Benefits of Space Exploration to Humankind

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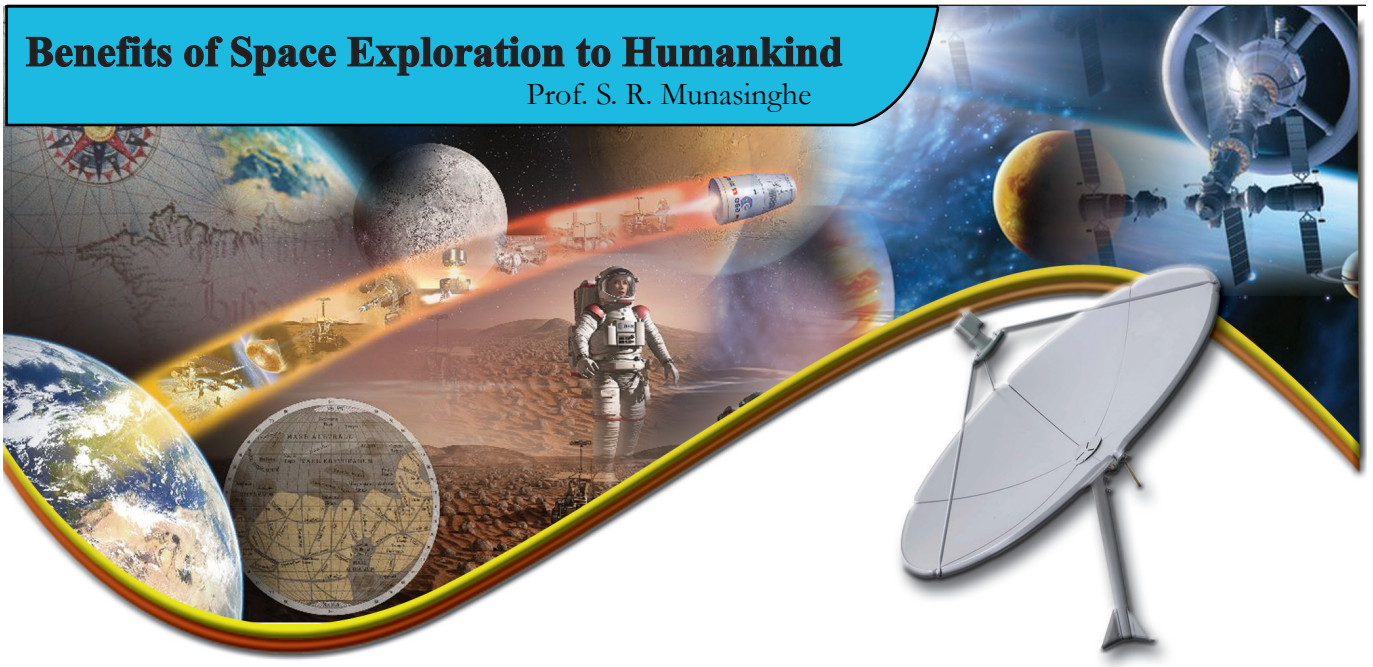


The launching of the first artificial satellite, Sputnik to Earth orbit in 1957 went a long way in setting up of the global communication system using communication satellites. Same effort led to the development of global positioning system (GPS). These two technologies; telecommunication and GPS have helped to make the Earth a global village, elevating social life to a more efficient and comfortable state. The propulsion technologies developed for space travel facilitated the aircraft technology and the safety of air travel. The requirements of space travel such as reliable communication, precise control, tracking and safe navigation have helped improve air traffic control and navigation systems. Much of the electronic and computer systems developed for space travel have in later years been used in many other technical fields to ensure reliability, accuracy, robustness, and redundancy.

