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AI—A Possible Solution to the Threats Against Human Lives Arising from Space Objects?

Abstract

With the 1957 launch of the satellite Sputnik I, the first space object reached outer space. Many more followed, and today space objects are considered an invaluable part of our everyday lives. Satellites and the data they provide are used for monitoring the environment through Earth observation, climate regulation, and natural disaster management, as well as economic activities, for example, agriculture, transportation, communication, and several others. Despite these numerous benefits, however, space objects pose threats to human lives in outer space, in airspace, and on Earth. The technological advancement of the 21st century, especially the increased use of artificial intelligence, brought hope that these threats would be minimised, mitigated, or even completely resolved. In this paper, I am going to evaluate whether such hope is reasonable and justified. To do this, I will, first, identify some examples of the threats to human lives arising from space objects and provide examples when such threats already materialised in reality. Second, I will present the applicable legal framework and then, third, evaluate it and show that it falls short in addressing those threats. Fourth, I will demonstrate how AI is planned to be used in mitigating these threats. Fifth, I will outline some of the new legal challenges such use of AI would bring and, against this background, finally assess whether such AI threat mitigation is going to be as effective as currently predicted.

Key words

AI, space technology, space debris, space objects, terrorism.

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On a Halloween night, I sat outside by the fire on the edge of a forest, and I saw something scary. Not a zombie, or a vampire or, a werewolf, or anything like that, but something even scarier—a bright spot of light above the trees that was moving noticeably slower than a shooting star, leaving behind a trail of burning little dots. I assumed I had witnessed the last few seconds of the life of a space object, entering and burning up in the Earth's atmosphere. Nothing happened, the evening went on, and now, in broad daylight, it probably sounds ridiculous that a distant object, which does not even exist anymore, could be scarier than a zombie, a vampire, or a werewolf. But a space object could, in fact, be considered deadlier than all three of these combined. In this article, I will therefore explain why I believe a Halloween costume of a satellite could easily beat all the aforementioned supernatural creatures, and furthermore examine whether artificial intelligence (hereinafter: AI) has the potential to become, *mutatis mutandis*, what garlic is to vampires.

I will, first, identify some examples of the threats space objects pose to human lives and provide examples of when such threats already materialised in reality. Second, I will present the applicable legal framework and, third, evaluate it to show that it falls short in addressing these threats. Fourth, I will demonstrate how AI is planned to be used in mitigating those same threats. I will be using the term AI as an umbrella term to describe the new generation of technologies, mainly characterised by a certain degree of self-learning, automatization, and autonomy.[1] Fifth, I will outline some of the new legal challenges such use of AI would bring, and lastly, against this background, I will assess whether such AI threat mitigation will likely be as effective as currently predicted.

1. Identifying the Threats

In this section I will present some examples of space objects with the potential of endangering human lives. In line with the definition of a space object under Article I(d) of the Convention on International Liability for Damage Caused by Space Objects—Liability Convention (hereinafter: LIAB)[2] and the identical Article I(d) of the Convention on Registration of Objects Launched into Outer Space—Registration Convention (hereinafter: REG),[3] as including component parts of a space object, its launch vehicle, and parts thereof, this presentation will extend to threats arising from such parts as well. Additionally, as there is no requirement of functionality in the aforementioned definition, this presentation will also include non-functional space objects and their fragments, i.e., space debris.

1 Custers & Frosch-Villaronga, 2022, pp. 3–8.

2 *Convention on International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 UNTS 187 (entered into force on 1 September 1972).

3 *Convention on Registration of Objects Launched into Outer Space*, 12 November 1974, 1023 UNTS 15 (entered into force on 15 September 1976).

1.1. Space Object Falling on Earth

The first identified threat to human lives is a space object crashing to the surface of the Earth, as demonstrated by the Kosmos 954 incident.

In 1978, the malfunctioning Soviet satellite Kosmos 954 re-entered the Earth's atmosphere.[4] Instead of burning up in the atmosphere, it intruded into Canadian airspace while failing to separate from its nuclear reactor containing about 50 kilograms of uranium-235.[5] The satellite crashed onto the ground, littering Canadian territory with a 600-kilometre-long path of radioactive debris.[6] During the aftermath of the incident—Operation Morning Light—a search of an area of more than 124,000 km^2 resulted in the finding of several intensely radioactive and potentially lethal pieces of the satellite.[7] The fear arose that civilians might notice the pieces and bring them into their homes, thereby further spreading radioactive contamination, and that fear was magnified once the most radioactive piece of debris, which contained enough radiation to have potentially killed its holder within a few hours, was discovered.[8]

Luckily, re-entry into the atmosphere was detected early on, and the area where the debris landed was sparsely populated. The effects of the Kosmos 954 crash would have been much more devastating if the debris had fallen onto densely populated areas, as many more people could come into contact with radioactive material. Likewise, if the fall had remained undetected or hidden, the damage would not be mitigated at all.

