Ingeniería en Computación

UDA: FUNDAMENTOS DE ROBÓTICA

TEMA: INTRODUCCIÓN A LA ROBÓTICA

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CU UAEM VM
## PROGRAMA DE ESTUDIO POR COMPETENCIAS

### FUNDAMENTOS DE ROBOTICA

### I. IDENTIFICACIÓN DEL CURSO

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<tr>
<th>Espacio Educativo: Facultad de Ingeniería</th>
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<td>Área de docencia: Interacción Hombre-Máquina</td>
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Año de aprobación por el Consejo Universitario: [Año]

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Programa elaborado por: Adriana H. Vilchis González

Programa revisado por: [Nombre]

Fecha de elaboración: 20 Septiembre del 2009

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Unidad de Aprendizaje Antecedente: Ninguna

Unidad de Aprendizaje Consecuente: Ninguna

Programas educativos o espacios académicos en los que se imparte:
Licenciatura en Ingeniería en Computación (Facultad. de Ingeniería, Centros Universitarios: Atlacomulco, Ecatepec, Texcoco, Valle de Chalco, Valle de México, Valle de Teotihuacán, Zumpango)
Image taken from http://www.cra.org/ccc/visioning/visioning-activities/robotics
ROBOTICS FIRST TIMELINE

- 1922 Czech author Karel Capek wrote a story called Rossum’s Universal Robots and introduced the word “Robota” (meaning worker, labor doing compulsory manual works without receiving any remuneration).

- 1954 George Devol developed the first programmable Robot.

- 1955 Denavit and Hartenberg developed the homogenous transformation matrices

- 1962 Unimation was formed, first industrial Robots appeared.
WHAT IS A ROBOT?

- **Random House Dictionary** A machine that resembles a human being and does mechanical routine tasks on command.

- **Robotics Association of America** An industrial robot is a re-programmable, multifunctional manipulator designed to move materials, parts, tools, or specialized devices through variable programmed motions for the performance of a variety of tasks.
WHAT IS A ROBOT?

- **Oxford dictionary** A machine resembling a human being and able to replicate certain human movements and functions automatically.

- Today's robots are a combination of manipulative, perceptive, communicative, and cognitive abilities. Today's robots are capable of so many tasks. Yet, there is so much more on the horizon.
WHAT IS A ROBOT?

- A manipulator (or an industrial robot) is composed of a series of links connected to each other via joints. Each joint usually has an actuator (a motor for eg.) connected to it.

- These actuators are used to cause relative motion between successive links. One end of the manipulator is usually connected to a stable base and the other end is used to deploy a tool.
TO QUALIFY AS A ROBOT

- A machine must be able to:
  - Sensing and perception: get information from its surroundings.
  - Carry out different tasks: Locomotion or manipulation, do something physical—such as move or manipulate objects.
  - Re-programmable: can do different things in different ways.
  - Function autonomously and/or interact with human beings.
ROBOTS ARE HARD TO DEFINE

As the field of robotics rapidly progresses it is not necessarily a bad thing that everyone has not agreed on a universal definition for a robot:

- Robots are likely to outgrow any definition placed upon them.

- Perhaps Joseph Engelberger, father of the industrial robot, summed it up best when he said: "I may not be able to define one, but I know one when I see one."
HOLLYWOOD’S ROBOTS
Isaac Asimov proposed the following three Laws of Robotics:

• Law 1: A robot may not injure a human being or through inaction, allow a human being to come to harm.

• Law 2: A robot must obey orders given to it by human beings, except where such orders would conflict with a higher order law.

• Law 3: A robot must protect its own existence as long as such protection does not conflict with a higher order law.

Go to http://www.asimovonline.com/asimov_home_page.html
CLASSIFICATION OF ROBOTS

- JIRA (Japanese Industrial Robot Association):
  - Class 1: Manual-Handling Device
  - Class 2: Fixed Sequence Robot
  - Class 3: Variable Sequence Robot
  - Class 4: Playback Robot
  - Class 5: Numerical Control Robot
  - Class 6: Intelligent Robot
CLASSIFICATION OF ROBOTS

• **RIA (Robotics Institute of America):**
  
  • Variable Sequence Robot (Class3): A device that performs the successive stages of a task according to a predetermined method easy to modify.
  
  • Playback Robot (Class4): A human operator performs the task manually by leading the Robot.
  
  • Numerical Control Robot (Class5): The operator supplies the movement program rather than teaching it the task manually.
  
  • Intelligent Robot (Class6): A robot with the means to understand its environment and the ability to successfully complete a task despite changes to the environment.
CLASSIFICATION OF ROBOTS

- **AFR** (Association FranÇaise de Robotique):
  - Type A: Manual Handling Devices/telerobotics
  - Type B: Automatic Handling Devices/ predetermined cycles
  - Type C: Programmable, Servo controlled robot, continuous point-to-point trajectories
  - Type D: Same type with C, but it can acquire information
ROBOTS IN THE WORLD

Painting Robot in Motor Company

Assembly Robot in Electronic Company
Wearable Robotic Arm and Tele-Operated Robot (KIST)
ROBOTS IN THE WORLD

HONDA (ASIMO) – Biped Robot  
Fujitsu – Biped Robot (Laptop Size)

Fundamentals of Robotics
ROBOTS IN THE WORLD

Sony (AIBO) – Toy robot
ROBOT CHARACTERISTICS

• Robots are:
  
  • Machines - mechanical devices designed for doing work.
  
  • Automatic - operations which are executed without external help.
  
  • Reprogrammable - multifunctional and flexible: not restricted to one job but can be programmed to perform many jobs (nearly all robot systems contain a reprogrammable computer).
  
