
The Use Of Robots In Space Exploration

Ever since the mid-1900s technology has been growing at a rapid rate and as of recent has become a huge part of modern society. Technology used to be just a want from the people who had the money to purchase it and did not have a truly beneficial purpose but as of recent with all the different types of technology that have been created like the telephone, computer, Internet, self-driving cars, and robots, technology has become more of a need than a want for the people. With all this sophisticated technology humans are now able to accomplish a lot more tasks and at a much higher efficiency level compared to when we did not have the technology that we have today and a big part of these accomplishments have come from one the most recent technologies we have created which are known as robots. Robots have made the crazy ideas of humans come to reality like the self-driving car, and space exploration, they can do almost everything a human can if not at a higher level without the risks of fragile humans being there physically performing the task. This article will try to discuss and explore the ideas of space exploration with robots throughout the paper.

After World War II ended during the mid-20th century, a new problem had begun. Which was known as the Cold War, this battle involved the world's two great powers at the time, the democratic, capitalist United States and the communist Soviet Union who were both trying to take the number one position as the strongest country in the world. Starting in the late 1950s, space had become another area for competition for both these countries, as each side tried to prove the superiority of its technology, its military firepower, and its political-economic system. Both Countries had started putting a lot of time and money into being the first country to reach the moon, at first the Soviet Union was thought to be leading the U.S in the race, on September 12th, 1959, the Soviet Union launched Luna 2, it was the first spacecraft to successfully reach the Moon. This had sparked the rivalry between the countries to a whole new level the U.S had underestimated the Soviet Union and they were behind in the race, they knew they had to work harder than they had ever before or else they would definitely lose the race and they did that exactly. One of the first things the U.S. had done was in 1958 President Dwight D. Eisenhower signed a public order creating the National Aeronautics and Space Administration (NASA), which was a federal agency dedicated to space exploration, around this time the U.S. also launched its satellite, Explorer I, designed by the U.S. Army under the responsibility of rocket scientist Wernher von Braun. Both Countries were hard at work trying to outcompete each other and were achieving great strides for humanity regarding space exploration in doing so, but neither of them had reached anywhere near the finish line. Through the next few years, the Soviet Union and the U.S. were using aircraft and chimpanzees for testing which would be what the astronauts would use to land on the moon one day, they had to make sure every single calculation was perfect. Everything was going well and according to plan, in May 1961 President John F. Kennedy made the bold, public claim that the U.S. would land a man on the moon before the end of the decade. The U.S. had kept that promise and won the race Apollo 11 was the spaceflight that first landed humans on the Moon. Commander Neil Armstrong and lunar module pilot Buzz Aldrin formed the American crew that landed the Apollo Lunar Module Eagle on July 20, 1969. This was the first time that humanity had a physical experience with the world outside the earth, and this caused us, humans, to become very intrigued with space exploration. This caused humans to create multiple robots that are specifically designed for space exploration and we sent them throughout space to answer all of the people's questions.

Since the early 1960's to the modern day there have been dozens of robots created and sent to different places for specific tasks. A few reasons we send robots to space is because firstly we can send robots to explore space without having to worry so much about the machine's safety. People want these robots to last because of how much money and time humans spent on them but people will value a human's life more than a robot. Scientists need robots to function just long enough for them to investigate and send information about their destinations. But even if the mission of the robot fails, the humans involved with the mission will stay safe without the need for the space crew worrying about them. Another reason we send a robot to space because it is much cheaper than sending a human. Robots don't need to sleep or eat or go to the bathroom. They can survive in space for many years and can be left out there so there is no need for a return trip back to earth which they would have needed for a manned mission. Also, robots can do a lot of things that humans can't physically or mentally do. They are specially designed to withstand harsh conditions, like extreme temperatures, high levels of radiation or terrible weather conditions that exist on planets like Mars. They can also explore a lot of rough terrains and areas where astronauts cannot go because of obvious reasons. Almost every robot is designed differently and meant for separate tasks until this day humans are creating new robots and always trying to upgrade their creations. One of the most famous robots is the Mars rover called Curiosity it is a mobile laboratory that was launched from Cape Canaveral in 2011. Curiosity landed on Mars surface on August 6, 2012. This was the largest rover NASA has put on Mars, it was twice as long and five times as heavy as its predecessors. It was designed with six-wheel drive, rocker-bogie suspension, and cameras mounted to the front of the rover to help the mission's team direct the rover and make sure it can handle almost any terrain; it also contains an entire inboard laboratory for analyzing the soil and rocks on Mars. Curiosity was capable of rolling over obstacles up to 65 centimeters high and traverses up to about 200 meters per day on Martian terrain. The main purpose of Curiosity was to determine if Mars ever had the proper conditions for any type of life to survive. Two other robots NASA created were Spirit and Opportunity they were twin rovers which both carried all of the same parts needed for their tasks each of them was about the size of a golf cart. They were mainly made to find any history of water being there and just to learn more about the Red Planet. Another type of robot humans use in space is satellites, there are multiple countries that own satellites like the USSR, USA, France, Japan, China, UK, India, Russia, Ukraine, Israel, Iran, and North Korea. Some of the main function satellites help humans perform are gathering atmospheric data and capturing cloud images, which allow scientists to track weather conditions and long-term climate patterns, they also handle telephone signals, mobile communications, and ship-to-shore radio. As you see Robots are very beneficial for humans and allow us to do millions of tasks from big to small like checking the weather or helping out the military find a specific location, these are a few ways some robots are used in space and how beneficial for humans.

