**Recent Advancements and Applications of Computational Automation in Deep Sea and Space Exploration**

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**Abstract**

About 30 percent of earth’s surface is made of land, from that we can conclude, approximately 70 percent of water encapsulates the earth. Even after numerous expeditions to learn more about the sea world, about 80 percent of it still remains a mystery. In recent times, to gain insights on the mystery of the sea world, scientists have been employing the use of scientific apparatus and using modern artificial intelligence (AI) technology to discover the secrets the deep waters carry within. Numerous efforts have been carried out to explore the space. At present, we have managed to know only our own solar system, that’s too on a limited scope. Hence, these explorations have been gaining tremendous interest among researchers enabling them to know the unknown and solving the unsolved. These efforts have been accelerated with new technologies from artificial intelligence, most of which are autonomous. On one hand these saves the involvement of human directly by not sending them to sea or space, thereby saving life, while cost-effective on the other. Hence, the application of such AI techniques is indisputable. This article lists some the recent exposures of AI on sea/ocean and space exploration and how these techniques would shape the future of such expedition related researches.

 **Keywords:**

Artificial Intelligence, Machine Learning, Deep sea Exploration, Space Exploration, Deep Sea Mining.

**1.Introduction**

Deep Sea mining projects provide new opportunities for subsea operations. The offshore oil and gas field is also an area where relevant authorities provide assistance in rescue and recovery, but offshore drilling is a deeper and more complex place that requires the support of automated systems with high application of artificial intelligence. The demand and price of industrial machinery has increased enormously. A field study was conducted in an attempt to identify deep sea mining as a green solution (Dengyun et.al., 2020). There are also systematic and attractive ways to obtain these raw materials. Technological and economic constraints have led to less interest in underwater mining since the 1970s. However, given recent advances in underwater research with maximum possible coverage of remote areas, International Seabed Authority (ISA) has increased the number of research permit applications to twenty policy nodes and research agreements.

Space exploration has been going on for a long time without using artificial intelligence. Apollo and other historic missions space flight is basically available with control or pre-programmed instructions with minimal changes in AI (Kumar et.al, 2018). However, the atmosphere of space flight has become intense in recent years (Abderrahmane et.al, 2020). Private companies, 1999 Like SpaceX, Electron and Blue Origin Key industry players have emerged. Put work before money Appeal a review Space exploration has become artificial intelligence the most popular. covered in this article The importance of artificial intelligence in different countries Space travel campaigns include LEO launches from Earth, space missions and more exploration of extraterrestrials.

**2.Importance of Deep Sea Exploration**

It is sometimes said that mankind has more knowledge about the surface of mars and moon than our own sea world. Previously it was considered that Hadal zones (the deepest zones) is not suitable for life to thrive. But after years of exploring and researching to gather data, it has been known that even in the deepest trenches where sunlight does not pass, life can exist. And the plants there rely on chemosynthesis, instead of photosynthesis (Munim et.al, 2020).

Looking into those trenches we have found how life forms can survive even in the most inhabitable conditions. Studying their survival techniques can give us a better overview of how to tackle the upcoming battle for the struggle for survival. A large aspect of Deep sea exploration is about discovering the unforeseen and atypical biochemical, archaeological, geological and not to mention physical processes that occur in the depth of the ocean worlds (Munim et.al, 2020). The collected data from these explorations could potentially answer a lot of emerging research and science.

Deep Sea Exploration also gives us a powerful insight as to how the ocean resource should be utilized ethically and sustainably so that the future generations can benefit from the natural resources as well. Solving the ocean's mysteries could provide new sources of drugs, vaccines, food, energy and more, and inspire new ways to track changes in marine animals. Data from oceanographic analysis can help us understand how Earth's environment is changing, such as climate change (Ma et.al, 2021).

Data from oceanography allows us to predict earthquakes, which can help us understand and respond to tsunamis and other natural disasters. The challenges posed by ocean research can inspire new techniques and technologies that can be applied in other contexts, allowing us to better respond to ocean emergencies such as oil spills. Exploring the ocean will enhance our knowledge of the ocean and inspire young people to pursue meaningful careers in science, technology, engineering and mathematics.

The deep sea is a place of extreme pressure, cold temperatures, salty water, and little or no light. We don't know what's out there, but we often lack the tools and skills needed to go to these extremes. Today's technology allows us to use ships and machines with more advanced systems to map the ocean floor. Measuring ocean properties and sampling the marine environment, we are preparing for the next quantum leap in self-driving cars, which will dramatically increase the speed and scope of research (Kampmann et.al, 2018).

Marine research provides the basic environmental information needed to respond effectively. In addition, the tools and techniques used can be adapted for use in emergency situations such as oil spills or unexpected changes that threaten aquatic life. The world's environment is constantly changing. Many of these changes are happening faster than before. The ocean plays an important role in many of these changes, from the frequency and intensity of coastal storms to rising sea levels and global warming (Santos et.al, 2018).

