International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 2 Feb. 2023, pp: 248-253 www.ijaem.net ISSN: 2395-5252

Operation Research for Space Industry

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Date of Submission: 01-02-2023 Date of Acceptance: 10-02-2023

ABSTRACT
Operation research for techniques have been used in the space industry, and various to use at the method of its infancy. Since, the characteristics, competing methods and codes are widely varying have been used over time. This current application of survey cases to intended is given an overview of different techniques methodology for space engineering and space science in the domain of operation research.

Keyword: Remote Sensing, Artificial Intelligence, Spacecraft Propulsion, Robotics, Small Satellite, Decision
Processes, Policy Space Identification.

I. INTRODUCTION

The research of the space industry is concerned with operation researching, selling, testing, designing, manufacturing, maintaining spacecraft and operating vehicles and missions in outer space. Organizations of space research include national and international agencies (e.g. ESA and NASA) as well as large and small to medium-sized enterprises, mainly in research and manufacturing. The past of most industries is present as geared towards governmental customers. While, space will be the next big industry, to make the case that the potential is certainly there. For operations management researchers in three categories- manufacturing operations, supply chain management, and sustainable operations. The importance related to stakeholder decisions and needs. Space research is scientific study carried out in outer space, and by studying outer space. From the use of space technology to the observable universe, space research is a wide research field. Earth science, materials science, biology, medicine, and physics all apply to the space research environment. The term includes scientific payloads at any altitude from deep space to low earth orbit, extended to include sounding rocket research in the upper atmosphere, and high-altitude balloons. The mathematical programming has these bulk of techniques that have been used in the space industry from optimization on techniques, but not exclusively focus. Parameter identification problems should be discussed, probably the oldest OR problems considered in space technology and astronomy. Considers problems arising in trajectories optimization (vehicles, satellite, etc.) and motion planning (mainly of robots).typical setting for trajectory optimization include low – thrust interplanetary space mission, fly-by maneuvers, gravity- and aero-assisted trajectories, ascent and re-entry trajectories, emergency trajectories, and rendezvous maneuvers. The path planning includes both motion of ground based as well as air based autonomous robots, and motion planning of robot arms, especially those mounted on space systems. Surveys system design, i.e. the optimization of architectures, components, modules and interfaces of a particular system, while discusses the optimization of satellite constellations and the corresponding communication problems emerging from constellation flights.

1.1 SPACE SCIENCE INVOLVE AN MATH

Astronomers use math all the time. One way it is used is when we look at objects in the sky with a telescope. The camera that is attached to the telescope basically records a series of numbers- those numbers might correspond to how much light different objects in the sky are emitting, what type of light, etc. In order to be able to understand the information that these numbers contain, we need to use math and statistics to interpret them.

Another way that astronomers use math is when we are forming and testing theories for the physical laws that govern the objects in the sky. Theories consist of formulas that relate quantities to each other. (A very simple example is Newton's second law, force equal mass times acceleration.) In order to be able to test these theories and use them to make predictions about what we will observe in the sky, astronomers need to use math to manipulate the equations.

1.1.1 USED IN SPACE RESEARCH

Understanding the size and mass of planets, their gravitational forces and how to use acceleration and deceleration for rockets to explore space are just some examples of math being used by rocket engineers, astrophysicists and astronauts. Every aspect of space travel is used.

Math is important to astronauts because it impacts. Astronauts must rely on their math knowledge to ensure a successful takeoff from earth, expertly direct their spacecraft, and to ensure a safe landing, often without the luxury of a calculator, miscalculations in either of these instances could put the space crew in harm's way. Objects in space, such as the planets and stars are constantly in motion, so knowing calculus is useful for astronauts when they journey into space. Astronauts use calculus to determine the spaceship itself moves.

1.2 RELATIONSHIP BETWEEN MATH AND SPACE EXPLORED

Perhaps you've looked up at the night sky and tried to count the stars or dreamt of being an astronaut. In 1961 humans first launched into space, eight years later in 1969, man first set foot on the moon. As we now explore the outer reaches of our solar system the concept of humans landing on mars is now a genuine goal to achieve in our lifetime – critical to all of these monumental achievements has been the use of math.