After discussing the brief history of humans and robots regarding space exploration and showing how humans use robots in space there is a big question should robots completely replace humans for space exploration the last time a human had gone to space was almost 50 years ago, and the next artificial mark on the lunar surface will probably be made by a robot's wheels rather than a human's footprint. Most astronomers say that virtually anything a human can do on another planet, a robot can do if not better. But the battle between humans and robots for who should take the main role in space exploration is not yet solved. 'In what was only a few days on the lunar surface, the Apollo astronauts produced a tremendous scientific legacy,' said planetary scientist Ian Crawford of Birkbeck College in London, author of a paper in the April issue of *Astronomy and Geophysics*. 'Robotic exploration of the moon and Mars pales in comparison.' Humans hold many advantages over robots regarding space exploration.

They can make quick decisions on the go regarding changing weather conditions or new scientific discoveries, rather than robots which have to wait for time-delayed instructions sent from Earth. Humans are more mobile than current robot explorers: The Apollo 17 astronauts covered more than 22 miles in three days, a distance that has taken the Mars Opportunity rover eight years to match. Humans can drill very deep for samples underground and deploy large-scale geologic instruments, something that no robot has ever achieved. But there is thought to be a lot of risks also involved when sending humans to space rather than robots. The Apollo program was incredibly expensive about \$175 billion in today's money although it wasn't only a scientific mission. It was mainly just a show put on during the Cold War to show how American technology is superior compared to Russia. Humans are heavy, fragile, dirty, vulnerable, and very picky about their environment, and have an especially low tolerance for the space environment a few examples are high energy radiation, extreme heat and cold, etc... Humans are very fragile there is no telling what can happen in space, there are millions of ways people can easily die in space from a single control malfunction in the spaceship to a terrible storm killing all the astronauts space is far too risky for people. All humans need consumables (food, water and oxygen) which require vast amounts of money to pay for the extra engineering and multiple redundant systems we need to reduce risks for astronauts, as well as the large support crews needed to make sure everything is going to plan during a manned space mission and the supplies needed for the astronauts to return safe and sound back to earth, there is no return trip needed for robots. There are a lot of risks and rewards for both sending a robot or a human for space exploration but the question seems it will never get answered, could robots completely replace people in space exploration?

In the end, there is no real choice between robotic and human exploration of space. Both are synergistic and mutually dependent. Robotic exploration is needed to enable human exploration by setting the context, providing important information, and reducing the risk for humans. For example, imagine how the Apollo program would have functioned without its robotic presence using Lunar Orbiter to map the moon's surface, Ranger to get close-up views of areas that helped perfect NASA's navigation skills, NASA had missed the moon with two of the first three Rangers to even get that far, and use Surveyor to explore the surface and determine its composition and practice where the soft landings are. Without these robots it would have been impossible to know where exactly to go on the moon, how to design the landing hardware, or think of any real idea of what to do once we got to the moon we would be completely lost robot space exploration played a very important part in space exploration.