**Robotics**

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**The History of robotics**

The ideas of robots or similar machines can be found relating back as far as medieval times. People of the time did not have the word robot to define such ideas and creations, but they still were thinking of machines that could perform the same tasks as they did. However, in medieval times these automatons were more often used to impress peasants of the church to believe in a higher power. Most were fooled since the technology was practically non-existent in the 13th century. (Wikipedia 2007) Later in the 18th century, smaller robots became very popular as toys for the rich, as they were designed to look and move like small creatures or people.

The word “robot” had first originated from the Czech word “robota” which when translated means ‘forced labour’, the new word was then cemented in Karl Capek’s playwright R.U.R (‘Rossum’s Universal Robots’) in the 1920’s. (Coiffet and Chirouze, 2012) Capek’s use of the word “robot” referred to humanoid machines that had been created to work on assembly lines within factories, that then later turn on their human creators. (Capek K, 2004)

The word “robotics” had in later years also been coined by the now famous Russian-born American science-fiction writer Isaac Asimov, in a short story he wrote called “Liar!” in the 1940’s. Asimov’s fame is due to his introduction to the three “Laws of Robotics”, which had made their first appearance within another of his short stories “Runaround”. The robots from Asimov’s stories were generally been described as helpful servants to humanity and were “a better, cleaner race.” A by far more optimistic view of a robot’s capabilities and uses when compared to Capek’s story’s view.

**Law One of Robotics**   
“A robot may not injure a human being or, through inaction, allow a human being to come to harm.”

**Law Two of Robotics**  
“A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.”

**Law Three of Robotics**   
“A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.”

(Anderson and Leigh Anderson, 2011)

Some of the earliest robots by which most people would define them would be “Elmer and Elsie”, built by William Grey Walter a British robotics pioneer in the 1940’s, two “tortoise-like robots” that were designed so when their power was low they would return to their charging docks. (Bellis 2019)

In the 1950’s an inventor by the name George C. Devol, created “Unimate”, known as the first industrial robot, ever built. (Nocks 2007) The “Unimate” was a hydraulic arm that could be programmed and made to do repetitive tasks. Devol then spent the next 10 years trying to sell the “Unimate” to industries, only to fail in the beginning before eventually passing the design onto an engineer, Joseph Engleberger also known as “the Father of Robotics”, who was able to alter the design and built a company to make and sell the robots. (Nocks 2007)

**Manufacture of Robots**

Robots are an ingenious piece of technology, simple basics pieces of machinery combined with one another to build something that is capable of taking commands given to them, generally as lines of code, or in modern days verbal commands, and completing the tasks given to them, like robots found within factories that are made repeat the same task over and over hundreds or thousands of times. These robots however, all share the same basic ideas in how they’re manufactured.

When robots had only started to be made, they had generally been designed to be for a singular purpose, like welding multiple pieces of metal together in quick succession or moving an item from one place to another. With this the robots were built with this particular task in mind, it was how they decided between a large and heavy frame for robots that may be used for an assembly line, or a smaller lighter material an frame for a more mobile robot like a drone.

Though the frame for the robot is important without its electrical components the robot itself is practically useless, like the frame the electrical component within were chosen based on the its purpose, like a robotic arm would need actuators, which acted as the “muscles” that allowed it bend like a human arm would. It would also need the ability to grab or manipulate something, generally there two types of grips, vacuum grips which are a very simple and effective given the object to be gripped has a smooth surface, such as a large glass pane. The other type of grip, is mechanical, this is the more common grip of the two, and it refers to a claw or hand like part of the machine that can either encompass the desired object cradling it using little friction, or like a set of jaws holding an object using a large amount of force and friction.

