Designing and Building Robots

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Robotics in Computer Science

What is a robot?
Robotics in Computer Science

What is a robot?
What Can Robots Be Used For?

- Manufacturing
- 3Ds: Dirty, Dull, Dangerous
- Space
  - Satellites, probes, planetary landers, rovers
- Military
- Agriculture
- Construction
- Entertainment
- Consumer?
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The three key questions in Mobile Robotics

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▶ Where am I going?
▶ How do I get there?
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To answer these questions the robot has to:

- have a model of the environment (given or autonomously built)
- perceive and analyze the environment
- find its position/situation within the environment
- plan and execute the movement
Two main components:

- **Sensors**: to “understand” the world around
- **Actuators**: to “act” (do actions) on the world around
What Does a Robot Do?

Sense, Plan and Act

- **Sense** - get information from sensors
- **Plan** - use the sensed information to decide to do things (e.g., go down the hallway, turn left, go 3 meters, and stop)
- **Act** - do the thing (e.g., turn 60 degrees with a velocity of 0.2 meters/sec)
How to Design a Robot?

Hierarchical: Sense → Plan → Act

Reactive: Sense → Act

Hybrid: Plan → Sense → Act
Lego EV3 Robots

Lego EV3 robot contains:

- a programmable EV3 controller (brick)
- user interface with an LCD screen
- Lego building blocks
- motors and various sensors such as light, ultrasonic, color, touch, gyro.
Lego EV3 Robots

The brick contains 4 outputs (motors), 4 inputs (sensors), USB, Bluetooth, or Wi-Fi connection, LCD screen, 16 MB flash memory, 64 MB RAM, SD Card Port, EV3 Brick Button lights, sound.

1 = Back, this button is used to reverse actions, to stop a running program, and to shut down the EV3.

2 = Center, press the center button to select and accept options, or run a program.

3 = Left, right, Up, Down. These four buttons are used to navigate through the various menus.
LeJOS is a small Java Virtual Machine, which allows us to write Java programs for Lego robots
LeJOS API documentation: http://www.lejos.org/ev3/docs/
EV3 Gyroscopes

- Preserve their orientation in relation to a fixed reference frame
- They provide an absolute measure for the heading of a mobile system
- Measure rotational motion and changes in its orientation;
- +/- 3 degrees accuracy;
- Maximum output of 440 degrees/second;
- Sample rate of 1 kHz;
EV3 Ultra sonic Sensor

- An ultrasonic sensor works with waves and often it is used in applications for measure distance between a robot and surrounded objects.
- The sensor emits sound waves and receives their echoes to detect and measure the distance from one or more objects.
- Distance measure up to 250 cm (100-inch);
- +/- 1 cm (+/- 0.394-inch) accuracy;
- Recognize other ultrasonic sound.
EV3 Touch Sensor

- Useful for detection with high accuracy.
- the EV3 Touch Sensor is an analog and simple tool with a button located in the front and a counter for press/release actions of the button.
- Usually used for start/stop control systems, games like maze-solving robots, and many other applications.
EV3 Color Sensor

- detection for up to seven colors;
- detect the absence of color;
- it works in ambient light;
- sample rate of 1 kHz;
- Auto-ID is built into the EV3 Software;
Now, we will check out some robot programs ... 
- demonstrate sensors 
- look at some of the lejos library’s classes and methods - navigation and localization
Programs

- **SquarePatrol**: move 40 cm, turn 90 degrees (repeated 4 times)
- **SoundPlay**: plays tones of (frequency in Hertz, duration in ms) pairs of (300, 500), (400, 500), (500, 1000)
- **LineFollower**: Takes samples from the light sensor. When the escape button is pushed, it moves forward until another color is detected.
- **SensorTest**: Takes samples from touch, sonic and gyro sensors. Push the escape button to exit.
- **LocalizationTest**: Select a random number, traverse that shape and draw it to the LCD screen.