



Introduction to Artificial Intelligent and Robotics

The course captures the essence of A.I. and introduces basic ideas regarding knowledge representation and search algorithms. The course will introduce the concepts and the techniques behind implementing these ideas.

One of the major fields of A.I. is the field of **Robotics**. This field is currently enjoying tremendous scientific, practical, and popular success in various fields.

This course will also cover some of the basic concepts in robotics systems covering issues like sensors, actuators, and describing the most important approaches of robot control. The field of robotics is strongly related to the engineering field. However, since this course is an introductory course aimed for I.T. department students, it covers all the necessary background information without delving into the inner workings of the subjects presented.

COURSE/STUDENT LEARNING OUTCOMES

- Understand the reasons behind, goals and trends of AI
- AI application areas.
- Basic knowledge representations schemes, their associated search techniques and state-space search.
- Robots background and basic robot components and its control.
- Methods of robot control and representation.

Course Details

Number of weeks: **17**

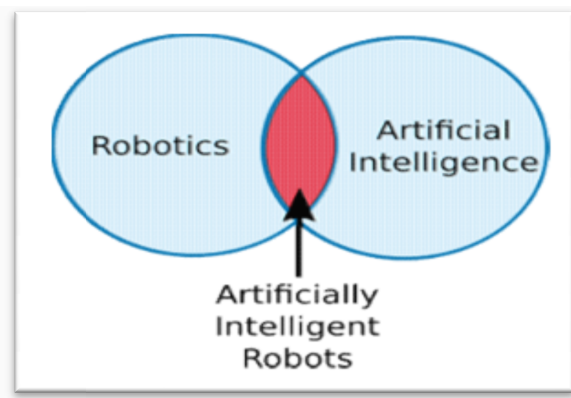
- Theoretical: **15** weeks
- Midterm exam: 40% (one week)
- Final exam: 40% (one week)
- Quizzes 20% (at least 2 quizzes)

References

- Robin R. Murphy, **Introduction to AI Robotics**.2000, the MIT Press Cambridge, Massachusetts London, England.

Robotics and Artificial Intelligence

- **Artificial Intelligence (AI)** is a general term that implies the use of a computer to model and/or **replicate** intelligent behavior. Research in AI focuses on the development and analysis of **algorithms** that learn and/or perform intelligent behavior with **minimal human intervention**. These techniques have been and continue to be applied to a broad range of problems that arise in robotics, medical diagnosis, gaming, mathematics, and military planning and logistics.
- The first thing to clarify is that **robotics** and **artificial intelligence is not the same thing at all**. In fact, the two fields are almost entirely separate.



- AI is used in many ways within the modern world. For example, AI algorithms are used in **Google searches**, **Amazon's recommendation engine** and **SatNav** route finders. Most AI programs are not used to control robots.

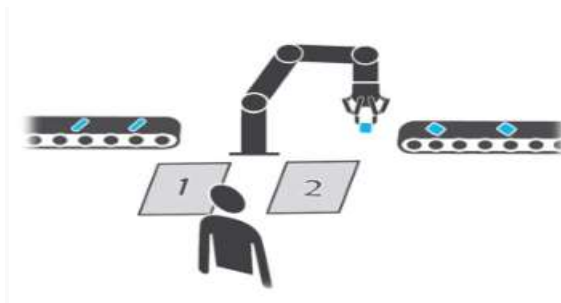


- Even when AI is used to control robots, the AI **algorithms** are only part of the larger robotic system, which also includes sensors, actuators.
- An **algorithm** is a procedure or formula for solving a problem, based on conducting a sequence of specified actions.

Artificial Intelligent Robots

Artificially intelligent robots are the bridge between **robotics** and **AI**. These are robots which are controlled by AI programs.

- Many robots are not artificially intelligent. Part of the industrial robots could only be programmed to carry out a repetitive series of movements. Repetitive movements do not require artificial intelligence.
- Non-intelligent robots are quite limited in their functionality. AI algorithms are often necessary to allow the robot to perform more complex tasks.
- A simple collaborative robot (cobot) is a perfect example of a non-intelligent robot.



