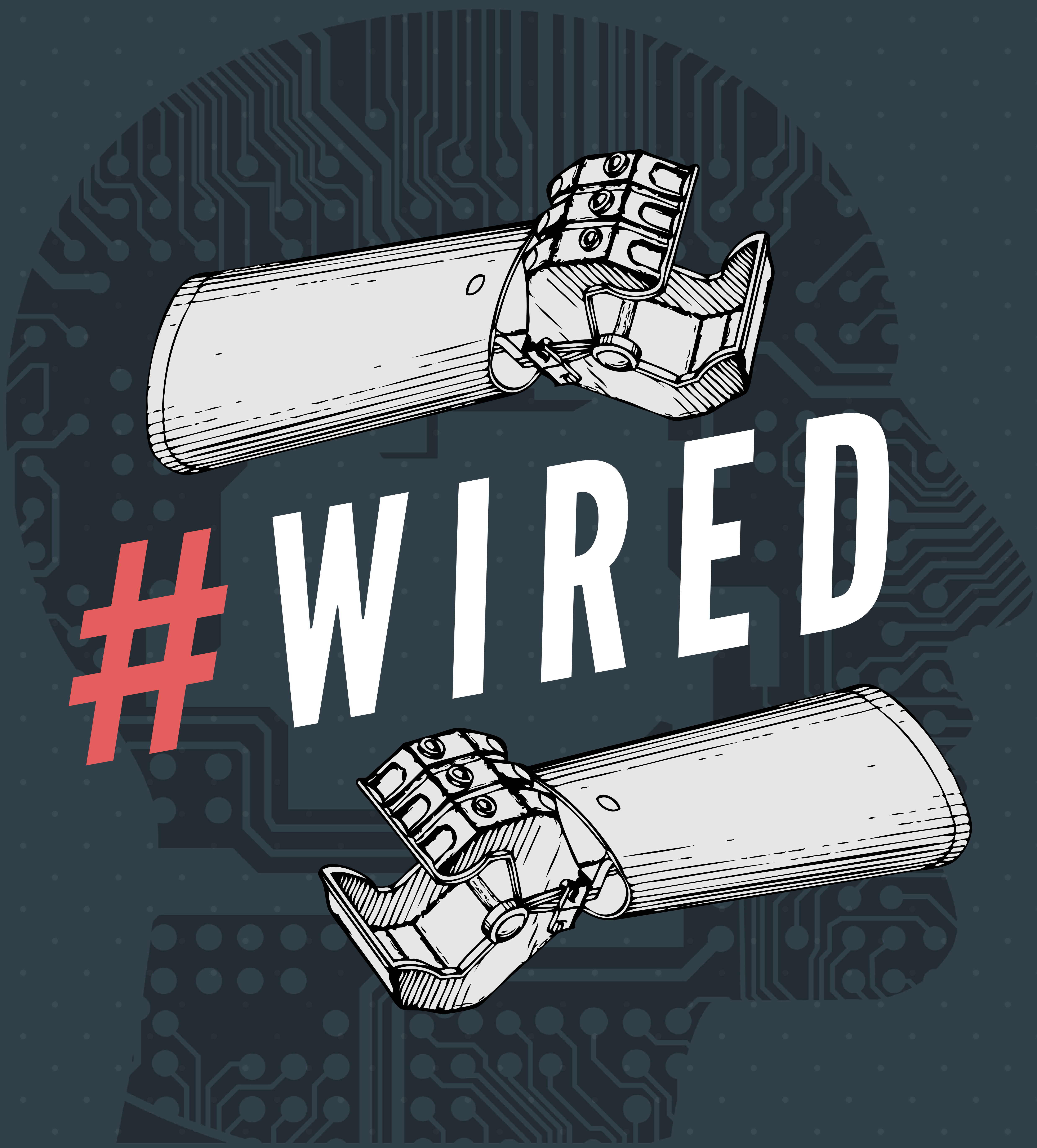
WANDERING INTO ROBOTICS EDUCATION
PRESENTS

#WIRED



AN ORIGINAL 9 PART CURRICULUM ON THE BASICS OF ROBOTICS

EACH CHAPTER CONTAINS CONCISE AND DETAILED EXPLANATIONS OF THE CONCEPTS ALONG WITH 2 APPLICATION QUESTIONS AT THE END!

JAI GUPTA

CONTENTS:

ABOUT THE PROJECT

Early in 2022, I launched Project WIRED (Wandering Into Robotics Education), which is an interdisciplinary robotics program that seeks to provide access to robotics education and learning for students from underserved communities.

With the ultimate and larger aim of contributing to the expansion of STEM learning avenues in India, Project WIRED (Wandering Into Robotics Education) seeks to empower and enable young and talented innovators to develop robotics based applications that can assuage pressing global challenges.