Currently, there are more than 5,000 functioning satellites orbiting the Earth, more than 1,500 of which belong to the private US corporation SpaceX.[9] In case of a malfunction, one of them could enter the Earth's atmosphere and not burn up completely, and the debris could hit the Earth's surface just like in the Kosmos 954 scenario. Moreover, pieces of satellite could hit populated areas and result in the loss of human lives on Earth.

1.2. Collisions between space objects

A second identified threat to human lives is the chance of collisions between two or more space objects.

Such collisions have already occurred several times. They often occur unintentionally, either as part of normal operation (low-speed collisions during rendezvous and docking) or as a coincidental high-speed collision. However, sometimes the collisions are caused

4 For the detailed description of the event see the Settlement of Claim between Canada and the Union of Soviet Socialist Republics for Damage Caused by "Cosmos 954", 1981.

5 Weintz, 2015.

6 Patowary, 2020.

7 Shultz, 2010.

8 Weintz, 2015.

9 Union of Concerned Scientists, 2022; Kizer Witt, 2022.

intentionally, with a clear goal of destroying the satellites—either to test anti-satellite weapons (hereinafter: ASAT tests) or destroy satellites that may pose an active hazard to Earth, aircraft in flight, or other space objects.[10] In all cases, the collisions result in an increased amount of space debris (see below).

These collisions could, in some cases, result in the loss of human life. Such loss could occur in outer space if at least one of the space objects involved in the collision were carrying humans on board. An example of such a collision is the 1994 collision between the crewed Soyuz TM-17 spacecraft and the space station Mir, which was fortunately a minor collision and did not cause severe damage.[11]

Loss of life due to a space object collision could also occur on Earth or in its airspace. In this case, the loss of life would be caused by a space object indirectly; for example, where one or both of the space objects involved in a collision would be crucial for the functioning of critical infrastructure, such as telecommunication or navigation systems. A detected collision between two satellites occurred in 2009, when a functioning commercial Iridium 33 satellite collided with the non-functional[12] military Kosmos 2251 satellite.[13] Luckily, no lives were lost due to this incident. However, this is no guarantee that space object collisions will not negatively affect human lives in the future. Moreover, despite not causing human casualties, the Iridium–Kosmos collision resulted in more than 1,800 pieces of new space debris, which spread throughout Earth's orbit, further endangering human lives (explained next).[14]

1.3. Space debris

A third identified threat to human lives from space objects is space debris. There exist many different technical definitions aiming to clarify this term; however, there is, as of yet, no universally adopted legal definition. Nonetheless, what is common to most of the existing definitions is that space debris is man-made material (space objects or fragments thereof) in outer space that is no longer functional.[15] In Earth's orbit, there are approximately 15,000 pieces of debris larger than 10 cm, about 200,000 pieces between 1 and 10 cm, and millions of pieces smaller than 1 cm, all travelling at incredibly high speeds.[16]

10 For more on the intentional collisions, definition and types of ASAT tests as well as the challenges and damages related to or stemming from them, see Ramuš Cvetkovič, 2023.

11 Harland, 2022.

12 Because Kosmos 2251 was put out of its functioning, it was technically considered space debris. For more on space debris, see section 1.3.

13 NASA, 2009; David, 2013.

14 NASA, 2009.

15 Sheer & Li, 2019, pp. 425–429.

16 Gregersen, 2022.

The incidents in which space objects are destroyed—collisions or ASAT tests—contribute enormously to the amount of space debris in orbit.[17]

The most obvious and direct threat that space debris poses to human life is that it significantly contributes to space object collisions. Pieces larger than 1 cm can already affect a space object, whereas pieces larger than 10 cm can seriously damage or even destroy a space object.[18] It has been reported that astronauts aboard the International Space Station (ISS) have already had to take shelter and cancel a spacewalk after a dangerous sudden increase of space debris caused by an ASAT test.[19] The ISS, moreover, had to take avoidance manoeuvres to move out of the way of space debris several times, and has even been hit by a piece of debris that damaged its robotic arm.[20]

