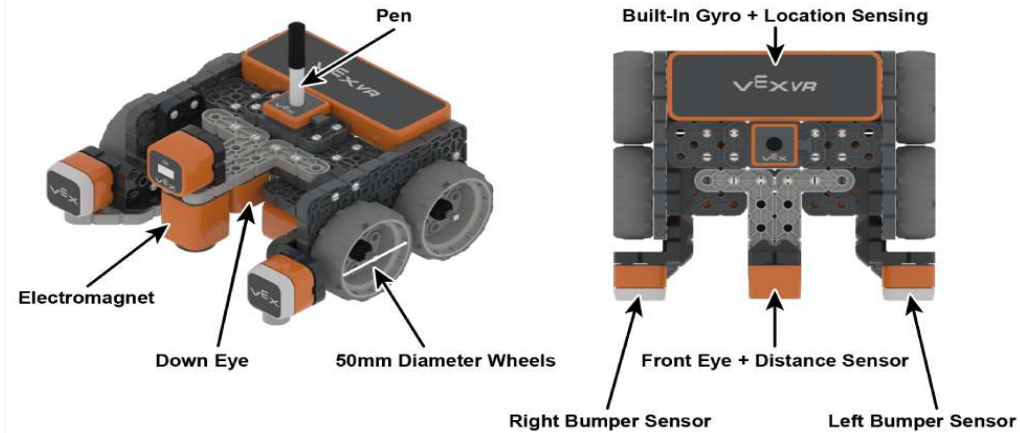


Exploring Robotics

Unit A Introduction to Robotics



VEXcode VR Robot



A-2

Virtual Robot Features

- VEXcode VR provides a virtual robot which is pre-built
- Use drivetrains to navigate
- Use sensors to perceive the surrounding and help solve mazes
- Use pen features on the art canvas to code a creative drawing
- Use the new electromagnet to interact with game objects (disks) in challenges

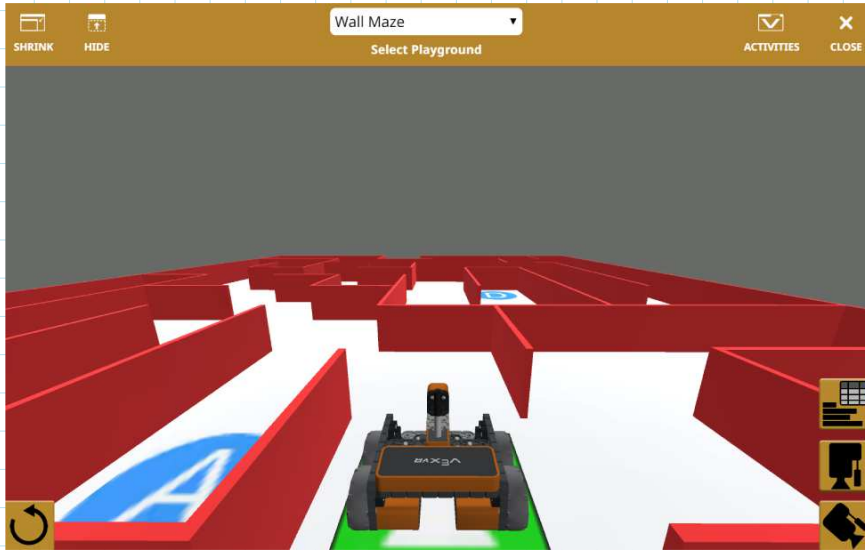
A-3

Virtual Background

- Choose from different virtual 2D/3D playgrounds to take advantage of the virtual robot's features
 - Grid maps
 - Art canvas
 - Mazes, etc.
- Control your point of view as the robot runs your code
 - Overhead view
 - Behind robot view
 - Front view