By allowing young and bright minds from underserved communities the space and resources to explore robotics and computer technology, Project WIRED (Wandering Into Robotics Education) hopes to further the cause of STEM learning and attempts to bridge the gap and consequent grave inaccessibility to STEM learning resources, focusing on the theory as well as practice of the subject of robotics.

MESSAGE FROM THE AUTHOR

Access and affordability of STEM learning opportunities is extremely sparse in our country. I have always been very passionate about science, technology, and robots and I have had the privilege to be able to further my passions. However, even as I wondered how many children like me were interested and loved robotics, I couldn't help but realize that children from underserved and low income communities perhaps had little to no access to learning more about the subject even if they were interested. This made me look up the lack of access to STEM learning in India and the exact statistics of inaccessible and unaffordable education opportunities. The results had me astounded. I knew I wanted to use my platform and resources to help and in the grand scheme of things, my effort may not be so impactful. However, somewhere down the line, I believe that no matter how small, effort must be made as the times demand it!

With that in my mind, I founded Project WIRED (Wandering Into Robotics Education), which is a robotics program seeking to teach young students from underserved communities the fundamentals of the subject so that they are able to develop their own robots. The #WIRED Curriculum is a simple guide and introduction to robotics that outlines its basics for a beginner. I hope this curriculum serves as a resourceful guide to you and I hope you have as much fun reading it as I did penning it down!

Happy Reading!
Jai Gupta

ONE BYTE AT A TIME

There has always been a common fascination with robots in popular culture, whether it's R2-D2, Optimus Prime, or Ex-Machina. Our attraction to these cultural figures has often made us wonder if such humanoids can replicate humans. These concerns are shared by the field of robotics. Robotics studies the design, construction, and use of mechanical robots from an interdisciplinary viewpoint. Robotics is an area of study that is at the intersection of science, engineering, and technology, focusing on the development and use of machines that are commonly known as robots.

A robot is a programmable device made to assist humans or to mimic their actions. It is a machine that has electrical components that provide power and control the machinery. Additionally, robots have a mechanical construction, shape, and form that may be designed to do specific tasks. There is also a computer program that determines how, when, and what the robot does. The robots can perform tasks autonomously or semi-autonomously on behalf of humans. Initially designed for repetitive tasks like packaging or assembling automobiles, robots have evolved to assist with extremely complex procedures, such as cleaning homes and performing intricate surgery. Historically, robots have been perceived to have their own intelligence because they are physically distinct units. There are several jobs across many industries like manufacturing, agriculture, entertainment, etc that require repetitive, tedious, and highly precise tasks. Robots may be better suited to such workplace situations than humans due to their precision, intelligence, and compatibility with the specific requirements of the task. Additionally, they have been used in environments such as outer space or underwater where human life may be at risk.

Recent technological advancements have greatly enhanced the field of robotics. With the introduction of big data, robotic systems have access to a wider range of programming opportunities. 'Big data' refers to large volumes of data that are difficult to manage. It can offer new methods for analyzing and extracting information while also marking a radical break from traditional data-processing systems. The robotics field has also become increasingly entangled with machine learning and artificial intelligence in recent years. Alexa, our favorite robot who can turn on the lights, play your music, and manage your tasks functions at this intersection of robotics and artificial intelligence.

Here are some examples of how robotics have been applied:

Agriculture: The agriculture industry has been actively adopting different types of robotic technology as a means to increase productivity while lowering overall costs. Tractors and harvesters that are self-guided by GPS are already in use by farmers. Recently, it has become more popular to experiment with autonomous systems that automate tasks such as pruning, thinning, mowing, spraying, and weeding. Pests and diseases that affect crops can also be managed with sensor technology.

Cooking: We will soon see one of the most lavish advances in robot technology in the kitchen. Home kitchens can now be equipped with intelligent, automated robots that are capable of preparing hundreds of meals at a time. Once it has been given a recipe and prepackaged containers of cut and prepared ingredients, the robot is able to cook a predetermined meal rapidly and efficiently. People with disabilities and illnesses who are unable to cook for themselves may also find such inventions extremely useful.

Healthcare: Medical robotics has the potential to transform a wide range of health care practices, such as surgery, rehabilitation, therapy, patient companionship, and every day activities. Health care robots are not designed to take over the duties of health care professionals, but rather to facilitate and simplify their work. Robotic devices such as an exoskeleton can provide assistance and guidance to patients who have suffered strokes or spinal cord injuries, or who are paralyzed. Further, inventions such as the da Vinci Surgical System lets the surgeon manipulate tiny, precise instruments inside the patient's body using the hand movements he or she makes. As a result, minimally invasive surgery can be performed in cardiac, colorectal, gynecological, head and neck, thoracic, and urologic surgeries. Furthermore, a robotic lifting machine can also assist nurses in lifting elderly or immobile patients. Additionally, inventions like PARO, developed by Dr Takanori Shibata, a therapy robot that resembles a baby harp seal with haptic sensors moves its tail, flippers, and opens its eyes when petted, and assists patients with mental health problems and aging individuals.

