Chapter 1

Introduction of Robotics

Text A

Robotics is an *interdisciplinary branch* of engineering and science that includes mechanical engineering, electronic engineering, information engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, *sensory feedback*, and information processing.

These technologies are used to develop machines that can *substitute* for humans and *replicate* human actions. Robots can be used in many situations and for lots of purposes, but today many are used in dangerous environments (including bomb detection and deactivation), manufacturing processes, or where humans cannot survive (e.g. in space). Robots can take on any form but some are made to resemble humans in appearance. This is said to help in the acceptance of a robot in certain *replicative* behaviors usually performed by people. Such robots attempt to replicate walking, lifting, speech, *cognition*, and basically anything a human can do. Many of today's robots are inspired by nature, contributing to the field of bio-inspired robotics.

The concept of creating machines that can operate autonomously dates back to classical times, but research into the functionality and potential uses of robots did not grow substantially until the 20th century. Throughout history, it has been frequently assumed by various scholars, inventors, engineers, and technicians that robots

New Words and Expressions

interdisciplinary /ɪntəˈdɪsɪplɪn(ə)rɪ/ adj.
各学科间的；跨学科的

branch/brɑːn(t)ʃ/ n.
树枝，分枝；分部；支流

sensory feedback
传感反馈

substitute/ˈsʌbstɪtjuːt/ v.
代替

replicate/ˈreplɪkeɪt/ v.
复制

replicative/ˈreplɪkətɪv/ adj.
复制的；重复的

cognition/kɒgˈnɪʃ(ə)n/ n.
认识；知识；认识能力

will one day be able to *mimic* human behavior and manage tasks in a human-like fashion. Today, robotics is a rapidly growing field, as technological advances continue; researching, designing, and building new robots serve various practical purposes, whether domestically, commercially, or militarily. Many robots are built to do jobs that are *hazardous* to people such as defusing bombs, finding survivors in unstable ruins, and exploring mines and shipwrecks. Robotics is also used in STEM[1] as a teaching aid.

Commercial and industrial robots are widespread today and used to *perform* jobs more cheaply, more *accurately* and more *reliably*, than humans. They are also employed in some jobs which are too dirty, dangerous, or dull to be suitable for humans. Robots are widely used in manufacturing, assembly, packing and packaging, mining, transport, earth and space exploration, surgery, weaponry, laboratory research, safety, and the mass production of consumer and industrial goods.

Etymology

The word robotics was derived from the word robot, which was introduced to the public by Czech writer Karel Čapek in his play R.U.R. (Rossum's Universal Robots), which was published in 1920. The word robot comes from the Slavic word robota, which means labour/work. The play begins in a factory that makes *artificial* people called robots, creatures who can be mistaken for humans – very similar to the modern ideas of androids. According to the Oxford English Dictionary, the word robotics was first used in print by Isaac Asimov, in his science fiction short story "Liar!", published in May 1941 in Astounding Science Fiction.

History

In 1939, the humanoid robot known as Elektro appeared at the World's Fair. Seven feet tall (2.1 m) and weighing 265 pounds (120 kg), it could walk by voice *command*, speak about 700 words (using a 78-rpm record player), smoke cigarettes, blow up balloons, and move its head and arms. The body consisted of a steel gear cam and motor skeleton covered by an *aluminium* skin. In 1939 Konrad Zuse constructed the first programmable *electromechanical* computer, laying the *foundation* for the construction of a humanoid machine that is now deemed a robot.

In 1951 Walter published the paper A Machine that learns,

New Words and Expressions

mimic/ˈmɪmɪk/ v.
模仿，摹拟

hazardous/ˈhæzədəs/ adj.
有危险的

commercial/kəˈmɜːʃ(ə)l/ adj.
商业的

perform/pəˈfɔːm/ v.
执行

accurately/ˈækjərətli/ adv.
精确地，准确地

reliably/riˈlaiəbli/ adv.
可靠地

artificial/ɑːtɪˈfɪʃ(ə)l/ adj.
人造的；仿造的

command/kəˈmɑːnd/ n.
指挥，控制；命令

aluminium/æl(j)ʊˈmɪnɪəm/ adj.
铝的

electromechanical
/ɪˌlektrəʊmɪˈkænɪk(ə)l/ adj.
电动机械的

foundation/faʊnˈdeɪʃ(ə)n/ n.
基础

documenting how his more advanced mechanical robots acted as intelligent agent by demonstrating conditioned reflex learning. The first digitally operated and programmable robot was invented by George Devol in 1954 and was called the Unimate. This later laid the foundations of the modern robotics industry.