Goals of AI

a. To Create Expert Systems

It is the type of system in which the system exhibit intelligent behavior, and advice its users.

b. To Implement Human Intelligence in Machines

It is the way of creating the systems that understand, think, learn, and behave like humans.

Applications and Examples of Artificial Intelligence

AI has been dominant in various fields such as:

Gaming

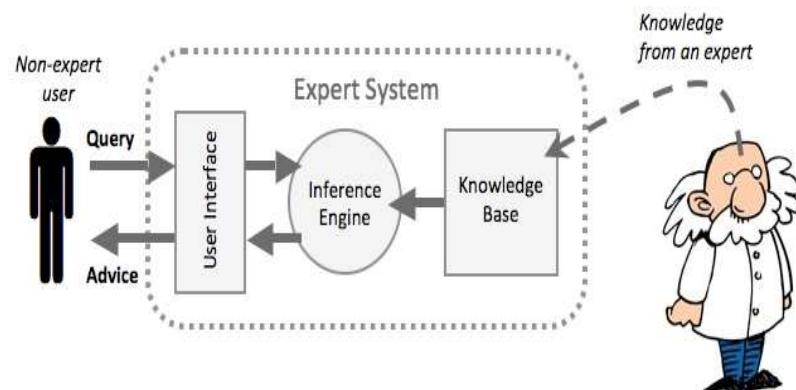
- AI plays crucial role in strategic games such as chess and poker etc., where machine can think of large number of possible positions based on heuristic knowledge.

Natural Language Processing

- It is possible to interact with the computer that understands natural language spoken by humans.

Expert Systems

- There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.



Vision Systems

These systems understand, interpret, and comprehend visual input on the computer. For example,

- A spying aeroplane takes photographs which are used to figure out spatial information or map of the areas, example U2.
- Doctors use clinical expert system to diagnose the patient.
- Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

Speech Recognition

- Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human's noise due to cold, etc.

Handwriting Recognition

- The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

Intelligent Robots

- Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

Smart Cars

- There are two examples: That is featured **Google's** self-driving car project and **Tesla's** "autopilot".



Fraud Detection

- Use to detect fraud, as many frauds always happen in banks. AI is often the technology deployed to monitor for this type of fraud.

Online Customer Support

- As artificial intelligence plays an important role in online customer support. As many websites have an option of **live chat** for their customers. In many cases, you're talking to a **rudimentary AI**.

Security Surveillance

- Monitoring a number of video cameras by a single person is not a secure system. Although, people easily get bored. Moreover, keeping all those at the same time is not an easy task.
- Thus, security algorithm can take input from the security cameras. As it happens to determine whether there may be a threat.

Smart Home Devices

- For lighting, we use artificial intelligence. Also, lighting is another place where you might see basic artificial intelligence. Although by setting defaults and preferences, the lights around your house might adjust. That is

based on where you are and what you're doing. For example: The uses of AI in smart homes are limited only by our imagination.

Manufacturing

AI is used in manufacturing company from the very beginning. Also, we use automobiles and electronic to manufactured goods. As we use AI to make more modifications.

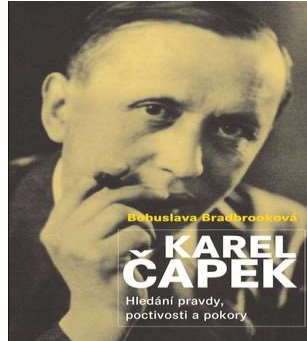
Home Appliances

Further, we use too many smart devices and gadgets used in our daily lives. That feature IoT technology also makes use of Artificial Intelligence.

Introduction to Robotics

- A **robot** is a programmable mechanical device that can perform tasks and interact with its environment, without the aid of human interaction. **Robotics** is the science and technology behind the design, manufacturing and application of robots (vexrobotics*, 2017).
- Simply, **Robotics** may be defines as “**The Study of Robots**”. The aim of **robotics** is to design an efficient **robot**.
- * <http://curriculum.vexrobotics.com/curriculum/intro-to-robotics/what-is-robotics>
- Another definition: a robot is a re-programmable multi-function manipulator designed to move material parts, tools or specialized devices, through variable programmed motions for the performance of a variety of tasks (Robotic Institute of America, 1979).

