FOCI2021- The Role of Artificial Intelligence in Space Exploration

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Abstract

Over the recent years, Artificial intelligence has played a vital role in space exploration; from finding planetary data to knowing about the distant galaxies. Scientists also improvised Artificial Intelligence in the area of spacecrafts and the telescopes to help astronauts to explore more about space. This paper will research the applications of Artificial Intelligence in the field of space exploration as a central idea, focusing on aspects such as schedule of astronomical observations and implementations of AI with the Hubble Space Telescope, space missions, robots and black hole. Furthermore, the challenges of AI in space exploration will also be discussed.

1. Introduction

Computer science consists of several branches and Artificial Intelligence (AI) is one of them. By the use of Artificial Intelligence, different computational machines can be developed with the means of either logically or by emulating humans to conduct more intelligent oppressions. To handle the routine and complex oppressions, for example data recording regarding the space travel, intelligent machines play a major role. Artificial Intelligence lets machines build software, complex programs, logical analysis over the problem, and also can interact with humans. The development of AI is raising enormously with the advancement of new technologies which also causes factors like employment and educational upliftment. Thus, the importance of Artificial Intelligence especially in the space exploration field, is unforgotten and makes everyone curious to know how the dominancy of Artificial Intelligence evolved.

2. Applications of AI in Space Exploration

2.1 Spacecraft Scheduling and Spike

Space exploration requires deep understanding and maintaining of scheduling astronomical observations and spacecraft activities. To encounter this problem, scientists have integrated Artificial Intelligence with NASA's Hubble Space Telescope (HST). For this integration, Spike project was commenced in early 1987 by the Space Telescope Science Institute. This project was useful for real world problem solving to utilize constraint search by the means of scheduling. The aim of scheduling is to utilize the telescope in the most organized manner rather than focusing on order or production deadlines (Johnston, 1990).

The Figure 1. shows the structure of Spike by exploring into its two different parts. The lower part represents constraint representation and reasoning level of the system, suggesting which

Figure 1.
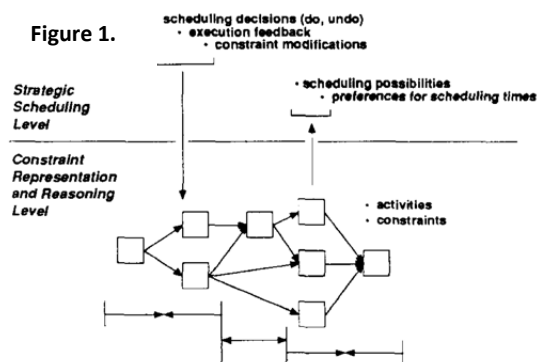
activities should be scheduled. The upper level also known as strategic scheduling level which networks with the lower level for searching the practicable schedules. (Johnston, 1990)

Artificial Intelligence also contributed while taking the first image of the black hole with the help of

CHIRP (Continuous High-Resolution Image Reconstruction using Patch Priors) algorithm (Prxjju, 2021). The image processing was presented with the help of CHIRP, using the image data from the Even Horizon telescopes. Although the image of the black hole is not in the clearest form, scientists and researchers proposed to use more difficult algorithms with the integration Machine Learning and Artificial Intelligence (Prxjju, 2021). This algorithm was utilized to coordinate the individual points of light on the image with the best possible brightness and coordination to the astronomical interferometric data. Later, the nearby bright points were blurred to achieve the most possible astronomical image. To finalize the overall picture of the black hole, Katy Bouman (Computer scientist) used a machine learning algorithm to provide 64-pixel patches of realistic images to analyse the pictorial patterns (Hardesty, 2016).

2.2 AI Based Space Missions

The AI based space missions also plays important contribution in the field of space exploration. This is because the communications between the spacecraft and the Earth could be restricted due to the restriction from the speed of light. This may impact the precision of the travel time of the spaceship and may effect the duration to reach at the required destination. For an illustration, the details regarding the landing of Curiosity rover came to know in seven minutes in 2012, due to the use of Artificial Intelligence (Kumar and Tomar, 2018). The autonomous system which is been used for Curiosity and Opportunity rovers also known as AEGIS (Autonomous Exploration for Gathering Increased Science) helped a lot to understand more about the Martian surface. Until today, AEGIS made new scientific discoveries by sending relatable pictures of boulders from Mars (Soroka and Kurkova, 2019).

2.3 Robots and AI Assistants

Robots and AI based assistants are the latest innovation in the field of space exploration. They are useful for the space missions and had been utilised particularly on Moon and Mars. Moreover, the robots have contributed to learn about the lunar and the Martian geography, and that technology has influenced the terrestrial robots (Bogue, 2012).

For an instance, International Space Station (ISS) have developed Robot Operating System (ROS) for the inter-related communications. The main purpose of ROS is to handle and accomplish kinematics templates and to implement tasks by planning. The other activities that robots at ISS could do is collecting and sending data to Earth by experimenting the test tubes by the means of heating and shaking (Frank, 2019).

3.   Challenges of AI in Space Exploration

As every coin has two sides, AI also has challenges along its way of space applications. The first and foremost challenge is to design a trajectory path for the space missions. This is because, in order to stay throughout the trajectory loop, the mission should not be escaped the Earth's gravitational field. Therefore, the use of AI should be implicated with the limited and more complex algorithms in order to follow the trajectory path precisely (Chien and Morris, 2014). The spacecraft which escapes the trajectory path can also lead to the fuel and maneuver costs. Perhaps, as per NASA, it takes approximately $1.7 billion to build a space shuttle (Bray, n.d).

Security is the biggest concern for any field and so is for AI. Due to the advancements in the cloud computing and wide use of AI based applications, there are more chances of being attacked and might possible chances of the data loss. The Artificial Intelligence is still under development in terms of data processing, especially in the spacecrafts. The reason might be a less performance caused by the integration of the hardware with deep learning networks. This might affect the weight and balancing of spaceship models and therefore creating inaccuracy in the memory segment of the satellites (Furano, Tavoularis, Rovatti, 2020).

4.   Conclusion

As discussed in this paper, Artificial Intelligence plays a developing role in the field of Space exploration from scheduling spacecraft activities to the making of AI based assistants. Thus, the data collection from the telescopes to the first image of the black hole is a remarkable achievement of Artificial Intelligence. At the same time, the issues regarding the privacy and the maintenance still needs to be prioritized. Hence, as per Stephen Hawking, "A superintelligent AI will be extremely good at accomplishing its goals, and if those goals aren't aligned with ours, we're in trouble (Rosso, 2018)".

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Figure 1.

Johnston, M., 1990. *SPIKE: AI SCHEDULING FOR NASA's HUBBLE SPACE TELESCOPE*. [ebook] Baltimore. Available at: <https://www.computer.org/csdl/pds/api/csdl/proceedings/download-article/12OmNs59JL3/pdf> [Accessed 18 March 2021].