The last part of manufacturing a robot is programming the desired function, this is where we tell the robot to something, such as take the right amount of power to complete its task. This is by far the most important section when building a robot, a robot could be well designed and built from the best materials available but if the programming code is badly written then the entire robot won’t work very well, if it works at all. There are three types of robotic programming, remote control, artificial intelligence and hybrid. Remote control is a set of preprogramed rules or commands it can perform when it gets a signal from its control. Artificial intelligence allows the robot to interact without a control but instead determines how they react to the encounter using pre-existing code. The last type hybrid uses both artificial intelligence and remote-control functions.

As technology developed people realised that robots could be designed in a better fashion allowing for them to be more adaptable and have several working functions. Also, as new technologies began to come to light people started to design and build even more complex robots and machines, some that may one day become sentient.

**Robotics in Space Exploration**

Robotics have been at the forefront of space exploration ever since the late 1950s when on the 4th of October, 1957, the Soviet Union laid the foundations of a new era by successfully launching Sputnik I, the world’s first artificial satellite. Sputnik’s satellite was roughly the size of a beach ball (58 cm in diameter), weighed just 83.6 kg, and took 98 minutes to orbit the earth on an elliptical path.

The robotics found on Sputnik I were primitive at best but undoubtedly laid the path for world altering robotics and technologies that power our lives to this very day. The launch of Sputnik I also spurred the Americans to create the “National Aeronautics and Space Administration”. More commonly known to us today as NASA.

On the 31st of January, 1958, just 4 months proceeding the Soviet unions success on Sputnik I, the United States launched Explorer I, the USA’s counter to Sputnik I. Explorer I carried a small scientific haul that discovered the magnetic belts that surround the planet.

Today however, after the “Space Age” has ran its course and manned missions have become few and far between, robots are at the forefront of modern Space Exploration. In the darkest and deepest depths of space, robots are exploring our universe like no human ever has before, or ever will for a long time.

Launched on the 5th of September 1977, Voyager I, at the time of writing, is 13.79 billion miles away from Earth. Further than any human made object has ever been from our planet. Voyager I is expected to continue to relay information back to Earth until 2025, wherein its “radioisotope thermoelectric generators” will no longer have enough power to keep its scientific instruments running. However, Voyager I will not stop. As a testament to the knowledge put into the robotics of Voyager I, the probe will continue to fly out to the depths of space forever.

The launch of the Hubble Space Telescope in April 1990 is marked as the most the biggest advancement in astronomy and robotics since Galileo developed and created his telescope in 1610. Since the launch date, the Hubble Space Telescope has made over 1 million observations of the cosmos. One of the most famous astronomical observations made by the Hubble telescope was the Eagle Nebula – more famously known as [The Pillars of Creation](https://www.nasa.gov/image-feature/the-pillars-of-creation).

The high-tech mirrors and cameras assisted by the state-of-the-art robotics and technologies found on the Hubble Space Telescope allow the telescope to capture high resolution images of astronomical phenomena. The Hubble Telescope is not outfitted with any thrusters or engines, instead it uses a sophisticated set of wheels and robotics to spin its interior motors in the opposite direction to utilise Newton’s third law and rotate at a rate of 90 degrees every 15 minutes. After 30 years of service and 5 servicing missions, the Hubble Telescope is still up and running. Thanks to a set of two 25ft square solar panels that absorb the Suns energy, the Hubble Space Telescope has a long life of science ahead of it.

The biggest advantage of using “Space Robots” is that they don’t need food, drink, or sleep, and can survive in the most inhospitable of climates. On top of this, while even though robots are expensive to design and create, the loss of mechanical components is always preferred to the loss of human life if a mission goes wrong.

Closer to home however, robots do an enormous amount of work on the International Space Station (ISS). There are an uncountable number of sensors and robotic assistances on the International Space Station, everything from terrestrial data gathering to astronomical observation equipment.

