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Legal Implications of Artificial Intelligence in Outer Space Activities and Explorations

Implicações jurídicas da inteligência artificial nas atividades e explorações do espaço exterior

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Sumário

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Legal Implications of Artificial Intelligence in Outer Space Activities and Explorations*

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Abstract

Outer space is an expansive domain that is majorly unexplored and uncertain. Gagrian and Armstrong have ushered an era of humans interacting with space. The space activities are always appended with certain degrees of risk and damage, whether it's a case of placement of space modules, extraction of resources from moon or launch of space objects. The space agencies may resort to autonomous technologies without leaving them unguarded as a possible solution to hurdles faced by space industry. To reduce fallacies and errors, the space programmers are effectively absorbing the Artificial Intelligence techniques and methods into the system. The symbiotic interaction between humans and machines give rise to various legal and ethical implications including liability issues and privacy infringements. Not to forget the untraveled trails of missions to mars and moon are now easily trodden by rovers and robots driven by artificial intelligence. The paper makes a modest attempt to explain how the technology must be deployed to make for an optimum use, keeping in mind the sustainable measures. The technologies evolving over a period of time must aim towards achieving the Sustainable Development Goal. A discussion on artificial intelligence and its interaction with outer space requires legal comprehension on issues that may arise over a period of time. The paper emphasis on retaining the fundamental foundation of fairness and accountability in the times of technological advancements. This paper employs a qualitative doctrinal legal research methodology, utilizing a combination of primary and secondary sources. The research involves a comprehensive analysis of international space law treaties, emerging national and international AI regulations, academic literature, and case studies related to the intersection of AI and space law. The methodological approach includes: (1) Systematic review of relevant legal documents and scholarly articles; (2) Comparative analysis of existing space law frameworks and emerging AI governance models; (3) Legal interpretation of treaty provisions in the context of AI applications in space; and (4) Synthesis of findings to identify key legal challenges and potential regulatory solutions. While specific hypotheses are not tested in this conceptual legal analysis, the paper aims to explore the following research questions: (1) How do existing international space law frameworks apply to AI-driven space activities? (2) What are the key legal and ethical implications of integrating AI into space operations? (3) What regulatory approaches can effectively address the unique challenges posed by AI in outer space?

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Keywords: artificial intelligence; outer space; privacy; international law; technology.

Resumo

O espaço exterior é um domínio vasto, em grande parte inexplorado e incerto. Gagrian e Armstrong deram início a uma era de interação do homem com o espaço. As atividades espaciais estão sempre associadas a um certo grau de risco e de danos, caso se tratem da colocação de módulos espaciais, da extração de recursos da Lua ou do lançamento de objetos espaciais. As agências espaciais podem recorrer a tecnologias autónomas sem as deixarem desprotegidas como uma possível solução para os obstáculos enfrentados pela indústria espacial. Para reduzir as falácias e os erros, os programadores espaciais estão a absorver eficazmente as técnicas e os métodos da Inteligência Artificial no sistema. A interação simbiótica entre humanos e máquinas dá origem a várias implicações legais e éticas, incluindo questões de responsabilidade e violações da privacidade. Não esquecer que os trilhos não percorridos das missões a Marte e à Lua são agora facilmente percorridos por rovers e robots conduzidos por inteligência artificial. O documento faz uma tentativa modesta de explicar como a tecnologia deve ser utilizada para otimizar a sua utilização, tendo em conta as medidas sustentáveis. As tecnologias que evoluem ao longo do tempo devem visar a realização do Objetivo de Desenvolvimento Sustentável. Um debate sobre a inteligência artificial e a sua interação com o espaço exterior exige uma compreensão jurídica das questões que podem surgir ao longo do tempo. O documento coloca a tónica na manutenção da base fundamental da justiça e da responsabilidade em tempos de avanços tecnológicos. O presente documento utiliza uma metodologia de investigação jurídica doutrinal qualitativa, recorrendo a uma combinação de fontes primárias e secundárias. A investigação envolve uma análise abrangente dos tratados internacionais de direito espacial, dos regulamentos nacionais e internacionais emergentes em matéria de IA, da literatura académica e dos estudos de caso relacionados com a intersecção da IA e do direito espacial. A abordagem metodológica inclui: (1) Revisão sistemática de documentos jurídicos e artigos académicos relevantes; (2) Análise comparativa dos quadros jurídicos espaciais existentes e dos modelos emergentes de governação da IA; (3) Interpretação jurídica das disposições dos tratados no contexto das aplicações da IA no espaço; e (4) Síntese das conclusões para identificar os principais desafios jurídicos e potenciais soluções regulamentares. Embora não sejam testadas hipóteses específicas nesta análise jurídica concetual, o documento visa explorar as seguintes questões de investigação: (1) Como é que os quadros de direito espacial internacional existentes se aplicam às atividades espaciais impulsionadas pela IA? (2) Quais são as principais implicações legais e éticas da integração da IA nas operações espaciais? (3) Quais abordagens regulamentares que podem efetivamente responder aos desafios únicos colocados pela IA no espaço exterior?