- The word robot was coined by the Czech playwright **Karel Capek** in 1921. He wrote a play called “**Rossum's Universal Robots**” that was about a slave class of manufactured human-like servants and their struggle for freedom. The Czech word **robota** loosely means “**compulsive servitude**.” The word **robotics** was first used by the famous science fiction writer, **Isaac Asimov**, in 1941.



Generally, **Robotics** is a branch of **Artificial Intelligence**. That is composed of Electrical, and Mechanical Engineering. Also, Computer Science for designing, construction, and application of robots.

Aspects of Robotics

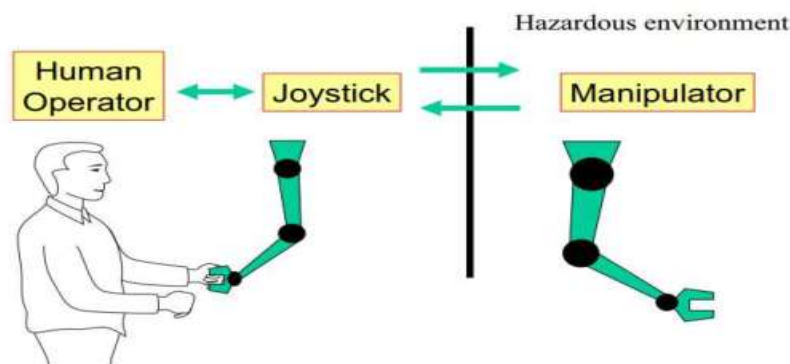
- Basically, robots have mechanical construction. That is to form or shape designed to accomplish a particular task.
- Also, it contains electrical components. That is use of power and control the machinery.
- Basically, it contains some level of a computer program. Also, it determines what, when and how a robot does something.

Industrial Robots

Industrial robots are programmable machines that can perform different operations by simply modifying stored data, a feature that has evolved from the application of numerical control.



Another origin of today's **industrial robots** can be found in remote manipulators. A remote manipulator is a device that performs a task at a distance. It can be used in environments that human workers cannot easily or safely access, e.g. for **handling radio-active materials**, or in some **deep sea** and **space applications**. The first master-slave manipulator system was developed by 1948. The concept involves an electrically powered mechanical arm installed at the operation site, and a control joystick of geometry similar to that of the mechanical arm.



Advantages of Industrial Robots

- Increased output rates.
- Improved product quality
- Reduced material wastage.
- Accident reduction.
- Greater flexibility and re-programmability.
- Can do repetitive task with accuracy.
- Working at places 24/7

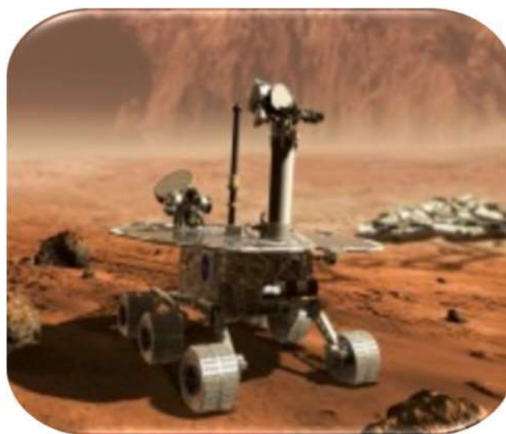
Disadvantages of Industrial Robot

- Replacement of human labor (Greater unemployment).
- Robots are an expensive initial cost.
- Can only do what it is instructed to do; nothing more, nothing less
- Consume energy
- Required maintenance.

Types of Robots

Mobile Robot

Mobile robots are able to move; usually they perform a task such as search areas. A prime example is the Mars explorer, specifically designed to roam the mars surface. Mobile robots are a great help to such collapsed building for survivors. Mobile robots are used for a task where people cannot go. Either because it is too dangerous of because people cannot reach the area that needs to be searched



Walking Robot

Robots on legs are usually brought in when the earth is rocky and difficult to enter with wheels.