However, the newest “crew members” of the ISS are three cubical floating robots named “Astrobees”. The Astrobees are about 1ft² and is fitted with numerous cameras and sensors to assist the astronauts on the ISS. Like a trio of 3D Roombas, the Astrobees will use their multidirectional fans and 360° cameras to navigate the zero-gravity space within the International Space Station. They can move in any direction and turn on any axis. The Astrobees can either be operated autonomously or operated remotely by astronauts within the ISS or by mission control. (Gonzalez, 2019)

One of, if not the, most famous robot to ever be launched into space is the Mars exploration rover, Curiosity. The Curiosity robot has been transmitting data of the Martian surface for over 8 years at the time of writing. Two of Curiosity’s biggest discoveries so far have been, volcanos and manganese oxide. The evidence of volcanos on Mars proves that at one point in its long history, Mars was geologically active. However, the manganese oxide has led scientists to conclude that Mars might have had an oxygen-rich environment at some point. (Thompson, 2016)

However, the rover isn’t always on the go. Curiosity in fact spends the majority of its time idle. The rover will spend extended periods of time at significant waypoints set by the scientist back home. As of the 27th of April 2020, the Martian rover as been active for only 800 Martian days out of a total of 2736. This stems from the fact the Martian rover cannot communicate with Earth instantaneously. Usual transmission delays can take anywhere from 4 minutes to 24 minutes, however on average it takes 14 minutes to relay information either to or from the rover. As the end result of this delay, ground control will send a command such as “drive forward Xm”, then Curiosity will use its computer and a state-of-the-art set of cameras to drive in that direction autonomously, avoided as many dangers as is achievable.

Thanks to robotics, space exploration has progressed exponentially over the last 60 years. Without the help of robotics, we wouldn’t have the unrivalled view into the cosmos that we have thanks to Voyager. We wouldn’t have a view of the surface of our closest celestial neighbour, and the human race would have never made that small step on the surface of the moon, and the giant leap into our orbit and beyond.

**Bionic Prosthetics**

Prosthetics are artificial body parts designed to replace body parts missing from birth or lost in an accident. Robotics has made Prosthetics closer to real human limbs. Prosthetics have come a long way from the days of solid plastic replicas with advances such as carbon fibre allowing making lighter and most robust limbs. Other advances such as robotic fingers that can move, pick up small or delicate objects and in more recent cases experience feeling through their hands. The movement of the bionic arm is done by wiring up electrodes to nerves on the person’s muscles that send singles for the arm and fingers to move. The electrodes transfer the signal to a computer which interprets those signals into movements for the arms.

The research in myoelectric (electrical impulses released by the muscles) have meant that bionic arms require any surgery and can be slipped on an off to the comfort of the person. 3-D printing has allowed people who wouldn’t be able afford high tech hands to purchase cheaper or create their own hands that still have some functionality. It also allows companies to quickly make light weight limbs that fit the person’s stump perfectly. The University of Utah developed the LUKE arm (in reference to Luke Skywalker’s arm) that replicates the feeling of force on an object to the brain. This allowed the man to “pick up an egg without cracking it”. It replicates this feeling by creating an array of microelectrodes that reads the person’s movement while also sending back a specific set of impulses to the brain to emulate the ability to feel.

The main benefits to bionic legs is that they allow ankle control, pressure feedback and knee flexibility. They measure what is left of the leg and create a model that will fit the person’s exact height. Much of the technology which is used for the legs are similar to the arm being used for ankle control and pressure feedback. Knees are controlled via a microprocessor which calculates the knee’s angle by using sensors which then moves the knee up or down by hydraulics within the knee joint.

Bionic enhancements can not only make an equal to people with all their limbs in with some cases then can make them better. Exo-suits are “wearable technology that conforms to the human figure” and are designed to enhance a human’s strength. They can help people with a weaker body move with the help of robotics, be used in construction or military. Exo-suits such as The Leg Squad Support System by Boston Dynamics allows soldiers to walk 20 miles in a 24 hour period while carrying 180kg of cargo. These exosuits may be loud due to the engines and require large power supplies. Advances in power supplies or the efficiency in which the suit uses the power may decrease the weight in the future making the suits even faster. The decreased strain allows people to more efficiently use heavy machinery more quickly meaning certain companies may invest in exosuits to improve productivity. This decreased strain also decreases the risk of workers doing long term damage to their body. Bionic limbs have since massive development in recent years and the future of bionics will hopefully make a lot of people’s lives a lot easier.

