late submission = zero marks)

What is expected from the instructor and T.A.s ?

- Professional communication and positive attitude towards students

- Clear explanation within the scope of the course material

- Encouraging questions in class and lab. sessions

- Fair grading of project demonstrations, quizzes, etc.

- Maintains laboratory inventory

- **Open-lab:** Open lab time is a dedicated extra time in the lab for students to work on their project without Instructor and teaching assistants presence. Nevertheless, lab. rules are strictly applied.

Course Outline

1. Introduction to Mechatronic Design and Robotics
   1. Introduction to sensors
   2. Introduction to actuators
   3. Introduction to programming

2. Robot Programming Basics (RobotC)

3. Robot Programming Basics and Iterative Design

4. Introduction to data acquisition and MATLAB

5. Robot Design and algorithm Development

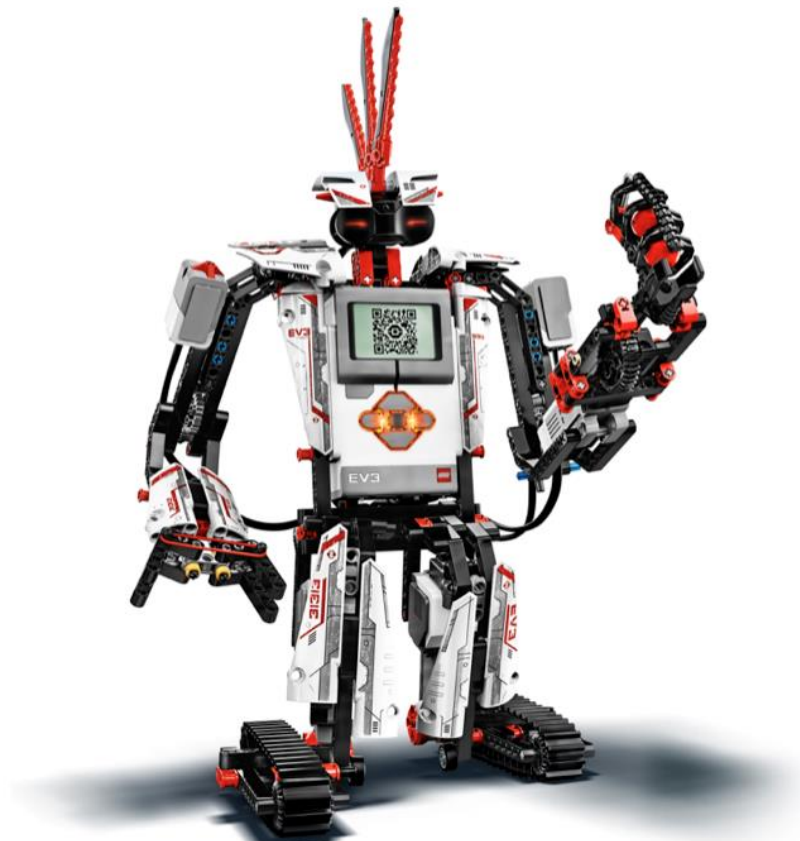# Mechatronics Systems Engineering
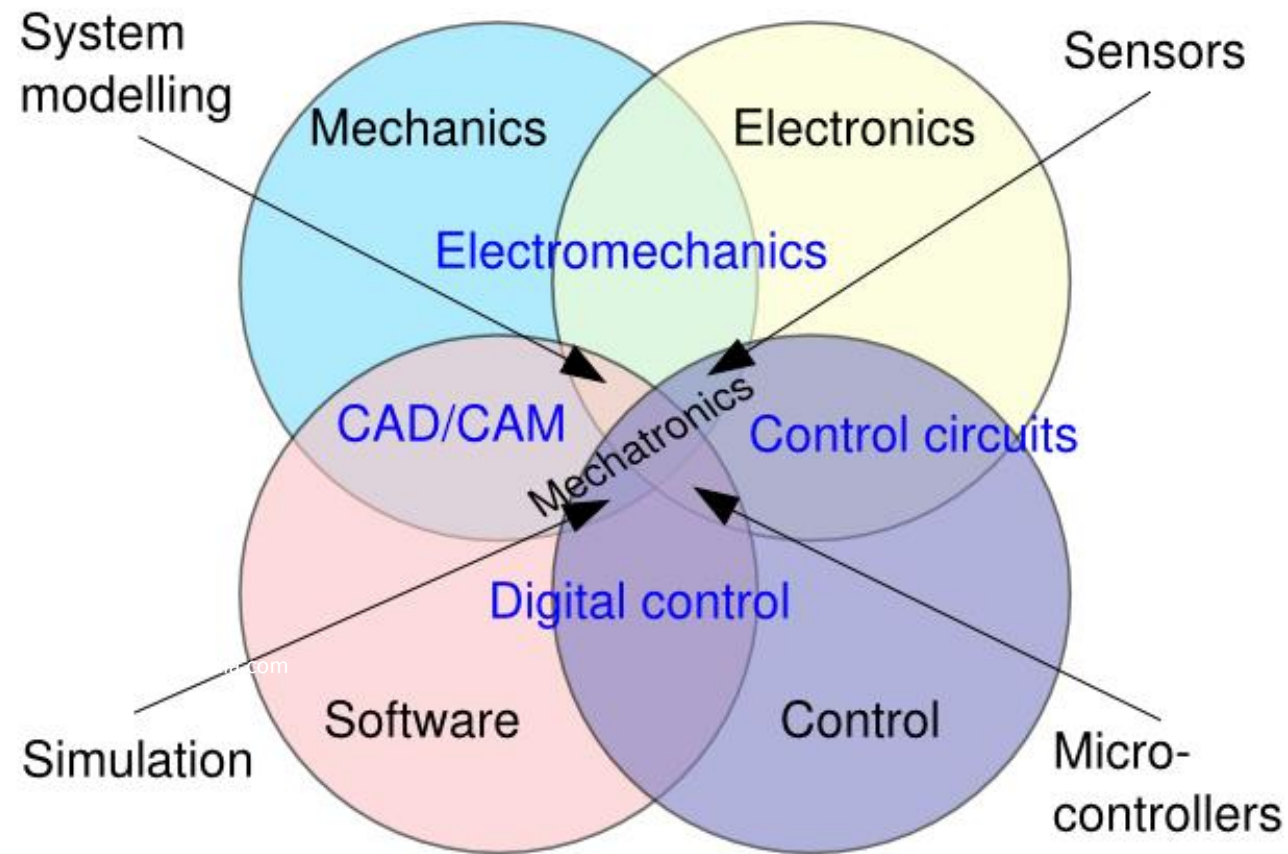
LEGO Mindstorms™ RCX
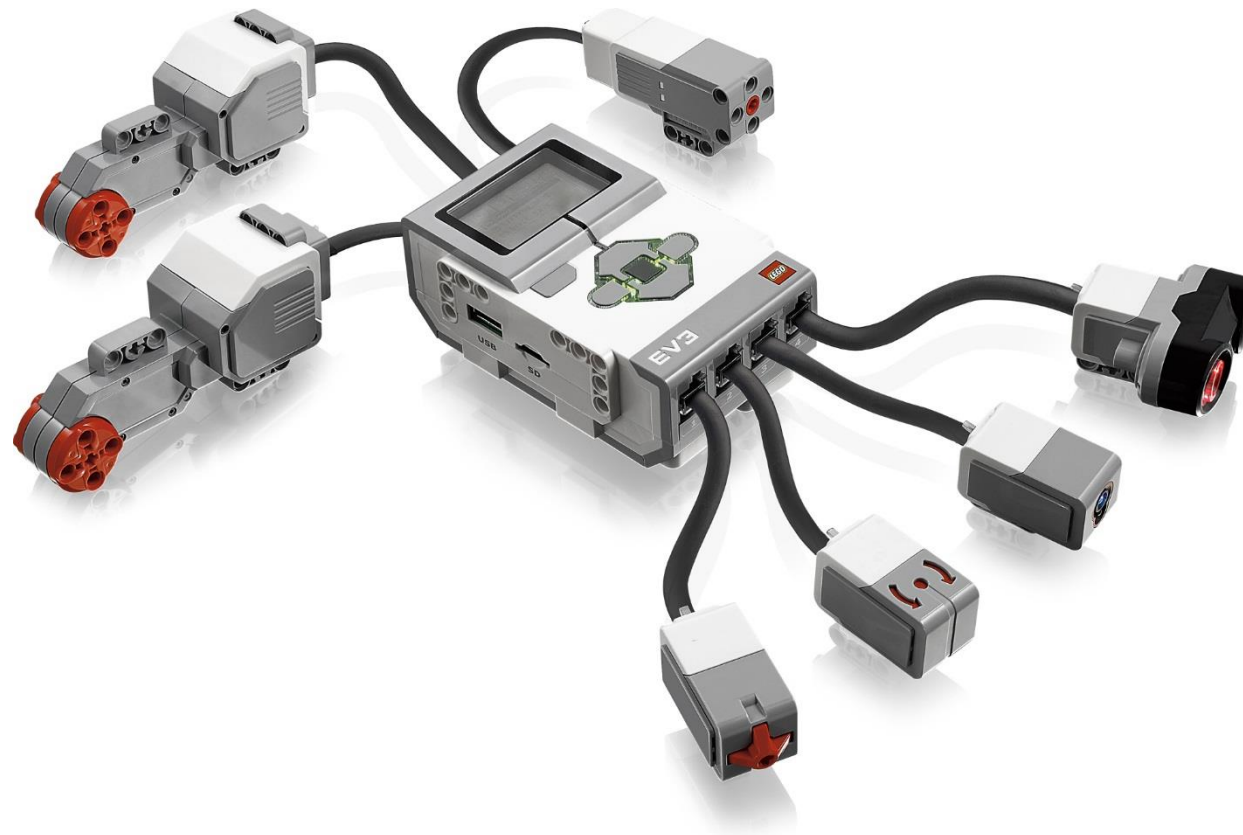
LEGO Mindstorms™ NXT