Space begins around 100 kilometers above the Earth, where the shell of our Earth's atmosphere around our planet becomes so thin that nothing can fly. Above Earth's atmosphere, astronauts enter an environment where there is infinite blackness, no air, zero gravity, incredibly cold temperatures (-270 degrees Celsius) and nothing but the quiet void of endless space. Our planetary system is the only system that is officially called a "solar system". However, astronomers have discovered more than 3,000 other stars with planets orbiting them in our galaxy (and that's just what they have found so far). Our solar system consists of eight planets that all orbit around the sun. These planets are all of different temperatures and sizes.

Uranus is the coldest planet in the solar system, with a minimum temperature of -224 degrees Celsius.

Whereas Venus is the hottest, with a surface temperature of 475 degrees Celsius. Venus' extreme heat means it is not safe to inhabit. Measuring and understanding planetary temperatures helps our understanding of our solar system and our expectation of life may exist. Space travel involves enormous distances and a commonly used math method called trigonometry is especially helpful to calculate the distances between planets, stars and galaxies that are measured in millions and millions of miles. In fact, these distances are so large that distance is often referred to in light years. Not a buzz lightyear, but the amount of distance traveled by light in a year, and light is the fastest thing known- so it's incredibly fast, which means a light year is a really, really long way.

Acceleration describes how rockets get faster and faster after take-off. The greatest acceleration happens at lift off. If a rocket is launched from the surface of the Earth, it needs to reach a speed fast enough to escape Earth's gravity to reach space. This speed of 7.9 kilometers per second, or 28,000 kilometers per hour, is known as the orbital velocity; it corresponds to more than 20 times the speed of sound. Once in orbit the force of the rocket's acceleration away from the Earth is balanced by the Earth's gravity pull so that it stays at a constant distance from Earth. They need to slow down so Earth's gravity can reverse and the spaceship will slow from an orbital speed of around 28,000 km per hour to 20,000 km per hour (still pretty fast).

1.3 SPACE IDENTIFICATION IN A FIXED ENVIRONMENTAL

Space is one of the most extreme environments imaginable. Above the insulting atmosphere of the earth, spacecraft are subjected to extremes of temperature, both hot and cold, and a significantly increased threat of radiation damage. The first extreme condition a spacecraft has to deal with is that of launch. The rocket that places the spacecraft into orbit will also shake it violently and batter it with extremely loud sound waves.

1.3.1 IMPORTANCE OF SPACE IN CRUCIAL ENVIRONMENT

Space exploration is foundational to climate science because it provides us with more information about the earth, our solar system and the role of gasses in our atmosphere, and nuclear energy has played an important role powering our missions into space. Human activities have contributed to deforestation, desertification, soil degradation, depletion of the ozone layer and climate change. Space-based technologies, such as remotely sensed data, have enhanced scientific understanding of water cycles, air quality, forests and other aspects of the natural environment.

