Seminar on Robotics

Introduction

Robotics is the interdisciplinary study and practice of the design, construction, operation, and use of robots.

Within mechanical engineering, robotics is the design and construction of the physical structures of robots, while in computer science, robotics focuses on robotic automation algorithms. Other disciplines contributing to robotics include electrical, control, software, information, electronic, telecommunication, computer, mechatronic, and materials engineering.

The goal of most robotics is to design machines that can help and assist humans. Many robots are built to do jobs that are hazardous to people, such as finding survivors in unstable ruins, and exploring space, mines and shipwrecks. Others replace people in jobs that are boring, repetitive, or unpleasant, such as cleaning, monitoring, transporting, and assembling. Today, robotics is a rapidly growing field, as technological advances continue; researching, designing, and building new robots serve various practical purposes.

Robotics aspects:

Robotics usually combines three aspects of design work to create robot systems:

Mechanical construction: a frame, form or shape designed to achieve a particular task. For example, a robot designed to travel across heavy dirt or mud might use caterpillar tracks. Origami inspired robots can sense and analyze in extreme environments. The mechanical aspect of the robot is mostly the creator's solution to completing the assigned task and dealing with the physics of the environment around it. Form follows function.

Electrical components that power and control the machinery. For example, the robot with caterpillar tracks would need some kind of power to move the tracker treads. That power comes in the form of electricity, which will have to travel through a wire and originate from a battery, a basic electrical circuit. Even petrol-powered machines that get their power mainly from petrol still require an electric current to start the combustion process which is why most petrol-powered machines like cars, have batteries. The electrical aspect of robots is used for movement (through motors), sensing (where electrical signals are used to measure things like heat, sound, position, and energy status), and operation (robots need some level of electrical energy supplied to their motors and sensors in order to activate and perform basic operations)

Software. A program is how a robot decides when or how to do something. In the caterpillar track example, a robot that needs to move across a muddy road may have the correct mechanical construction and receive the correct amount of power from its battery, but would not be able to go anywhere without a program telling it to move. Programs are the core essence of a robot, it could have excellent mechanical and electrical construction, but if its program is poorly structured, its performance will be very poor (or it may not perform at all). There are three different types of robotic programs: remote control, artificial intelligence, and hybrid. A robot with remote control programming has a preexisting set of commands that it will only perform if and when it receives a signal from a control source, typically a human being with remote control. It is perhaps more appropriate to view devices controlled primarily by human commands as falling in the discipline of automation rather than robotics. Robots that use artificial intelligence interact with their environment on their own without a control source, and can determine reactions to objects and problems they encounter using their preexisting programming. A hybrid is a form of programming that incorporates both AI and RC functions in them.

Applied robotics:

As many robots are designed for specific tasks, this method of classification becomes more relevant. For example, many robots are designed for assembly work, which may not be readily adaptable for other applications. They are termed "assembly robots". For seam welding, some suppliers provide complete welding systems with the robot i.e. the welding equipment along with other material handling facilities like turntables, etc. as an integrated unit. Such an integrated robotic system is called a "welding robot" even though its discrete manipulator unit could be adapted to a variety of tasks. Some robots are specifically designed for heavy load manipulation, and are labeled as "heavy-duty robots".

Current and potential applications include:

Manufacturing. Robots have been increasingly used in manufacturing since the 1960s. According to the Robotic Industries Association US data, in 2016 the automotive industry was the main customer of industrial robots with 52% of total sales. In the auto industry, they can amount for more than half of the "labor". There are even "lights off" factories such as an IBM keyboard manufacturing factory in Texas that was fully automated as early as 2003.

Autonomous transport including airplane autopilot and self-driving cars

Domestic robots including robotic vacuum cleaners, robotic lawn mowers, dishwasher loading and flatbread baking.

Construction robots. Construction robots can be separated into three types: traditional robots, robotic arm, and robotic exoskeleton.

Automated mining.

Space exploration, including Mars rovers.

Energy applications including cleanup of nuclear contaminated areas; and cleaning solar panel arrays.

Medical robots and Robot-assisted surgery designed and used in clinics.

Agricultural robots. The use of robots in agriculture is closely linked to the concept of AI-assisted precision agriculture and drone usage.

Food processing. Commercial examples of kitchen automation are Flippy (burgers), Zume Pizza (pizza), Cafe X (coffee), Makr Shakr (cocktails), Frobot (frozen yogurts), Sally (salads), salad or food bowl robots manufactured by Dexai (a Draper Laboratory spinoff, operating on military bases), and integrated food bowl assembly systems manufactured by Spyce Kitchen (acquired by Sweetgreen) and Silicon Valley startup Hyphen. Other examples may include manufacturing technologies based on 3D Food Printing.

Military robots.

Robot sports for entertainment and education, including Robot combat, Autonomous racing, drone racing, and FIRST Robotics.

Mechanical robotics areas:

Control robotics areas:

The mechanical structure of a robot must be controlled to perform tasks. The control of a robot involves three distinct phases ? perception, processing, and action (robotic paradigms). Sensors give information about the environment or the robot itself (e.g. the position of its joints or its end effector). This information is then processed to be stored or transmitted and to calculate the appropriate signals to the actuators (motors), which move the mechanical structure to achieve the required co-ordinated motion or force actions.

The processing phase can range in complexity. At a reactive level, it may translate raw sensor information directly into actuator commands (e.g. firing motor power electronic gates based directly upon encoder feedback signals to achieve the required torque/velocity of the shaft). Sensor fusion and internal models may first be used to estimate parameters of interest (e.g. the position of the robot's gripper) from noisy sensor data. An immediate task (such as moving the gripper in a certain direction until an object is detected with a proximity sensor) is sometimes inferred from these estimates. Techniques from control theory are generally used to convert the higher-level tasks into individual commands that drive the actuators, most often using kinematic and dynamic models of the mechanical structure.

At longer time scales or with more sophisticated tasks, the robot may need to build and reason with a "cognitive" model. Cognitive models try to represent the robot, the world, and how the two interact. Pattern recognition and computer vision can be used to track objects. Mapping techniques can be used to build maps of the world. Finally, motion planning and oth