**Boston Dynamic.**

Boston Dynamics are probably one of the more famous robotics companies in the modern age. Whether it is because of the frankly astonishing impressive robots which can, walk, run, lift heavy loads and jump, or the videos of the employees beating up the robots who’s to say. The four robots that they are currently selling or are working on are Spot, Handle, Pick and Atlas.

Spot is probably their most famous robot and one currently in sale. Its dog like physique allows stable movement along multiple terrains while mapping it. The robot can go up and down stairs with ease, with certain models having arms that can open doors increasing its urban terrain capabilities. Spot’s main use is collection of video data in hazardous environments such as construction site, gas sites and Massachusetts State police even looked into using Spot of bomb sites. The investigation carried out by showed potential but that it still is work in progress. A more recent use of spot is helping out at Brigham and Women’s Hospital of Harvard University. Spot has been mounted with a screen with a mic so nurses can take reports from their patients within the hospital and move from different patient’s rooms minimizing the spread of Covid-19 though out the hospital.

Handle and pick were both designed with quick efficient box moving in mind. Pick is a robotic arm that uses deep-learning to find the box location and thinking about the best way to move a box from one place to another. It picks up the boxes uses pneumatic suckers. What Pick is great at doing is recognizing the different types of boxes, the size, colour, what different labels mean and process what to do. Pick’s max movement rate is 720 boxes per hour. Pick wasn’t actually developed by Boston dynamics but they bought the company Kinema Systems and started to integrate Pick into the heaps of research they have in robotic movement to create Handle. Handle is a smaller version of Pick except it has wheels that allow it easily move boxes through different facilities or move boxes onto trucks. It has a max speed is 4mps allowing it move boxes at a good pace. Its max pick rate is 360 boxes per hour.

Atlas is a biped robot designed to replicate the full potential of the human body mobility. Atlas’s mobility is frankly impressive being able to jump over obstacles, do forward rolls, and leap up steps while still maintaining its jogging pace. The parts for Atlas are 3D printed which decreases its weight while still allowing it to be strong. Some version of Atlas have integrated two smaller Picks as hands allowing it to pick up boxes. Atlas’s main functions is for search and rescue, removing debris and other tasks that could potentially injure a human.

All of these robots have been built on by previous robots such as the Big Dog which was their first working quadruped. The Wildcat which could run up to 32 km/h while still being able to turn and manoeuver. The Petman which simulate human movement on a rig with a treadmill. Its designed “to test the performance of protective clothing designed for hazardous environments” by running, squatting and doing jumping jacks to make sure the material is up to scratch.

Boston Dynamics have shown some of the most interesting and impressive robots of the modern era and whatever the future holds for them it surely won’t be boring.

**Hanson robotics**

Hanson Robotics is an AI and robotics company dedicated to creating socially intelligent machines that enrich the quality of our daily life’s by providing entertainment, service, healthcare, and research applications. David Hanson Jr. is an American roboticist who is the founder and Chief Executive Officer (CEO) of Hanson Robotics, a Hong Kong-based robotics company founded in 2013.

The designer and researcher create human-looking robots who have realistic facial expressions. Hanson Robotics’ robots feature a patented spongy elastomer skin called Frubber that resembles human skin in its feel and flexibility. He is mainly known for Hanson Robotics, the company that created Sophia and other robots designed to mimic human behaviour. Sophia has received widespread media attention and was the first robot to be granted citizenship.