Manufacturing: The use of robotics is increasing and reducing production costs in a wide range of manufacturing areas. Worker-operated robots perform repetitive, monotonous, or intricate jobs under the guidance and control of workers in manufacturing. The machines are designed to be precise and to be reprogrammed for any number of tasks, regardless of their size and complexity.

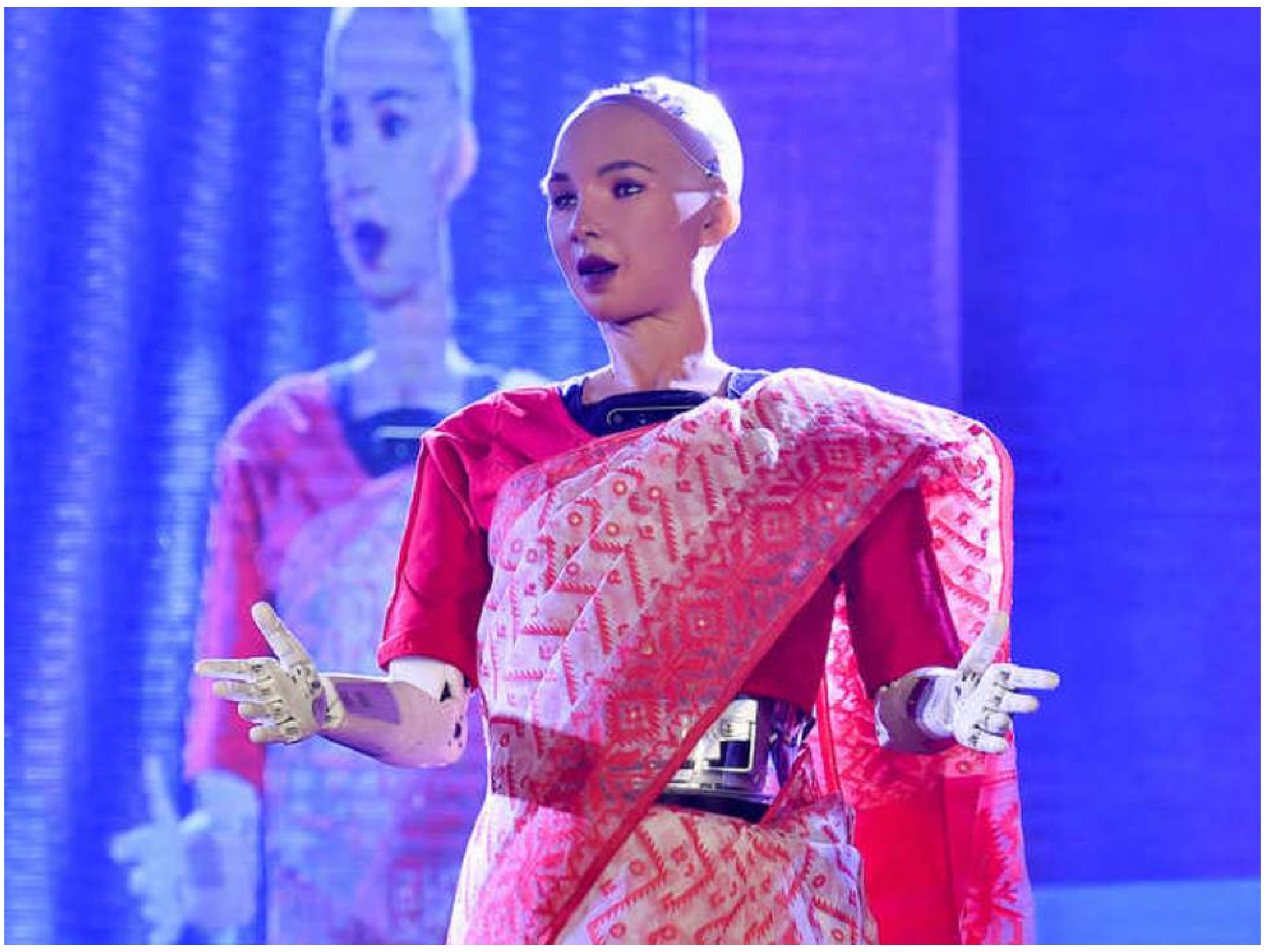
Military: Many areas of military and public safety use robotic technology. Unmanned drones are one of the most visible examples. These machines are often used by the military for surveillance and support of operations. In combat zones, hostage situations, natural disasters, and situations involving hostages, military drones can assess danger levels and provide real-time information to soldiers and first responders. As a result of their ability to reach hazardous areas with remarkable speed and precision, drones are transforming disaster response.

Further advancements in robotics will enable even the common man to access these technologies, which will revolutionize our quality of life.

