THE GLOBAL INEQUALITY IN AI AND SPACE RESEARCH AND ITS EFFECT

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Abstract

Artificial Intelligence has influenced a number of industries and has seamlessly integrated into older technologies and industries. One of such industries is the space and satellite technology sector, this integration has provided an enhanced advantage to players of this industry (state and non-state players). Inadvertently, this crates a gap between nation states as to the capabilities of their agencies and industries in space research and exploration.

The paper examines the role of AI in space technology especially on whether it can integrate onto the satellite and spacecraft onboard computing system. Furthermore, the integration of AI capabilities in ground stations and how it passive and analyse data collected by satellites and space stations.

The paper also attempts to draw a distinguishing functionality and capabilities factors of various space programs of developed and developing nations and influencing variables. Factors such as availability of technology, expertise and funding play influential roles as to developing nations approach space research and how they rely on the functionality of systems in orbit for their commercial, economic, security and sovereignty survival.

The paper concludes in offering recommendations to nation players in the quest for space reliance for a more secured and functional global regions.

Key Words: Artificial Intelligence (AI), Space Technology and Satellite Technology

I. INTRODUCTION

Strategic capabilities, innovation, industrialisation, and economic development in recent times have been largely influenced by advancements in artificial intelligence and space research. Transformative breakthroughs across industries, including aerospace, have been amplified due to the integration of artificial intelligence into space systems (Casilli, A, Tubaro, P, Cornet,M, Ludec, C, Cierpe, J, & Braz, M, 2024). As aerospace systems increasingly rely on AI-driven analytics automation, having strong and continuously technological capabilities in both AI and space science has become a tool of global influence, scientific influence, economic competitiveness, and national security.

Irrespective of all its potential benefits, participation in Artificial Intelligence and space research in many ways remains uneven among actors in the international system. For years, certain actors like the National Aeronautics and Space Administration (NASA), China National Space Administration (CNSA), and European Space Agency (ESA) have continuously dominated space research. These countries and agencies excel in global AI launch capabilities, sophisticated AI integration networks, research infrastructure, and research funding. It is this dominance in space and satellite capabilities that has assured the military might of these nations (Weichert, 2017). On the other hand, many developing nations encounter significant challenges, such as weak research infrastructure, limited funding, and dependency on technology that hinders their ability to effectively participate in AI-driven aerospace research.

The fast-growing integration of AI within space technologies has vital impacts on the space industry, especially for missions with critical implications. (Chein, Doyle, Davies, Jonsson, & Lorenz, 2006) as these activities can pose a risk of reinforcing existing geopolitical, economic, and technological thereby putting a dent to the “peaceful purposes” principle enshrined in the Outer Space Treaty (OST) (Jakhu, Chen, & Goswami, 2020). This argument is based on the fact that when access to AI space data is unequal, it can significantly impact vital sectors like communication, security, and even disaster management systems, particularly in areas and countries that are already vulnerable.

The rationale behind the study of global inequalities in AI and space research is vital because there is a growing necessity to understand patterns of technological power, digital dependency, and strategic autonomy in the evolving AI and aerospace landscape. As such, this paper aims to identify and discuss the impacts of global inequalities in AI and space research on developing countries.

II. AI IN SPACE RESEARCH

The evolution of AI in space research has been a slow, gradual process that has, over time, deepened structural inequalities among certain actors in science and technology. Masir (2024) posits that the journey of Artificial Intelligence can be traced back to the 1950s, when researchers realised that machines could perform certain tasks similar to humans. In the 1960s, the U.S. Department of Defence recognised the potential of AI and began to fund AI initiatives, which led to the establishment of specialised labs for AI development. Over time, researchers soon discovered that AI could significantly impact numerous sectors, from security to space exploration and research.

At its inception, AI in space research was largely about experimentation. A key example is NASA's Remote Agent System, which was tested on the Deep Space One spacecraft as an innovative subsystem on-board controller ((Muscettola, Nayak, Pella, & Williams, 1998). This experiment contributed to the development of science and technology; however, such experiments require advanced research landscapes and continuous research funding, resources that are mostly available to certain high-ranking global agencies like NASA and the European Space Agency (ESA). During this period, AI in space research was mostly common to technologically advanced states, further entrenching the disparities in scientific developments as seen in the growth pattern of developing nations in this industry.