Devol sold the first Unimate to General Motors[2] in 1960, and it was installed in 1961 in a plant in Ewing Township, New Jersey to lift hot pieces of metal from a die casting machine and place them in cooling liquid. Devol's *patent* for the first digitally operated programmable robotic arm represents the foundation of the modern robotics industry.

The development of humanoid robots was advanced considerably by Japanese robotics scientists in the 1970s. Waseda University initiated the WABOT project in 1967, and in 1972 completed the WABOT-1[3]. Its *limb* control system allowed it to walk with the lower limbs, and to *grip* and transport objects with hands, using tactile sensors. Its vision system allowed it to measure distances and directions to objects using external receptors, artificial eyes and ears. And its conversation system allowed it to communicate with a person in Japanese, with an artificial mouth. This made it the first android.

Robotic aspects

There are many types of robots; they are used in many different environments and for many different uses, although being very diverse in application and form they all share three basic similarities when it comes to their *construction*:

Robots all have some kind of 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*. The mechanical aspect is mostly the creator's solution to completing the *assigned* task and dealing with the physics of the environment around it. Form follows function.

Robots have electrical components which 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

New Words and Expressions

patent/ˈpæt(ə)nt;/ n.
专利权

limb/lɪm/ n.
肢，臂

grip/grɪp/ v.
紧握；夹紧

construction/kənˈstrʌkʃ(ə)n/ n.
建设

dirt/dɜ:t/ n.
污垢，泥土

caterpillar track
履带

assign/əˈsaɪn/ v.
分配

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).

All robots contain some level of computer programming code. A program is how a robot decides when or how to do something. Programs are the core essence of a robot, it could have excellent mechanical and electrical construction, but if its program is poorly constructed 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 programing 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 a remote control. 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. Hybrid is a form of programming that *incorporates* both AI and RC functions.

Applications

As more and more 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 as "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.

Current and potential applications include:

- Military robots. Military robots are autonomous robots or remote-controlled mobile robots designed for military applications, from transport to search & rescue and attack.

New Words and Expressions

combustion process
燃烧过程

motor/ˈməʊtə/ n.
发动机

interact/ɪntərˈækt/ v.
互相影响；互相作用

determine/dɪˈtɜːmɪn/ v.
（使）下决心，（使）做出决定

incorporate/ɪnˈkɔːpəreɪt/ v.
包含

relevant/ˈreləvənt/ adj.
相关的

seam welding
[机] 缝焊

equipment/ˈɪkwɪpm(ə)nt/ n.
设备

integrate/ˈɪntɪgreɪt/ v.
使…完整

Figure 1-1 Introduction of Robotics：Military robots

- Industrial robots. An industrial robot is a robot system used for manufacturing. Industrial robots are automated, programmable and capable of movement on three or more *axis*.
- Collaborative robots. A cobot is a robot intended to *physically* interact with humans in a shared workspace. This is in contrast with other robots, designed to operate autonomously or with limited guidance, which is what most industrial robots were up until the decade of the 2010s.
- Construction robots. Construction robots can be separated into three types: traditional robots, robotic arm, and robotic exoskeleton.
- Agricultural robots. An agricultural robot is a robot deployed for agricultural purposes. The main area of application of robots in agriculture today is at the *harvesting* stage.
- Medical robots. A medical robot is a robot used in the medical sciences. They include *surgical* robots. These are in most *telemanipulators*, which use the surgeon's actions on one side to control the "effector" on the other side.
- Domestic robots. A domestic robot is a type of service robot, an autonomous robot that is primarily used for household *chores*, but may also be used for education, entertainment or *therapy*.