PROTO-TYPED

When we think of the word “robot”, often a very specific picture comes to mind. We imagine a humanoid robot such as Sophia, the popular social humanoid robot that was developed by Hanson Robotics that received a lot of attention and publicity. But that’s not all that there is to robots! Robots do not necessarily have to take human shape, or perform human functions. They perform a variety of tasks in different sectors such as industry, medicine, and agriculture. In this chapter, let’s explore the different kinds of robots that exist:

Humanoids:
These are the most popular types of robots, and the ones we often see in mainstream media. The robot Sophia is an example of a humanoid robot. A humanoid robot takes on the appearance and motor functions of a normal human, and is designed to look and act like them. A popular example of humanoid robots in media is in the show Westworld.



sophia the robot

Autonomous Mobile Robots (AMRs)

These types of robots can move and perform functions in a controlled setting without direct supervision by humans, thus the name autonomous mobile robots. Roomba, the robot vacuum cleaner, is an example of an AMR. It can do a limited set of functions without direct control. These types of robots are generally used in warehouse/factory settings.

Roomba, the automated vacuum cleaner.

Automated Guided Vehicles (AGVs)

AGVs are automated vehicles that can move and navigate along certain predetermined paths. They are often used in industrial or warehouse environments to lift and transport heavy loads. In order to function, they use sensors such as motion detectors, cameras, and magnetic paths.

An AGV at work in a warehouse.

Cobots

Cobot is a portmanteau of collaborative robots. They are designed to work in tandem with human beings, helping them to perform their tasks. The way they are structured is not to act autonomously, but to act on the guidance of humans who are using them. Forbes Magazine describes cobots as "the hardware version of augmented intelligence that we talk about in the software world. Instead of replacing humans with autonomous counterparts, cobots augment and enhance human capabilities with super strength, precision, and data capabilities so that they can do more and provide more value to the organization." These are often used in the medical context, to help surgeons with accuracy during surgery.

Cobots at work with humans.

Hybrids

As there exist multiple types of robots, sometimes there arises a need for a robot that can perform a diverse range of functions. When a robot incorporates qualities of several different types of robots, they are known as hybrids. They are most often mobile, and are capable of navigating their environment on their own. They may also perform other tasks like collecting information, doing manual labor, and the like.

Curiosity, the Mars Rover, is an example of a hybrid robot.

A TRIP DOWN MEMORY LANE

In the 21st century, we are surrounded by various different kinds of robots. Some, like Siri or Alexa, help us with everyday tasks, while others perform highly complex functions, including heart surgery. However, it has taken a long, long time for robots to be seamlessly integrated into our lives.

It is thought that the first robotic devices can be traced back to Egyptian civilization. Egyptian water clocks used figurines shaped like humans to strike the bell. There was also a wooden pigeon that could fly created by Archytus of Tarentum. Further, a doll that could move like a human being was also made by Petronius Arbiter in the first century. This was followed by Giovanni Torriani creating a robot that could fetch bread for the Emperor in 1557. It was then in the 1700s that a lot of ingenious but frivolous inventions took place in the realm of robotics. This trend followed till the 19th century, where even a steam powered robot was created!

The first mention of a robot as we know it today is found in Czech playwright Karl Capek's work in 1921. These machines were called Rossum's Universal Robots and featured in a play centered around mechanical men built to work on factory assembly lines. Eventually, these slave-like robots rebel against their human masters in the story. The genre of science fiction was also further developed and fleshed out by Russian author Isaac Asimov, who introduced robots for the first time in his work, Runabout. He viewed robots as superior to human beings, and presented 3 Laws of Robotics as well.

These laws were,

Law One: Robots could not injure human beings or cause any harm to them through action or lack thereof.

Law Two: Robots had to be obedient to humans, and act in accordance with their duty unless it violates Law One

Law Three: Robots always had to protect themselves and their existence unless it is in contravention of Laws One and Two

While these laws find little relevance in how modern day robots are built or used, it is definitely interesting to inspect how they took birth. Now, the Robot Institute of America has defined Robots to be a manipulator that is reprogrammable and multifunctional. It is developed to move parts, tools, materials, or even specialized devices. This is done through programmed motions to perform various tasks.

Modern day robots were first created by George C. Devol in the early 1950s. He invented 'Unimate', which was short for universal automation. This invention was a reprogrammable manipulator, but flopped on the markets. It was then subsequently acquired by Joseph Engleberger (now called the Father of Robotics) who used it as an industrial robot as part of his company, Unimation.

In the late 1950s, Shakey also came to life. He was a robot created by the Stanford Research Institute and was able to carry out specialized applications, owing to his much more advanced engineering, especially compared to Unimate!

While Shakey wobbled around awkwardly, his foundations laid the groundwork for more advanced and complex techniques, some of which are still used today. Shakey's legacy was passed down through robots such as Genghis, ISAC, P-1, P-3, Hadaly, and many others.