Space exploration has helped to accumulate an enormous amount of information (data and images) using spacecrafts and space telescopes in many space missions from sputnik (1957) to Mars Science Laboratory (2014). Space stations (Skylab and International Space Station) have carried out many experiments under low gravity, while monitoring Earth from the orbit. The knowledge gathered from these space missions have revealed the origin and evolution of the Earth, life, the solar system and the Universe. Space exploration has caused alarm among human beings because of the protential threat to their survival on the earth resulting from the adverse affects of environmental unfriendly industrial practice. Today we know that the Universe is 13.7 billion years old and is expanding with an increasing rate. There are many planetary systems other than our solar system, and there are more

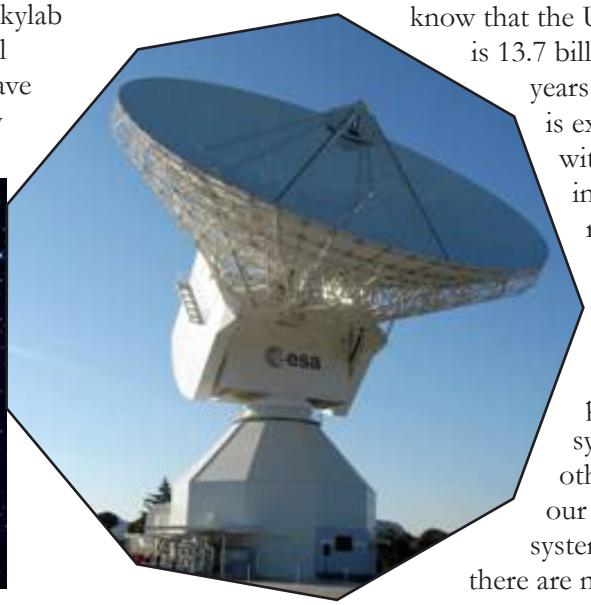


Fig.1 : Artist's view of global communication **Fig.2 : Deep space tracking antenna**

than 250 planets around other stars, but there is no evidance of intelligent life within our vicinity. Mars does not have any significant life on it, and the moon has only traces of water. The continuous exploration for new knowledge has

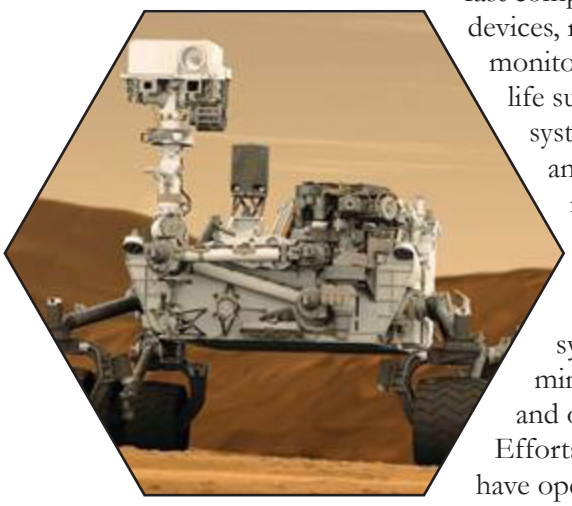


Fig.3 : Curiocity, the Mars Science Laboratory

inspired humankind and nurtured human culture. Human kind is more versatile today than ever before because of the knowledge gathered through space exploration.

Space exploration needs autonomous machines and robots for space missions. Mars Science Laboratory, named "Curiosity" is the latest such robot, which is described as a robot geologist that can carry out many geological experiments autonomously. In the future, even more advanced robots will be needed for space exploration, perhaps for colonization of Moon and Mars. This will trigger a rapid growth in the fields of robotics leading to advanced robotic equipment for medical, industrial, and social activities.

Space travel needed light weight materials, miniaturized devices, fast computing devices, remote health monitoring systems, life support systems, water and air filtering/ purification systems, energy harnessing systems (solar cells and mini atomic power plants) and other robotic devices. Efforts in building such systems have opened new inventions and products that are useful in improving social wellbeing of humankind. The new technological requirements for space travel stemmed as new fields of engineering, and these developed independently over the past half century. It has created new industries, products, and services. New jobs and new career paths were created in technical and medical fields.

Fig.4 : Latest eye measurement tool, a NASA spinoff

NASA's next episode in space telescopes will begin with the James Webb Space Telescoope (JWST) scheduled for 2018. This telescope has 18 flat-smooth mirror segments, collectively of the size of a two storey building. These mirror segments were manufactured in an iterative cycle of grinding-polishing-measuring, which takes a very long time and required a massive effort because the mirror surfaces need to be extremely accurate in order to bring clear images of the first galaxies of the Universe. JWST will collect infra-red light coming from the objects nearly at 13 billion light years away in search of the nature of the universe at its infant stage. The most challenging part of the mirror manufacturing process was to measure the surface with the required accuracy, for which the engineers had to develop a new

Fig.5 : Life Support systems in space and on EarthCourtesy NASA

Fig.6 : Leaf thickness sensor developed for automated farming

technique they named as Infrared Scanning Shack Hartmann System (ISSHS).