Space debris can, and already has, caused damage on Earth, as some pieces have hit houses in villages and, in at least one documented incident, even a person.[21] It has been estimated that the risk of space debris resulting in human casualties upon its re-entry into Earth's orbit is increasing, noting that even a small piece of debris can cause extreme devastation if it hits places with a high population density in a relatively small area, such as large cities or airplanes.[22]

The amount of space debris is, furthermore, rapidly increasing. Not only because that more and more space objects are launched every year, but also due to the Kessler syndrome—a process of continuous fragmentation of existing pieces into ever-smaller fragments, which can, in the worst-case scenario, result in a dense debris cloud around the Earth.[23] Such a dense presence of space debris negatively impacts the climate, as re-entering debris burning in the atmosphere contributes to stratospheric O_3 depletion, and could therefore worsen the effects of climate change.[24] Furthermore, it would likely cause the malfunction of all satellite services, impairing or completely disabling the functioning of critical infrastructure. In this way, space debris indirectly endangers human lives in the long term.

1.4. Misuse of space objects

The fourth identified threat is the misuse of space objects. By this, I mean the use of space objects with the purpose of directly and specifically targeting human lives—either

17 David, 2013.

18 Chen, 2011, pp. 538–539.

19 Chow & Mitchell, 2021; Mukherjee, 2021.

20 McFall-Johnsen, 2021.

21 Byers *et al.*, 2022, p. 1093; Zander, 2022.

22 Byers *et al.*, 2022, pp. 1093–1095.

23 Kessler & Cour-Palais, 1978, pp. 2637–2646.

24 Ryan *et al.*, 2022, pp. 10–11.

by an entity controlling the space object, or by another entity gaining control over the space object (for example, by means of cyber-attacks). In the past, such misuse has already occurred in practice.

Although the technology that would enable direct strikes on humans from space objects does not yet exist, space objects can, and have, already been indirectly used to target human lives. Data collected through space objects is already extensively used to determine military targets on Earth.[25] This demonstrates that it is possible to endanger human lives by means of using space technology, as such data could be misused for harmful or even unlawful purposes, such as, for example, the deliberate targeting of the civilian population.

A misuse of a space object occurs, moreover, when space objects become targets of cyber-attacks.[26] Cyber-attacks are, for now, mostly aimed at obtaining satellite data but could also gain complete control over a satellite and turn it into a lethal weapon.[27] In both cases, such cyber-attacks could result in losses of human lives. For example, it has been claimed that the cyber-attack on the KA-SAT satellite, providing communication services in Europe, including Ukraine, occurred on 24 February 2022—at the beginning of the Russian invasion of Ukraine.[28] A cyber-attack disrupting communication at a time when evacuation of civilians was needed demonstrates how such attacks could easily contribute to mass losses of human lives. Even a mere disruption of a space object's activity due to a cyber-attack could turn lethal if the satellite failed to perform essential services on which humans rely, for example, predictions of extreme weather conditions or natural disasters, enabling medical activity, water or electricity networks, traffic management, etc.—or if it crashed into another space object enabling such activities.[29]

Another threat to human lives is that space objects are used for the purpose of a terrorist attack. Liberation Tigers of Tamil Eelam (hereinafter: LTTE), considered a terrorist organisation by several states, hijacked an INTELSAT satellite and used it for publicity.[30] This demonstrates that satellites and other space objects have already gained the interest of non-state actors linked to terrorism, and that they are likely to become even greater objects of interest for such entities in the future.

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[25] Lee & Steele, 2014, pp. 71–73; Bt & Cummings, 1991, pp. 46–52; Dunlap, 2021; Borowitz, 2022, pp. 1–4.

[26] Puttré, 2022.

[27] Hobe, 2019, p. 101.

[28] See ESPI, 2022. See also Burgess, 2022; Viasat, 2022; Jewett, 2022.

[29] Akoto, 2020.

[30] Miller, 2019, p. 39; Stuart, 2015.

2. Outlining the Safeguards in the Applicable Legal Framework

In this section, I will outline the legal principles and rules applicable in outer space that contribute to minimising threats to human lives arising from space objects. The main focus will be on the principles enshrined in the 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 (hereinafter: OST),[31] the fundamental space law instrument, supplemented by other relevant provisions of space law treaties and customary international law.