Components

- Power source. Many different types of batteries can be used as a power source for robots. They range from lead–acid

New Words and Expressions

axis/ˈæksɪs/ n.
轴；轴线

physically/ˈfɪzɪkəllɪ/ adv.
身体上

harvest/ˈhɑːvɪst/ v.
收割

surgical/ˈsɜːdʒɪk(ə)l/ adj.
外科的；手术上的

telemanipulator
/telɪməˈnɪpjɪleɪtə(r)/ n.
遥控机械手

chore/tʃɔː/ n.
日常的零星事务

therapy/ˈθerəpɪ/ n.
治疗，疗法

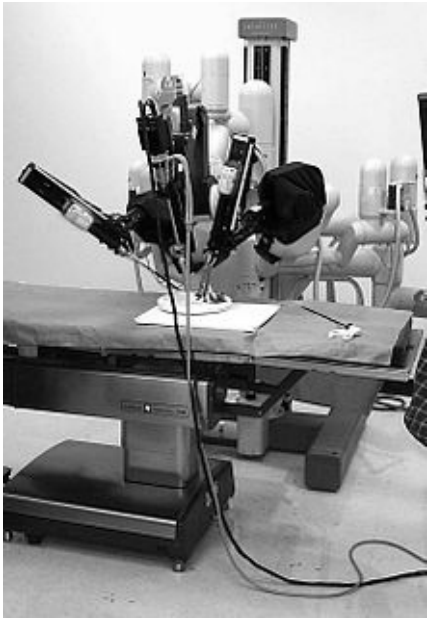

Figure 1-2 Introduction of Robotics：A robotic surgery machine

batteries, which are safe and have relatively long shelf lives but are rather heavy compared to silver–cadmium batteries that are much smaller in *volume* and are currently much more expensive. Designing a battery-powered robot needs to take into account factors such as safety, cycle lifetime and weight.

- *Actuation*. Actuators are the "*muscles*" of a robot, the parts which convert stored energy into movement.
- Sensing. Sensors allow robots to receive information about a certain measurement of the environment, or internal components. This is essential for robots to perform their tasks, and act upon any changes in the environment to calculate the appropriate response. They are used for various forms of measurements, to give the robots warnings about safety or malfunctions, and to provide real-time information of the task it is performing.
- Manipulation. Robots need to *manipulate* objects: pick up, *modify*, destroy, or otherwise have an effect. Thus the "hands" of a robot are often referred to as end effectors, while the "arm" is referred to as a manipulator. Most robot arms have replaceable effectors, each allowing them to

New Words and Expressions

volume/ˈvɒljuːm/ n.
体积

actuation/ˌæktjʊˈeɪʃən/ n.
冲动，驱使

muscle/ˈmʌs(ə)l/ n.
肌肉

manipulate/məˈnɪpjʊleɪt/ v.
操纵；操作

modify/ˈmɒdɪfaɪ/ v.
修改，修饰

perform some small range of tasks. Some have a fixed manipulator which cannot be replaced, while a few have one very general purpose manipulator, for example, a humanoid hand. Learning how to manipulate a robot often requires a close feedback between human to the robot, although there are several methods for *remote* manipulation of robots.

- Locomotion. Robot locomotion is the collective name for the various methods that robots use to transport themselves from place to place. A major goal in this field is in developing capabilities for robots to autonomously decide how, when, and where to move. However, *coordinating* a large number of robot joints for even simple matters is difficult. Autonomous robot locomotion is a major technological *obstacle* for many areas of robotics, such as humanoids.

Control system

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.

The processing phase can range in complexity. At a reactive level, it may translate raw sensor information directly into actuator commands. Sensor fusion may first be used to estimate parameters of interest from noisy sensor data. An immediate task is inferred from these estimates. Techniques from control theory convert the task into commands that drive the actuators.

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 they 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 other artificial intelligence techniques may be used to figure out how to act. For example, a planner may figure out how to achieve a task without hitting obstacles, falling over, etc.