The 2010s witnessed a remarkable transformation as machine learning reshaped the landscape of space research, including scientific data analysis and planetary exploration. A notable example is NASA's Kepler mission. After its initial data processing pipeline had flagged thousands of potential exoplanets, researchers turned to deep learning models to dig into archived data, uncovering even more exoplanets that previous detection methods had overlooked (Shallue & Vanderburg, 2018). The training of AI models requires advanced computing chips which are mostly produced and found in developed countries like the United States, China, and some countries in Europe (OECD, 2022).

Presently, AI plays a crucial role in mission architecture and space exploration. Take the Mars 2020 Perseverance Rover, for example, which employs autonomous navigation (AutoNav) to navigate across terrains independently, which boost explorations efficiency. These innovations highlight a major shift from traditional ground-based AI support to intelligent systems operating in orbits. Nevertheless, the development of high-performance processors suitable for the deployment of AI which can withstand altitude radiation requires high semiconductors and engineering skills which always often concentrated in a few industrialised countries.

III. AI IN SATELLITE TECHNOLOGY

(Punjani, 2024) argued that in today's world. Satellites are essential for space research, space infrastructure development, and to (Sanchez, Vasile, & Minisci, 2020) facilitate global communication and planetary observations. AI plays a vital role in satellite technology by facilitating:

a. Autonomous Navigation and Control: (Punjani, 2024) asserts that human supervision was often required to monitor traditional satellites; however, with the advent of AI, satellites can make decisions independently with AI-powered algorithms, without reducing the need for human intervention (Punjani, 2024).

b. Earth Observation and Image Analysis**:** Massive amounts of data vital for disaster management, climate monitoring, and environmental studies can easily be processed through AI-generated algorithms. Satellite imagery of anomalies, patterns, and objects can be identified, recognised, and analysed by AI. This can help scientists to prevent disasters and manage resources properly (Tuia, et al., 2024).

c. Collision System: In recent times, researchers and scientists have developed AI-driven collision avoidance systems due to the large number of satellites present in orbit and other space debris in orbit which a collision would significantly affect the satellite and inadvertently the mission. These AI-driven systems were created to help detect and predict possible collisions between satellites, creating room for timely responses (Zotovici, Miyashiro, Ferrerira, & Carvalho, 2025) .

IV. AI IN PLANETARY SCIENCE AND DATA ANALYSIS

The vast amounts of data generated from space missions and observations of satellites offers tremendous possibilities in space research. However, the large volume of this data makes it difficult to analyse manually. Due to this shortcoming, AI plays a vital role by revolutionising how large volumes of data are processed, analysed, and used (Punjani, 2024). AI plays a key role by:

i. Analysing Planetary Image: Images of the planets, moon, and other celestial bodies can rapidly be analysed by AI-powered computer vision. NASA, for example, is using AI to bypass Venus dense atmosphere and map out the surface of Venus (Patil, Patil, & Arora, 2023).

ii. Exoplanet Discovery: AI has played a key role in the discovery of exoplanets. Space telescopes like Kepler and TESS have played a vital role in the search for planets orbiting other stars. Data from space telescopes like Kepler and TESS are analysed using AI-powered algorithms to identify changes in star brightness and other systems (Pearson, Palafox, & Griffith, 2018).

iii. Prediction of Space Weather: (Punjani, 2024) posits that in order to properly protect satellites, astronauts, and other space assets, data from solar observations and other sensors are being analysed through AI-powered models to provide a timely and accurate forecast of mass ejections, solar flares, and other weather events in space (Camporeale, 2023). AI systems can predict minacious space weather events, providing operations with time to implement preventive measures for an overall mission preservation (Shirke & Parihar, 2025).