2.1. The Freedom of Exploration and Use, the Obligation to Carry out Exploration and Use of Outer Space for the Benefit and in the Interests of all Countries, and the Province of Humankind

Article I of the OST sets out important principles governing the use and exploration of outer space. It provides that the exploration and use of outer space are free to all states without discrimination of any kind. It further establishes that they shall be carried out for the benefit and in the interests of all countries, and that outer space shall be the province of all mankind. These two principles together form the so-called "common benefit clause", conditioning and limiting the freedom of exploration to the common benefit of all states. [32]

For the topic at hand, namely threats to human lives arising from space objects, these principles carry special relevance as they provide fundamental guidance for conducting space activities. They entail that even though there is freedom to use and explore outer space, including the freedom to launch space objects, such freedom is subject to limitations, such as taking into account the freedoms, benefits, and interests of other states.[33] Even though it has not been precisely determined what that means for every case of space activities in practice, it has been claimed that it can at least be concluded that the benefits and interests of other states are not respected when pursuing merely one state's military objectives, such as, for example, conducting ASAT tests.[34] This is further relevant for the threat posed by space debris, as it has been argued that these obligations in Article I preclude states from conducting their activities in a way that could potentially close ac-

31 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205 (entered into force on 10 October 1967).

32 Hobe, 2009, p. 36.

33 *Ibid.*, pp. 34–38.

34 Zedalis & Wade, 1978, pp. 466 and 480. For more on the (in)compatibility of the ASAT tests with the legal framework established by the OST, see Ramuš Cvetkovič, 2023.

cess[35] to outer space to others, meaning that they must reduce space debris emissions and actively work to maintain outer space usable for all, including future generations.[36] There already exist several soft-law mechanisms aimed at limiting the generation of space debris and ensuring greater sustainability of space activities,[37] but they are usually not directly enforceable, unless translated into a legally binding document, as has been done, for example, by Austrian[38] and Slovenian[39] national laws governing space activities. However, concrete and precise legally-binding rules effectively defining the scope and governing the enforcement of all the principles enshrined in Article I of the OST have not yet been established. By aiming to eliminate obstacles to the freedom of use and exploration of outer space, and by putting forward the benefits and interests of all states, the obligations set out in Article I of the OST therefore to some extent increase the protection of human lives against the threats posed by space objects. However, it cannot be claimed that Article I in itself is a sufficient mechanism to fully eliminate such threats.

2.2. The Obligation to Carry on Activities in the Exploration and Use of Outer Space in Accordance with International Law

Article III of the OST dictates that activities in the exploration and use of outer space must be carried out in accordance with international law, including the Charter of the United Nations (hereinafter: UN Charter), in the interest of maintaining international peace and security and promoting international co-operation and understanding. This Article, therefore, provides that international law applies to all human activities in outer space, including launching, operation, and return of space objects.[40] It can, moreover, be deduced that space objects shall not be used so as to jeopardise international peace and security.[41]

35 It must be mentioned here that Article II of the OST explicitly prohibits national appropriation of outer space. It is yet to be determined whether disabling other states access to outer space could constitute *de facto* appropriation in contradiction with Article II.

36 Palmroth, Tapio & Soucek *et al.*, 2021, p. 4; Niewęgłowski, 2021; Hobe, 2009; p. 43.

37 See, for example, UN COPUOS *Guidelines for the Long-term Sustainability of Outer Space Activities*, 2018, A/AC.105/2018/CRP.20 and IADC *Space Debris Mitigation Guidelines*, 2021, IADC-02-01.

38 See Article 5 of the Federal Law on the Authorisation of Space Activities and the Establishment of a National Registry (Outer Space Act), BGBl. I No. 132/2011 (Austria), which demands compliance with 'state of the art and in due consideration of the internationally recognised guidelines for the mitigation of space debris'.

39 See Article 5 of the Space Activities Act, Official Gazette of the Republic of Slovenia, 43/22 (Slovenia), which states that space activities must 'envisage measures for limiting the generation of space debris in accordance with the applicable UN Space Debris Mitigation Guidelines and for limiting adverse environmental effects on Earth or in outer space or adverse changes in the atmosphere'.

40 Ribbelink, 2009, pp. 64–66.

41 *Ibid*., pp. 66–67.