FOR WATT IT'S WORTH

The term "robot" derives from the Czech word "serf," which means "forced labour." It was introduced by writer Karel Capek, whose fictitious robotic devices were made via chemical and biological means rather than mechanical ones. A robot is made up of the following components:

- A mechanical structure: capable of interacting with its surroundings, such as a wheeled platform, arm, or other building.
- Sensors: That perceive the surroundings and provide the gadget with meaningful input.
- Systems: Sensory information is processed in the context of the present scenario, and the device is instructed to act in response to the circumstance.

Mechanical Structure

The robot body, which comprises arms and wheels, is the most fundamental part of the robot construction. To make the arms and wheels turn under command, some power like electricity is necessary. One of the most fascinating features of a robot is its behaviour, which necessitates some kind of intelligence.

Motors

Robots are powered by a range of electric motors that allow them to move in various programmed motions. A motor's efficiency rating indicates how much of the power it consumes, which is turned into mechanical energy.

- DC motors are electric motors: Permanent-magnet DC motors employ a combination of fixed and electromagnets (stator and rotor) as well as switches and only require two leads. These combine to make a commutator, which uses a rotating magnetic field to generate motion.

- Motors that run on alternating current: These motors continually move the field by cycling the power at the input-leads.

- Stepping Motors: They function similarly to a brushless DC or AC motor. They move the rotor by sequentially supplying power to the motor's magnets (stepped). Stepping motors are designed for precise control, and they may spin at any number of steps-per-second on demand (up to their maximum speed).

- Servo motors: Simple DC motors with gearing and a feedback control mechanism are referred to as servos. They make adjustments until they are in sync with the signal. Radio-controlled aeroplanes and automobiles employ servos.

Mechanisms

- Chains and gears: Gears and chains are mechanical components that offer a system for transmitting rotational motion from one location to another while also having the ability to change it. The number of teeth on each gear determines the speed difference between them.

- Belts and pulleys: Pulleys and belts, two additional common robot components, function similarly to gears and chains. Pulleys are wheels with a groove around the outside edge, while belts are the rubber loops that fit into the groove.

- Gearboxes: A gearbox works in the same way as a gear and chain do, but without the chain. The transmission in an automobile and the paper-feed of a printer are both examples of gearboxes.

Power Supply

In general, there are two sorts of power sources: disposable batteries that are used once and then discarded, and rechargeable batteries that function on a reversible chemical process and may be recharged thousands of times. When a rechargeable battery is used for the first time, it can provide up to 4 hours of continuous operation in an application.

System of Control

A logic circuit and a microcontroller are the two major methods for controlling robots.

- *Logic Circuit*

The mechanical system is controlled by a digital logic circuit. A bridge relay is frequently used to connect the circuit to the mechanical construction. A control signal causes a magnetic field in the relay's coil to close the switch mechanically. Transistors, for example, are good silicon switches that may be used to control mechanical systems in a variety of technologies.

- *Microcontroller*

Microcontrollers are electrical devices with intelligence that are employed inside robots. They execute functions that are comparable to those of a microprocessor (CPU) in a computer. Microcontrollers are built for real-world control challenges and are slower and have less memory than CPUs. The quantity of external components required to run CPUs and microcontrollers is one of the most significant variances between them. Microcontrollers may run without any additional components and usually just require an external crystal or oscillator to function. A microcontroller's three primary factors to consider are speed, size, and memory.