V. SOURCES OF INEQUALITY IN AI AND SPACE RESEARCH

Systematic disparities in various factors like data ownership, funding opportunities, computational infrastructure, and many others have led to the emergence of certain structural inequalities in AI and space research. These inequalities are embedded within global hierarchical structures reinforcing technological disparities and favouring certain actors over others.

Factors associated with this disparity us thus covered in this section of the research.

A. Technology Divide

Unequal access to computational power is a crucial structural factor driving inequality in AI and space research. Modern AI models often require large, deep learning systems that depend on sophisticated computing resources. Research indicates that AI conferences are increasingly dominated by elite private companies and institutions, mainly because they have better access to certain computational resources (Ahmed, N, & Wahed, M, 2020). For researchers from countries or agencies lacking these high-performance computing systems, this computing gap presents a major challenge and weakens their space research prospects and capabilities. (Strubell, E, Ganesh, A, & McCallum, A, 2019) highlight the fact that the process of training large Natural Language Processing (NLP) models can result in considerable financial and environmental costs, such costs considerations can create obstacles for participating in innovative AI research.

In the field of space research, there are some notable disparities in infrastructure. Cutting-edge space missions require high technological advanced ground stations, advanced data processing facilities, and AI-powered independent systems. Countries with space agencies like NASA or ESA that are well established have built their technological expertise for decades, while many countries in the Global South often depend on technology transferred from other countries (Oyewole, 2017) (Gaillard & Mouton, 2022).

B. Funding Constraints

Research capabilities in space and AI application are largely influenced by funding structures of an agency, institution and governments. Currently, countries like the U.S., China, and some countries in Europe dominate the AI research and funding space. This factor causes an uneven distribution of knowledge and production globally.

Similarly, in the year 2026, NASA's budget was estimated to be $24.4 billion to pursue missions to Mars, the Moon, and even deeper into space (Congress.gov, 2026). While in contrast, Nigeria budgeted $42.1 million in 2025 which highlights the budgeting reality of developing countries (Budget Office of The Federation, 2026).

These financial gaps play a vital role in determining which research questions obtain priority. (Crawford & Joler, 2018) asserts that the political and economic interests of global powers are now reflected in the manner in which AI is developed and used in the international system. Rather than fostering innovation processes, this inequality further reinforces existing global hierarchies.

C. Data Ownership

AI systems rely on large datasets in order to function properly, but the distribution of the required data is quite uneven. Because of their exclusive data pipelines, proprietary datasets are often controlled by high-income agencies and companies, giving them a significant edge in AI and Space research and reinforcing existing structural inequalities (Gal, Santos, Markovich, & Torre, `2020).

In the realm of space research, there is a growing trend in the commercialisation of earth observation data, as high-resolution images are locked behind subscription services (OECD, 2022). Certain space agencies might be provided with open-access to satellite data, as they have adequate computational resources and technical expertise to analyse and interpret data, while other agencies in other developing countries have limited access to these resources. Disparities like this further strengthen already existing inequalities, making it difficult for the global south to actively compete in AI and space research (Koshina & Konstantinos, 2023).

VI. IMPACT OF AI AND SPACE RESEARCH INEQUALITIES IN DEVELOPING REGIONS

A. Economic Inequality

AI and space research provides a unique opportunity for the present players in the industry in the areas of military superiority and economic edge for its industries that require space and AI solutions and technologies for operations. The global advantages that these technologies and solutions provide further deepen the economic gaps between the developed and developing countries. As cited by (Reuters, 2025), reports by the United Nations warn that AI could lead to great divergence among nations in terms of their economic performance. Without equal access to AI and the ability to adapt to contemporary changes, developing countries might lose opportunities for rapid economic, health, and educational growth, while developed nations will continually benefit from the productive gains of AI and space research.

In reality, developing countries face multiple challenges, such as limited infrastructure and funding, making it more difficult for them to adapt and compete in the AI and space research ecosystem, which in the long-run will negatively impact their economic development. (Kirikkaleli, 2026) and (Mhlanga, 2021) assert that AI can boost economic output, with some studies suggesting that AI-driven intervention could add up to $13 trillion globally by 2030.