**3.History of Deep Sea Exploration so far**

**3.1. Exploration Primitives**

In 1868, Scottish naturalist Charles Wivell Thomson persuaded the Royal Society to support a project to mine the seabed in the North Atlantic. Thompson used a tool called marine bioscanning, which was a net mining device used to scrape the ocean floor to capture life. The first excavation by Otto Friedrich Müller in 1830 had no locking mechanism. Thus, the tests often fail. Increasingly convince people that there is no life on or below the surface. This arrangement consists of sponges, shells, molluscs, etc. up to 300 m (548.64 ft) at sea. This discovery led to an increase in seabed exploration, and in 1872 H.M.S. Challenger embarked on a three-and-a-half-year voyage under Thomson's command. The well was sunk to a deeper level, and by the end of the voyage in 1876, new species of marine life were discovered and hundreds of samples of sea and ocean water were collected (Song et.al, 2018).

**3.2. Exploring the ocean world**

In 1872, Sir William Thomson replaced strings with thin piano wires and invented the Thomson Sound Machine. This machine still used steel wire, but the rope was released from the pulley and brake, and the dial recorded the number of ropes used. In 1872, Sir William Thomson created the Thomson Sounding Machine by replacing the wire with a thin piano string. Through these experiments Thomson invented the radio. These technological changes have ultimately changed the way for scientific studies. Wireless machines worked faster and more precisely.

From 1872 to 1974, Under the command of Commander George Belknap, USS Tuscarora surveyed the Pacific between Cape Flattery, Washington, and Japan using Thomas's telegraph transmission equipment. During this period, he discovered the Juan de Fuca Ridge, the Aleutian Trench and the Japan Trench. In 1874, Master Charles Sigsbee Thompson expanded the sound system by replacing piano wires with steel ones. This new machine was called the Sigsbee Sound Machine and would become a staple of wireless sound systems for the next 50 years. After the sinking of the Titanic in 1912, efforts were made to develop bathing techniques to locate underwater objects. In 1914, Reginald A. Fessenden developed Fessenden oscillations using a method called resonance estimation. The Fessenden Oscillator is a powerful underwater speaker that produces sound. Using the new technology, Fessenden experimented with arrow measurements and was able to determine waves of two kilometers, ranging from 130 to 450 feet.

During World War I, researchers developed the Fessenden generator to search for submarines. This is how modern ultrasonic systems (SONAR) are developed. Currently, scientists use two types of ultrasounds: active and passive (Song et.al, 2018). Active transmitters send sound signals into the water. The sound then bounces off objects in its path and is sent to an "echo" device that measures the strength of the signal. By knowing the echo and the time of the echo, the intensity of the object can be estimated. Passive acoustics are used to detect ocean sounds or animal sounds.

**3.3. Reaching the unexplored ocean regions**

Scientists wanted to explore our Earth by mapping the oceans. The first ship was built by the Dutch colonel Drebel in 1623.These early ships went 12 to 15 feet deep. In 1800, Robert Fulton built a submarine called the Nautilus with the permission of Napoleon Bonaparte. The frame is made of copper plates with metal walls; A new part of the ship is the ballast tank. "Nautilus" dives, takes water from the ballast tank and throws it into the water. Add a horizontal rudder for easier handling. The submarine seats four people and has enough air to keep two fires going for three hours.

During World War I, submarines were powered by diesel engines. A large battery-powered electric motor propels the submarine at 15 knots for two hours. Built in 1954, the USS Nautilus was one of the first nuclear submarines designed for diesel and electric propulsion. During the day the unit had to engage in quiet fire with a short submarine battle. Basically, the heat from the uranium boils water or iron to create steam that drives turbines under the sea.

New underwater technology allows humans to enter the ocean floor at lower temperatures and higher pressures. But in order for people to come close, they had to know how to swim underwater for long periods of time (Kampmann et.al, 2018, Manish Verma, 2023).

The idea behind modern snorkeling is that people swim underwater using a long straw as a snorkel. The original design of underwater diving was inspired by the idea of ​​oxygenation of diving water. In 1690, Edmund Halley invented the water alarm (camera), which connected pipes to large drums and supplied oxygen to divers. Then, in 1788, John Semton added a hand pump to provide oxygen effectively so that the air would not return to the suite when the pump was stopped. In 1823, Charles Anthony Deane created a patent for smoke helmet. This helmet was originally designed for firefighters, but has since been used by a variety of people, especially for diving. The helmet is lightweight and attached to the oxygen tank, but not the helmet itself, only the strap. It protected divers from bending over and drowning.

 In 1834-1835 care was successfully restored to a cannon from the Royal George that had sunk.

In recent decades, scientists have worked to create underwater oxygen that can melt ice. The underwater breathing machine was invented and unveiled in 1865 by French tunnel engineer Benoit Lecarol and military commander Auguste Deneros. The reservoir is horizontal and steel with 250 to 350 pounds of water per square inch on the swimmer's chest. The valve and water nozzle are connected to the tank.

The device, called the "Aerophore", releases air only when trying to breathe under the external pressure of the water on your skin. Oxygen cylinders are included, but are removed and sealed in minutes. In 1933, French Admiral Yves Le Prior refined the design. William Beebe and Otis Barton made the first deep sea voyage. They discovered a world which was unknown before by reaching a depth of 914 meters off the coast of Bermuda in 1934. In 1941 Research during World War II produced new tools. More for Ocean Exploration: The First Deep-Sea Camera The first magnetic sensor sonar technology and remote control vehicle (ROV) equipment. The sonar of the British ship HMS Challenger, known as Challenger Deep and located in the Mariana Trench in the Pacific Ocean, was found at the deepest point of the ocean at a depth of 10,929 meters in 1951.