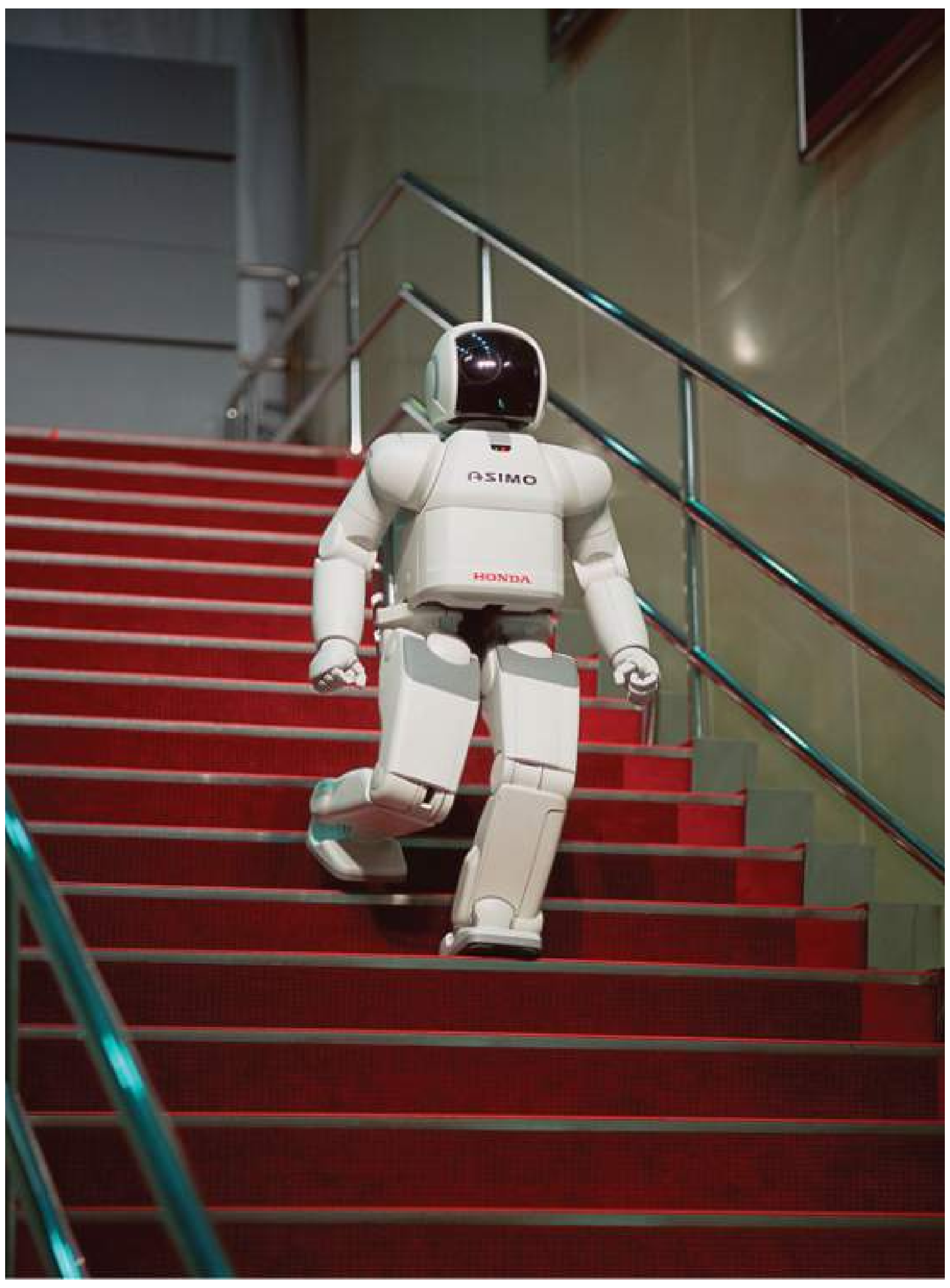
- Speed is measured in millions of cycles per second and is expressed in clock cycles (Megahertz, MHz).

- The Microcontroller's size indicates how many bits of data it can handle in a single step (for example, 4-, 8-, 16-, and 32-bits).

- Most read-only memory (ROM) and random access memory (RAM) on microcontrollers are measured in thousands of bytes (kB).

PULL UP YOUR SHOCKS - LEARN THE ELEMENTS

Honda's ASIMO is an impressive robot, as shown here climbing down stairs, one of the most difficult of human actions to reproduce on a machine—it is not a robot per se, but what is called a “humanoid” robot, i.e. a robot which resembles a human. The word robot is in fact a very broad term and fits many different varieties of machines, some of which look nothing like humans, and some only slightly. Take for example this industrial robot employed frequently in the automobile industry:



Any semblance that it bears is to a severed, independent human arm, which is exactly what it has been designed to replicate in function. Such factory robots can lift and assemble heavy machinery, weld pieces of metal together, and even tighten screws just like a human hand.

Input—

Machines are blind, because, let's face it, they are ultimately non-living, no matter how human-like they might be. In order to function they need to be told what they are working with, and constantly so. This is where various input devices come in handy. Robots use sensors, to "sense" what is going on in their surroundings, and thereby decide what the next steps for them are. Sensors are specialised devices which interact with different physical elements, and generate electronic data which can then be fed into a robot as input. Depending on which type of physical feature or activity they capture, sensors can of many types, such as:

- Proximity Sensors: Such devices are used to sense how close or far a robot is from a surface. This is often done with the help of infrared technology, and the use of such sensors helps robots navigate their surroundings, avoid obstacles, interact with objects and more.

- Tilt Sensors: Capable of detecting which way is down and which is up, Tilt Sensors use gravity to help robots balance themselves. These sensors are what makes it possible for robots like ASIMO to walk.

- Vision Sensors: While Proximity Sensors help robots locate where objects are, vision sensors—essentially cameras—are what truly help robots "see" what these objects are and which features they bear. Such sensors can help robots with object identification, 3-D assessment and more. They are also what make self-driving cars possible, by allowing robots to see exactly where they are and where they are going.

Computing—

Once robots are "aware" of what is going on around them, they must also be made aware of what to do with that information. Every tiny little thing that a robot is capable of has to be planned in advance and taught to the robot before it can achieve its tasks. This "teaching" of function and actions is called programming. Fitted with many computers, robots are uploaded with important code written in programming languages such as C++ and Java—or a specialized programming language designed especially for that robot—so that they know how to interpret and process the input data they receive from the sensors, and move on to the next most important step: Output.

