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Analysing the Effects of Artificial Intelligence Application in Commercial Space Law: An Indian Perspective

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Abstract. The human race is at a nascent stage in terms of applying artificial intelligence in space exploration activities. Although this being the case, various advancements in the use of artificial intelligence in commercial space can be seen in today's world on a recurrent basis. India has been a prominent partaker in the commercial space race since the past decade. Despite this, India still does not have a space law in place. In fact, only three countries, viz., United States of America, Luxembourg and Japan by far have been able to formulate domestic space laws. Under such circumstances, the only legally guiding principles for commercial space activities are enshrined under the sphere of international law. The first international instrument which dealt with the subject of space law was the 1967 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty). This was subsequently followed by the 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched Into Outer Space (Rescue Agreement), the 1972 Convention on International Liability for Damage Caused by Space Objects (Liability Convention), the 1976 Convention on Registration of Objects Launched Into Outer Space (Registration Convention) and the 1984 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement). Two significant Declarations and three important Principles also exist under international law under this subject, viz., the 1963 Declaration of Legal Principles Governing the Activities of States in the Exploration and Uses of Outer Space (Declaration of Legal Principles), the 1982 Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting (Broadcasting Principles), the 1986 Principles Relating to Remote Sensing of the Earth from Outer Space (Remote Sensing Principles), the 1992 Principles Relevant to the Use of Nuclear Power Sources in Outer Space (Nuclear Power Sources Principles) and the 1996 Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking Into Particular Account the

Needs of Developing Countries (Benefits Declaration). It is manifestly pristine that the expanding nature and unexplored possibilities in the field of commercial space may open Pandora's Box if efficacious, coherent and orderly development does not occur. This is because the private sector will play a pivotal role in the economic, size and functional development of commercial space activities, especially since the use of artificial intelligence will open access to uncharted realms in commercial space. An unregulated commercial space will inevitably lead to negative exploitation, destruction and give rise to various qualms in country relations. It is paramount that the same mistakes of commercial activities carried out on Earth are not repeated and emphasis is laid upon sustainable exploitation and use of commercial space. Therefore, this paper aims to provide recommendations for a resilient, impregnable and implementable Central space law, keeping in mind the intricacies and novelty of Indian jurisprudence, that not only conforms with the existing international space law instruments, but also deals with additional facets of commercial space. This research will achieve that by studying the existing structure of Indian law and exhibit results that provide answers, so that an Indian commercial space law that applies artificial intelligence can be accommodated into the extant legal structure. Delegated legislation that can be prescribed under such Central space law will also be dealt with and the paper will strive to explore the present development and provide suggestions for further development of artificial intelligence in individual sub- fields of commercial space such as commercial use of data collected in space, commercial remote sensing, research and manufacture of space products and accessories, prolonged space travel, commercial management of space product debris and the like..
Keywords: Territorial jurisdiction, Doctrine of Territoriality, Cloud data, Data, Data Exceptionalism, Location-independence, Cyberspace, Cyberterritory.

1 Introduction

The vision of commercial space activity in India is not a newfound phenomenon and has already been introduced through the Space 2.0 phase which is currently dedicated to enable space entrepreneurs, small and medium scale enterprises to compete in the commercial space race which is worth $300 billion dollars (Prasad, 2017). Evidence of the origin of commercial space activities can be traced to the year 1992, which was when Antrix Corporation Limited, a company owned by the Indian Government was established (Make in India, 2018). The Pragyan Rover launched with Chandrayaan- 2 is one of the most successful artificial intelligence rovers launched by India and showcases the potential of artificial intelligence in space missions (Gupta, 2019).

Some of the areas where artificial intelligence can contribute in enhancing commercial space activities in India are risk assessment of projects, commercial data collection, analysis, transmission, mapping and management, efficacious manufacture and development of space products such as spacecrafts, rockets, probes, rovers, space suits and

telescopes, technology capacity building, efficient launch and landing, improvement in mission success rates, commercial remote sensing, prolonged space travel, simulated training for astronauts, improved mission support systems, amelioration of services in India like geospatial positioning, internet and telecommunications and some long term goals such as asteroid mining and space tourism. All these aspects will be individually discussed in the next part.