Jacques Picard and two other men entered the sea at a depth of 10,911 meters, almost seven kilometers, in the Trieste complex. At this incredible depth, researchers have discovered incredible sea creatures in 1960.

On September 19, 1979, Sylvia Earle set an impressive new record for the deepest wetsuit dive. Using new technology (JIM's suit), he reached a depth of 381 feet off the coast of Oahu.

On August 10, 1992 The TOPEX/Poseidon satellite was launched into space and began to provide ocean data that was not possible before. TOPEX/Poseidon measures about 95 percent of the ocean's height with great accuracy. This new information is helping to develop a new understanding of ocean currents and their impact on global climate.

Around 1995, Data mining Geosat radar altimeters created a world map of the ocean floor from space. Launched by the US Navy in 1985, Geosat measures sea level by returning radar beams from it. In 1995, the Navy finally deleted the Geosat data. David Sandwell of the Scripps Institution of Oceanography and Walter Smith of the National Oceanic and Atmospheric Administration can use this information to create detailed maps of the ocean floor. His observations have improved the accuracy of previous images of ocean waves.

The ten-year project involved 2,700 scientists from 80 countries who completed the world's first marine life survey in 2010. In 2017 Seabed 2030 is a new international initiative that aims to map the seabed. The goal set by Japan's Nippon Foundation and the General Oceanographic Map of the Ocean (GEBCO) is to combine all available hydrometric data to create a definitive map of the planet's ocean floor by 2030.

**3.4. Exploration using Technology**

Once people reached the bottom of the Mariana Gulf, travel was expensive and limited exploration was possible (Santos et.al, 2018). Modern research is based on robotic systems. A remotely operated vehicle (ROV) is a submarine controlled by scientists on board. ROVs typically carry cameras, manipulators, sonar equipment, and sample containers. Autonomous Underwater Vehicles (AUVs) operate without a driver. map building vehicle Measure temperatures and chemicals and take pictures (Crosby et.al, 2023). Some vehicles, such as the Nerios, work as ROVs or AUVs.

Engineers at NASA's Jet Propulsion Laboratory in Southern California are building an underwater vehicle called Orpheus, after the ancient Greek warrior who entered the abyss and returned to impossible depths.

Using navigation technology similar to NASA's Mars rovers, Orpheus uses highly sensitive cameras to detect rocks, shells and other features on the ocean floor to create a 3D map of the destination. At around 250 kg (550 lb) in ATV size and weight, the Orpheus is designed to be significantly lighter, smaller and less expensive than previous submarines. This will gave more flexibility to explore underwater tunnels and open spaces was not explored before (Li et.al, 2020).

**4. Importance of Space Exploration**

Mankind's interest in the sky is universal and enduring. Man is driven to explore the unknown, discover new worlds, and cross scientific and technological frontiers. An insatiable desire to explore and challenge the boundaries of what we know and what our society has benefited from over the centuries. Human space exploration helps answer fundamental questions about our place in the universe and the history of our solar system.

To meet the challenges of human space exploration, technology is being updated, new industries are being created, and peaceful communication with other countries is a must. Curiosity and exploration are vital to the human spirit, and embracing the challenge of going deep into space invites citizens today and for generations to join NASA on this exciting journey (Kumar et.al, 2018).

It opens a new era of space exploration and calls on NASA to develop the systems and resources needed to explore beyond low Earth orbit, including interstellar space, near-Earth asteroids and eventually destinations like Mars.

NASA is testing and testing the International Space Station on this challenging journey. What they learn there will prepare astronauts for the challenges of long-haul flight and other advancements, in human expeditions beyond those we have been before. Going to and exploring other Planets the will give us valuable mission experience and prepare us for the next step. Remote robotic probes to visit places, do research, collect scientific data to provide deep answers to our society. Combining human research and robotic arms technology and sensory approaches to improve our ability to see, adapt and discover new ideas.

Among the first steps in a long and arduous journey is building a solid foundation for a successful business. The International Space Station is a national laboratory for human health, biology and materials research, a testing ground for technology, and a constant for the advancement of the solar system (Abderrahmane et.al, 2020).

On the International Space Station, scientists develop and study new ways to keep astronauts safe, healthy and productive, expanding our knowledge of how life and living things work outside of gravity. NASA continues to do great work with the commercial sector and industry in general, as private companies develop and operate safe, reliable, cost-effective commercial systems to provide crews and equipment to the International Space Station and global orbit.

Extra Lunar space is a large region around the Earth-Moon system that extends far beyond the lunar orbit and is governed by the gravitational pull of these two celestial bodies. Geomagnetic protection as well as space exploration will provide an unprecedented experience of space missions.

By operating in space, NASA can study the heat of space, perhaps the most dangerous part of human deep exploration, and develop models that could lead to medical advances here on Earth. The Lagrangian region, where the gravitational effects of the Earth and the Moon are balanced, is suitable for exploration and exploitation, where little is needed to stabilize the object or spacecraft. The Lagrange point at the edge of the Earth-Moon system, known as L2, also provides a "radio" for astronomical observations (Knight et.al 2001).

Lunar missions allow NASA and its partners to develop operational tools and technologies that will support future exploration for decades while remaining close to Earth.

 **4.1. First Flight**

By the end of the 20th century, rockets were powerful enough to overcome gravity and go into orbit which opened the way for space exploration. In the 1930s and 1940s, Nazi Germany realized the potential of using long-range rockets. On a 320-mile flight across the English Channel at the end of World War II, the V-2 blasted London from 90 miles to 3,500 miles per hour. After World War II, the United States and the Soviet Union developed their own missile programs.