Palavras-chave: inteligência artificial; espaço exterior; privacidade; direito internacional; tecnologia.

1 Introduction

The development related to artificial intelligence (AI) is being propelled on everyday basis due to advancement in technology. Artificial intelligence can assure fulfillment of aims and objectives of space exploration. Artificial intelligence's convergence in space exploration programs can lead to evolution of 'intelligent Space Objects'. The debates related to human standards and robotic standards is ongoing, when it comes to resolving legal, technological, social, political and ethical implications.[1] The legal issues will be a cocktail of matters concerning interactivity, complexity, autonomy, opacity, confidentiality, predictability, data dependence and weakness of machines that pretend to be smarter than elite class of sapiens. The intrusion of the artificial intelligence into space activities is at its nascent stage but complicated in every form. The matters of Artificial intelligence entwined with space activities can lead to contestable propositions under international space law, matters of privacy and data protection etc. The involvement of Artificial intelligence at this stage may be novice but its gradual dependence is certainly drawing a trajectory towards disruption of the space activities. Even on specifying the initial algorithmic imprints the output can still me unpredictable. These legal aspects give rise to the question of liability of an Artificial In-

[1] STERN, Simon. Introduction: artificial intelligence, technology and the law. *The University of Toronto Law Journal,* p. 1-11, 2018.

telligence machine or of a human enabled by Artificial intelligence to perform such a function.[2]

Artificial intelligence is composed of various tools for instance, machine learning, deep learning, deep neural networks etc. which assist in debris removal missions, resource exploration programmes, management of satellites etc. The machine learning characteristic enables a machine to automatically analyze the information and learn from previously fed data with the capability of making improvements without external involvements or programming requirements. Looking at the present situation, it is pertinent to mention that international space law must equip itself with an exhaustive legal framework which can deal with apprehended situations triggered by use of Artificial Intelligence. A complete legal policy will not only help us in providing a concept of AI in space activities but also help in identifying areas where the AI can be best put to use along with minimizing the risk or the legal violations caused by it.[3] It would be interesting to note that whether the AI machines can be guaranteed same set of standards to follow, assuring principle of equality and equal protection of laws so as to ensure substantive safeguards.[4]

2 Notion of Artificial Intelligence as a 'Legal Person'

Recognition of an AI as a legal personality would possibly resolve the liability issues, as it would help in defining 'Artificial Intelligence' specifically and also assist in evaluation of risk and impact assessments. The moment we accept the existence of an artificial mind capable of making autonomous decisions and intentional actions, we move a step closer to accepting it as a legal person. Bestowing legal personality on an AI entity is due to certain considerations, such as, determining legal responsibility or liability on occurrence of a damage or a legal consequence as a result of artificial intelligence involvement, benefits that can be derived on claiming certain intellectual property rights. Another reason for giving recognition to an AI entity is the level of autonomy attained by the artificial intelligence being in terms of decision making like humans as defined by the Turing Test. The argument has been reiterated in the recommendations provided by European Parliament in one of its Resolution on Civil Law Rules on Robotics, wherein the Commission has stated that a legal status of being an electronic person be given to robots to determine the damage they may cause.[5]

The concept of assigning liability to an object or instrument is not an archaic concept but rather of recent origin, where the debates are ongoing to treat machines as humans, if they develop rationality in terms of decision making. The idea of assigning legal personality to a machine is not well conceived as it is believed that artificial intelligence machine does not take into account the emotions, consciousness or discretion and they obtain the reasonable results based on the data and their decision making can never be equated to rationality of human mind.[6]

3 Involvement, Interaction and Impact of Artificial Intelligence in Space Activities

The artificial intelligence machines are being slowly injected into the space related activities. The advantages or the threats are not yet effectively realized. The gradual use of Artificial intelligence machines in various missions is indicative towards the upcoming dependance and usage of highly cognitive machines infused with superintelligence. There are certain examples where the artificial intelligence has already made its place, viz., the remote sensing satellites (like, Copernicus and Smart Sat) which are always in dire need of competent and efficient data processing mechanisms. The abundant data collected from the space is filtered using artificial intelligence, to transmit the relevant data sets to the

[2] BUCHANAN, Bruce G.; HEADRICK, Thomas E. Some speculation about artificial intelligence and legal reasoning. *Stanford Law Review,* p. 40-62, 1970.