2 Central Space Law and Solutions for the Application of Artificial Intelligence

In order to ensure the successful application of artificial intelligence in commercial space activities, it is extremely vital that a central space law is passed. Such law would have to preliminarily stipulate the areas of commercial space in which private enterprises can contribute and the areas in which they are restricted, provide guidelines for jurisdiction over space objects and discoveries, envisage clear principles of liability and a penal structure mechanism. It is indisputable that in the initial decades of the operation of such law it will not be possible to accommodate fully privatised space commercial activities and supervision will require to be strict in order to facilitate sustainable and orderly utilisation of commercial space.

In view of the fact that space activities involve country responsibility, a critical effect on diplomatic and international relations and impact on the planet itself, it is pertinent that the penal mechanism inculcated within an Indian space law will not only have to be closely connected to Indian criminal jurisprudence, but will have to create a *right in rem* in the form of a special law. In view of the factors that are at stake, the amalgam of liability and penology will have to be stringent. One of the unique aspects of a *right in rem* is that although it is available against the world, it is truly a right that resides in a person which makes other parties who are incumbent to a co- relative duty answerable (Kocourek, 1920). Therefore, a special tribunal will also have to be constituted under a central space law that will be empowered to penalise offenders under the law by imposition of adequate fines and imprisonment. Under normal circumstances, these tribunals will adjudicate matters filed by aggrieved persons within India. Needless to say that sovereign nations who choose to launch their space products and objects through India will also need to possess relief in instances where they incur damages due to private players. Such relief providence can be enabled by the help of the Indian Government. In practice, the central space law would have to clearly stipulate the instances attracting liability, but also at the same time prohibit excessiveness. This is necessary to ensure the balance between sovereign nations choosing to launch from India and the private sector not being discouraged from investing in commercial space activities. It is noteworthy that in the absence of these elements in a codified space law, commercial space

activities will not occur smoothly and the application of artificial intelligence might not bring out the best results. In other words, a resilient and all- embracing central space law is quintessential to accommodate further development in commercial space by the application of artificial intelligence.

2.1 Development of Space Products, Commercial Remote Sensing Activities and Commercial Use of Data Collected in Space

After achieving the first step of implementing a coherent central space law, public-private partnership would have to be embraced within the provisions of such law. Several applicable public private partnership models such as Design Build Operate Transfer (DBFOT), Operate Maintain Transfer (OMT), Build Own Operate Transfer (BOOT) (Indian Economy, 2019), other innovative models that suit the requirement and a model concession agreement to cater the relationship between the public and private sector for commercial space will have to be formalised. Although the Indian Space Research Organisation and the Indian Government (Government of India, 2017) have already floated various tenders for public private partnerships in the recent past (Indian Space Research Organisation Satellite Center, 2018), after the adoption of a central space law, the volume of operations will significantly rise and the present structure will then be rendered insufficient. For increased development and use of artificial intelligence in these activities, a partnership with technology based, robotics and artificial intelligence development companies will have to increase. Incentive schemes have been one of the most successful methodologies to attract investment and partnerships in any sector in India which has included tax and duty waivers, partial and absolute, land allocation and government grants (United Nations, 2008). Attraction of investors and constructive public private partnerships between artificial intelligence tech- companies and the Indian Space Research Organisation can lead to the positive development of enhancement in manufacture and innovation of space products such as spacecrafts, rockets, probes, rovers, space suits, ground systems and telescopes, including the introduction of lights- out or autonomous manufacturing of space products that will significantly boost the duration of space travel and its activities.