Modern space exploration has reached unexpected heights. Mars is the center of this space exploration, and Mars exploration is its long-term goal. United States. In the 1930s, NASA focused on Mars with the goal of sending humans to the Red Planet. NASA and its partners have sent orbiters, landers and explorers to expand our knowledge of Earth. The Curiosity rover collects radio data to protect astronauts, and the Mars 2020 rover investigates the presence of oxygen and other Martian resources.

**4.2. Exploring the Orbit of earth**

On October 4, 1957, the Soviet Union launched its first satellite, Sputnik 1. Four years later, on April 12, 1961, Russian Admiral Yuri Gagarin became the first person to orbit the Earth in Vostok 1. After a 108-minute flight, Gagarin reached an altitude of 327 kilometers. The first American satellite, Explorer 1, was launched into orbit on January 31, 1958. In 1961, Alan Shepard became the first American to walk in space, and on February 20, 1962, in the famous John Glenn flight, he became the first American to orbit the Earth.

**4.3. Exploring Planets**

In the 1960s, an unmanned spacecraft photographed and analyzed the moon before astronauts landed. In the early 1970s, communications and navigation satellites were used in everyday life, and the Mariner spacecraft orbited the surface of Mars to produce maps. Ten years later, the Voyager spacecraft visited Jupiter and Saturn. Skylab, the first American space station, was the first demonstration of human spaceflight in the 1970s, the Apollo-Soyuz mission, the world's first space launch (USA and Russia).

In the 1980s, satellite communications expanded to broadcast television. And people can receive satellite signals from their dish antenna. Satellites have captured the Antarctic ozone hole, documented wildfires, and provided us with images of the 1986 Chernobyl disaster. Astronomical satellites search for new stars and provide new insights into the galactic core (Kumar et.al, 2018).

In April 1981, the era began with the April launch of the Space Shuttle, with most of the military's commercial space missions using space-suited spacecraft. The Columbia disaster was the second largest space disaster. On February 1, 2003, the spacecraft was released after returning to Earth, killing all seven crew members. The crash happened minutes before landing at the Kennedy Space Center in Texas. An investigation determined that the crash was caused by the foam insulation crushing the fuel tank and damaging the car's wingtips. This was the second loss of spacecraft associated with Flight 113. After each disaster, bus service was suspended for more than two years (Knight et.al 2001).

**4.4. Spacecraft of the 21st century**

Discovery was the first of three spacecraft to be launched and was scheduled to complete its final mission on March 9, 2011. Endeavor also completed its mission on June 1. The spacecraft landed on July 21, 2011, completing its final flight, ending the 30-year space shuttle program. The Gulf War demonstrated the importance of satellites in modern warfare. In this war, the Allies were able to use their control of the air "above ground" to great advantage (Purcell et.al, 2022).

Satellites provide information on enemy formations and movements. It was used to provide early warning of enemy missile attacks and precise navigation in featureless deserts. The advantage of satellites allowed the Allies to end the war quickly and save many lives.

Space systems are becoming increasingly important for homeland security, weather monitoring, communications, navigation, imaging, chemical remote sensing, fire and other hazards. The International Space Station is a Low-Earth research laboratory. with the participation of many different participants in its design and construction. This flying laboratory has become a symbol of cooperation in space exploration, now working with former rivals.

The station has been continuously occupied since the first probe arrived in November 2000. The station is served by various spacecraft, including the Russian Soyuz and Progress. American Dragon and Cygnus. Japanese H-II vehicle. Before spaceships and European self-driving cars. Astronauts from 17 countries. Astronauts and space tourists have also visited.

The positioning system is designed to reduce costs and improve reliability, safety and reliability. Most US military and scientific satellites are launched into orbit by multiple launch vehicles designed for multiple missions. Some countries have their own infrastructure and there is fierce competition in the commercial market for infrastructure development.

**5. Relevance of Exploring Deep Sea and Space**

The depth of Earth's oceans is very similar to the conditions NASA hopes to find on other worlds in our solar system. They may also indicate where scientists should look for extraterrestrial life. We hope their underwater discoveries will help unlock the secrets of space and test some of the equipment and experiments needed for missions to other parts of the solar system.

Ocean and space exploration have a lot in common. In both cases, robotic explorers are sent to work in places inaccessible to humans, communicating with groups of people both near and far. Joining the two worlds will help the SUBSEA team, led by Darlene Lim of NASA's Ames Research Center in Silicon Valley, California, prepare for a new kind of space exploration mission through real-world training on Earth.

The SUBSEA team conducted scientific research to help NASA better understand the survivability of other ocean environments and to explore the role of oceanography in determining how to conduct remote science missions to improve future research.

Using ship-to-shore telepresence technology developed by OET over the past decade and enhanced for missions by NASA technology, the team will be able to increase the size of its scientific team to become one of the most multidisciplinary research teams in the world. Missions led by the SUBSEA team will have a direct impact on human exploration destinations such as the Moon and Mars.

Ultimately, the SUBSEA research results will help the design team develop a more efficient, effective and safe way to conduct research during rare robotic missions in deep space such as Mars. The scientific results will help SUBSEA better understand the potential for life on other oceanic worlds in our solar system. Scientists will thus be able to better understand how different properties of water rocks affect the supply of energy sources for the further growth of bacteria and where such conditions can occur.

