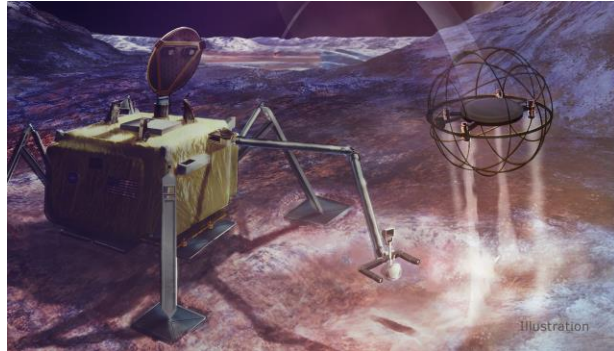


## Introduction

With the rapid growth of technology in the last half century, NASA has been able to adapt to using autonomous robotic vehicles. By using various kinds of robots, rovers, and rotorcrafts, we can explore space in ways that was never possible before. This, alongside with many other benefits, prove how valuable this rise of technology has been for space exploration.

## Robot SPARROW



Credit: NASA/JPL-Caltech

- SPARROW: Steam Propelled Autonomous Retrieval Robot for Ocean Worlds
- Conceptual steam-powered robot (NASA)
- Utilizing large leaps for movement
- Designed for hazardous terrains that are too dangerous for humans to explore
- Specifically icy celestial bodies like Europa
- Depends on lander serving as a home base
- Lander would mine the ice, melt it, and load the water into Sparrow
- SPARROW would use this water for its steam-powered leaping

## Asteroid Redirect Mission (ARRM)

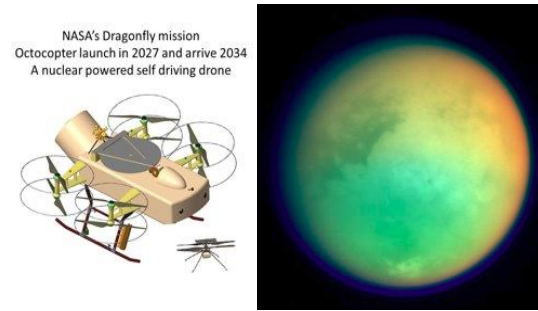
- Was a proposed mission to study the composition of NEO's that had the possibility of collision with Earth before it was cancelled in 2017
- It would find a large boulder and remove it from the surface of the asteroid and redirect it to orbit the moon to be studied

Project for Dr. Mukherjee's Space Science Class

# Robots Role in Exploration

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## Dragonfly Rotorcraft



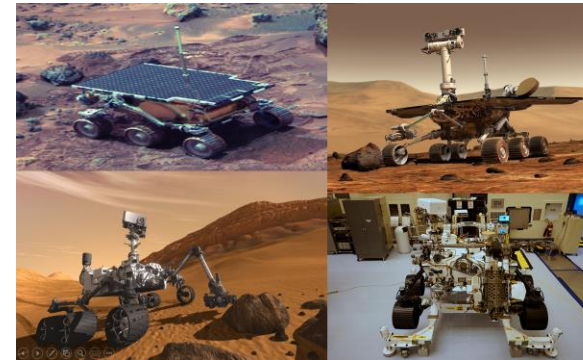
- Mission to search for signs of life on Titan, the moon of Saturn. Titan is the only other place in our solar system with stable liquid on the surface
- Dragonfly will initially land near Titan's equator
- Nuclear powered autonomous octocopter with an H shaped frame
- Designed for long flights in Titan's dense atmosphere where the surface temperature is around -290 F or -175 C
- Equipped with mass & gamma-ray spectrometer to examine organic compounds

## Ingenuity Rotorcraft



- First rotorcraft used on another planet
- Wingspan is 4 ft., weight is 4 lbs.
- Uses solar cells to charge
- Equipped with cameras but no scientific equipment
- It will attempt to use carbon fiber propellers generate vertical thrust in the thin Martian atmosphere
- First test flight expected to take place as soon as Mission Control can establish

## Martian Rovers



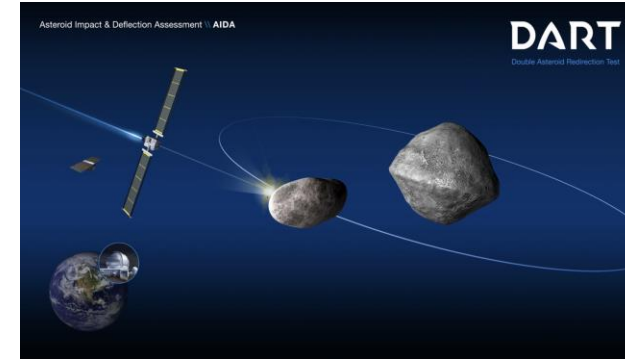
(Starting top right, moving clockwise) Sojourner, Spirit/Opportunity, Perseverance, Curiosity  
Photos from NASA

- Rovers are used to explore Mars.
- Their bodies are specifically designed to protect vital electronics and withstand temps of -40 to 104 degrees Fahrenheit.
- A rover's brains is the computer stored inside the body. They are programmed to do their own processes as well as receive information from the flight team to be executed.
- The computer controls all on-board components including the arms, wheels, cameras/sensors, and equipment used for data collection.
- The rovers are powered by solar arrays or nuclear power.
- The rovers' mission are to find past signs of life/water flow and finding suitable places for future human landings on Mars. They do this by collecting rock samples, taking pictures, and using other sensors to collect data.

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## Double Asteroid Redirection Test



- Mission meant to test a proposed solution to protect the Earth from Near-Earth Objects (NEO)
- Utilizes the new NASA Evolutionary Xenon Thruster solar electric propulsion system
- Uses 3.5 kilowatts of power while weighing 500 kilograms
- Going to be tested on NEO Didymos A, B; a binary asteroid system approximately 1,200 ft. and 280 ft. in radius respectively
- DART will deliberately collide with the smaller object with a velocity of 6.6 km/s to alter its orbit away from earth by 0.4 mm/s
- Expected to launch in late fall 2021 and has an estimated timeline to intercept Didymos' Moonlet Dimorphos in September 2022
- Before collision, the Light Italian CubeSat will separate and take a picture of the collision
- The collision will be viewed by ground-based telescopes

## Conclusion

Whether it's the DART protecting the Earth from potential devastation, or SPARROW exploring icy moons in search of life, the technology that NASA has been developing has been critical for space exploration. These robots, rovers, and rotorcrafts will surely continue to improve and expand our knowledge of space.

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