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AI in Human Extraterrestrial Settlement on Mars

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Abstract:

Human settlements on Earth have been successful due to two essential factors: human evolution and mutual support. However, in order to continue this trend in space-based settlements, advanced technology will be required. Settlements on Mars will need human-machine collaboration, where AI willaugment human skills and knowledge. Current missions near Earth have been successful due to contingency planning by organizations like ISRO,

NASA, Roscosmos, and ESA. However, when it comes to traveling to Mars, technology developers have limited knowledge of the environment in which AI needs to operate. Thus, new algorithms will need to be developed to work in partially observable environments. While humans can survive brief periods without power or water, handling infrastructure failures requires significant human involvement. Today, AI is being developed to help robots monitor critical infrastructure using machine learning algorithms. Both construction and protection of future space infrastructure will heavily rely on such evolving technologies. Additionally, AI will play a vital role in the mobility of future space settlements. AI will be built into robots to navigate partially known and unknown terrains. The approach used by most robots for navigation is called heuristic search, where a robot takes in a map with available data about a terrain and uses rules or heuristics to identify optimal paths. In summary, human settlements in space will rely on advanced technology, including AI, to augment human skills and knowledge. As the environment will be unfamiliar and partially observable, new algorithms will need to be developed. Such technologies will also help handle infrastructure failuresand support mobility in the settlements, making them sustainable for future generations.

Keywords: *Oxygen and Fuel Extraction using Sabatier Process, Full observability, Heuristic search,Machine learning, Pioneering Challenges*

I. Introduction:

Stephen Hawking has warned that within the next century, we must find another planet to inhabit, or else we risk extinction as a species due to problems such as overpopulation, resource scarcity, pandemics, and pollution. Therefore, we need to become a multi-planetary species and search for a new world to call home. Among the potential options, Mars has always been shrouded in mystery and romanticism, but it has become a popular topic of discussion for space exploration and colonization.

While the moon is close to Earth, it is small, barren, and devoid of an atmosphere, making it unsuitable for habitation. Other neighbouring planets, like hot Venus and gas giants Jupiter and Saturn, are equally inhospitable to human life. However, Mars is a different story. With an average radius of 0.53 that of Earth, it offers a potentially more hospitable environment for colonists from Earth, with 0.38 of Earth's surface gravity. Additionally, the promising results obtained by rovers and low-frequency microwave radar installed on the Mars-specific spacecraft have long supported the idea that it is possible to find liquid water beneath the surface and in subglacial areas. Furthermore, Mars is expected to have significant natural resources both on and beneath its surface, similar to Earth, with recently confirmed evidence of metal ores and other important mineral substances. Although no one has yet demonstrated a practical means of extracting and purifying these resources into useful products on Mars, the possibility of doing so is considered a significant reason in favor of colonization. Despite immediate challenges such as a dirty atmosphere rich in carbon dioxide with a pressure of only 0.09 atm, Mars's characteristicshave firmly established it as the ultimate destination for space exploration and colonization soon.

Nonetheless, the question of how to colonize Mars remains a mystery for humanity.

Mars Atmosphere (composition)

Carbon dioxide - (95.32%)Nitrogen - (2.7%)

Argon - (1.6%)

Oxygen - (0.13%)

Water vapor - (0.03%)Nitric oxide - (0.01%)

Earth Atmosphere

Nitrogen - (77%)

Oxygen- (21%)

Argon - (1%)

Carbon dioxide - (0.038%)

Atmosphere mars (pressure)

7.5 millibars (average) **Atmosphere earth** (pressure)1,013 millibars (at sea level)

Distance from Sun

(average)

Mars -227,936,637 kilometers

(142,633,260 miles)

Earth -149,597,891 kilometers

(92,955,820 miles)

Equatorial Radius

Mars-3,397 kilometers(2,111 miles)

Earth-6,378 kilometers(3,963 miles)

Gravity

Mars-0.375 that of Earth

Earth-2.66 times that of Mars

Length of Day

(Time required to make a full rotation on its axis)

Mars-24 hours, 37 minutes

Earth-Just slightly under 24 hours

Length of Year

(Time required to make a complete orbit of the Sun)

Mars-687 Earth days

Earth-365 days

Surface Temperature

(average)

Mars (-81 degrees F) (-63 degrees C)

Earth (-59 degrees F) (14 degrees C)

- **STUDIES AND FINDINGS:**

1. **Oxygen & Fuel Extraction using Sabatier Process** – *The Sabatier process is a chemical reaction that can be used to produce methane (CH4) & water (H2O) from carbon* *dioxide (CO_2) & hydrogen (H_2).*

This process can be useful for creating oxygen and fuel on Mars because the Martian atmosphere ismostly composed of carbon dioxide.

