

Robotics in Space Exploration

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Abstract: This report provide a way for shows the current state of space exploration using space robots and its application. The report begins with the expressing the history of space robot and about the new rovers and landers used now for the space exploration using the modern technology. It then covers about the interrelationship between the robot and the humans and practical precaution taken for robot safety and factors that strongly support space robots is better than the traditional method and future scope for the space robotics and classes or category in which the space robots are classified according to their use in the space and it also discuss about the two major type of space robots types such as the remote manipulator system and remotely operated vehicles and it also contains some factors that are effecting the rocket while at the deploying time due to the earth magnetic and gravitational field and contact between other external objects and it also maps some frequently used rovers to the space

Keyword: Spacecraft, Rovers, Landers, remote manipulator system, remotely operated vehicles

I. INTRODUCTION

The space robotic is field growing significantly developed due to the advancement in technology and in the older period we just experienced only 5 percent of this vast universe after some years due to the advancement in technology we can explore more than 50 percent of this vast universe easily with the help of technology many of the space agency have continuously deploying many rovers into different planets and helps to get details about it along with the government agencies many private centers are also deploying rovers to the other planets in search of microbial life and checking the resources available there. Many of the organization are planning for the human transport toward the others planets. Huge amount of information is collected from the mars and moons and planets mission are in the developing, with the use of non-automotive robots that helps to reduce the cost of the space robot and thereby increases the production of space robots and help even smaller organization to deploy space robots and collect information form this vast universe. The rovers used in the early stage was completely changed when considered to the newer system in size, speed, accuracy and durability too. According to the research says that after 2050 we are able to explore 75 percent of the vast universe and get more information about it and human transport should be made possible easily.

II. HISTORY OF SPACE ROBOTICS

The introduction of space robotics has changed the concept of space exploration it was the Russians who sent the first working space robots into the space ,its name was sputnik in Russian the word sputnik means fellow traveler, it was the first human made object into the space it was a successful mission it carries two dogs called “strella and bellka” and an electronic program called “kudrayavaka” which is an program which were used to collect health information and other materials changes between the two dogs. The major base for the space exploration was the construction of international space station it helps many rovers systems to seek support from that and later the candaian space agency then created the “candaarm” system which were not actually a space rover it was an robot assistant which contains two big arms which were able rotate in 360 degree mode and it can do many works easily and it can easily change its parts easily in space without any helps ,if any of its parts get wear it can be easily displaced in the space. The us space agency also proposed many systems at that time , the first one was the pioneer mission Pioneer it was the first mission it were used for detecting the ionizing radiation, cosmic rays, magnetic fields, and micrometeorites in of the Earth and in lunar orbit.by this mission it can easily identify the earth and lunar orbit nature and according to data we can deploy the rockets to the space easily without causing much problems while deploying this data collected from this mission were used by many other agencies for their missions so it was the backbone for the space rocket emission . The Indian space agency first deployed the Aryabhata in 1975 with the help of the russian launch and finally in 1980 , “Rohini “ is placed in the orbit with an Indian made launch vehicles. India was first developing country to deploy a rocket toward the orbit at that time it was all done by the developed nation. At that time due to the limited technology used the durability of the space rockets was a problem it were difficult for the emission and data collected by the systems were not fully accurate. But all this new technology are all developed from this base.at that there was only government agencies to carry out space research private agencies were not available in that time so, rapid growth in space robotics was not applicable at that time and financial issues were also prolonged at that time.

III. FACTORS AFFECTING SPACE ROBOT DEPLOYMENT

There some factors which effect the space robots while at the time of emission if they are not properly noticed that when led to the failure to all emission. They are

A. Dynamics of Space robots in Orbit

The robot dynamic which mainly deals with forces acting in the robot when it is deployed. It is a freefall environment which consists of earth's gravitational force and non-gravitational forces such as magnetic , solar pressure variation and the atmospheric drag it can be easily neglected because the non-gravitational force are small .The free fall environment mainly consists of two modes the freeflying mode in which the thrusters are active in which they provide a juice to overtake the earth gravitational force easily and the center of mass can be easily translated ,no momentum control devices are required, but in the case of free-floating

method the thrusters are not active this part in which the rocket overtakes the earth gravitational force and the center of mass of the rocket cannot be translated so, we can use momentum control devices for that.