Commercial remote sensing in India has been carried out by Antrix Corporation (Antrix, 2015) in partnership with the National Remote Sensing Centre (NRSC, 2015) since its formation. The data collected has significantly boosted telecommunications, internet services, geospatial positioning, crop surveillance, disaster management and other commercial activities (Government of India, 2019). The current phase has already seen a partnership between India and other countries such as the United States of America, Germany, Russia, China, United Arab Emirates, Australia, Kazakhstan, Algeria, Myanmar, Thailand and Saudia Arabia in commercial remote sensing where commercial access has been granted to these nations to collect data directly from Indian remote sensing

satellites (Murthi, 2017). The Indian Space Research Organisation has already employed artificial neural networks in mission support systems and the collection, analysis, transmission, mapping, management of data and for monitoring structural health of space products (Indian Space Research Organisation, 2018). In a layman's terms, artificial neural networks are replicas of the human brain neural structure which has been applied in many fields such as speech recognition, image recognition, fingerprint scanning, signature verification, weather forecast, neural network research, chemical formulation optimisation, operational analysis and sales forecasting to name a few (Manickam, 2017). Law and policy- making needs to permit an increase in private sector involvement to further develop commercial use of remote sensing data. International Business Machines (IBM) is already using remote sensing data, artificial intelligence and blockchain for the development of precision agriculture in India (Pereira, 2019). Therefore, private sector involvement in managing commercial remote sensing data can also prove to be resourceful in other fields.

2.2 Risk Assessment, Capacity Building and Training

It is pertinent that artificial intelligence is also used for the improvement of simulated training of astronauts, risk assessment and analysis, which can result in progress of the mission success rate of the targeted commercial space activity. Softwares using artificial intelligence algorithms such as Space Mission Architecture and Risk Analysis Tool (SMART) are already being used for conducting risk analysis, assessment, mission success and outcomes (NASA, 2020). However, this is used by the National Aeronautics and Space Administration (NASA) for their space missions. India utilises Technology Risk Design/ Dependency Structure Matrix (TR-DSM) for risk analysis and mission planning (Sundararajan, 2013). However, this technology seems to have its limitations in identifying and analysing various parameters (McLaughlin, 2007). Visual Environment for Remote Virtual Exploration (VERVE) is one of the training simulation platforms used for training NASA astronauts (NASA, 2020). Astronauts for India's upcoming Gaganyaan Mission have begun their training in Russia (Spacewatch, 2020). This would be India's first manned mission. The reason as to why Indian astronauts have to be sent to other nations for space mission training is due to the lack of available training technology in India. It is significant that law and policy- making is rethought for the purposes of commercial space activities. This is because the rise in such commercial activities in space will inevitably result in the development of new professions and the increase in space travellers that will not essentially be astronauts. The role of artificial intelligence will be extremely high as more virtual and augmented reality based simulations will be used for the rigorous training of such non- astronaut space travellers. Under such circumstances, if technology for training astronauts and non- astronaut category of space travellers is not present in India, then it would become extremely

expensive and unviable, drastically affecting the volume and quality of commercial as well as non- commercial space activities.

Therefore, it is trite that capacity building in artificial intelligence technology forms the crux of how progress can be achieved in these activities. Bilateral treaties that emphasise upon import of artificial intelligence technology for commercial space activities can prove to be resourceful for capacity building. However, it is necessary that simultaneous indigenous development is also facilitated and catered using the Make in India Initiative and the involvement of the private sector so that dependency rates do not remain extremely high in the upcoming decades.

2.3 Licensing, Registration, Exploration, Jurisdiction and Commercial Launch

Another key aspect which a central space law would have to emphasize on is the distinction of regulations between autonomous and manned missions. A host of delegated legislation that include procedures for registration, mission supervision and licensing will have to be prescribed under a central space law. In order to ensure the development and increment of space exploration and sub- orbital activities, it is pertinent that the application of artificial intelligence is also explored in robotics to create autonomous space products such as autonomous rovers, landers and probes. Simplification of procedure in attaining reciprocal treatment of intellectual property rights of existing artificial intelligence-based space products and a robust mechanism that permits the ownership of certain specified space objects on discovery by private entities is capable of magnifying the amount of autonomous commercial space activities from India.