A-4

Virtual Background



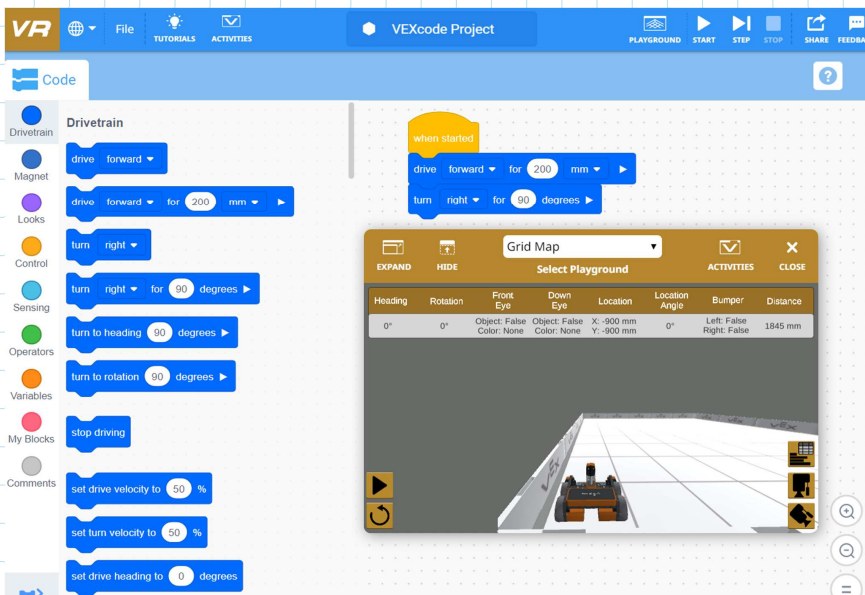
A-5

Programming the VEXcode VR Robot

- VEXcode VR lets you code a virtual robot using a block-based coding environment powered by Scratch Blocks
- No need to download the software
- Can be run in any browser, to launch just go to
 - <https://vr.vex.com/>
- Other programming software include:
 - Robolab – graphical programming environment
 - Not-Quite C (NQC) – based on C
 - Brickos – based on C++
 - Lejos – based on Java

A-6

Programming Environment



A-7

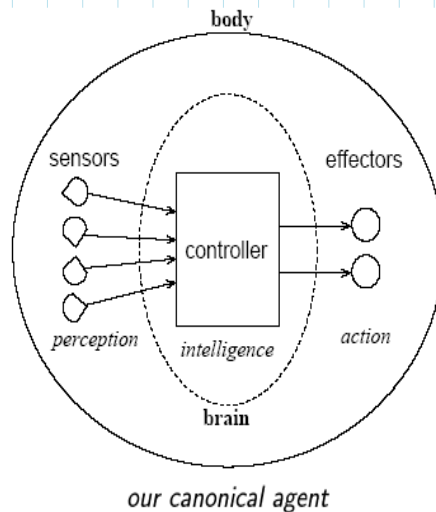
A bit of Robot History

- The word *robot* came from the Czech word *robota*, which means slave
- Used first by Czech playwright Karel Capek, “Rossum’s Universal Robots” (1923)
 - Robots: artificial people made of synthetic organic matter, much like the modern idea of androids or clones
- Human-like automated devices (not a robot by our current definition) date as far back as ancient Greece
 - Talos, a bronze giant, was made to patrol the island and throw rocks at enemy ships (Greek mythology)
- Modern view of a robot (an intelligent machine) stems from science fiction literature
 - Foremost author: Isaac Asimov, “I Robot” (1950)

A-8

Modern View of a Robot

- is a mechanical device (just a machine)
- exists in the physical world (rather than the virtual or simulated world)
- has a *body* and a *brain*
- contains *sensors* to perceive its own state
- contains *sensors* to perceive its surrounding environment
- possesses *effectors* which perform actions
- has a *controller* which takes input from the sensors, makes *intelligent* decisions about actions to take, and effects those actions by sending commands to motors



A-9

Defining a Robot

- There are many definitions
- Our definition of a robot
 - **Robot = Autonomous Embodied Agent**
- What is autonomy?
 - Not controlled by human
 - Ability to make its own decision and act on them
 - But we write the program to make the decisions
- What is an agent?
 - Anything that can perceive its environment through **sensors** and act upon the environment through **effectors**

A-10

What Is a Robot?

- **Summary – A robot is an autonomous system which exists in the physical world, can sense its environment through sensors, and can act on it through effectors to achieve some goals**
- **Is a thermostat a robot?**

A-11

Three Laws of Robotics

- The following rules were devised by Issac Asimov to set a safety guide lines for robots
 - A robot should never harm a human being
 - A robot should obey a human being, unless this contradicts the first law
 - A robot should not harm another robot, unless this contradicts the first or second law

Hollywood broke these rules: e.g., “The Terminator” (1984)

A-12

Basic Components of a Robot

■ **Sensors**

- **Function:** provides information about external environment and internal state
- **Human:** five senses
- **Robot:** touch sensor, light sensor, camera, ...