[3] ABASHIDZE, Aslan K.; ILYASHEVICH, Marianna; LATYPOVA, Aysylu. Artificial intelligence and space law. *Journal of Legal, Ethical and Regulatory Issues*, v. 25, n. 3S, 2022. Available at: https://www.abacademies.org/articles/artificial-intelligence-and-space-law-14535.html. Access in: 8 june 2023.

[4] GREIMAN, V. A. Human Rights and Artificial Intelligence. *Journal of Information Warfare*, p. 50-62, 2021.

[5] ALARIE, Benjamin; NIBLETT, Anthony; YOON, Albert H. How artificial intelligence will affect the practice of law. *The University of Toronto Law Journal,* p. 106-124, 2018.

[6] CARY, G. Debessonet; CROSS, George R. An artificial intelligence application in the law: CCLIPS, a computer program that processes legal information. *High Technology Law Journal,* p. 329-409, 1986.

ground station making it time and cost effective for further assessment and analysis. The data obtained from the satellites is of immense use to the residents of the planet earth, for example the giant oil corporations monitor by way of imaging the positions for setting the oil plants or detecting leakages from oil pipelines which would otherwise be an arduous task.

The next example is of use of AI tools by SpaceX, wherein the Artificial Intelligence is used for taking corrective measures, repairing space station for any malfunction or equipment failure, helping crew with systematizing and collection information (Crew Interactive Mobile Companion assisted robots) and also in some cases provide guidance for preventing space collisions (European Space Agency's mission ClearSpace-1).[7] Another example is of SpaceX's Starlink satellite constellation that is equipped with Artificial intelligence powered collision avoidance system. This one was developed after the incident of narrow escape of collision between SpaceX and One Web satellites. This kind of system avoids collision between constellation satellites by regularly monitoring their positioning and their surroundings as well. Other than these, there are examples where the Artificial Intelligence machines are assisting in monitoring plane traffic or provide services like Global Navigation Satellite System which supports navigation mechanic in self driven cars, maritime engagements, drones etc.[8]

The cognitive technologies are contributing towards making communication networks more effective, productive and sustainable for the outer space missions. A cognitive radio assist in mitigating the effects of electromagnetic radiations emitted by the Sun and other celestial bodies that causes disruption of communication signals for example during a mars mission, it took 24 minutes for the rover to transmit and communicate with ground station for purpose of decision taking which resulted in major loss of information. By developing the cognitive abilities of the space robots, the engineers are enabling the space robots to take autonomous decisions and take charge of certain on-board managements like power consumption reducing the involvement of humans.[9]

4 Future use of Artificial Intelligence in Space Activities

Till now, the artificial intelligence's use in space activities has been assessed to be constructive and influential to provide a definite shape to the future space activities. The latest synchronization and revolution that has been brought up because of development of large service constellation satellites, its launch in lower earth orbit and communication between them is all possible because of AI endurance. The launch of these service constellations in lower earth orbit can be advantageous to various corporations, which provide high internet services and generates the Internet of Things (IoT). Although, introduction of these constellation satellites can be fruitful and make the systems efficient but what we must fear is the congestion or traffic in the Lower Earth Orbit. To ensure the autonomous movements of these satellites an AI driven Space Traffic Management will have to be put in place, which will make adjustments as per altitude and traffic in orbit. The convergence of advanced technologies with space exploration will turn out beneficial only if it is utilized for the advantage of all.[10]

Presently, the dominance and prevalence of artificial intelligence can be seen in applications related to data and image processing for sensing concentration of carbon dioxide emissions or monitoring climate change across globe. The satellite imaging can help in identification of methane and carbon dioxide emissions or forest fires which contributes not only towards climate change majorly but also impact the health industry and reconstruction expenditure. The challenge pertaining to such automations and involvement of artificial intelligence in the outer space is the propelling force of determining and enforcing a 'meaningful human control' over the third-order technologies. This concept is valuable in terms of striking a rational decisive balance between

[7] ABASHIDZE, Aslan K.; ILYASHEVICH, Marianna; LATYPOVA, Aysylu. Artificial intelligence and space law. *Journal of Legal, Ethical and Regulatory Issues*, v. 25, n. 3S, 2022. Available at: https://www.abacademies.org/articles/artificial-intelligence-and-space-law-14535.html. Access in: 8 june 2023.

[8] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

[9] Available at: http://asljournal.org/journals/2019-3/ASL_vol_3_SorokaKurkova.pdf. Access in: 7 june 2023.