Establishing jurisdiction and control over launched space products and space objects has always been a dilemma under space law. Presently, the 1967 Outer Space Treaty stipulates that the sovereign State from whose jurisdiction a space object is launched, jurisdiction and control of such State will prevail over such space object (Marchisio, 2010). A central space law can also accommodate this. Even though the involvement of the private sector will be high, it is pertinent that the State has jurisdiction and control over any and all space objects and products. Considering that sovereign nations are involved and will continue to be significantly involved for the coming few decades, the State will have to closely supervise commercial space activities and take accountability for such activities. However, this certainly does not imply that ownership of space products and objects needs to be centralized to the Government as well. Ownership involves few basic rights such as the right to use subject matter of ownership, the right to exclude others from using subject matter of ownership and the right to dispose or destroy subject matter of ownership (Saxena, 2017). However, this is not an absolute right and is subject to exceptions. Thus, in order to maximise the results out of commercial space and ensure

that accountability exists, once a space product or space object is launched then the State will have jurisdiction and control over such product or object. The exclusive right of disposing or destroying such space product or object will also have to be suspended when such space product or object is indulged in a commercial space activity. At the same time, the limitations of this privilege enjoyed by the Government need to be clearly demarcated in the central space law or else it may lead to increase in arbitrary and whimsical official actions. As far as space objects discovered in space are concerned, for the initial few decades full ownership for private entities that discover space objects will not be conducive and will have to be jointly owned by the private entity and the State which has power to exercise jurisdiction over such private entity. Moreover, a list of space objects that will not attract a right of ownership on discovery will have to be clearly specified under law to avoid manifest absurdity.

Over the years, India has become extremely popular for commercial launches of space products. Currently, Antrix Corporation is involved in commercial space launches (Antrix Corporation, 2019). The number of foreign satellites launched from India are two in 1999, two in 2001, three in 2007, eight in 2008, six in 2009, three in 2010, two in 2011, two in 2012, six in 2013, five in 2014, sixteen in 2015, twenty one in 2016 and one hundred and thirty three in 2017 (Make in India, 2018) and by 2019 a total number of 319 foreign satellites were commercially launched by India (Sriharikota, 2019) which led to a revenue of INR 1,245 crores from launching foreign satellites from 2015 to 2019, a five year period alone (Business Today, 2019). The magnification of commercial space activities in India will also result in the indulgence of private entities in providing commercial launch services over the span of time. Initially, the private sector can be permitted to provide construction and support services for commercial launches. Therefore, in order to avoid incoherent construction and development that affects Master Plans of urban and rural development, this aspect has to be regulated efficiently by way of delegated legislation. If the commercial space sector is flourishing without a space law and prominent usage of artificial intelligence, it would not be wrong to presume that implementation of these aspects will only contribute to the sector's amelioration. Up till the present moment, India has been successful in launching space products that use artificial intelligence. However, the use of artificial intelligence in commercial launch services will also prove to be extremely advantageous since it would involve autonomous launches or minimum supervision launches.

3 Utilization of Clean Energy, Reduction of Space Mission Costs and Assistance to Other Countries

Increased usage of the latest artificial intelligence enabled 3D printing tools using computer aided designs (CAD) and introducing additional benefits under the Make In

India Scheme can significantly aid in the reduction of manufacture, operation and ultimately, the overall mission costs. Indian space missions are already popular for being cost- effective and are also considered as one of the best nations who is capable of efficiently launching nano and mini satellites. However, the central space law will have to address certain challenges to ensure that all types of commercial space activities are cost- effective and ecological. Since space law is not concretely codified in India till today, its formulation can mandate manufacturers to research, develop and utilise clean and sustainable technology to build space products that reduce prices. Application of Space Based Solar Power (SBSP), reusable space vehicles, better payload management, efficient Power Management and Distribution (PMAD) and energy storage systems are few of the clean technology methods that can be mandated as "basic standards" for Indian based space products. Moreover, a space regulatory wing under the Indian Space Research Organisation will have to be established which not only will regulate the private sector in India but will also regulate exports of Indian manufactured space products to other nations of the Global South. Furthermore, the national agency can also be entrusted to provide training to other Global South nations and also, create guidelines for Indian partnerships with other nations to launch their products into outer space. In fact, the Indian Space Research Organisation is already set to provide training to 45 countries including Egypt, Mexico, Chile, Indonesia, Malaysia, Oman, Myanmar and others to build nano satellites under the Unispace Nano- Satellite Assembly and Training (UNNATI) program (Siddiqui, 2019).