The applicability of international law through Article III, however, raises issues regarding the *lex specialis*[42] nature of space law, as well as the scope of the applicability of international law.[43] Even though there is no doubt that a substantial part of international law applies in outer space, its applicability *in toto* remains disputed.[44] For now, it is agreed that not only the long-established rules of customary international law and the explicit rules enshrined in the UN Charter (including non-aggression, prohibition of the use of force, self-defence and the peaceful settlement of disputes), but also subsequent generally accepted principles—such as, for example, the precautionary principle—apply.[45] It has additionally been established that specific sub-branches of international law, including human rights law, environmental law and international criminal law, apply as well, even though the scope of their application is not yet precisely determined.[46] This could mean that, to rely on a specific rule or principle from these sub-branches of international law, it would first need to be established that such a rule is indeed applicable through Article III.[47]

In short, this provision, therefore, demands that space objects are operated in accordance with international law. Thus, at least to a certain degree, human rights and environmental principles must be respected. This means that international legal safeguards aimed at protecting human lives principally apply to the handling of space objects; however, the precise scope of their application will have to be further defined to enable a direct and undisputed applicability of various rules and principles of international law in outer space through Article III.

2.3. Limitations on Weaponising Outer Space

Article IV(1) of the OST imposes certain limitations on the weaponisation of outer space. It prohibits placing in orbit around the Earth any objects carrying nuclear weapons or any other kind of weapons of mass destruction, installing such weapons on celestial bodies or stationing them in outer space in any other manner. It has been stressed that even though only space objects carrying such weapons are prohibited, this provision must be understood as covering the weapons themselves as well.[48]

The issue arises in defining precisely which weapons are prohibited by Article IV(1). It is clear that this prohibition does not cover space objects carrying conventional weapons

[42] For more on the *lex specialis* nature of space law, see Ramuš Cvetkovič, 2021.

[43] Ribbelink, 2009, p. 67.

[44] *Ibid*.

[45] *Ibid*. For more on the concrete issue of the application of precautionary principle to space activities, see Novak, 2022.

[46] *Ibid*.

[47] For more, see Hoe, Umar & Kamarudin, 2018, p. 336.

[48] Schrogl & Neumann, 2009, p. 78; Gorove, 1973, p. 117.

or military satellites.[49] The use of satellite data for military activities on Earth is therefore not prohibited by Article IV.[50] Less clear, on the other hand, is what precisely constitutes a "nuclear weapon" or a "weapon of mass destruction". It has been claimed that for a nuclear weapon, all arms utilising atomic energy would qualify.[51] Even though the concern has been expressed that, for a space weapon to qualify as a weapon of mass destruction, the number of human lives lost would have to be greater than in the case of a biological or chemical weapon,[52] there is no reasonable ground for such a distinction, especially from the perspective of protecting human lives from the threats arising from space objects.

Further uncertainty arises as to whether the prohibition in Article IV(1) extends to all space objects capable of causing a nuclear reaction or severe devastation, or merely to those intended to be used as weapons. Relying on an ordinary-meaning interpretation in accordance with Article 31 of the Vienna Convention on the Law of Treaties (hereinafter: VCLT)[53] of the term "weapon", it has been concluded that only objects intended to be used in warfare or in combat to attack and overcome an enemy, that can cause a nuclear reaction (nuclear weapons) or widespread devastation and loss of life (weapons of mass destruction), are prohibited by Article IV(1).[54] That means that space objects that contain a nuclear component but not for the purpose of attacking and overcoming the enemy—for example, using small atomic bombs for propulsion—do not qualify as prohibited.[55] However, after the Kosmos 954 accident, the Principles Relevant to the Use of Nuclear Power Sources in Outer Space (hereinafter: NPS Principles)[56] were accepted, aimed at regulating precisely these types of space objects (e.g. space objects with non-weaponised nuclear components). Even though the NPS Principles are soft-law guidelines of a non-binding nature, they introduced important safeguards, such as the obligation to conduct and make public a comprehensive safety assessment (Principle 4), notification of re-entry of radioactive materials to Earth (Principle 5), and an emergency assistance responsibility (Principle 8).[57]

Another dilemma arising from Article IV(1) and the use of the word "weapon" concerns the definition of the word "enemy". This dilemma was sparked by the debate on as-

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49 Schrogl & Neumann, 2009, p. 78; Zedalis & Wade, 1978, p. 459.

50 Hobe, 2019, p. 106.

51 Gorove, 1973, p. 115.

52 *Ibid.*, pp. 115–116.

53 *Vienna Convention on the Law of Treaties*, 23 May 1969, 1155 UNTS 331 (entered into force on 27 January 1980).

54 Schrogl & Neumann, 2009, pp. 75–77.

55 *Ibid.*, p. 76.

56 UN GA Res. 47/68, *Principles Relevant for the Use of Nuclear Power Sources in Outer Space*, 14 December 1992 (not yet entered into force).