Sophia was activated on February 14, 2016. Sophia is the world’s first robot citizen and the first robot Innovation Ambassador for the United Nations Development Programme. Sophia is a framework for cutting edge robotics and [AI research](https://www.hansonrobotics.com/hanson-ai/), particularly for understanding human-robot interactions and their potential service and entertainment applications. For example, Sophia has been used for research as part of the [Loving AI project](https://youtu.be/ZhKcaea34RQ), which seeks to understand how robots can adapt to users’ needs through intra and interpersonal development. Hanson designed Sophia to be a suitable companion for the elderly at nursing homes, or to help crowds at large events or parks.

Cameras within Sophia's eyes combined with computer algorithms allow her to see. She can follow faces, sustain eye contact, and recognize individuals. She can process speech and have conversations using a natural language subsystem. Around January 2018, Sophia was upgraded with functional legs and the ability to walk. Sophia is conceptually like the computer program ELIZA, which was one of the first attempts at simulating a human conversation. The software has been programmed to give pre-written responses to specific questions or phrases, like a chatbot. These responses are used to create the illusion that the robot can understand conversation, including stock answers to questions like "Is the door open or shut?" The information is shared in a Cloud network which allows input and responses to be analysed with blockchain technology.

In succession of Sophia, Hanson Robotics ltd went and built a miniature version of Sophia known as little Sophia. Little Sophia can walk, talk, sing, play games and, like Sophia. The company’s’ aim with little Sophia is to teach young kids so that they will inspire children to learn about coding, AI, science, technology, engineering and math through a safe, interactive, human-robot experience. Little Sophia delivers a high-quality, entertaining and educational experience so young students are highly motivated to spend time learning with her. The interaction between Little Sophia and users focuses on storytelling and learning new things. Little Sophia has the same endearing personality as Sophia the Robot. She is intensely curious, refreshingly innocent, and uniquely playful. She is the only consumer robot with a human-like face who can generate a wide range of human facial expressions. She not only responds to commands, but also actively engages in conversations. This unparalleled responsiveness together with her humanoid design makes Little Sophia a smart, educational companion.

“Character robotics could plant the seed for robots that actually have empathy. So, if they achieve human level intelligence or, quite possibly, greater than human levels of intelligence, this could be the seeds of hope for our future.”

“My goal is to create friend machines. Friendly genius machines. Machines with genius capabilities.”

“I have found in experiments, people become used to the robots. The less startling, they become, the more commonplace they get. If these robots do become commonplace, then that uncanny effect will go away.”

David Hanson jr.

**Future of Robotics**

Over the countless years and of many years to come modern robotics have been used to aid the development of the human environment for essential services. The early development of robotics was used for simple operations. However as society developed, so did the development of robotics. Robotics has become an extremely dynamic field with its many accomplishments and statistics this can evidently be seen on the market. New developments in regions difficult or dangerous for humans to work in could be enabled with maintenance, inspection and repairs carried out by remotely-controlled industrial robots. A lot of funding is being pumped into this technology to help us continuously evolve society. Some examples of funding are in America where they spend over $200 million on military robotics. A number of trends in technology will aid the further development of robotics. Robotics has many divisible sectors however in this report will be focused on specific sectors and how this will lead to the development of robotics in many years to come.

Space robotics is the whole process of developing a general purpose machine which is capable of surviving out in the space environment for a limited time from its manufacturing space and its performance in the space environment. Space robots are sent to explore the space environment. These are carefully built robots to last. They have a purpose to stick around long enough to investigate and send information back about their destinations. Space robots are essential for the operations as they are much cheaper, help with an acceleration time schedule and are less risk involved then sending humans to manually collect the data.

The design of these robotics are designed and spaced according to these 4 types of factors in order to survive the harsh conditions of the space environment. These 4 factors are mobility - the ability to move quickly to coordinates without colliding with other robots, manipulation - using an arm like hand to collect material for data usage, time delay - allowing humans to manually control the robot without any delay and extreme environments - the ability of the robot to operate within the harsh environment of space e.g extreme heat, cold and radiation.

Future trends of in the space robotic department is to build a high level space robotics that can last days without command can approach and analyse scientific materials from a distance without command and robots that can repair/assemble and maintain space hardware

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