3.1 Space Debris and Defense

Space debris has always been a threat to orbital and sub- orbital space products (Sylvestre & Parama, 2017). Moreover, the chances of such space debris entering the Earth's atmosphere always exists. Artificial intelligence has already been employed for the purposes of catastrophic distribution analysis and space debris tracking using software tools like PHILOS- SOPHIA that uses a graphical user interface and hydrocode numerical simulations (Samal, 2020). Identifying space debris in advance can effectively aid in charting the route for launched space vehicles and avoid unprecedented loss and damage during the course of the space activity. In March 2019, India destroyed its own test satellite using a ground- based missile which led to a significant increase in space debris (Grush, 2019). Even otherwise, creation of space debris was always an inevitable occurrence. Using robotics and artificial intelligence for space debris clean up is not a new idea in today's world. The European Space Agency is planning to launch the world's first space debris clean- up robot called Chaser under its Clear Space Mission- 1 (Business Insider, 2019). India currently does not possess any plans for creating space debris cleaning robots. It is vital that India encourages the development of such artificial intelligence and robotics amalgamated products that are involved in the clean- up of space

debris to boost and expand the sectors of commercial space activities in India. As specified earlier, sovereign nations are responsible and liable for their space products including space debris and that is another important reason as to why India has to encourage the development of artificial intelligence solutions for space debris tracking, management and clean- up.

The contribution of artificial intelligence in boosting the defence sector has been inordinate. The relationship between space activities and the defence sector is extremely old. Improvement in guidance systems of ballistic missiles, drone control, intelligence gathering and surveillance have been some of the results of this collaboration. The Indian Ministry of Defence has already initiated the process of investing in artificial intelligence for the advancement of the Indian defence sector. A multi- stakeholder Task Force on Strategic Implementation of Artificial Intelligence for National Security and Defence has been formed which includes the Indian Space Research Organisation in the team (Press Information Bureau, 2019). Although at the present moment conventional instruments such as the Partial Nuclear Test Ban Treaty, 1963, Outer Space Treaty, 1967 and the Moon Agreement, 1984 prescribe demilitarization of space and prohibit the development, storage or tests of nuclear or other weapons of mass destruction (Matignon, 2019), the use of military or paramilitary forces to safeguard State assets in space might not be extremely far. The nomenclature of these conventional instruments are being defied by many nations due to its ambiguity and armament has been continuous for space militarisation. This is evident by the concerns raised by the United Nations (United Nations General Assembly, 2018). Therefore, strict inclusion of only Governmental activities in the application of artificial intelligence in space for improving the defence sector would be the most secure option. It is indeed undeniable that only a binding instrument in the sphere of international law can affect domestic law and policy-making in a manner so as to avoid space militarization.

4 Way Forward and Conclusion

Presently, a legal framework for space tourism and asteroid mining which are long term goals of commercial space activities, is highly conducive and having a mechanism in place for such activities could prove to be substantially beneficial. This is because the United States of America and Luxembourg have already enacted laws for asteroid mining (Porras, 2017) and such activities may really not be so far from achievement. India's stable and resilient space programs make it extremely potential for space tourism. The success of Gaganyaan could mean that it would also be used for space tourism (Space Daily, 2020). The sector of space tourism and asteroid mining is so vast that the central space law enacted might not be able to meet its needs and will require separate legislation. The application of artificial intelligence in commercial space is going to

boost activities at an exorbitant rate, a sight also seen in the telecommunications and internet based services sector.

It is not wrong to infer that a commercial space race may lead unsustainable activities that harm space objects and the whole planet itself and therefore, it is extremely vital to stringently and manifestly frame and implement policies that will facilitate and promote sustainable commercial space activity and sustainable exploitation of space resources. Sustainable use of commercial space is the only manner in which the use of fourth industrial revolution devices such as artificial intelligence can be maximised for development.

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