Output—

This is the part of a robot's life that we get to witness. All robots, hopefully, serve a purpose, and to do so they must move about, pick up and drop things, heat up or cool down, get up and turn around. Every one of those functions is possible because of the movable mechanical parts which robots are made of, including gears, motors, wheels, hydraulics, etc. Most robots also provide visual and audio output for which they use LCDs or LED displays, as well as audio speakers.

Thus, it is through these various components that a robot can take information in, process it and carry out functions as desired by the manufacturer.

CURRENT AFFAIRS

Digital logic design is an electronic and computer engineering process that generates input and output actions using basic numerical value. You might work on the development of mobile phones, laptops, and other consumer electrical gadgets as a digital logic design engineer. Technological devices such as phones and computers, are built on the foundation of digital logic design. Binary code, which represents information using zeroes and ones, gives each number in the binary code an opposing value; it is the foundation of digital logic.

This method makes it easier to construct information-transferring electrical circuits, such as logic gates with operations like AND, OR, and NOT. Input signals are translated into specified outputs by the value system. Computers, robotics, and other electronic and digital applications benefit from these functionalities.

To optimize device speed, enhance performance, reduce energy consumption, and troubleshoot possible faults, logic design is essential.

Logical function, power, current, protocol, and user input are all used by digital logic designers to create sophisticated electronic systems that employ both electrical and computational features. Hardware such as circuit boards and microchip processors are developed using digital logic design.

In navigation systems, mobile phones, and other elevated-tech systems, this technology handles input from the user, system protocols, and other data. Information processing components, information storage, and signal transmission are used by logic design engineers to create device structures.

In digital logic design, logic gates are used. A digital circuit's most fundamental components are logic gates. They take two inputs or more and output just one.

There are mainly 3 different types of logic gates:

- Basic gates: We may describe logical functions in this sort of gate as either a sum of products or as a product of sums. AND, OR, and NOT gates are known as necessary and most fundamental logic gates.

- Universal gates: These are the logic gates that can be used to build all other gates. The two gates which are universal are NAND and NOR.

- Special gates: EX-OR and EX-NOR are two exceptional gates that are special instances of OR and NOR gates.

The conclusion is that employing logic gates to build a robot lowers the project's cost while increasing the robot's speed.

ABOVE C LEVEL

The way we are taught to write code in school, say using C++, Java or Python, falls under the paradigm of Object-Oriented Programming. But OOP is not the only way of programming, there also exist other programming styles, such as the one we are going to discuss in this chapter: Functional Programming.

In a nutshell, OOP is the more intuitive way of programming wherein we write code to model or mimic real world phenomena, thereby estimating the behaviour of real world entities using computer models. These models are called objects, and since this style of programming emphasizes on the concept of "objects" it is adequately termed Object-Oriented Programming. Functional Programming, however, differs from OOP in that it does not employ the concept of objects at all, instead it is all about data manipulation. Thus unlike OOP it does not model real life objects per se but rather it takes a real world scenario, represents it purely in the form of data, and then works on that data to produce any desirable results.

But what does all of this have to do with robotics? Well, nothing in particular. One can build robots perfectly well using OOP alone, but as they often say, "contentment is death". It is always a good idea to keep approaching complex problems with different attitudes so as to continue finding better and more efficient solutions.

In fact Functional Programming does have many significant advantages over OOP:

1. **Reactive Programming:** Functional Programming fares brilliantly when it comes to working with and analysing reactive systems, and since robots, at least at a higher level, are reactive systems Functional (Reactive) Programming, or FRP, proves to be an easy and efficient way of manipulating their behaviour.

2. **Parallel Programming:** Another life saving feature of Functional Programming is the possibility of parallel programming. In simple terms, parallel programming refers to the process of breaking down large tasks to many smaller ones and then executing all of the sub-tasks at one and the same time, so as to accomplish the larger task quicker. This brilliant feature, which is missing from OOP, increases code efficiency and speed manifold, and therefore has very important applications in the field of robotics.

Aside from those discussed above there exist many other features of Functional Programming which, although they might not be particularly useful for robotics, offer significant advantages over OOP, nonetheless. These are attributes such as bug-free code, minimal troubleshooting, nested functions, and the possibility of evaluating code in any order.

Thus, it is due to these plus points that many existing programming languages today, such as Java and Python, have been developing their architecture to better support Functional Programming, while other languages such as Haskell are going completely “functional”.