  • Responsive - must be able to react based on their sensory input.
WHAT IS ROBOTICS?

- Robotics is the art, knowledge base, and the know-how of designing, applying, and using robots in human endeavors.

- Robotics is an interdisciplinary subject that benefits from mechanical engineering, electrical and electronic engineering, computer science, biology, and many other disciplines.
WHAT IS ROBOTICS

• History of Robotics:
  • 1922: Karel Čapek’s novel, Rossum’s Universal Robots, word “Robota” (worker)
  • 1952: NC machine (MIT)
  • 1955: Denavit-Hartenberg Homogeneous Transformation
  • 1967: Mark II (Unimation Inc.)
  • 1968: Shakey (SRI) - intelligent robot
  • 1973: T3 (Cincinnati Milacron Inc.)
  • 1978: PUMA (Unimation Inc.)
  • 1983: Robotics Courses
  • 21C: Walking Robots, Mobile Robots, Humanoid Robots
ADVANTAGES VS. DISADVANTAGES OF ROBOTS

• Robots increase productivity, safety, efficiency, quality, and consistency of products.

• Robots can work in hazardous environments without the need.

• Robots need no environmental comfort.

• Robots work continuously without experiencing fatigue of problem.
ADVANTAGES VS. DISADVANTAGES OF ROBOTS

• Robots have repeatable precision at all times.
• Robots can be much more accurate than human.
• Robots replace human workers creating economic problems.
• Robots can process multiple stimuli or tasks simultaneously.
ADVANTAGES VS. DISADVANTAGES OF ROBOTS

• Robots lack capability to respond in emergencies.

• Robots, although superior in certain senses, have limited capabilities in Degree of freedom, Dexterity, Sensors, Vision system, real time response.

• Robots are costly, due to Initial cost of equipment, Installation costs, Need for Peripherals, Need for training, Need for programming.
WHY USE ROBOTS?

• Application in 4D environments
  • Dangerous
  • Dirty
  • Dull
  • Difficult

• 4A tasks
  • Automation
  • Augmentation
  • Assistance
  • Autonomous
WHY USE ROBOTS?

• Increase product quality:
  • Superior Accuracies (thousands of an inch, wafer-handling: microinch)
  • Repeatable precision
  • Consistency of products

• Increase efficiency:
  • Work continuously without fatigue
  • Need no vacation
WHY USE ROBOTS?

• Increase safety:
  • Operate in dangerous environment
  • Need no environmental comfort:
    • Air conditioning, noise protection, etc.

• Reduce Cost:
  • Reduce scrap rate
  • Lower in-process inventory
  • Lower labor cost
WHY USE ROBOTS?

- Reduce manufacturing lead time:
  - Rapid response to changes in design

- Increase productivity:
  - Value of output per person per hour increases
• Robots can be classified according to six different characteristics:
  
  • Use
  • Mobility
  • Motion control
  • Capability
  • Arm configuration
  • End effector
TYPES OF ROBOTS

• Use:
  • Industrial robots vs Non industrial robots.

• Mobility:
  • Mobile robots vs Fixed robots.

• Motion control:
  • Servo-controlled robots vs Non-Servo Control
TYPES OF ROBOTS

• Capability:
  
  • First Generation Robots include both playback and numerically controlled (NC) robots.
  
  • Second generation robots incorporate basic sensory systems to feedback information to the computer controller and can respond to their environment (adaptive robots).
  
  • Third generation robots use artificial intelligence (AI) computers.
TYPES OF ROBOTS

• Arm Configuration (Robots that have arms):
  
  • Rectangular Coordinate Robot vs Cylindrical Coordinate Robot vs Spherical Coordinate Robot.
  
  • Jointed Arm Robot vs Spine Robot.

• End effector:
  
  • End effectors are the type of tool attached to the end of the robot arm.
  
    • ability of end effectors to be automatically changed to a different tool is a major factor in robot flexibility.
ROBOTICS FOR ALL

• Robot Manipulators:
  • Assembly
  • Automation

• Field robots:
  • Military applications
  • Space exploration

• Service robots:
  • Cleaning robots
  • Medical robots

• Biotechnology:
  • Micro/Nano manipulation
  • Sample Handling
  • Automated Analysis

• Urban challenge:
  • Fire Fighting
  • Search and Rescue

• Entertainment robots:
  • Toys

• There are over 4 million robots in use in society of which, about 1 million are industrial robots:

  • 50% in Asia, 32% in Europe, 16% in North America
WHAT CAN ROBOTS DO?

- Jobs that are dangerous for humans.

- Repetitive jobs that are boring, stressful, or labor-intensive for humans.

- Menial tasks that human do not want to do.

- Chances are, something you eat, wear, or was made by a robot.

- Even much more: When robots enter the public domain, the robot revolution will demand that information age people be “robot literate.”

- The future uses and applications are very promising: Future robots will be able to relieve man of many types of physical work.
REFERENCIAS


• José Santos, Richar J. Duro. (2004). Evolución Artificial y Robótica Autónoma. Alfaomega-RaMA.


Esta presentación tiene como fin lo siguiente:

- ¿Qué es un robot?, sus tipos, características y clasificación.
- Leyes de la robótica y ¿Qué es la robótica?
- Qué pueden hacer los robots, sus ventajas y desventajas.
• El contenido de esta presentación contiene temas de interés contenidos en la Unidad de Aprendizaje Fundamentos de Robótica.

• El material va en Inglés para reforzar la práctica de esta lengua y fomentar el uso de la misma en UDAs avanzadas y especializadas.

• Las diapositivas deben explicarse en orden, y deben revisarse aproximadamente en 24 horas, además de realizar preguntas a la clase sobre el contenido mostrado.