B. Contact Dynamics

The contact dynamics which mainly deals with contact for the physical contact between the rocket and the external environment. For the elastic bodies or for the rigid bodies the contacts are known but, in the case multibody systems the contact is unknown. The Contact mainly happens between the other robots or with asteroid debris in serious cases that even led to the destruction of the rocket so, contact dynamics should easily maintained and proper precautions should taken to control it. one of the best example showing contact dynamics is the three peg in hole arrangement of the batteries and housing structure in the international space station and large gap which placed between the upper and lower portions in which through that cap asteroids debris even space ships can go easily without any contacts.

C. Rigid Satellites and Tumbling Objects

The rigid satellites are the types in which they have fixed shape and orientation spot and they are capable of doing functions they are given. They are not effect by the earth magnetic field and they are typically stable. The tumbling objects are the types which are effected by the earths magnetic field and due to it a torque act on the rocket and that leads to decrease in its rotation and changes to spinning rotating in a larger axis then decreases tumbling rotation in smaller axis. Due to this condition were not able to find its altitude so we, measure the inertia and velocity to measure the momentum and finding the rockets altitude easily.

IV. SPACE ROBOT CATEGORY

According to the use the space robots are mainly classified two three major type. The classification is mainly depending on the use of the particular robots in the space and the way in which they collect information form the area

A. Robot Explorers

The robot explorers are the type in which they are used to collect information from other planets and other sample data collections. They are the type of rovers which mainly move through the other planets and identify the terrain and mainly collect data form the surface. They also checks for the availability of natural resources such water, air and also checks the conditions for microbial life. They also contains particular sensors that helps them to directly communicate to the base and gave the information they collected directly to the ground. They mainly consists of camera's for taking pictures and solar panels for charging their battery they are similar to small car liked structure.

B. Robots Assistants

The robot assistants are types which are mainly designed to assist the humans they are not able do any activity by there own they can do any work according to the humans command. They have no power of thinking by themselves. They are only designed to help humans to reduce there work load and due it with more perfection and accuracy. They are systems that is placed mainly inside in the space ship to help the humans. They can large amount of work with small amount of time, but they always requires commands from humans to do any works so ,they are considered as assistants.

C. Automated Systems

The automated systems are the types in which they have the capability to think by themselves act according to that. They can take decisions in dangerous situations and they can potentially responds to difficult environment accurately. This types of systems are mainly used in the rocket thruster area which are used to overtake earth's gravitational force and provide a juice to the rocket when the rocket reached beyond of earth's atmosphere it suddenly remove the rocket and they fell down to the earth to crossponding place they are expected to be fell down there job is to helps the rocket to overcome the earth gravitational force and move the rocket forward.

V. HUMAN ROBOT INTERACTION

The human robot interaction means the way in which the humans interact with the space robots in a controlled environment during the mission without the proper interaction between humans and space robots the whole mission become a failure so, we want To ensure proper criteria for human robot interaction.

Some of the practical measures that are taken to ensure human robot interaction include:

- proper communication should made between the space robot and humans towards the base station.
- A mutual collaboration should made between humas and robots for taking various decisions.
- The humans should be mentally prepared to work with space robot in a closed environment for a long time for the mission.
- The space robot is able to take decisions in serous problems without from the help of humans.

If the all factors maintained with all proper standards we can ensure maximum results from both the humans and the robots. Considering all the points we want to give space for both robots and for the humans to work independently in the space and make them to make decisions by themselves.

VI. PRACTICAL ROBOT SAFETY

Space robotics safety is crucial for the success of space missions, as robots are used to perform a variety task such as deploying and retrieving payloads, servicing satellites, and assisting with spacewalks. Safety concerns include protecting the robot from damage and ensuring that robot do not interface with other ships.

Some of the practical measures that are taken to ensure space robot safety include:

- Design the robot in a way that in which it can overcome the condition such as pressure variations, radiation, collisons from other space shapes etc.
- The robot should properly tested depending on all the factors that it must experience when it reached in the space and exact precaution should be taken to control it easily.
- The space robot should provide proper communication with the ground when it reaches in the destination and base should be able to fully control the robot easily with a proper communication.

- Proper fault tolerance should be provided for the space robot in the chance of sudden incident and proper backup should be easily provided to the rocket in case of any major problems.
- Emergency precaution should activate if the space robots go through any serious problems and leads the entire mission down should respond cleared quickly without causing much problems to the robots.
- Weather forecasting must be accurate in which the space robot can easily detect the weather change quickly respond to the change.

Overall, it is important for base station take necessary actions to maintain and check their space robot to minimize the risks and also to work on the problem of asteroid debris and pollution in orbits.