New Words and Expressions

remote/rɪˈməʊt/ n.
远程

coordinate/kəʊˈɔːdɪneɪt/ v.
协调

obstacle/ˈɒbstək(ə)l/ n.
障碍

paradigm/ˈpærədaɪm/ n.
范式

sophisticated/səˈfɪstɪkeɪtɪd/ adj.
复杂的

cognitive model
[计] 认知模型

Note:

The text is adapted from the website:

https://en.wikipedia.org/wiki/Robotics#Applications

Terms

1. STEM

science, technology, engineering, and mathematics 科学、技术、工程和数学

2. General Motors

通用汽车（财富 500 强公司之一，总部所在地美国，主要经营汽车）

3. WABOT-1

世界上第一台全尺寸仿人智能机器人

Comprehension

Blank filling

1. Robotics is an interdisciplinary branch of engineering and science that includes_____, _____, _____, _____, and others.
2. Military robots are _____ robots or remote-controlled mobile robots designed for military applications, from transport to _____ and attack.
3. A domestic robot is a type of service robot, an autonomous robot that is primarily used for household chores, but may also be used for _____, _____ or _____.
4. The control of a robot involves three distinct phases: _____, _____, and _____ .

Content Questions

1. What are the three basic similarities when building robots?
2. What are the components of the robot?

Answers

Blank filling

1. mechanical engineering; electronic engineering; information engineering; computer science
2. autonomous; search & rescue
3. education; entertainment; therapy
4. perception; processing; action

Content Questions

1. Robots all have some kind of mechanical construction, a frame, form or shape designed to achieve a particular task. Robots have electrical components which power and control

the machinery. All robots contain some level of computer programming code.

2. Power source, actuation, sensing, manipulation, locomotion.

参考译文 A

机器人学是工程与科学的跨学科分支，包括机械工程、电子工程、信息工程、计算机科学等。机器人学涉及机器人的设计、构造、操作和使用，以及控制、感觉反馈和信息处理的计算机系统。

这些技术被用来开发可以替代人类和复制人类行为的机器。机器人可以用于多种情况和多种目的，但现在在危险的环境中（包括炸弹探测和拆除）都应用了机器人，危险的环境包括制造过程，或人类无法生存的地方（如太空）。机器人可以以任何形式出现，有些机器人的外形与人类相似。据说这有助于人们接受机器人的某些复制行为，而这些行为通常是由人类能够完成的。这些机器人试图复制走路、举重、说话、认知，以及人类几乎能做的所有事情。今天的许多机器人都受到自然的启发，为生物机器人领域做出了贡献。

创造能够自主操作的机器的概念可以追溯到古典时代，但是对机器人的功能和潜在用途的研究直到 20 世纪才有实质性的发展。纵观历史，许多学者、发明家、工程师和技术人员经常认为，机器人有一天将能够模仿人类的行为，并以类似人类的方式管理任务。今天，随着技术的不断进步，机器人技术是一个快速发展的领域。无论是自用、商用或军事用途上，研究、设计和制造新型机器人都具有各种实际使用场景。被一些对人类有害的任务都用机器人来解决，如拆除炸弹，在不稳定的废墟中寻找幸存者，以及探测地雷和沉船。STEM 也用机器人作为教学辅助工具。

商业和工业机器人在今天很普遍，它们比人类更便宜、更准确、更可靠地完成工作。他们还从事一些太脏、太危险或太枯燥以至于不适合人类的工作。机器人广泛应用于制造、装配、包装和装潢、采矿、运输、地球和空间勘探、外科手术、武器装备、实验室研究、安全以及消费品和工业品的大规模生产。

语源

机器人学这个词来源于“机器人”这个词，这是由捷克作家卡雷尔·卡佩克在他 1920 年出版的戏剧 R.U.R.（罗莎的全能机器人）中向公众介绍的。robot 这个词来自斯拉夫语 robota，意思是劳动/工作。该戏剧开始于一家称为“机器人”的人造人的工厂，这些被制造的人可能会被误认为是人类——这与现代的机器人概念非常相似。根据《牛津英语词典》的说法，1941 年 5 月，艾萨克·阿西莫夫在他发表的科幻短篇小说《说谎者》中首次使用机器人一词。