Stationary Robot

Robots are not only used to explore areas or imitate a human being. Most robots perform repeating tasks without ever moving an inch. Most robots are ‘working’ in industry settings. Especially dull and repeating tasks are suitable for robots. A robot never grows tired; it will perform its duty day and night without ever complaining. In case the tasks at hand are done, the robots will be reprogrammed to perform other tasks.





Autonomous Robot

Autonomous robots are self-supporting or in other words self-contained. In a way, they rely on their own 'brains'. **Autonomous robots run a program that gives them the opportunity to decide on the action to perform depending on their surroundings.** At times these robots even learn new behaviour. They start out with a short routine and adapt this routine to be more successful at the task they perform. The most successful routine will be repeated as such their behaviour is shaped. Autonomous robots can learn to walk or avoid obstacles they find in their way. Think about a six-legged robot, at first the legs move ad random, after a little while the robot adjusts its program and performs a pattern which enables it to move in a direction.

Remote-control Robot

An autonomous robot is despite its autonomous not a very clever or intelligent unit. The memory and brain capacity is usually limited

Complicated tasks are still best performed by human beings with real brainpower. A person can guide a robot by remote control. A person can perform difficult and usually dangerous tasks without being at the spot where the tasks are performed. To detonate a bomb it is safer to send the robot to the danger area.

Virtual Robot

Virtual robots don't exist in real life. Virtual robots are just programs, building blocks of software inside a computer.

Robotic Applications

Exploration

- Space missions
- Exploring volcanoes
- Underwater exploration



Medical Science

- Surgical assistant (Da Vinci robot)



Other Application

- Painting
- Monitoring
- Security (for example bomb disposal)
- Home help (grass cutting, nursing)

Components of a Robot

Sensors: To collect information about the internal state of the robot, or to communicate with the outside environment, for example, Speech, Vision, Acceleration, Temperature, Distance, Touch, Light, Sound and Position Sense.

Effectors: In robotics, an end effector is a device at the end of a robotic arm, designed to interact with the environment.

