

Note

Lecture 1 - Introduction to Robotic

Learning Objectives

Objectives:

1. Definition of robotics & it's history
机器人定义以及历史
2. Current robotic sectors
当前的机器人领域
3. Industrial robotics & manipulators
工业机器人和操纵者

Robot Definition

Two common definitions are:

- (old)An industrial robot is a reprogrammable, multifunctional manipulator designed to move parts, tools or special devices through variable programmed motions for the performance of a variety of tasks
(旧) 工业机器人是一种可重新编程的多功能操纵器，旨在通过可变的编程动作移动零件、工具或特殊设备，以执行各种任务
- A robot is an artificial physical agent that perceives its environment through sensors and acts upon that environment through actuators.
机器人是一种人工物理代理，它通过传感器感知其环境并通过执行器对该环境采取行动。

Current Robotic Application Sectors

- Manufacturing 制造业
- Surgical 外科
- Service 服务业
- Military 军事
- Healthcare 医疗保健
- Home 家居
- Space 太空
- Farming 农业
- Security/surveillance 安全/监视
- Rescue 救援
- Extreme Environments 极端环境

Lecture 2 - Actuators & Sensors

Learning Objectives

Objectives:

- Different Types of Actuators 不同类型的执行器
- Sensors 传感器

Actuators

Three commonly used actuator types:

- Electromagnetic(The most common types of actuators) 电磁
- Hydraulic 液压
- Pneumatic 气动

Electromagnetic Actuators 电磁执行器

- Brushed DC Motor 有刷直流电动机
 - Current flowing through armature generates a magnetic field and permanent magnets torque the armature
通过电枢的电流产生磁场，永久磁铁扭转电枢
 - Advantages: Provides variable speeds, low-cost
优点：提供可变速度，成本低
 - Disadvantages: Brush wear out, low precision
缺点：刷子磨损，精度低
- Brushless DC Motor 无刷直流电动机
 - Armature is fixed, and permanent magnets rotate
电枢固定，永久磁铁旋转
 - Advantages: Efficiency, Low noise, Cooling, Water-resistant
优点：效率高、噪音低、散热、耐水
 - Disadvantages: low precision, costly
缺点：精度低，成本高
- Stepper Motor 步进电动机
 - Brushless, synchronous motor that moves in discrete steps
无刷、同步电机，以离散步进运动
 - Advantage: Precise, quantized control without feedback 优点：精确、量化控制，无需反馈
 - Disadvantages: Slow and moves in discrete steps, expensive 缺点：速度慢，以离散步进移动，成本高

Hydraulic Actuators 液压执行器

- Cylinders(linear actuators): 气缸（线性执行器）
 - Advantages:
 - Very powerful that offer very large force capability, but expensive 非常强大，提供极大的力输出，但成本高

- High power-to-weight ratio 功率与重量比高
- Drawbacks:
 - Their power supplies are bulky and heavy 电源体积大且沉重
 - Oil leakage 漏油问题
- Motors(rotary actuators) 马达（旋转执行器）
- Integrated Smart Hydraulic Actuator 集成智能液压执行器
 - Usual hydraulic actuator-valve configuration 常见的液压执行器-阀门配置

Pneumatic Actuators 气动执行器

- Cylinders(linear actuators) 气缸（线性执行器）
- Motors(rotary actuators) 马达（旋转执行器）

Sensors

Motivation

A robot would be easily controlled if a complete model of the environment was available for the robot, and if its actuators could execute motion commands perfectly relative to this model
如果机器人拥有完整的环境模型，并且其执行器能够相对于该模型完美执行运动命令，则机器人将更容易控制。

Robotic sensor classification

- Proprioceptive 本体感知
 - Internal state of the robot 机器人的内部状态
 - Measures values (e.g. wheels position, joint angle, battery level, etc)
- Exteroceptive 外感知
 - External state of the system 系统的外部状态
 - Observing environment, detecting objects, etc
- Active 主动
 - Emits energy(e.g. radar)
- Passive 被动
 - Receives energy(e.g. camera)
- Real-world Characteristics of sensors
 - **Sensitivity:** Ratio of output change to input change
灵敏度：输出变化与输入变化的比率
 - **Error/Accuracy:** Difference between the sensor's output and the true value
误差/准确度：传感器输出与真实值之间的差异
 - **Systematic/Deterministic Error:** Caused by factors that can be modelled(in theory), e.g., calibration of a laser sensor
系统/确定性误差：由可建模的因素引起（理论上），如激光传感器的校准

- **Random Error:** e.g., hue instability of camera, black level noise of camera
随机误差：如相机色调不稳定、相机的黑电平噪声
- **Reproducibility:** Reproducibility of sensor results
再现性：传感器结果的可重复性

Various sensors overview

- A simple On/Off switch
- Tilt sensor(mercury tilt) 倾斜传感器（汞倾斜）
- Dual axis inclinometer 双轴倾斜仪
- Potentiometer 电位器
- Bumpers 缓冲器
 - Mechanical switches
- Light sensors
 - Photoresistors, light dependent resistors(LDR)
 - Phototransistors 光电晶体管
- Thermal sensor
 - Thermal resistor
 - Temperature sensors
 - Analogue
 - Digital
- Proximity sensors 接近传感器
 - Non-contact
 - Devices that can be used in areas that are near to an object to be sensed
 - Different types of Proximity Sensors
 - Infrared
 - Ultrasonic
 - Inductive 电感
 - Capacitive 电容
- Position Sensors
 - Potentiometer 电位器
 - Resolver 解算器
 - Optical Encoders
 - Relative position
 - Absolute position
- Heading sensors: 方位传感器
 - Heading sensors can be proprioceptive(gyroscope, inclinometer) or exteroceptive(compass)
方位传感器可以是本体感知（陀螺仪、倾角仪）或外感知（指南针）

- Used to determine the robots orientation and inclination
用于确定机器人的方位和倾斜角
- Accelerometer
 - be made to sense acceleration by simply measuring the force on a mass
- Gyroscope 陀螺仪
 - Heading sensors for measuring and to keep the orientation to a fixed frame
用于测量和保持相对于固定框架的方向的方位传感器
 - Two methods:
 - Mechanical(flywheel)
 - Electronic

Components used for Manipulators

- Components in a joint:
 - Motors(electric or hydraulic)
 - Motor Encoders
 - Angle(joint angle)
 - Displacement sensor 位移传感器
 - Gearbox 齿轮箱