[10] Available at: https://hightechjournal.org/index.php/HIJ/article/view/360/pdf. Access in: 8 june 2023.

human control and AI autonomy. By striking a proper balance we can increase the social acceptability of the usage of such technologies to reduce distance, efforts, costs and faults in space activities.[11] The question of focus is to check admissibility of governance of Artificial Intelligence in space activities and explorations.[12]

As the crew stays in outer space for longer durations, they are exposed to different set of risk and exposure such as ionizing radiation, extreme temperatures, microgravity etc. The concern has been raised many a times that beyond the Low Earth Orbit, the supply of medical equipment's, restocking, delayed communication with base stations aggravates the health hazards of the members of the crew. Various experiments were carried on Crew members of International Space Station such as project Cardinal Heart 2.0, wherein the drugs injected reduce the changes caused by microgravity in the heart cells. Initiatives have been taken by NASA to bringing together a cohort of biologists, AI and Machine learning experts to use artificial intelligence technologies for enabling space research. The upcoming research on biomonitoring and self-driving laboratories in deep space and initiatives supported by artificial intelligence that may require regulation in the coming times within both legal and ethical constraints.[13]

5 Provisions under International Space Law

Space law is a broad category of law that governs and regulates the outer space activities and usage of corresponding technologies related to space projects, satellite dealings, deep-space communications, space stations managements and other infrastructure equipment requirements etc. The sources of space law traditionally fall back on international outer space treaties which talks about principles that govern the activities of the nation states in matters of exploration and use of outer space inclusive of moon and other celestial objects. To substantiate the principles and directions given in the outer space treaty, the United Nations provides three agreements viz., The Rescue Agreement, 1968, The liability Convention 1972 and the Registration Convention, 1976.[14]

Although, it has come to notice that many a times issues and concerns regarding use of Artificial Intelligence machines to process satellite images have been raised before the Committee on Space but nothing has been figured out either in the Report of the Committee on the Peaceful uses of Outer Space (2018) or in any of meetings of the committee. Although, the discussion is taking place at global level but certain initiatives by States at national level require a humble mention. Some of these initiatives include, Executive Order 13859, which discusses, 'Maintaining American Leadership in Artificial Intelligence', Luxembourg's Law on exploration and use of space resources, Order of the Russia, 'On Approval of the Concept for the development of regulation of relations in the field of artificial intelligence and robotics technologies for the period up to 2024', Germany's law on protection against the security risks due to the dissemination of high grade earth remote sensing data, 2007, etc. Also, the European Space Agency has come out with report on 'Robots in Space' and 'What is Space 4.0' to evaluate the benefits and limitations of use of Artificial intelligence in outer space activities. The law and technology philosophies refer to this as 'Third-order technologies', where the machines interact without human involvement. These kinds of initiatives can boost the inclusion of Artificial intelligence in the space industry but can also result in overpowering individual interests of the State. What the world is being monitored by at present is the, set of substantial norms laid down in the outer space treaties which refers to basic ethics of using outer space for instance, using outer space for benefit of all, responsibility of States for its national activities etc. The world needs to be monitored by an advanced set of legal provisions that are capable of understanding the concept and characteristics of Artificial Intelligence and by showcasing

[11] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

[12] MARTIN, Anne Sophie; FREELAND, Steven. The avent of artificial intelligence in space activities: new legal challenges. *Space Policy,* 2021. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0265964620300503. Access in: 7 june 2023.

[13] Available at: https://www.nature.com/articles/s42256-023-00643-3. Access in: 7 june 2023.

[14] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

its answerability in areas such as intellectual property violations, cybersecurity issues, data protection and privacy related matters, global security and responsibility, liability etc.[15]

6 Notion of Liability

The issue related to 'liability' is of paramount importance as the legal process and its framework cannot be initiated without knowing the 'wrongdoer'. The Outer Space Treaty of 1967 provides for responsibility of States for a wrongful or damaging act. The provisions of the Outer Space Treaty are further substantiated and clarified by the Liability Convention of 1972, imposing the international responsibility on the launching State which means that the responsibility lies with the State that launches a project into space or is responsible for damage caused by space object of the nation in space, on earth or to an aircraft in flight. The liability will be determined with respect to the place of damage. A bare reading of the international space instruments indicates that only the States can be made liable and the responsibility of the non-state factors is not discussed.[16]