Now this innovation, which is capable of measuring complex surfaces with a very high accuracy, is used by eye surgeons for taking measurements of the eye lens before performing surgeries. The original lens measurement tool ISSHS developed for space exploration has now turned into a tool in the medical field by the name Complete Ophthalmic Analysis System (COAS), which is 20 times faster compared to the other existing systems. COAS provides a detail map of the eye-lens from which the eye-surgeon can determine cataracts, keratoconus, and eye movement.

The two famous Mars Rovers-Opportunity and Spirit were equipped with 1Megapixel cameras. However, it was possible to create 96Megapixel wide angle images by stitching multiple images together. NASA had to develop a special tripod for this purpose, which allows the rotation of the camera while shooting photos. The set of photos taken are identified with respective tripod orientation, and later using a custom-built software, these photos are stitched together to make large wide-angle images. This technology has been transferred to the consumer market, and is used in many general purpose photo editing tools. Journalists and individuals are using this tool to generate very effective memorable panoramic photos of special events.

If we ever want to plan for setting up human habitats (colonies) on Mars, a number of new technologies need to be developed to solve key problems in long-haul space travel. One of these problems is continuous food supply for up to one year's journey to Mars. It is not feasible to carry a huge load of food, or to assign farming on flight for astronauts. Therefore, NASA has funded projects to develop techniques for automated growth monitoring, watering, and fertilizer supply to plants to ensure proper growth and nutrition of harvest.