Extracting water: Water is a crucial resource for humans on Mars, as it can be split into oxygen andhydrogen through electrolysis. There are different ways to extract water on Mars, such as drilling intothe subsurface to access underground ice or using solar-powered heaters to melt ice from the surface. Once the water is extracted, it needs to be purified before it can be used in the Sabatier process.

Electrolysis: The water extracted on Mars can be split into oxygen and hydrogen using electrolysis. Electrolysis is a process in which an electric current is passed through water to separate it into its parts. Oxygen gas is produced at the anode, while hydrogen gas is produced at the cathode. The oxygen can beused for breathing, while the hydrogen can be used in the Sabatier process.

Sabatier reaction: The Sabatier reaction involves combining carbon dioxide and hydrogen to producemethane and water. The chemical equation for the reaction is:

$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$

The reaction requires a catalyst, which helps to speed up the process. The most used catalyst for theSabatier process is nickel.

Methane production: Methane is a useful fuel for human missions on Mars, as it can be used to powervehicles and equipment, and can also be used as a source of heat. Methane can be stored in tanks and transported to different locations on the planet.

Water production: The Sabatier process also produces water as a by-product, which can be used for a variety of purposes, such as drinking, growing plants, and generating power through steam turbines.

Energy requirements: The Sabatier process requires a significant amount of energy, which can be provided by solar panels or other power sources on Mars. The energy is needed to power the electrolysisof water and to drive the Sabatier reaction.

In summary, the Sabatier process can be a useful way to produce oxygen and fuel on Mars, as it takes advantage of the resources available on the planet and can reduce the need for resupply missions fromEarth. However, it requires a reliable source of energy and

2. **Full observability** – *describes associate atmosphere at intervals that associate AI has access to anyor all or any data at intervals the atmosphere relevant to its task*

- A troublesome space radiation atmosphere

The space environment is characterized by a complex radiation atmosphere consisting of charged particles ranging from gas to iron, as well as various secondary radiations, including neutrons produced by charged-particle interactions with materials such as spacecraft, planetary surfaces, the Martian atmosphere, base structures, and even the astronauts themselves. During long-duration missions, the primary contributor to radiation exposure, whether in transit or on the Martian surface, is galactic cosmic radiation (GCR). GCR is composed mainly of highly penetrating protons, primarily in the range of several MeV to many GeV, and heavier nuclei from helium to iron. These radiations are particularly challenging to shield against due to their high energies.

3. **Heuristic search** – *Heuristic search involves using knowledge about the problem space orenvironment to guide the search for an optimal environment.*

Help the Mars Rover notice the shortest path between a pair of points whereas avoiding obstacles on the way. Gateway Heuristic The maze and patterns gift inside the repository were any to see a fresh heuristic referred to as the entrance heuristic. The entrance heuristic pre-calculates the distances between entrances/exits of the areas. It put together soak up a pair of phases. Pre-processing Phase: The map is rotten into areas within the same manner as for the inactive heuristic. we've got a bent to stipulate the boundaries between areas as gateways (or gates). An entrance is of Associate in Nursingdiscretionary size, but Associate in Nursing object of our decomposition algorithm is that its orientation is usually either horizontal or vertical. Next, we've got a bent to use multiple A* searches to pre-calculate the (static) distance between gates. for each entrance we've got a bent to calculate the path distance to all or any or any the other gateways (cost of your time if no path exists). instead, one might calculate only the distances between gateways among each space thus use a little search to accumulate the total worth throughout run-time. However, our approach finishes up in extra correctheuristic estimates and faster run-time access

4. **Machine learning:** *It is a type of artificial intelligence that focuses on creating and utilizingalgorithms to detect and analyze patterns in data.*

Economical communication with rovers in space is a crucial factor in the exploration of outer space. The National Aeronautics and Space Administration (NASA) Propulsion Laboratory is currently engaged in numerous activities involving portable computer vision and autonomous driving with the Mars 2020 Perseverance Rover Mission. However, the communication delay of approximately 20 minutes between the rover and scientists at NASA slows down the analysis process. If humans were on Mars, the communication delay would be even longer. Therefore, it is necessary to implement some level of automation in all communication between Martian astronauts and NASA to streamline analysis, as the chance of failure is high due to the uncertainties involved. To avoid the risk of having one person manage and maintain the crew's resources, flight surgeons, mission directors, and the entire support team may eventually be brought to Mars to work with field researchers and astronauts.