The damage caused because of Artificial intelligence or any other automated machine has yet not been discussed. A legal jurisprudence for the machines needs to be developed and assessed. Making machines responsible for damage would require assessment of 'fault', which will become a challenging task, as determining the fault requires obedience to certain 'due care standards', which is difficult to ascertain in case of a machine. The extent of Artificial Intelligence involvement will be required to check the level of AI's participation, decision making or data processing in causing the damage. One may say that the general rule is that the launching State will be responsible so it is obvious to understand that if damage is caused by Artificial intelligence tool, the State launching the AI tool be made responsible. A clarification here by citing a provision can help us bring more clarity to the issue. Referring to Article II of the Liability Convention, in the event '*a launching State establishes that the damage has resulted either wholly or partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of natural or juridical persons it represents*'. This above stated provision raises eyebrows on two aspects, the first one on deciding the legal personality of a machine and second one that talks about the mental element or the intention. It is also pertinent to mention that the damage or the occurrence may be due to automated response of Artificial Intelligence tool or algorithm, something that was unassessed or unpredicted by the launching State. The artificial intelligence autonomy becomes a key element for newer controversies and complications of the third-order technologies, where the machine can augment, displace and replace the decision making of the humans by depending on available data without any external stimulus.[17]

7 Notion of 'Space Object'

An additional subject matter is considering if artificial intelligence should be considered as a 'space object' and should be registered alike physical objects despite lacking physical characteristics. The Liability Convention is not certain about application of artificial intelligence. The definition of 'launching State' and 'Space object' would need a stricter scrutiny and analysis. As per the liability convention, the definition of 'space object' includes component parts of a space object along with its launch vehicle or any other parts. Component parts as such is not clearly defined leaving behind an ambiguity. But, going by the reference to dictionaries, a component part indicates towards 'something that cannot be removed without causing substantial to itself or to immovable property it is attached therewith'. This brings in an interesting proposition that Artificial Intelligence space objects that could not be removed without substantial damage would be considered as space objects for purpose of liability convention and thus attaches liability to the State, that procures the launching of AI aboard

[15] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

[16] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

[17] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. *The Legal Challenges of AI in Outer Space and the Relignment of Terrestrial Standards*. 2022. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4258313. Access in: 6 june 2023.

along with other State[18]. The question here is will the States agree to share the responsibility or joint liability for a poor AI enabled system procured from another nation. An AI is not a physical component but rather a composition of algorithms or coded programmes and making every man-made object sent into space as space object would demand clarifications about the concept in the future. The ambiguity of terms raises concerns when agreeing upon licensing or contractual terms.[19]

Moreover, the Convention does provide for a dispute resolution mechanism, but in certain situations there may be a dilemma in determining whether the State party is responsible for the 'fault' and whether the damages so incurred and calculated are inclusive of indirect damages. The precedents indicate that the contractual or tortious liability issues pertaining to space laws have mostly been resolved by means of arbitration by the Permanent Court of Arbitration which follows the UNCITRAL arbitration rules 1976 or the 'Optional Rules for Arbitration of Disputes Relating to Outer Space Activities'.[20]

8 Notion of Data Privacy and Human Rights

When we talk about the interface of data privacy and human rights issues we intend to talk about the excessive interference and manipulation of data by these technologies intruding into personal spaces, being discriminative etc. The above stated issue raises to major concerns firstly, protection of personal data and ensuring confidentiality secondly, retention and storage of data so collected during the process. These two concerns become important because of lack of access rights, deletion and erasure of data, issues related to tracking and de-anonymizing data etc. The most relevant document that talks about the 'personal data' and the subject concerned is General Data Protection Regulation (GDPR) which includes information collected from space observations as a form of personal data in relation to an identified or identifiable person (including the location of that person). The earth observations so quoted refers to analyzes using facial recognition technologies and information gathered from security cameras etc., which may be violative of confidentiality rights. Other than the provision of GDPR, the Council of Europe's Convention for the Protection of individuals with regard to Automatic Processing of Personal Data provides the acceptable range of use of facial recognition. Another important Article 22 of the Regulation provides that data subject possesses the right to be not subjected to any decision made by automated process on sole basis, including profiling, which produces legal effects impacting him/her.[21]

9 Need for International Legal Framework Converging Artificial Intelligence into Space Activities

While formulating an extensive legal framework for use of advanced technologies in space activities, certain standards and norms must be established which will assist both courts and policymakers to evaluate the impact caused by the risks of technology. We may be confining our thoughts on liabilities under space laws but the domain can stretch to rise in liabilities under tort law, criminal law, administrative law etc. The task won't be accomplished by simply determining the fault and ascertaining the damages, the proper procedure and process needs to be carved for execution of the orders. The legal framework that we aim to build in the near future must firstly, be universal in nature in order to leave an impact, irrespective of advancements in technology and secondly, the framework must be flexi-

[18] GRAHAM, Thomas; THANGAVEL, Kathiravan; MARTIN, Anne Sophie. *New Challenges for International Space Law*: Artificial Intelligence and Liability. 2023. Available at: https://www.researchgate.net/publication/369201650_New_Challenges_for_International_Space_Law_Artificial_Intelligence_and_Liability. Access in: 6 june 2023.