历史

1939 年，名为 Elektro 的人形机器人出现在世界博览会上。它身高 7 英尺（2.1 米），体重 265 磅（120 千克），能通过语音指令行走，能说大约 700 个单词（使用 78 转的录音机），能抽烟，能吹气球，还能活动头部和手臂。身体由钢齿轮凸轮和覆盖铝皮的电机骨架组成。1939 年，康拉德·楚泽建造了第一台可编程的机电计算机，为现在被认为是机器人的仿人机器的建造奠定了基础。

1951 年，沃尔特发表了一篇论文《机器学习》，记录了他的更先进的机械机器人是如

何通过条件反射学习来充当智能代理的。1954 年，乔治·德沃尔发明了第一台数字操作和可编程的机器人，名为 Unimate。后来它奠定了现代机器人工业的基础。

德沃尔在 1960 年将第一台 Unimate 卖给了通用汽车，1961 年在新泽西州尤因镇的一家工厂安装了 Unimate，用来从压铸机中取出热金属片，并将其放入冷却液中。德沃尔的首个数字操作可编程机器人手臂专利奠定了现代机器人工业的基础。

日本机器人科学家在 20 世纪 70 年代推动了仿人机器人的发展。早稻田大学于 1967 年启动了 WABOT 项目，1972 年完成了 WABOT-1。它的肢体控制系统允许它用下肢行走，用触觉传感器用手抓住和运输物体。它的视觉系统允许它使用外部感受器、人造眼睛和耳朵来测量物体的距离和方向。它的对话系统允许它用仿真的嘴与人用日语交流。这使得它成为第一个人形机器人。

机械方面

机器人有很多种。它们用于许多不同的环境和用途，用于许多不同的用途，尽管在应用程序和形式上非常不同，但它们在构建时都有三个基本的相似之处。

机器人都有某种机械结构、框架、形式或形状设计来完成特定的任务。例如，设计用于穿越重泥土或泥浆的机器人，可能会使用履带。机械方面主要是创造者完成分配的任务和处理周围环境物理的解决方案。形式服从功能。

机器人有电子元件，为机器提供动力和控制。例如，履带机器人需要某种动力来移动履带。这种能量以电能的形式产生，电能必须通过电线，并由电池（一种基本的电路）产生。即使是以汽油为主要动力的汽油动力机器，也需要电流来启动燃烧过程，这就是为什么大多数像汽车这样的汽油动力机器都有电池的原因。机器人的电气部分用于运动（通过电动机）、传感（电信号用于测量热、声、位置和能量状态等）和操作（机器人需要向电动机和传感器提供一定程度的电能，以激活和执行基本操作）。

所有的机器人都包含某种程度的计算机编程代码。程序决定机器人何时或如何做某事。程序是机器人的核心本质，如果它有优秀的机械和电气结构，但它的程序构造不好，它的性能就会很差（或者它可能根本不执行）。有三种不同类型的机器人程序：远程控制、人工智能和混合类型。带有远程控制程序的机器人有一组预先存在的命令，只有当它接收到来自控制源的信号时才会执行这些命令，通常有人远程控制。使用人工智能的机器人可以在没有控制源的情况下独立与环境进行交互，并可以使用已有的编程来确定对对象和遇到的问题的反应。混合编程是一种结合了 AI 和 RC 函数的编程形式。

应用

随着特定的任务应用变得越来越多的机器人，分类方法也变得更加与之相关。例如，许多机器人是为装配工作而设计的，也就不适用于其他应用程序。它们被称为“装配机器人”。对于缝焊，一些供应商提供完整的焊接系统，将机器人即焊接设备与转盘等其他物料搬运设施作为一个整体。这种集成的机器人系统被称为“焊接机器人”，尽管其独立的机械手部分可以适应各种任务。

目前和潜在的应用包括：

- 军事机器人。军事机器人是为军事应用而设计的自主机器人或遥控移动机器人，从运输到搜索、救援和攻击。
- 工业机器人。工业机器人是一种用于制造的机器人系统。工业机器人是自动化的，