However, the number of people required for this level of collaboration is too high to be feasible soon. Therefore, it is essential to rely on AI companions and support robots to assist astronauts and field researchers. An example of this type of AI robot-human relationship can be seen in the movie "2001: A Space Odyssey," where the robot HAL 9000 serves as a companion to the crew, managing food production, task and repair management, and science goals and directives while monitoring the crew and colony's health and activities. Innovative technology has played a crucial role in space exploration, as demonstrated by the successful moon landing over fifty years ago. To achieve the goal of reaching Mars, it is essential to shift our focus towards utilizing technology to make missions safer and deliver faster results. This requires a constant mindset geared towards developing programs that inform launches and modify hardware accordingly.

We have developed novel artificial evolutionary algorithms that generate a diverse array of robots capable of driving or crawling and learning to navigate intricate mazes. Our algorithms are responsiblefor evolving both the body structure and brain of these robots, which include a controller that governs their movements by interpreting sensory information from the environment and translating it into motor controls. Once constructed, a learning algorithm quickly fine-tunes the robot's brain to account for any discrepancies between its inherited brain and its newly-formed body. From an engineering standpoint, we have designed a robotic arm known as "RoboFab," which fully automates the manufacturing process. This robotic arm attaches wires, sensors, and other components selected by theevolution process to the robot's 3D-printed chassis. We have designed these components to streamline the assembly process, providing the RoboFab with a vast selection of robotic limbs and organs to choose from.

*5. **Pioneering Challenges**– the use of artificial intelligence to overcome challenges for humansthrough the missions*

- **Surface Habitat and Mobility:**

One of the biggest obstacles to human exploration missions is ensuring the safety and well-being of the crew during extended periods of up to 1,100 days. Creating habitable environments, along with necessary systems and supplies such as food, clothing, breathable air, and user interfaces, constitutes amajor component of any exploration plan. The habitation component includes both in-transit and on- surface capabilities for Mars. To minimize development costs, increase reliability, and ensure the safety of crew members across multiple missions, NASA can optimize the use of common elements and subsystems between surface, transit, and Mars moon habitats. Environmental Control and Life Support Systems (ECLSS): Leveraging the ISS, NASA is focused on demonstrating advanced capabilities for robust and reliable ECLSS, which must operate for up to 1,100 days with minimal spares and consumables. Systems demonstrated on the ISS and Orion will be further validated in the Proving Ground environment and incorporated into a reliable long-duration, deep-space habitation capability. Pioneering Challenges 32 Crew Health: Long-duration human missions, including missions with up to 1,100 days in microgravity, potentially increase the risks of bone loss, atrophy, trauma, neurometabolic issues, loss of clear vision, and illness for the crew. To address these increased risks, crews will require new diagnostic, monitoring, and treatment tools and techniques, including exercise systems and other countermeasures, to maintain crew health. The ISS provides an ideal test bed to develop these capabilities.

II. Result:

To establish a settlement on Mars, several challenges need to be addressed. One of the main challenges is transportation, as it takes about 6-8 months for a spacecraft to travel from Earth to Mars. Additionally, Mars has a thin atmosphere that provides little protection from radiation, which poses a health risk to astronauts. The extreme temperatures on Mars, which can range from -195°F to 70°F, also pose a challenge to human survival.

To mitigate these challenges, various technologies and strategies have been proposed. One of the most important is the development of more efficient propulsion systems, which could reduce travel times to Mars. Other technologies, such as radiation shielding and life support systems, would need to be developed to ensure the safety and health of astronauts. Additionally, habitation structures would needto be designed and built to protect settlers from the harsh Martian environment. Another important aspect of Mars settlement is resource utilization. Water, which is abundant on Mars in the form of ice, could be used for drinking, irrigation, and the production of oxygen and rocket fuel.

III. Conclusion:

The overall question during this report has been "Why colonize Mars?". In 3 elements, we have tried to hide the question from totally different associate degrees to allow an advised answer. it was created clear that similar events have happened traditionally which a general motivating issue for each the house race and imperialism has been to demonstrate political power. Another necessary conclusion tobe drawn from is that spotlight and support from the general public contains a massive result in what selections get created on behalf of a rustic. As seen antecedental throughout the house race, once the eye of the general public drops, therefore will the government's funding and consequently the event in that field. we tend to conclude, that their area unit some major issues on Earth now that a lot of folks can doubtless notice a lot of pressing than colonizing another planet. but as technology moves nearer and hopefully several the necessary issues on Earth are going to be resolved, it's doubtless that the question of colonizing Mars can gain a lot of interest and a lot of folks can get entangled within the discussion. we tend to discuss whether colonizing Mars needs taking a major risk in terms of contaminating the earth. we discover that the danger is quite tiny because of intensive sterilization procedures and it is thought unlikely that any bacterium coming back from humans would be able to survive in exceedingly Martian surroundings and thereby contaminate Mars.

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