[19] GRAHAM, Thomas; THANGAVEL, Kathiravan; MARTIN, Anne Sophie. *New Challenges for International Space Law*: Artificial Intelligence and Liability. 2023. Available at: https://www.researchgate.net/publication/369201650_New_Challenges_for_International_Space_Law_Artificial_Intelligence_and_Liability. Access in: 6 june 2023.

[20] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 6 june 2023.

[21] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

ble and adjustable to cope up with intense changes in information and communication technologies. There are certain observations which can be considered when resorting to resolve issues concerning artificial intelligence for instance, the first principle to follow is that we need to solve issues as they come, which means if there is no problem or complication there is no requirement to regulate it, which in simple terms can be referred to as a 'non-interactive approach' as it is believed that normative interventions can act as a blockage to upcoming inventions. The second principle is 'proactive', where we believe that certain rules and norms must be in place before the problem occurs, we should be equipped with pre-emptive norms to tackle it.[22]

It is important to understand before dealing with the law that artificial intelligence is now a part of both spacecraft applications and space operations and missions which have opened up a completely new horizon promoting new startups like space hotels (as announced by Cable News Network, to be opened by 2025), space tourism, privatization of space, mass space explorations giving a shout out to principles of democratizing the outer space. The abovementioned situations open the window to apprehending a set of contractual claims, tortious issues impacting rights. Although, artificial intelligence ensures physical and cyber security to space assets and properties but one must also not undermine the threats of cyberattacks and failures of cybersecurity measures.[23]

There are different ways and means of rearranging and realigning the legal standards when it comes to regulating role of AI in outer space activities, firstly, Sui Generis standard, there are arguments and debates on having stricter standards for the robots than the humans. Space law encompasses varied security and safety standards for every space program for example the European Cooperation for Space Standardization, European Space Agency's specification standards etc. When it comes to artificial intelligence, new standards must be developed keeping in mind the cyber-attack analysis, cybersecurity initiatives and also by considering the complicated infrastructure of the machine learning models. Secondly, the soft and stricter standards may be considered, the soft standards in terms of humanoids or social robots who company the astronauts in difficult terrains and stricter standards of legal protection for deployment of autonomous vehicles as compared to humans. The stricter standards are necessity in times of privatization which can be adopted to raise standards of duty of care, compensation ways, presumptions etc. Contesting for stricter standard does not mean that every robotic standard or human robot interaction standard in outer space should be kept strict but sui generis standards in terms of maintaining privacy and data protection could be retained.[24]

10 A bottom-up approach for regulating AI based Space Activities

It requires a global consensus and action to build a community accepting common norms and responsibilities. Nations scrutinizing, analyzing and criticizing the unavailability of the artificial intelligence norms for space related activities and explorations must come forward to cooperate and collaborate in drafting legislations, guidelines or norms binding the nations actively engaged in space industry. The non-state actors must also be given an equal standing looking at their participation in blooming space industry. Initially, there may be trouble in drafting an exhaustive law so as an initial step to begin with, States may engage in drawing guidelines and standards for artificial intelligence regulation. The approach is called the botton-up approach as the acceptance would start from referring to non-binding documents and slowly rising to a stature of acceptable legal norms seeking commitment from all. Thus, the movement has to be upwards from drafting guidelines like, 'Guidelines for Automated Activities in Space' to actual formulation of substantive legal rules. These guidelines must encourage the Nations to opt for best practices for artificial intelligence governance. Regulatory requirements may include certification,

[22] RUSSO, Antonio; LAX, Gianluca. *Using artificial intelligence for space challenges*: a survey. 2022. Available at: https://www.mdpi.com/2076-3417/12/10/5106. Access in: 7 june 2023.

[23] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

[24] PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

licensing, documentation of protocols etc. Another important factor that can be considered as a part of the AI governance could be the Artificial Intelligence Impact Assessment' to demonstrate essential, safe and effective deployment of artificial intelligence. To make it more workable, the insurance companies can come forward to assist if parties readily supply their detailed assessment report and compliance certificates to benefit from insurance schemes in case of liability concerns. The benefit of adopting the bottom-up approach is that by enforcing the technical and regulatory standards, the chances of impact from poorly designed AI or defective AI operating system will be mitigated.[25]