 In 2019 SUBSEA had its first expedition. It focuses on the energy flowing through the system and the microbial communications. The telepresence architecture used in the Nautilus mission was studied as a model for designing future NASA missions. In mid-2019 SUBSEA had its second expedition. The Gorda Ridge location adds Lo`ihi, but that year the Mars communications delay added to its simulation program. Computer systems developed by AMS to manage the project's long-term operations and help with delays will be tested on sea missions for the first time this year. SUBSEA researchers will use social studies to examine how organizations respond to new challenges and solutions.

**6.Application of Artificial Intelligence techniques in Deep Sea Exploration**

**6.1. Concept of Deep Sea Mining**

Deep sea mining is the process of extracting mineral deposits, 200 Meter below the marine floor. Environment for deep sea mining is isolated, under enormous pressure, very dark and cold and with some major difficulties. There is deep-sea mine research on the use of bots is growing rapidly in the Department of Extreme Exploration Studies. There is a keen interest in sustainable raw materials, due to which deep sea mining is finding its way to the limelight.

**6.2. AI and ML in Deep Sea Mining**

This can be done with AI and ML technologies analyzing and interpreting data from sensors and other sources wells, surface and open pit mining not more. Its steps are AI and ML researchers, software developers and data analysts. Overall, digital adoption is deep. Offshore mining can create new job opportunities, especially in robotics, Data management and AI/ML. But it happened. It is important to remember that it is cleverly designed and executed. Continuity of power Environmental and Social Impacts of Gurgite Mining and things (Santos et.al, 2018).

Continuous advances in space and sensor technology over the past 40 years have made ocean remote sensing possible. Sensation enters the Big Data era with the essential 5 Vs (Volume, Variety, Value, Velocity, Veracity). This will enable the collection of data from tens of petabytes or more of satellites for remote ocean sensing. We collect data from all over the world every day (Kampmann et.al, 2018).

Data mining such as ocean remote sensing is a big challenge. Recently, new technologies in machine learning are becoming more and more traditional physical or statistical image data mining systems. There is growing interest in many industrial and marine remote sensing applications.

**6.3. Robotics in Deep Sea Mining**

Increased demand for rare earth minerals is also increasing black hole production. Many wrecks are inaccessible to various people, and therefore require deep working robotic skills. For example, an underwater vehicle can continuously monitor its operation and signal the need for human intervention via remote control. Increased demand for rare earth elements has increased the production of black holes. As most of the ruins are inaccessible to humans, advanced robotic control is required. For example, an underwater vehicle continuously monitors its performance and indicates the need for human intervention via remote control. Following are some of the nuanced robotic systems (Kampmann et.al, 2018).

**6.3.1. Increasing Intelligence of AUV**

Standard Autonomous Underwater Vehicle (AUV) mostly use sensors and orientation sensors. Accelerometer uses DVL (Doppler Velocity Log) and gyroscope and accelerometer to measure the current position. These major updates can sometimes be fixed by updating the entire USBL product. It can combine physical data such as cameras and sonars with advanced 3D data such as laser (longitudinal) sensors. This allows the AUV program to create 3D images of the object compared to the original CAD model or survey data. By fully opening the 3D model, the AUV will be able to detect visible changes, anomalies, lack of CP in CP, or sea growth

**6.3.2. AUV infrastructure for Seafloor**

Current AUVs have limited endurance due to battery capacity. In addition to the sensor package, internal data storage can be a limiting factor. This results in an AUV deployment time upto several days, depending on the size and characteristics of the AUV, the mobility and capabilities of the sensors, and the environmental conditions of the site. Depending on the load requirements, inductive power transfers or immersion connections are used. Both require precision, but the latter allows for higher load currents but requires a more complex and powerful power management mechanism.

A large data stream needs to be sent to the AUV for further analysis and research. Current research techniques include Light Emitting Diode (LED) or laser integration, and sub-centimeter intensity integration. However, optical data transmission is very simple. The radio frequency interface can achieve nautical mile bandwidth.

In order for a self-driving car to charge its batteries and send data, it needs to find a way to successfully complete the parking process on the way home. It uses an array of sensors to determine the location of the station. This ranges from the USBL (ultra-short baseline, also sometimes known as SSBL for “Super Short Base Line”) site within a 1-mile radius to the installation of the sonar array and provides visual signal to the surveillance camera for remote and servo control.

 **6.6. Case Study**

 **6.6.1. Minimal Invasive Mining Platform**

Based on data from mobility projects and the methods a robotic platform with a weak foundation that avoids the inflation of mobility has been developed. At the front of the robot there is a high-speed sensor that selects each block based on data from multiple sensors, including camera and laser data. A feeder inside the robot collects all the waste generated and transports it to the beach. In addition to reducing ground contact. The system adjusts the changing letters. The Custom Node option allows you to set the node selection location to the beach location (Kampmann et.al, 2018).

This approach and its advantages should be confirmed by future laboratory and field experiments. Several examples of robots with advanced control techniques are used to monitor and control autonomously living robotic groups and various sensory probes in subterranean and aquatic environments using vehicles that offer an interesting alternative to modern methods.

**6.6.2. The H2020 EU Robust Project**

There are two main areas where the accelerated growth and recognition of deep sea mining has been observed are:

a) Mapping the seabed utilizing high resolution sensors that covers a large portion of the seabed.

b) Thorough analysis of compositions of the present elements on the mining site.