LEGO Mindstorms™ EV3

EV3 Hardware

EV3 Main Controller (The Brick)

- Processor: ARM9 300MHz

- Memory: 16MB Flash, 64MB RAM, MicroSD

- Operating System: Embedded Linux

- Output ports: 4

- Input ports: 4

- On board buttons: 6

- Communication support: Wifi, BT, USB

- Sensor Sampling Rate: 1 KHz

EV3 Ultrasonic Sensor

- Simplified theory of operation:

- The ultrasonic sensor transmits high frequency sound waves (pings) and measures the time for this wave takes to propagate and reflects back from an object. Given the time it takes the signal to propagate and the speed of sound in air (340 m/s), the sensor's processor can calculate the distance to the object.

- Note: The ultrasonic sensor emits sound wave that propagates as a cone shape (not a straight beam like LASER). This means it will be affects by objects placed not directly in front of it.

Velocity (m/s)= Distance (m) /Time (s)
The time the wave takes to propagate and
reflects back is twice the time it takes to
propagate from the sensor to the object.
V= D/(2*T)
D = 680 * T (m)
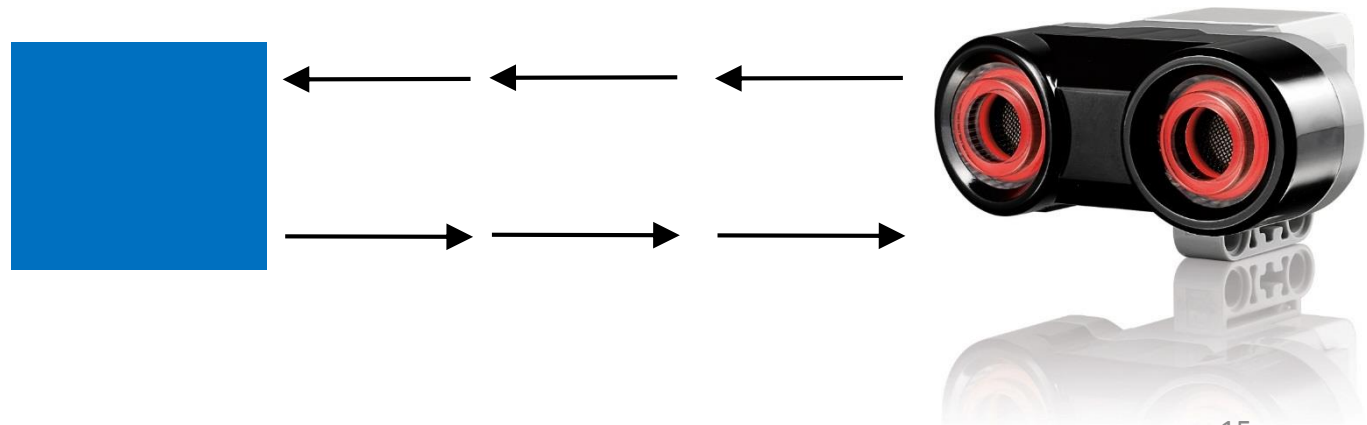
EV3 Light/Color Sensor

- The EV3 color sensor can be used as a grey-scale light sensor or a color sensor.

  - Grey-scale light sensor: the sensor's microcontroller emits red light and measures the reflection from the surface. However, this can pose a challenge (ex: red surface will reflect red light with intensity/brightness close to a white surface)

  - Color sensor mode: the sensor's microcontroller emit three light colors (Red, Green and Blue) subsequently using LEDs (Light Emitting Diode). Then it measures the reflection when each color is lit. By knowing the amount of red, green and blue in a surface, the microcontroller can estimate its color.

EV3 Touch Sensor

- The touch sensor is simply a switch (push button) that closes a circuit when pressed.

- It is not a force sensor, it is a binary sensor (ON-OFF).

EV3 Communication

- ## USB (Universal Serial Bus)
  - Needed to change the name of the brick via the standard LEGO Mindstorms graphical programming interface.

- ## Bluetooth ™ (built-in)
  - Will be used for controlling the brick/robot using C# programming language running on the PC
  - Needs the PC to have Bluetooth connection (BT USB dongle is provided in the kit)

- ## Wifi™ (requires a USB dongle)
  - Not used in this course.

EV3 Servo Motor

- The EV3 servo motor is a geared DC motor with a built in angular displacement sensor (shaft-encoder).

- The shaft encoder can be used to control the angular position of the motor. It consists of a slotted disk coupled to the motor. When the motor rotates, a light beam is interrupted using the slots in the disk, which is then counted by a microcontroller.

- The EV3 servo motor shaft-encoder has 360 slots. This means it can measure up to 1 deg of rotation.
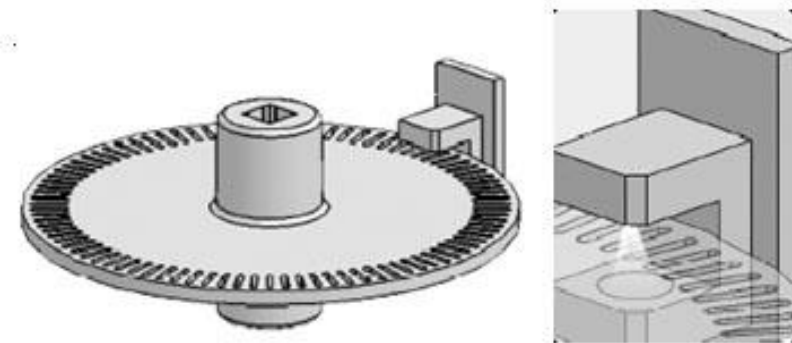
Project I – Line Tracking

- Robot should track a dark line/track on the lab. workbench.

- Robot should detect a cubic object placed on the line and sound a beep sound (300Hz) for 1 second.

- Robot should move the object to the side of the track.

- After removing the object from the track, the robot should get continue line tracking.

Next Class
Introduction to Robot-C