VII. TYPE OF SPACE ROBOTS

According to the use of space robots in the orbit and in the space they are mainly classified into two major categories and according to the functionality they are different

A. Remotely Operated Vehicles

The remotely operated vehicles are the type in which the rovers which mainly circulate through the surface of the planets and collect the available resources such as the water and air and also the search of microbial life. The main purpose of this type of rovers are mainly used for collection of sample data. The main example of the remotely operated vehicle is the Curiosity rover which was mainly used in the Mars mission for collecting data from the Mars surface in search of a microbial life. They are similar to a big sized car in which they have tyres and they move in the planets surface just like a car in a road. They also contain camera to take pictures and they are powered by solar panels and they are always connected towards the base ground. If connection is an important factor to monitor this type of rovers. These rovers are very important in search of microbial life or other availability of natural resources.

B. Remote Manipulator System

The remote manipulator system are not similar to the rovers they are mainly designed to help the humans to assist their task and make it more easier and they mainly consist of two large robotic arms in which they can be easily rotated in 360 degrees and do work with less effort and they are larger systems which are mainly placed in the base or in the ship along with the humans to assist them. They have capability to change their parts independently from the space itself. For both of the above rovers must provide proper communication to ground or to the base for success of the mission. In case of emergency proper backup is provided. The main example of this type of system is the Canadarm 2 used in the International Space Station to do any work with its robotic arm structure and assist the humans. They are not able to move as the ROS rovers they can only perform their task using their robotic arm structure.

VIII. PRACTICAL APPLICATIONS

Due to the advancement in the technology many robots are developed and more information about the vast universe can be easily known with the help of this rapid growth in technology.

A. Vyommitra

It is the first humanoid robot built by Indian space research organization for the Gaganyaan, for the human flight mission towards the moon.

Some of the practical functions of Vyommitra include:

- receiving and acting on commands sent from base station
- responding to the environment as per problems
- generating warnings depending on the environment
- replacing carbon dioxide cans
- operating the various switches on the ship
- controlling of the crew members on the ship
- receiving voice as commands
- responding through speech

B. Perseverance

It is the successor of NASA's Mars mission Curiosity. The Perseverance is a big car-sized rover which is similar to a car moving around the Mars surface. Which is mainly used for collecting sample data from the Mars surface and checking the availability of natural resources and microbial life. It was fully powered with solar panels in which it provides maximum energy to the battery and enhances its life. It consists of large and wide camera to take deep pictures of the Mars surface and they are always connected to the base for the exchange of data from the rover towards the base station.

C. Ingenuity

It was NASA's first small robotic helicopter along with the Perseverance rover to collect more data and information about the Mars atmosphere and the different layers available in the Mars surface and understanding the amount of radiation on the Mars surface and act according to the radiation on it. It was the robotic helicopter ever deployed by any agency considering first it is still active and it provides information about the Mars surface accurately. It was the base for robotic helicopter technology.

D. Curiosity

[1] The Mars Science Laboratory mission's Curiosity rover landed in Mars' Gale Crater the evening of August 5, 2012 PDT using a series of complicated landing maneuvers never before attempted [1]. It was the successor of the Opportunity rover due to the low powered battery system the Opportunity rover was not able to move for greater distance. But Curiosity was able to travel more distance and take more data collection from the Mars surface due to the use of high powered solar panel system. It consists of many cameras all round the sides and takes detailed pictures about the Mars surface and many information about it. It is mainly used for checking the availability of microbial life in the Mars surface. It classifies the biological parts into nine major portions to sustain life conditions. It was the Curiosity rover which gave the major breakthrough for identifying the Mars surface and detailing that there is a chance for microbial life in that planet. The Curiosity rover is still providing signals to the base about the major details to the Mars.

surface. The curiosity rover is a type of remotely operated vehicles similar to a car moving around the mars surface using its tyres and checks the availability of microbial life.

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X. FUTURE SCOPE

The future scope of space robots are in rapid growth state in which the technology is advancing day by day in which it helps to explore more than 50% of this vast universe within a few years.

Some areas where space robotics plays a major role in future are:

- Space robotics can be used for deep exploration in space to know more about the vast universe
- By advancement in technology the rovers can easily serviced and replaced simply in the orbit itself with the help of new helper rovers
- Proper utilization of all available resources on each planets and searching for the availability of microbial life.
- Use remotely manipulator systems space debris can be easily removed irrespective of their size
- Scientific research can be done with the vast universe and find the existence of life other than in earth by the advancement in technology

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