To achieve this sophisticated new technology requires a Remotely Operated Vehicle (ROV) which is deployed from a surface support vessel. Samples collected by the ROV are then analyzed on land (Sartore et.al, 2019 ). Such sophisticated new technology is being implemented in ROBUST.

Part of the Horizon 2020 program, funded by the European Union. It is basically an underwater Vehicle Manipulator System which automatically scans a large area and performs on site identification of materials employing its Laser Induced Breakdown Spectroscopy, which mostly relies on manganese nodule field exploration.

**6.7. Deep Sea Mining and STEM Research**

The meaning of STEM Science, Technology, Engineering and Mathematics, all of these areas are important in deep sea mining. As more utilization of Deep Sea mining is in progress it is important to analyze the pros and cons of Deep Sea mining in STEM research constituting its main objective. Advantages and disadvantages of deep sea mining is of Scientific and Engineering perspectives.

Deep sea is believed to contain significant mineral reserves such as copper, nickel, cobalt and rare earths, it is very important for many high-tech industries.

Deep sea mining is able to provide valuable opportunities for scientific research especially in marine Biology, Oceanography and Geology. Development of new technology could enable deep-sea mining, enhancing Innovation and development in STEM fields, leading to better discovery and success. Deep sea exploration can have a negative effect on performance through the destruction of marine habitats, marine life, and changes in ocean chemistry.

Deep mining, the main problem of education, is solved by high depth performance even in harsh conditions bringing minerals to the surface. Deep-sea mining operations can be expensive, and it is unclear whether the potential economic benefits will outweigh the costs in the long term (Manish Verma, 2023).

STEM fields will play an important role in understanding potential gains and losses in intensive excavation. But there are also potential benefits: valuable Mineral Benefits and Scientific Advances with research and technology. Consider potential environmental impacts technical problems associated with underground mining tasks enable GIS-based optimization analysis handy tool for identifying many cases perfect for deep sea drilling.

**6.7.1. Applications of Deep-Sea Mining**

There are some very vast applications of Deep Sea Mining. Let's take a look at some of them.

Mineral Production:

Deep sea mining extracts precious minerals such as copper, nickel, cobalt and rare metals and are utilized by High Tech industries such as Electronics, Renewable energy Electric and electric cars.

Production of Energy:

The deep sea may be the solution to the upcoming developing technologies. It is a source of renewable energy technologies such as deep sea thermal energy and transformation of ocean thermal energy.

Deep sea Infrastructure:

For the transportation of oil and gas underwater cables and pipelines are very important. So the deep sea can be used for that purpose.

Storage of Carbon:

The deep sea is suitable for carbon capture and storage. By carbon fixation Technical and global management skills. It is built at the bottom of the sea.

**7. Applications in Space Exploration**

Artificial intelligence (AI) is essential for navigation and space exploration, supporting scientists and ground operations. Space telescopes, star systems, maps, black hole detection and more. They help us do what humans cannot do in space. NASA, Google, the European Space Agency (ESA) and others are using artificial intelligence (AI) to discover new planets and develop life for astronauts. Artificial intelligence has shown a lot of potential and also plays an important role in space exploration. It helps to map undiscovered galaxies, stars and black holes and study extraterrestrial phenomena. It can also help with communication, automatic vessel tracking, tracking and control systems.

**7.1. AI in Space Science**

Artificial Intelligence (AI) has emerged as a new technology that has the potential to revolutionize many industries, including the aerospace industry. Artificial intelligence enables big data processing, intelligent judgment and decision-making, and better management and efficiency. Advanced intelligence technology enables aircraft to operate more efficiently, gather intelligence and increase mission success rates through automated guidance, data processing, error detection and simulation. This article explores the role of artificial intelligence in space to help humans explore the universe and solve its mysteries.

**7.2.AI and Spacecraft**

AI is used to manage engine performance during takeoff and landing and to perform tasks such as landing planning. This helps improve fuel economy. CIMON 2 is a robot developed by Airbus and billed as a virtual assistant for sailors, similar to Amazon's Alexa. The plane is piloted by enthusiasts using IBM's Watson artificial intelligence system and wearable devices that can learn at critical sound levels to detect the astronaut's emotional state. It serves as a data store for computers and cameras. At NASA's Jet Propulsion Laboratory, the program uses artificial intelligence. This knowledge will be used in the design and development of future aircraft. The data collected will also be used to plan a number of future observations, including landings on the icy moons of Jupiter, Venus and Europa. SpaceX uses artificial intelligence algorithms to prevent its spacecraft from orbiting and colliding with other objects in space.

Their automated tracking allows them to detect threats in real time and take countermeasures by adjusting the speed and direction of the satellite. The British Space Agency has also developed an autonomous system that allows its ships and satellites to operate autonomously to avoid space debris. By 2025, they plan to continue this work by launching independent investigations into missions to capture and clean up debris in space, a problem that threatens the future of spaceflight.

Contribution of AI in Space craft creation has been widely noted. The sensor reading is fast and accurate, this information will allow the aircraft to respond more quickly working with artificial intelligence. It takes a long time for a satellite to go into orbit.