11 Forthcoming Domestic Discussions and Regulations about Artificial Intelligence

It is believed that the nations retain their control and jurisdiction over the space objects they launch or procure, thus making national laws applicable to them and thus any artificial intelligence related object would also be presumed to be covered by the national laws as well. As the major treaties like Outer Space Treaty provides no details of automated devices, a wide discretion is left with the nations to decide on liability issues. The national laws so crafted by States aim to maintain a balance between interests of private sector and States, assuring protection to public and encouraging innovation. Citing some examples would provide clarity such as the case of European Union proposing to enact Artificial Intelligence Act which aims to regulate artificial intelligence by creating different set of categories defining concepts like minimal risk, no risk etc. The European Union legislation will be impactful for space operations based in the European Union or matters concerning the Earth Observation systems concerning imaging and sensing engaging with data which will be termed as personal data and also as an outcome of the system in place. When one considers managing data, ethics and trust in artificial intelligence become the center point. Similarly, the United States of America also has plethora of legislations dealing with space concerns but none of them addresses the usage or impact of artificial intelligence. However, as an emerging initiative the State has proposed the Algorithmic Accountability Act which requires corporations to make assessment of automated decision-making systems in terms of impactful biases and productivity. The peculiar feature about the Algorithmic Accountability Act is that the assessment results are gathered both at the beginning and after the deployment of the system. The drawback of this enactment will be that it will be applicable to large companies limiting the protection to individuals. The enactments in regard to technology in United States do not get an instant green flag, but its initiatives like AI Bill of Rights showcase their awareness about the artificial intelligence. In case of Australia again the country doesn't have a law regulating artificial intelligence but it discusses the necessity of reform but for now they depend heavily on laws related to privacy or consumer to tackle the arising legal issues.[26]

12 Conclusion

The space exploration is no more a playground for the States and their governmental agencies, the private actors have been equally participative in space explorations and travels. The outer space involvements are becoming more technologically complicated and human independent. The introduction of artificial intelligence to the outer space explorations is fruitful when it comes to monitoring the outer space events and launches, providing assistance to astronauts or taking charge of research in areas which are not conducive to humans. We may be benefitting a lot from the advancements and outgrowth of technological use in the outer space industry but such infusion leads to certain legal implications. There are certain findings that can be drawn looking at the prevailing situation such as:[27]

[25] GRAHAM, Thomas; THANGAVEL, Kathiravan; MARTIN, Anne Sophie. *New Challenges for International Space Law*: Artificial Intelligence and Liability. 2023. Available at: https://www.researchgate.net/publication/369201650_New_Challenges_for_International_Space_Law_Artificial_Intelligence_and_Liability. Access in: 6 june 2023.

[26] GRAHAM, Thomas; THANGAVEL, Kathiravan; MARTIN, Anne Sophie. *New Challenges for International Space Law*: Artificial Intelligence and Liability. 2023. Available at: https://www.researchgate.net/publication/369201650_New_Challenges_for_International_Space_Law_Artificial_Intelligence_and_Liability. Access in: 6 june 2023.

[27] Available at: https://www.nortonrosefulbright.com/en/knowledge/publications/102a426e/the-commercialisation-of-outer-space. Access in: 6 june 2023.

- Determining the concept of 'artificial intelligence' and its composition which can help us ascertain the amount of human supervision and control when it comes to decision making and automation.

- Whether artificial intelligence should be considered as a 'space object' and be required to register as any other physical object.

- The artificial intelligence may not follow the general set of rules to be recognized as a legal personality. It is pertinent to identify and recognize its juristic personality to open the doors for liability discussions and shared responsibilities. It calls for revisiting the notions of fault and due diligence standards, duty of care, presumptions and theory related to agency.

- A thought may be given to reinforcing doctrine of strict liability for danger posed by third-order technologies like Artificial Intelligence, which may assist in cases of accidents triggered by AI systems.

- The sovereigns across the globe are adapted to the existing international space instruments which do not cover the use of advanced and disruptive technologies. The States must consider an adequate legal framework or relevant modifications to existing norms to not only consider the liability quotient but also for more unambiguous interpretations. Rather, the nations must built up their domestic legal framework, taking guidance from advanced frameworks available.

- There may arise a problem in coordinating concerns between public international law and national space laws on matters related to cybersecurity standards, consumer law issues etc. Also, whether use of AI technologies can compromise the reliance on State's obligation to retain the control over the space object it launched or registered with it?

- The international outer space treaty may not be in a position to deal with issues arising out of different trends of privatization. It would become a difficult contention to decide on to the jurisdiction of private parties launching objects into space trespassing other's jurisdiction.

- There is a need to thrust research on emerging areas and concerns such as data protection in human robot interaction, safety of missions in adverse environments, striking balance between standards of humans and robots for legal regulation and protection etc.