■ **Actuators**

- **Function:** converts energy into movement
- **Human:** muscles, tendons
- **Robot:** motors, hydraulic/pneumatic cylinders

A-13

Basic Components of a Robot

■ **Effectors**

- **Function:** enables robot to take actions; to do physical things
- **Actuators** are the underlying mechanisms that enable effectors to execute actions. They work together to enable the robot to do its job
- **Types:** arm, leg, wheel, gripper
- **Two basic usages:**
 - 1) manipulation
 - 2) locomotion

A-14

Basic Components of a Robot

■ **Controllers**

- **Function:** makes decisions about actions to take and responds to sensory inputs
- **Human:** brain
- **Robot:** usually a computer of some kind

■ **Power source**

- **Function:** supplies the energy needed to run the brain, actuators, sensors, etc.
- **Human:** food and digestive system
- **Robot:** usually batteries of some kind

A-15

Basic Components of a Robot

■ **Communications**

- **Function:** to communicate between a robot and a human, or a robot and a robot
- **Human:** voice, gesture, hearing, writing
- **Robot:** usually through wired I/O (e.g. ports), wireless (e.g. IR transceivers, sonar, radio), visual display (e.g. LED display), buttons

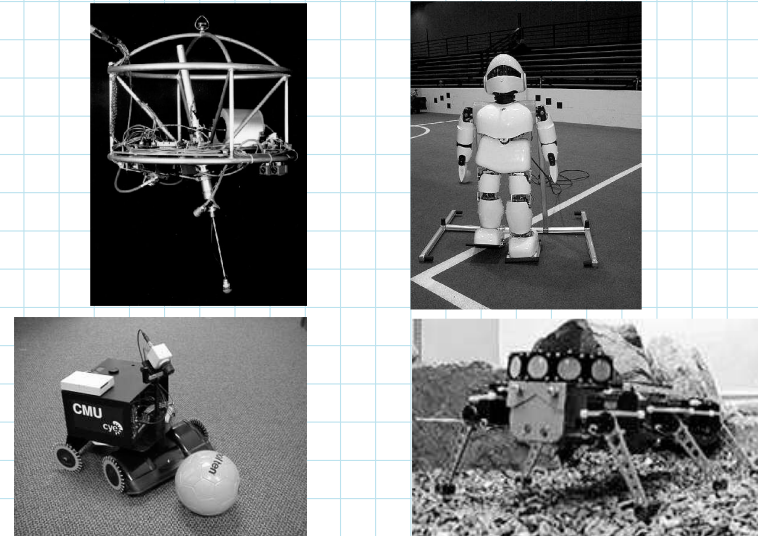
A-16

Two Categories of Robots

- 1) mobile robots; 2) manipulators
- Mobile robots
 - Concerned with moving robots around mostly on the ground
 - Classified by manner of locomotion:
 - wheeled (uses wheels, tracks)
 - legged (uses legs)
 - Stability is important:
 - static stability
 - dynamic stability

A-17

Mobile Robots



A-18

Manipulators

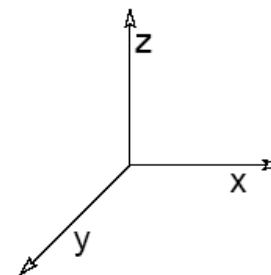
- Manipulators
 - Concerned with moving objects using mostly robotic arms and grippers of various types
 - Can move things in one or more dimensions
 - <https://youtu.be/TzZHKEPqZ5I>



A-19

Degrees of Freedom (DOF)

- Number of directions in which robot motion can be controlled
- Free body in space (3D) has 6 degrees of freedom:
 - Three translations (x, y, z)
 - Three rotations (roll, pitch, yaw)



A-20

Degrees of Freedom

- Most simple actuators control a single degree of freedom
- A car has only two controllable degrees of freedom
- If there is an actuator for every degree of freedom, then all degrees of freedom are controllable \Rightarrow holonomic
- Most robots are non-holonomic
- **Question: How many controllable degrees of freedom does a jet airplane have?**

A-21

Why Robots?

- Dirty, dangerous, dull tasks
- Can we replace humans with Robots?
 - Where?
 - Home (i.e. Roomba robot)
 - Industry (i.e. manipulator robot for building cars)
 - Medical (i.e. surgical robot, stjosephsatlanta.org)
 - War (i.e. BigDog)
 - Public place (i.e. CMU Sage museum robot)
 - Other places?
 - What do you think? (open discussion)

A-22

Homework Assignment

- Read the articles about BigDog on the Coursepack (Unit A Case Study: “Robotic ‘pack mule’ displays stunning reflexes” and “BigDog, the Rough-Terrain Quadruped Robot”), and then answer the following questions:
 - 1) What is BigDog? What was BigDog developed for? (1 pt)
 - 2) Who is the developer of BigDog? Who is the sponsor of this project? (0.5 pt)
 - 3) Describe about BigDog’s special capabilities? (1 pt)
 - 4) What is the ultimate goal of BigDog project? (0.5 pt)
 - 5) Identify the six components (controller, actuators, effectors, sensors, power source and communications) of BigDog. Describe what they are made of? (e.g. the actuators are the motors – not necessary right). (2 pt)

A-23