WIRE CONSEQUENCES

Robots and automated systems have been developed with the help of robotics and artificial intelligence and have made their way into a variety of industries. In 2018, researchers at MIT and the automaker BMW explored the possibility of humans and robots working together at close range to assemble car parts. The team set up a robot on rails for delivering parts between workstations in a replica of an actual factory floor. Workers from nearby stations crossed its path every now and then. When a human passes by, the robot stops momentarily. Researchers found, however, that the robot would often freeze in place long before a person crossed its path, overly cautious. As such pauses would occur in a real manufacturing setting, they would add up to significant inefficiencies. The problem was traced to a limitation in the robot's trajectory alignment algorithm. In this case, the algorithms were unable to anticipate a person's time spent at any point along the predicted path due to the poor time alignment. This is where algorithm development comes in.

Algorithm development refers to the process of designing the steps that a computer or other device should follow to solve a particular problem, not excluding humans, but in this case computers only and devices similar to computers. Algorithms development includes the following steps:

- Step 1: Defining the problem
- Step 2: Developing a model
- Step 3: Specifying the algorithm
- Step 4: Designing the algorithm
- Step 5: Checking the algorithm's correctness
- Step 6: Analyzing the algorithm
- Step 7: Implementing the algorithm
- Step 8: Testing the program
- Step 9: Preparing documentation

As an example, the auto industry has many features designed to help the driver, either already commercially available or in development vehicles. Self-driving cars are in fact the most robust examples of algorithmic development in the field of robotics.

Robotics relies heavily on algorithm development. Consider PRM (probabilistic roadmaps): the problem of motion planning for complex systems (such as robotic arms) is very difficult to do and one solution proposed has been to change the frame of reference and think of the configuration space -- our arms can be configured in many different ways. Similarly, algorithms in robotics are developed to be cognizant of such motions and configurations and navigate them accordingly. As long as one knows how the various parts of the system are moving from one relative to another, the approach can be applied to any complex chain of systems.

As another technique, SLAM is also being defined and explored by the robotics community, however, it is emerging in slightly different domains. Simultaneous Localization and Mapping or SLAM for short is a catch-22 problem for robotics: for the robot to build a map, it needs good localization, but for good localization, one often needs a map. SLAM is still one of the most active fields for Robotics. Localization and mapping aren't just for robots; they can be applied anytime one wants an accurate map of their surroundings, and recently Google showed what could be done by applying this to smartphones

This chapter offers just two examples of an inexhaustible list of algorithmic development in the world of robots. Ultimately, it's what gives the robots their money moves!

AS A MOTOR OF FACT

There are endless applications for robots—technology has advanced so far in recent years that we can now create robots to assist us with just about everything, from relatively basic tasks like household chores and serving a glass of fresh juice to performing complex challenges like solving difficult equations, security, military, and space exploration!

Let's start with the robots that are now available for commercial usage. There are a few robots capable of cooking and preparing full meals for you! This robotic kitchen staff can prepare food from a variety of recipes. All people have to do is select a recipe and supply the robot with pre-packaged containers containing all of the ingredients required for that recipe. After that, the robot can actually cook on its own. There are also well-known robot vacuum cleaners that clean your home for you and identify any areas where they may have missed a spot!

Robots, apart from doing housework, may be quite amusing! They're utilized in the entertainment business to do things like manage the camera and produce spectacular effects, as well as the more boring aspects of a creative work. As a stand-in for actual people, robots frequently do risky stunts. Even Disney World uses robots to keep visitors entertained!

In the military, robots can be used in a variety of ways. They can be utilized as surveillance drones to keep an eye on the enemy, as weaponized systems to attack enemy troops, or as medics to assist friendly forces. Because robots do not experience the same hazards as humans, they provide exceptional security. They're effective deterrents against robberies, hit-and-runs, and even domestic violence!

Robots also contribute to progress by being beneficial in areas such as healthcare, agriculture, and space and undersea exploration studies. Robots have revolutionized healthcare; they may assist surgeons in executing more accurate procedures, serve as prosthetic limbs, and give additional assistance for those recovering from spinal injuries, strokes, and other conditions.

There are numerous repetitive jobs in agriculture that are draining of energy for farmers and can be handled more efficiently by robots. Sowing, weed management, harvesting, and other tasks are among them. Typically, robots are employed to harvest crops, allowing farmers to be more productive and efficient.

Robots are employed for exploration and study because they can reach places that people cannot and therefore obtain more information. NASA and other space agencies routinely deploy robots and autonomous vehicles to perform tasks that people cannot. Mars Rover, for example, is an intelligent system that goes to Mars and takes photographs of Martian rock formations, which it then transmits back to Earth for NASA scientists to investigate.

Due to the tremendous pressure in deep waters, robots are ideal for underwater research. It is a mystery region that can finally be investigated with specially developed robots. These remote-controlled robots can travel to the ocean's deepest parts to collect data and photographs about underwater biological diversity.

Robotics has a bright and promising future. Robots, when combined with emerging technology such as artificial intelligence, may be employed in almost any industry to make labor more efficient while also reducing the weight and responsibility thrust upon most people. Robots have allowed us to understand more about the world we live in, and they have the potential to bring about significant change and discovery all throughout the globe.