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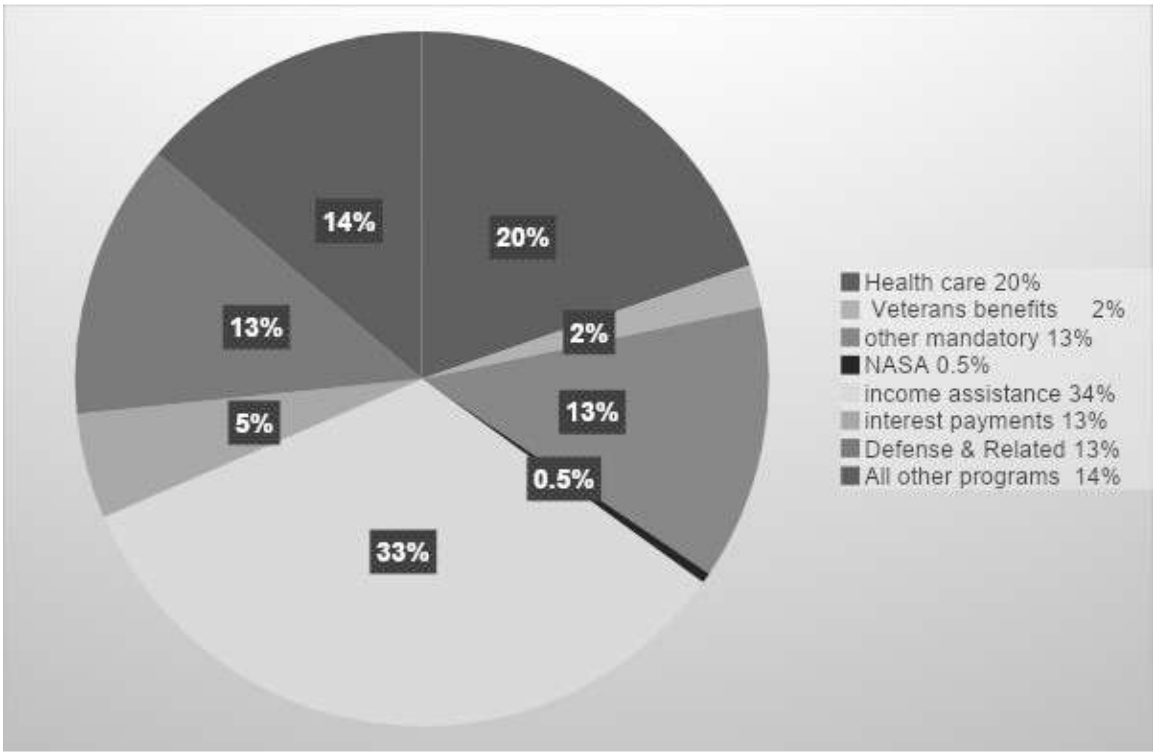

Many countries around the world invest in space science and exploration as a balanced part of their total federal budget. Public opinion research has shown that people estimate NASA to take up as much as a quarter of the U.S. federal budget, but in fact, NASA's budget only represents about 0.5% of the total federal budget and the proportion is even smaller for other spacefaring nations. The correct information may go a long way to reassuring critics that space spending isn't eating up as many public resources as they think.

The United States government spent approximately $6.27 trillion in fiscal year 2022 of which just 0.5% ($29.20 billion) was provided to NASA. In this chart, shades of blue represent mandatory spending programs; shades of green are discretionary programs that require annual appropriations by congress. "Defense and related" includesboth the department of defense and veterans affairs. Source: office of management and budget historical tables 8.7 and 8.9.

1.4 SPACE IMPORTANT TO HUMAN EXPLORATION DESIGN

The importance of space to humans is that without space programs, we wouldn't have GPS, accurate weather prediction, solar cells, or the ultraviolet filters in sunglasses and cameras. There's also medical research happening in space right now that could cure diseases and prolong human lives, and these experiments can't be done on Earth.

Human space exploration helps to address fundamental questions about our place in the universe and the history of our solar system. Through addressing the challenges related to human space exploration we expand technology, create new industries, and help to foster a peaceful connection with other nations.

Space missions in themselves need to be designed such that they fulfill the corresponding design criteria.

Often, special- purpose decision- support systems are designed to be used for the problem at hand. Interesting topics, that only recently emerged, are the mitigation, interception and deflection of dangerous near-Earth objects and the delivery of solar power from space various subsystems on- board a flight system are also amenable to.

1.4.1 Salyut 1

Salyut 1 was the first space station ever built. It was launched on April 19,1971 by the soviet union. The first crew failed entry into the space station. The second crew was able to spend twenty-three days in the space station, but this achievement was quickly overshadowed since the crew died on reentry to Earth. Salyut 1 was intentionally deorbited six months into orbit since it prematurely ran out of fuel.

1.4.2 Skylab

Skylab was the first American space station. It was 4 times larger than Salyut 1. Skylab was launched on May 14,1973. It rotated through three crews of three during its operational time. Skylab's experiments confirmed coronal holes and were able to photograph eight solar flares.

1.4.3 Mir

Soviet (later Russian) station Mir, from 1986 to 2001, was the first long term inhabited space station.
Occupied in low Earth orbit for twelve and half years, Mir served a permanent microgravity laboratory. Crews experimented with biology, human biology, physics, astronomy, meteorology and spacecraft systems. Goals included developing technologies for permanent occupation of space.