57 See Hobe, 2019, pp. 153–154.

teroid mitigation programmes and planetary defence.[58] In that case, it is unclear whether targeting a natural object in outer space with the use of a space object carrying a nuclear device (thus transforming the space object into one carrying nuclear weapons prohibited under Article IV(1)) would constitute a breach of Article IV(1).[59] The main question here is whether a natural threat could be considered the "enemy", in the sense that the means to tackle such a threat would be considered a "weapon".[60] Even though such an interpretation is possible, the question whether the use of a space object with nuclear power in such a non-military way is allowed or prohibited by Article IV(1) remains unresolved.[61]

Article IV(2) of the OST regulates weaponisation on celestial bodies, stating that the Moon and other celestial bodies shall be used exclusively for peaceful purposes, prohibiting the establishment of military bases, installations and fortifications, the testing of any type of weapons, and the conduct of military manoeuvres on celestial bodies. However, the exclusively peaceful purposes clause pertains only to celestial bodies. Therefore, it is not applicable to space objects not situated on celestial bodies. That means that even though Article IV(2) prohibits the testing of weapons, this does not apply to ASAT tests aimed at satellites. It has been expressed that even Article IV(1) does not prohibit ASAT tests.[62]

As demonstrated by this analysis, despite the fact that Article IV of the OST provides certain safeguards against threats to human lives stemming from space objects, it does not explicitly and unambiguously eliminate all potential threats.

2.4. Assistance to Astronauts

Article V of the OST contains several provisions aimed at protecting the life and health of astronauts. Firstly, it dictates that States Parties to the Treaty shall regard astronauts as envoys of mankind in outer space and shall render them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas (Article V(1) of the OST). Secondly, it adds that in carrying on activities in outer space and on celestial bodies, the astronauts of one State Party shall render all possible assistance to the astronauts of other States Parties (Article V(2) of the OST). Lastly, it obliges States Parties to the Treaty to inform other States Parties to the Treaty or the Secretary-General of the United Nations immediately of any phenomena they discover in outer space, including the Moon and other celestial bodies, which could constitute a danger to the life or health of astronauts (Article V(3) of the OST).

58 Schrogl & Neumann, 2009, p. 76.

59 *Ibid.*, pp. 76–77.

60 *Ibid.*, p. 77.

61 *Ibid.*, p. 77.

62 *Ibid.*, p. 78.

It is clear that Article V, therefore, provides a certain level of protection to human lives from the threats posed by space objects. However, the extent of that protection depends on the interpretation of the text. In this regard, the question arises whether all humans in outer space fall under the definition of an "astronaut", or merely trained professionals. This dilemma was non-existent at the beginning of the space era, when only professional astronauts were sent to outer space, but with the changed nature of space activities and the introduction of private actors to outer space, as well as space tourists, three categories of space travellers have to be distinguished:

1. The classical professional astronaut, bearing certain fundamental responsibilities in relation to the spacecraft and its operation;
2. The professional spaceflight participant, entrusted with a special job to perform in outer space, that is not related to operating the spacecraft; and
3. The private spaceflight participant travelling to outer space for leisure reasons and essentially paying for the trip.[63]

A subsequent dilemma concerns whether all three categories are entitled to the rights and obligations accorded to astronauts in Article V of the OST. Several authors agree that it is not appropriate to confer the status of an astronaut on completely untrained personnel travelling to outer space exclusively for private leisure purposes, especially in light of the fact that astronauts are considered envoys of mankind by the OST.[64] It has also been agreed that categories 2 and 3 should not be blurred into one, as there are important distinctions between them.[65] As the OST leaves us with little guidance on how to resolve the dilemma of which rights and obligations pertain to the three aforementioned categories of humans in outer space, a subsequent Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space—Rescue Agreement (hereinafter: ARRA) must be consulted.[66] This document, concretizing Articles V and VIII of the OST, mentions "astronauts" in its Preamble (as a reference to earlier documents) but in the operative part of the text uses only the term "personnel of the spacecraft".[67]

Views differ on whether the protection accorded to astronauts by both the OST and the ARRA applies to space tourists as well. Arguments following an ordinary-meaning interpretation conclude that an astronaut is only a highly trained, state-employed professional, whereas arguments following an object-and-purpose interpretation—which seeks

63 Von der Dunk & Goh, 2009, pp. 97–98.

64 *Ibid.*

65 *Ibid.*

66 *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space*, 19 December 1967, 672 UNTS 119 (entered into force on 3 December 1968).