- There is also a need to assess the requirement of an international law enforcement agency or a space specialized agency of United Nations (other than the International Civil Aviation Organization and the International Maritime Organization) to check the implementation of rules and norms established in terms of use of artificial intelligence in space activities. The new agency must contribute towards defining AI usage regulations for dealing with functioning of intelligent space object and space debris which currently needs definition in international space Law.

- There is a need to maintain a special registry for the purpose of tracking the details of AI enabled objects for transparency and record of licenses, designs, operation and ownership.

References

ABASHIDZE, Aslan K.; ILYASHEVICH, Marianna; LATYPOVA, Aysylu. Artificial intelligence and space law. *Journal of Legal, Ethical and Regulatory Issues*, v. 25, n. 3S, 2022. Available at: https://www.abacademies.org/articles/artificial-intelligence-and-space-law-14535.html. Access in: 8 june 2023.

ALARIE, Benjamin; NIBLETT, Anthony; YOON, Albert H. How artificial intelligence will affect the practice of law. *The University of Toronto Law Journal,* p. 106-124, 2018.

BARBOSA, Lutiana Valadares Fernandes. Artificial Intelligence: a Claim for Strict Liability for Human Rights Violations. *Brazilian Journal of International Law*, v. 20, n. 2, p. 149, 2023.

BUCHANAN, Bruce G.; HEADRICK, Thomas E. Some speculation about artificial intelligence and legal reasoning. *Stanford Law Review,* p. 40-62, 1970.

CARY, G. Debessonet; CROSS, George R. An artificial intelligence application in the law: CCLIPS, a computer program that processes legal information. *High Technology Law Journal,* p. 329-409, 1986.

FAROOQUI, Mohammad Owais; KISSWANI, Nazzal; ABBAS, Sheer; QURESHI, Tahir. A Legal Analysis of the Air Defense Identification Zone (ADIZ) with Special Reference to East China Sea Air Defense Identifcation Zone. *Brazilian Journal of International Law*, v. 19, n. 3, p. 272, 2022.

GRAHAM, Thomas; THANGAVEL, Kathiravan; MARTIN, Anne Sophie. *New Challenges for International Space Law*: Artificial Intelligence and Liability. 2023. Available at: https://www.researchgate.net/publication/369201650_New_Challenges_for_International_Space_Law_Artificial_Intelligence_and_Liability. Access in: 6 june 2023.

GREIMAN, V. A. Human Rights and Artificial Intelligence. *Journal of Information Warfare*, p. 50-62, 2021.

HEINTSCHEL VON HEINEGG, Wolff. Neutrality and Outer Space. International Law Studies Series. *US Naval War College*, v. 93, p. 526-547, 2017.

HORSFORD, Cyril E. S. Outer Space and the Law. *Medico-Legal Journal*, v. 35, n. 1, p. 42-55, mar. 1967.

MARTIN, Anne Sophie; FREELAND, Steven. The avent of artificial intelligence in space activities: new legal challenges. *Space Policy,* 2021. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0265964620300503. Access in: 7 june 2023.

MENON, P. K. Outer Space and Disarmament. *Military Law and Law of War Review*, v. 15, n. issues 3/4, p. 361-392, 1976.

PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. *The legal challenges of AI in outer space and the relignment of terrestrial standards*. 2022. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4258313. Access in: 6 june 2023.

PAGALLO, Ugo; BASSI, Eleonora; DURANTE, Massimo. The normative challenges of AI in outer space: law, ethics, and the realignment of terrestrial standards. *Philosophy & Technology*, v. 36, n. 23, p. 1-23, 2023. Available at: https://link.springer.com/article/10.1007/s13347-023-00626-7. Access in: 8 june 2023.

REINSTEIN, Ezra J. Owning Outer Space. *Northwestern Journal of International Law & Business*, v. 20, n. 1, p. 59-98, 1999.

RUSSO, Antonio; LAX, Gianluca. *Using artificial intelligence for space challenges*: a survey. 2022. Available at: https://www.mdpi.com/2076-3417/12/10/5106. Access in: 7 june 2023.

SCHMIDT, William G. Law in Outer Space. *Update on Law-Related Education*, v. 21, n. 1, p. 45, winter 1997.

STERN, Simon. Introduction: artificial intelligence, technology and the law. *The University of Toronto Law Journal,* p. 1-11, 2018.

UPADHYAY, Niteesh Kumar. Using artificial intelligence to address criminal justice needs, problems and perspectives. *Legal Analytics,* p. 21-34, 2022.

WALIA, Ivneet Kaur. Cyber surveillance and privacy issues vis-à-vis international law. *Brawijaya Law Journal*, 2023.

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