Close attention should be paid to space and its components, such as asteroid, black hole etc which is possible to explore through AI. Obstacles are automatically detected with the help of sensors or also linked to other satellites. AI is complementary and useful for rapid analysis of large volumes of data, doing it better than people. AI algorithms' regularities and anomalies are often revealed. Data is faster and more efficient than people. AI also does maintenance and sensor analysis and data telemetry. It can also detect system and equipment failure and provide repair recommendations (Purcell et.al, 2022).

 **7.3. Explorations of the Planets**

Robotic rover is sent to Mars that explores the surface of the red planet and sends data back to Earth for analysis. Thanks to the ML algorithm, the robot can navigate itself in space, avoiding potholes and waterfalls that could cause damage or stagnation. This is not a problem with tests like NASA's 2011 wind test. In recent years, NASA's Jet Propulsion Laboratory has used image recognition to analyze images taken by ground-based robots and classify terrain. It consists of a hole in the surface of Mars that is only 4 meters in diameter. The Perseverance spacecraft has a computer vision system called AEGIS that detects and tracks various rock formations on the Earth's surface, helping us learn more about the Earth's composition.

AI4Mars, a platform to run tools related to the intelligence and optimization, allows users to identify images which will train the machine learning algorithm for the Curiosity rover.

So far most ground-based research has been done on wheels, but the European Space Agency is testing a robot called Basket that can hop on wheels.

Nowadays AI is also used to detect asteroids, or moons, even exoplanets, in outer space. AI is used to detect patterns and anomalies of extraterrestrial bodies. Utilizing AI’s data analysis and pattern recognition techniques, scientists are able to understand and look into the composition and structure, and history of deep space. In recent times data analysis, AI has been in the front seat of autonomous exploration and navigation. This is especially true for exoplanets where human traveling is nearly impossible. This is why AI is crucial for autonomous decision-making in our pursuit of space travel.

Even before life was discovered on individual planets, it turned out that there were more planets than was previously presumed. NASA is exploring how to use artificial intelligence to discover new planets outside our solar system. This method uses data from satellites and previous space missions. Artificial intelligence technology analyzes this data to decide where to look for new planets. The collected data and direct satellite data were used together to map the Earth.

**7.4. Mapping the Cosmos**

Astronomers are using AI to map the sky to identify patterns of galaxies that make up distant nebulae and learn other patterns in the sky. An example of this is NASA's Kepler telescope, which is used to determine the possible locations of planets by analyzing the brightness of light emitted by stars. This indicates that the planet is passing between the star and us. AI is also used to predict the behavior of stars and galaxies. This will help us understand cosmic events such as supernovae.

Several black holes have been discovered when the mysterious object collides with neutron stars in gravitational waves. Artificial intelligence technology to monitor Earth and beyond. The project, called "Automated Science Experiments," dates back to 2004, when the Earth Observation Satellite-1 was docked to automatically sort the images captured by its cameras. This allows us to decide which images are worth using our bandwidth and returning to Earth.

SETI (search for extraterrestrial intelligence), run by the University of California, Berkeley, uses artificial intelligence algorithms to scan the vast amounts of data collected by radio telescopes in space.

Additionally, science now aims to go beyond events by using AI to reveal what lies inside the black hole. The project will accelerate quantum computing and help physicists solve one of their biggest challenges – combining Einstein's theory of general relations with standard models and particle physics.

Artificial intelligence is expected to help determine the size and shape of the universe. In Japan, the best way to use intelligent supercomputers is to explore astronomical data is to create artificial maps that mimic the universe we already know. This means we can predict the properties of the universe beyond the current limit of the speed of light (the observable universe).

 **7.5. Satellite Operations**

Artificial intelligence is changing the way satellites are used by providing better, smarter and faster solutions to manage satellite operations. SpaceX uses encryption-based algorithms to help satellites avoid collisions with other humans in orbit. Algorithms use a combination of satellite sensor data, including position and speed, to detect potential threats and take action. The satellite's desktop computer detects the satellite's speed and orientation and adjusts to avoid collisions. AI can optimize the process of moving satellites into their correct orbits, reducing the amount of fuel needed and the duration required to achieve the desired orbital position.

Artificial intelligence plays a key role in improving the interpretation of satellite images, especially in the field of advanced satellite image analysis. Artificial intelligence allows us to extract valuable information from large amounts of satellite data using advanced algorithms and machine learning techniques. Convolutional Neural Networks (CNNs) can assist this process by automatically detecting and classifying various objects such as buildings, roads and vegetation in satellite images. These networks detect patterns and features in images and provide accurate and efficient results.

AI can perform advanced interpretation of satellite images by tracking objects and detecting changes. Deep learning algorithms allow artificial intelligence systems to compare multiple satellite images taken at different points in time, making it easier to detect and monitor changes. This capability is especially important in applications such as urban development monitoring, environmental change analysis, and disaster monitoring.

AI greatly improves the efficiency of satellite imagery interpretation by automatically detecting changes and flagging them for further analysis. Another important aspect of using artificial intelligence to interpret satellite imagery is semantic analysis.

AI can use advanced neural networks such as U-Net and Mask R-CN to identify individual elements in an image and divide them into specific types or species. This advanced feature automates the segmentation process and eliminates the manual work required to generate accurate and precise maps using land maps that map different areas based on unique properties. This reduces and enhances the accuracy of interpreting satellite images.