1.4.4 INTERNATIONAL SPACE STATION

The international space station received its first crew as part of STS-88 in December 1998, an internationally co- operative mission of almost 20 participants. The station has been continuously occupied for 22 years and 73 days, exceeding the previous record, almost ten years by Russian station Mir. The ISS provides research in microgravity, and exposure to the local space environment. Crew members conduct tests relevant to biology, physics, astronomy, and others. Even studying the experience and health of the crew advances space research.

1.5 TRAJECTORY OPTIMIZATION AND MOTION PLANNING

Trajectory optimization and motion planning are space application areas in which optimization is most widely used. In trajectory optimization, the optimal path of a flight system or a group of flight systems is searched for, often in an interplanetary setting. Trajectory optimization methods have already previously been surveyed. Basically, there exist two different solution strategies for such problems and both strategies need techniques from nonlinear.

1.5.1 PARAMETER IDENTIFICATION

Parameter identification problems are abundant in space technology and astronomy. Most, if not all, physical models of a particular flight system or a whole solar system, contain certain physical parameters, which are not known a priori but have instead to be estimated based on certain observations of the system under consideration. In astronomy, the first use of optimization technology for parameter identification was Gauss' use of the method of least.

1.5.2 STATION KEEPING

A satellite in geostationary orbit (GSO) or low earth orbit (LEO) should make some orbital maneuvers to compensate for the orbital perturbations and remain on its orbit. The main cause of these perturbations are gravitational attractions of the sun and moon which results in orbital latitude inclination to increase which is countered by a (normal) north-south station keeping maneuver(NSSK).The average velocity change (delta v) is accountable for 95% of the total station keeping propellant budget.

1.6 FUTURE GOAL

NASA'S (National Aeronautics and Space Administration) is the United States government agency responsible for U.S. space exploration, space technology, Earth and space science, and aeronautics research. NASA's Artemis program aims to land another man and the first woman on the moon by 2024 and eventually establish sustainable space travel by 2028. The Artemis program is NASA's stepping stone to their ultimate goal of landing on Mars. The first two goals of the space program. The program's main goals were:'' to test an astronaut's ability to fly long duration flights (14 days)"; "to understand how a spacecraft could rendezvous and dock with another vehicle in Earth orbit; to perfect reentry landing methods"; and to further understand the effects of longer spaceflights on astronauts. The goals of ISRO (Indian Space Research Organization). Harness, sustain and augment space technology for national development, while pursuing space science research and planetary exploration. Design and development of launch vehicles and related technologies for providing access to space.

In the future of space tourism with the rapid growth of space tourism, traveling to outer space could soon be as easy as booking a flight to Europe. Experts even say that in just a matter of years, this industry could change the world, much like other NASA inventions, including real- life robots.

II. CONCLUSION

As techniques have been used in the space industry for operation research since its infancy, and various competing methods and codes, with widely varying characteristics, have been used over

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time. It can be seen, the use of operations research permeates vast areas of space technology and astronomy. The field, from control theory to discrete optimization in total we have been tools from optimization is used span the full breadth of this also reflected in the corresponding set of tools used. Advances in PC and workstations technology, in optimization engines and in modeling techniques now enable solving problems, never before attained by operation research. Humanity requires more efficient, more sustainable, and much less costly access to space, if it wants to dramatically expand it use of Earth orbit and make interplanetary space part of its Economical sphere. We need ways to get into orbit to reach other planets that do not leave large amounts of debris, require enormous amounts of propellant, or take incredibly long periods of time. The space tether systems described in this various solutions. Space elevators could provide an easy and regular way to get into Earth orbit, and electro dynamic momentum exchange tethers could send space- craft from low orbits up to higher ones and vice versa. Tethers could even de- orbit return capsules or send spacecraft on their way to other planets. Further out into space, momentum exchange tethers or aero braking tethers could be used to capture spacecraft into orbits around the Moon, Mars, and Jupiter. The 22 nd century may see a fleet of spinning tethers strategically placed around Earth, the Moon, and Mars creating efficient interplanetary highways for spacecraft that require almost no propellant. Damage protection is an important issue, both in terms of tether materials and concepts and in terms of collision and impact avoidance. There are serious risks associated with having a cable tens of kilometers long rotating in orbit together with other satellites.

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