67 Marboe, Neumann & Schrogl, 2013, pp. 33–35.

the broadest possible human welfare—find that no distinction should be made.[68] The second view is further supported by the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies—Moon Agreement (hereinafter: MOON),[69] which clarifies that, for the purposes of that document, any person, whether professional or private, on the Moon is regarded as an astronaut.[70] It seems that, for the purposes of minimising the threat posed to human lives by space objects, the broad interpretation of the term "astronaut" is more suitable. On the other hand, equalising the status of space tourists with groups 1 and 2 might in effect cause more people to decide to go to outer space for private leisure purposes, which would lead to launching more and more space objects, generating more space debris and increasing the likelihood of collisions and pollution, thereby further endangering human lives in the long run.

An additional dilemma arising from the interpretation of the text of Article V of the OST is the threshold of the standard "all possible assistance". The difficulty of defining this standard is enhanced by the fact that in Article V(1) of the OST it is stated that "all possible assistance" must be rendered to astronauts in the event of accident, distress, or emergency landing, whereas in Article V(2) these qualifying circumstances are omitted and only the obligation to render "all possible assistance" remains.[71] Even though the absence of these qualifying circumstances hints that the standard is set higher in Article V(2), the interpretation of Article V must, according to Article 32 of the VCLT, not lead to absurd or unreasonable results. The standard must therefore be interpreted in somewhat a more limited manner, namely, to assist humans in threatening circumstances.[72] The limitation on the interpretation, however, should be such that it still enables effective protection of human lives.

Article V of the OST's standards are further concretised by the obligations set out in the ARRA. However, it must be noted that the ARRA contains similar standards—namely, "all possible steps" and "all necessary assistance" (Article II of the ARRA), meaning that the dilemma regarding such thresholds is not completely resolved.

The effect of Article V of the OST and the ARRA on preventing threats to human lives stemming from space objects is, for the reasons stated above, limited.

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68 *Ibid.*, p. 35.

69 *Agreement governing the Activities of States on the Moon and Other Celestial Bodies,* 5 December 1979, 1363 UNTS 3 (entered into force on 11 July 1984).

70 Marboe, Neumann & Schrogl, 2013, p. 35.

71 Von der Dunk & Goh, 2009, p. 98.

72 *Ibid.*, p. 100.

2.5. State Responsibility for National Space Activities and the Obligation to Authorise and Continuously Supervise Space Activities

Article VI of the OST dictates that states bear international responsibility for national activities in outer space, whether such activities are carried on by governmental agencies or by non-governmental entities, and for ensuring that national activities are carried out in conformity with the provisions set forth in the OST. The term 'national activities' must be understood broadly, not merely as activities in national interest, but in contrast to international activities carried out by international organisations.[73] There exist two distinct views on the nature and effect of this rule.[74] One view is that it is a rule of a secondary nature, and it, therefore, applies only in case of a breach of a primary international obligation.[75] According to this view, Article VI is much broader than customary international law on state responsibility, as it ascribes international responsibility to a state without having to establish the attributability condition.[76] The second view supports a narrower interpretation, claiming that a state is only responsible for its own actions and omissions, meaning that it is only responsible for the actions of private actors when it fails to supervise them. [77] It remains to be authoritatively determined which of the two views is determinative of the nature of the obligation from Article VI. As the first view is broader, and, therefore, extends state responsibility to private actors completely, it is more suitable to meet the goal of protecting human lives from threats posed by space objects, as the possibility of bearing international responsibility represents motivation for a higher standard of care.

Article VI of the OST also establishes that states must authorise and continuously supervise the activities of non-governmental entities in order for the latter to be allowed. The detailed procedure of authorisation and continuous supervision is usually subject to particular national legislations, which regulate in further detail the safeguards aimed at protecting human lives from threats posed by space objects.[78] States, therefore, have the opportunity to actively and extensively mitigate threats to human lives posed by space objects through their own national legislation, and should, when creating it, bear in mind these threats and the importance of effective continuous supervision of all national space activities. It must be noted, however, that when drafting their national legislation, States are forced to balance mechanisms for ensuring the safety of humans with other requirements of the private sector to maintain competitiveness and support the devel-

[73] See Gerhard, 2009, pp. 108–110.

[74] For more on this, see Ramuš Cvetkovič, 2021, pp. 19–20.

[75] Cassese, 2005, p. 244.

[76] Hobe & Pellander, 2012, pp. 7–8.