**8.Conclusion and Future Scope**

Artificial intelligence (AI) is making waves in industries from healthcare to finance, and is now poised to change the world of marine and marine science. As we continue to unlock deeper mysteries, artificial intelligence will play an important role in helping scientists collect and analyze more data, leading to new discoveries and understanding the quality of our oceans.

As space agencies and the space industry continue to develop, intelligent systems and AI assistance will become important partners for astronauts in space. These AI-powered assistants can assist astronauts in various aspects of spacecraft missions, from navigation and satellite missions to remote monitoring of satellite health. With the ability to process big data and make detailed decisions, AI is helping to provide valuable support to the space industry. Also it facilitates to develop value and skill for workers during space exploration and space infrastructure development.

**8.1. Future aspects of Deep-sea mining**

**8.1.1. Ocean Vision**

As marine scientists study different species and materials, they increasingly rely on imaging tools for analysis. These professionals have many data collection tools but few resources for automatic analysis. In this article, we report on the research carried out by respective authors to identify the needs in the field of deep sea mining and oceanography along with the latest technologies. Four main problems where identified which hinders the effective development of image analysis tools for marine science. The workshop, held in various countries, focused on the open source web-based data set construction through the AI model named Fathom Net. Fathom Net attempts to create annotated image database for marine surveys. Ocean's vision for AI development, tools and services is progressive aimed to develop the ability to see marine life (Crosby et.al, 2023).

**8.1.2. Deep sea Visual Information Processing**

In recent years, in addition to rapid production and economic development, the demand for access to minerals is constantly increasing. With the rise of emerging countries, the critical concept of sustainable supply and the revival of nationalism is critical. An agreement to change the structure of the resource allocation. Many countries are surrounded by the sea.

Today, most of the world's energy and food comes from maritime transport. Most of the protein that supports the world's food supply comes from seafood that is known as Exclusive Economic Zone (EEZ). The continent has several promising areas with deep mineral resources such as manganese (polymetallic) nodules (Lu et.al, 2019). Cobalt compounds have been found in hydrothermal vents. Many countries like China, Canada, England, Belgium, France, Germany, the United States of America and Japan have embarked on high seas trade. Sea minerals fall into four categories: manganese, hydrothermal vents, and rich sediments. with cobalt. Gas hydrates depend on location, composition, size differences and metal properties. Manganese pellets of round or oval iron-manganese oxide, about 2 to 15 cm in diameter in the seabed is known to be flat and extends at a depth of 4,000 to 6,000 m. Those pallets are examined to be of large oxide of manganese and iron. It also contains precious metals such as copper and cobalt. There exist hot springs of copper, tin, and zinc; which comes from the hot water of the sea, forms steam and barrels at the bottom of the sea, and produces gold and silver.

**8.2. Future aspects of Space Exploration**

**8.2.1. Autonomous Spacecraft**

AI is now being used to create planetary maps based on previously obtained images and data. Technology has been developed that provides millions of images taken by satellites and during previous space exploration missions. AI technology analyzes all this data and creates a map of the world. This will provide better navigation for future projects. The field of space exploration is increasingly relying on artificial intelligence and machine learning to improve the autonomy of robotic spacecraft. One of the biggest challenges in space exploration is communication delays between spacecraft and mission control on Earth. Artificial intelligence systems can help alleviate this problem by allowing spacecraft to make critical decisions in real time without waiting for instructions from Earth. For example, NASA's Mars rovers use an AI system called Autonomous Exploration to Gather Augmented Science (AEGIS) (Omer et.al, 2021). This system allows routers to identify and analyze interesting rock and geological features without clear instructions, prioritizing targets for further investigation. This level of autonomy is important in an environment like Mars, where communication with Earth can be delayed by up to 20 minutes.

AI supports advanced satellite imagery interpretation by tracking objects and detecting changes. Deep learning algorithms allow AI systems to easily detect and track changes by comparing multiple satellite images taken at different times. This capability is particularly important for applications such as urban development monitoring, environmental change analysis, and climate disaster assessments (Ma et.al, 2015).

AI greatly improves the efficiency of satellite imagery interpretation by automatically detecting changes and still analyzing them. Another important aspect of AI when interpreting satellite imagery is semantic segmentation. Through advanced neural networks such as U-Net and Mask R-CNN, AI can specify individual elements in an image and distinguish them into types or regions.

**8.2.2. Astrophysical Data Analysis**

Astronomical data analysis is an area where artificial intelligence (AI) is playing a transformative role. The amount of data generated by modern telescopes and spacecraft is staggering, making traditional data analysis inadequate. Machine learning, a subset of AI, provides solutions by creating algorithms that can examine large data sets, recognize patterns, and make predictions.

In Astrophysics, for example, machine learning is used to study the cosmic microwave background (CMB), the heat left over from the Big Bang. This algorithm can analyze CMB patterns faster and more accurately than existing methods, helping to solve the mysteries of the early universe. Another area where artificial intelligence has proven invaluable is in detecting transient phenomena such as supernovae and gamma-ray bursts. AI algorithms can continuously monitor the telescope's data stream and alert astronomers immediately when transients occur.

Artificial intelligence can also help with automatic categorization of elite organizations. Deep learning models trained on large amounts of labeled data can classify galaxies, stars, and other objects based on their observed properties. This automatic sorting not only saves manual time but also reduces the possibility of human error. The use of artificial intelligence in the analysis of astronomical data is changing the understanding of the universe and promises more important discoveries in the future.

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