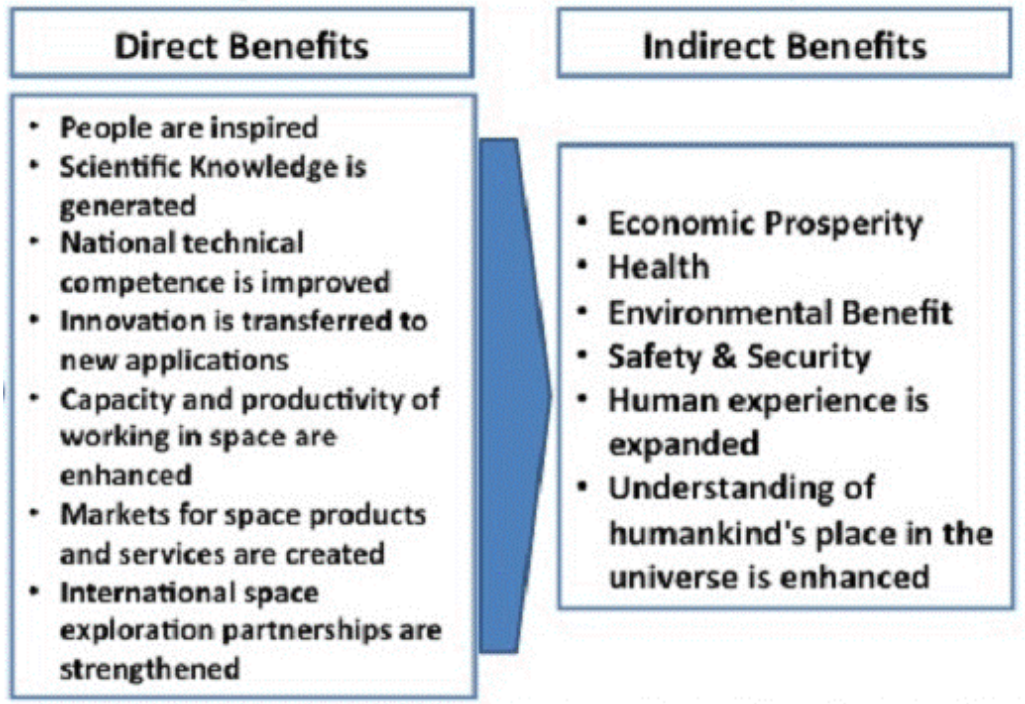


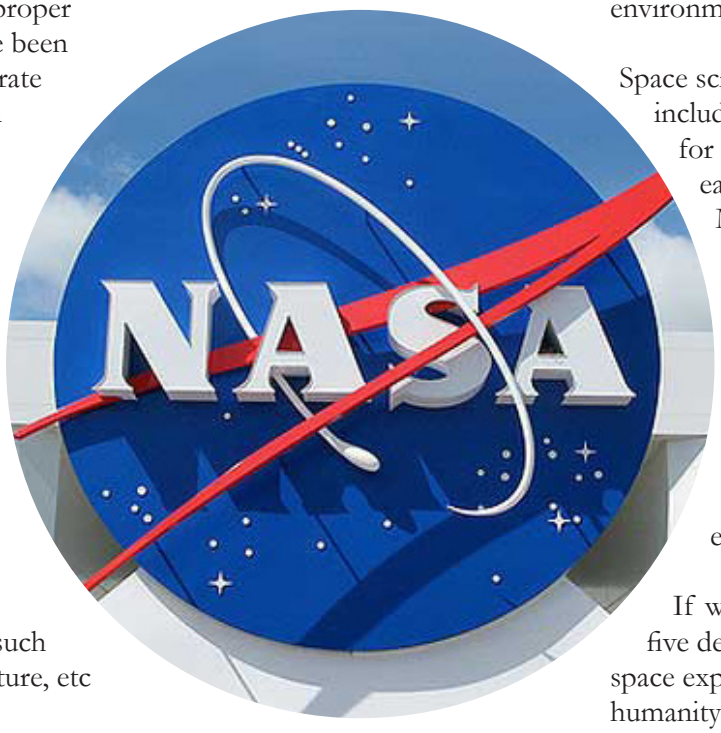
Fig.7 : Direct and indirect benefits of space exploration

One such invention uses sensors to measure leaf thickness and to control watering accordingly. These techniques are now being tested for large scale farming, and it has been found that such automated irrigation has reduced water usage by about 25%, while at the same time maintaining proper growth. These systems have been augmented recently to generate automated SMS alerts when anomalies of plant growth are detected. In the future, farming will be mostly automated, and farmers will only have to attend if there is an issue.

NASA maintains a website titled NASA Spinoffs (http://spinoff.nasa.gov/), where all technical innovations of NASA that have been transferred for useful applications in other fields such as industry, medical, agriculture, etc are listed.

Space exploration is inherently multi-disciplinary, But it is also a costly activity. Therefore, space explorations are usually carried out collectively with other nations. Many countries led by USA, Europe, Japan, Russia and China have worked together in space missions despite the disputes they have among themselves on other issues. Space exploration has united rivals for a common cause.

Colonizing Moon and perhaps Mars too are on the agenda of space exploration. Capturing asteroids, mining them for valuable minerals have also been thought of. After effects of the exposure of human body to the cosmic radiation, and effects of living in zero gravity during long-haul space travel have been studied in the international space station (ISS). These initiatives and ongoing experiments produce immense knowledge and technology for the benefit of humanity. Space watch programs, specially the Near Earth Object (NEO) program is on alert in search for asteroids and comets that are destined to travel closer to the Earth, thus causing a potential threat of collision. It is believed that the dinosaurs, the dominant species on Earth some 65million years ago became extinct after a comet colliding with the Earth, and the records of mass extinction events show that such mass extinctions in which about half of the species is wiped out takes place at an average periodicity of 25 million years. In accordance with this view, it is unusual that such an event had not taken place during the last 65million years. However, it may alarm humankind to be on alert for the next mass extinction event, which can probably be triggered by a nuclear war or environmental pollution. Space exploration has revealed the evolution of humankind. It has also showed us what our destiny will be if we do not conserve our environment.



Space science (Astronomy included) is a fascinating hobby for kids. The curious mind at early ages wonder why the Moon changes its shape over a period of 28 days; what are shooting stars; are aliens real?; Is there life elsewhere? etc. And it inspires curious minds to explore and invent. Space exploration makes humankind more curious, exploratory, and inventive.

If we look back at the past five decades, and identify how space explorations have benefitted humanity in various ways, it would become clear that such benefits and their significance were unpredictable and unforeseen to a great extent. It would be difficult to foresee how today's space explorations will benefit humankind in the future, yet one thing is for sure, that such benefits will be of very great significance.

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