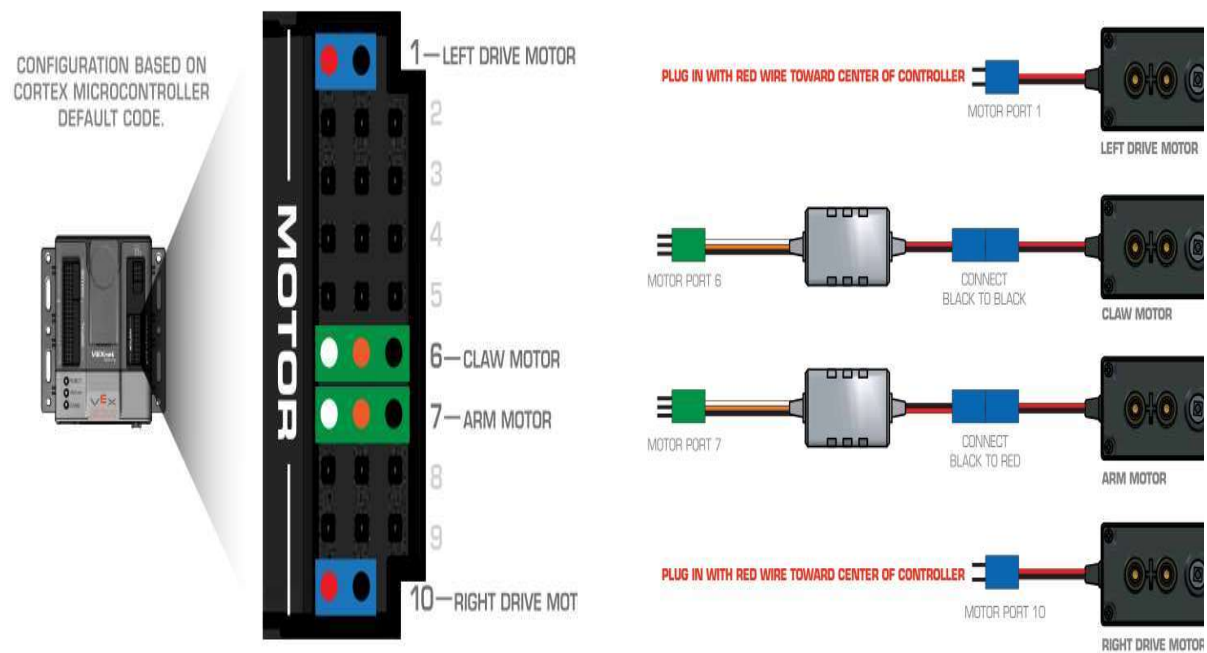
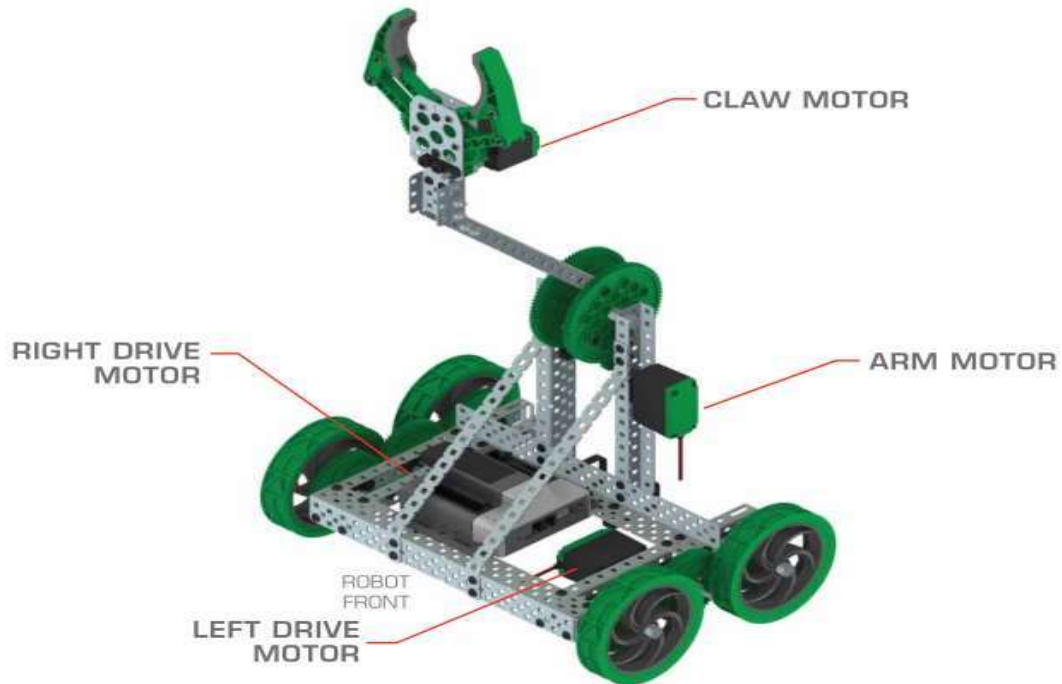
Actuators: Muscles of the manipulators (servomotor, stepper motor, pneumatic and hydraulic. cylinder).

Controllers: Similar to the cerebellum. It controls and coordinates the motion of the actuators.

Manipulator: Robot main body (Links and Joints of the robot).

Processor: The brain of the robot. For example, it calculates the motions and the velocity of the robot's joints.

Software: Operating system, robotic software and the collection of routines.





Difference in Robot System and AI Programs

Here is the difference between Artificial Intelligence and Robotics:

AI Programs

- Usually, we use to operate them in computer-**simulated worlds**.
- Generally, input is given in the form of **symbols** and **rules**.
- Basically, to operate this we need **general purpose computers**.

Robots

- Generally we use robots to operate in **real physical world**.
- Basically, inputs are given in the form of the analog signal, example in the form of the speech waveform.
- Also, to operate this, special hardware with sensors and effectors are needed.