(Stanford University., 2023) also noted that over 70% of global AI leading companies are located in the U.S and China, while most developing countries are dependent on AI tools and data services developed by these countries. As a result of this, developing countries are often markets or dumping grounds for these AI products rather than being producers and suppliers of AI-driven innovations. However, some countries in the Global South, like Rwanda, in recent years have started investing in AI and technology as a means to develop their economy and their STEM program.

B. Unequal Access to Satellite Data

Agencies like NASA, China's National Space Administration, and the European Space Agency dominate AI development and space research. These inequalities have created structural imbalances among agencies, as some agencies are known for generating, processing, and monetising satellite data, while most agencies in developing countries are dependent on them for access to satellite data.

In recent years, access to some datasets has been made easier by programs like Copernicus, yet many developing countries do not have the required infrastructure or technical expertise to use these raw satellite data to produce actionable programs.

In Sahel regions, for example, satellite imagery is essential for predicting weather changes and droughts, yet many institutions in Africa find themselves dependant of foreign research labs for AI-based analysis and predictions.

Irrespective of these, certain global south counties, like India, have made efforts to develop their space research capabilities through partnership of local Indian Earth Observation companies to build a national Earth Observation constellation as a means to reduce dependency on foreign imagery. The country is making efforts to produce its own imagery and control its own data rather than rely solely on foreign companies (Wang, 2025).

C. Technological Dependency

Developing countries like Nigeria, for example, have established space programs and agencies such as the National Space Research and Development Agency (NASRDA); however, foreign partners provided technical support and also helped in building and launching the satellite. Currently, as AI plays a vital role in space research and satellite constellations, developed countries with advanced AI research will continue to make progress in space research, while developing countries remain dependent on foreign powers for technology transfer. This reliance on foreign technology increases dependence and hampers local industrial and technological growth.

These effects are far-reaching as it impacts not only technology but also places on job opportunities, educational systems, skill gaps, and capital concentration (Montgomery, R, 2024).

D. Limited Participation in Global Space

Countries that are still developing face significant financial and technological challenges in the pursuit of independent space research. There are high expenses associated with spacecraft launches, satellite infrastructure, and sophisticated research tools. Due to this, most developing countries depend on foreign partnerships, which limit their independence and capabilities to compete in the global space and the global economy.

The majority of global orbital slots, for example, are essentially controlled by developed countries and high-income agencies that have the means to access resources. These factors further limit the access of developing nations to crucial space infrastructure.

RECOMMENDATION

Due to the fact that global inequalities in AI and Space Research significantly impact the level of abilities of developing countries to compete in AI and space research, as well as their abilities participate in the global market. Developing countries should include certain policies that would:

i. Promote Human Capital Development: Most developed countries have made significant strides in science and technology because they invest in the development of their existing human capital. By actively pursuing and funding STEM programs, developing countries would begin making an effort to bridge the knowledge gap between them and the developed world. Providing well-funded AI and aerospace engineering scholarships, and developing specialised interdisciplinary curricula for AI and Space research.

Through this, developing countries would make efforts into reducing long-terms inequality by building on indigenous capacities and innovations. Countries like Rwanda, for example, have aggressively pursued an active STEM program as a means to promote human capital development and growth in the country. More developing African countries can use their policies as a guide to promote human capital and development.

ii. Strengthening Research Infrastructure: National governments in developing countries should implement policies geared at strengthening their domestic research capabilities. These could include investing in AI-driven incentives, advanced satellite technology, and vital infrastructures like high-performance computers, among others.

iii. Lastly, South-South countries should establish AI and Space cooperation platforms to promote knowledge sharing, share AI research fellowship and launch joint satellite missions as a means to build autonomy outside Western dominance.

CONCLUSION

To sum up everything that has been stated, inequalities have always existed among states; however, with the advancement of AI and Space research, these inequalities have intensified. Certain countries, like the U.S., through agencies like NASA, have dominated space research, and this has increased their growth and influence in the international system, while other developing countries still rely on these developed countries for AI innovations, technological transfer, and satellite data. These disparities have negatively impacted the capabilities of developing countries to contribute to or advance in AI and space research.

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