[77] *Ibid.*, pp. 8–9; Marchisio, 2018, p. 201.

[78] In Slovenia, this procedure is regulated in Space Activities Act (*Zakon o vesoljskih dejavnostih* – ZVDej), Official Gazette of the Republic of Slovenia, No. 43/22.

opment of their economies.[79] It is difficult to imagine that one State would put forward very limiting and strict legislation, as it could drive private actors to seek to register and conduct their space activities in a State with more favourable space legislation. The main initiatives for increasing the protection of human lives will therefore probably have to be made at the international level.

2.6. Liability for Damages Caused by Space Objects

Article VII of the OST establishes liability to pay compensation for damages caused by space objects. It dictates that a state that launches or procures the launching of an object into outer space, or from whose territory or facility an object is launched, is internationally liable for damage to another state or to its natural or juridical persons by such object or its component parts on the Earth, in air, or in outer space, including the Moon and other celestial bodies.

International liability is further defined in the LIAB. Its provisions are relevant to threats to human lives arising from space objects, as loss of human life is recoverable damage under the LIAB. In particular, Article I(a) of the LIAB defines damage as including loss of life, personal injury, or other impairment of health.

Furthermore, the LIAB covers space object threats to humans both on Earth and in outer space, establishing two different liability regimes based on where the damage occurs. In case damage occurs on the surface of the Earth or to an aircraft in flight, Article II of the LIAB establishes absolute liability, dictating that the launching state of the space object causing the damage is absolutely liable to pay compensation. There is no need to prove that a state failed to perform a duty or satisfy a standard of care.[80] Article II of the LIAB therefore governs situations where a space object would re-enter orbit and crash onto the Earth or damage an airplane in flight. In case damage occurs in outer space, Article III of the LIAB states that, in the event of damage being caused to a space object of one launching state or to persons or property on board such a space object by a space object of another launching state, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible. This means that, in outer space, liability is not absolute but fault-based, whereby fault means a deviation from a legal duty or applicable standard of care.[81]

The extent to which liability contributes to minimising threats to human lives posed by space objects is questionable. Even though international liability for damages caused by a space object increases States' motivation to exercise due care to avoid potential damage, its main effect occurs *ex-post*, after the damage is already done (and proven).

79 See Linden, 2016.

80 Hobe, 2019, p. 82.

81 *Ibid.*, p. 83.

Furthermore, issues may arise regarding the establishment of causation between damage and the space object. In certain cases, usually when the damage occurs on Earth (such as in the Kosmos 954 situation), the proximity of the object to the damage constitutes *prima facie* evidence that it was indeed that particular object that caused immediate damage.[82] In other cases, when the damage occurs in orbit, it will most likely be more difficult to establish causation, but that difficulty does not remove the requirement of proving the causal nexus between a space object and damage.[83] In addition, difficulties may arise in obtaining evidence for identifying the precise object and its launching state, especially when damage does not occur immediately but after some time has passed.[84] This is especially problematic in the case of space debris, as it is extremely challenging, if not impossible, to determine which space object a small piece of debris once belonged to. A final issue regarding causation occurs in subsequent chains of events, when it is difficult to assess whether it was a space object that initiated the chain of events resulting in damage. This issue might arise in the case of ASAT tests or cyber or terrorist attacks on space objects, complicating the process of proving the causal nexus.

While the regulation of international liability plays an important role in establishing and encouraging respect for a required standard of care—since the sanction for its violation is often an obligation to pay compensation for damage—it cannot be seen as the sole means of minimising the threats to human lives arising from space technology.

2.7. Jurisdiction and Control Over a Space Object

Article VIII of the OST establishes that the state that has registered a space object in its national register obtains jurisdiction and control over that object and over any personnel thereof, while in outer space or on a celestial body. Jurisdiction, in the sense of Article VIII of the OST, means the enforcement of laws and rules in relation to persons and objects, whereas control means the exclusive right and the possibility to supervise the activities of the space object and its personnel.[85] The state of the registry, therefore, directly impacts the activities of the space object and human lives, not only those of the personnel on board that space object but also of all others who could potentially be affected by it. It is important that such a state, therefore, makes use of the powers conferred by Article VIII and takes appropriate measures aimed at mitigating threats to human lives arising from space objects registered in its registry. The problem with national as well as international registrations is that they often do not occur in a timely manner, and the identification and tracking of space objects is, therefore, more difficult.[86]

82 Kerrest, A. & Smith, L.J., 2009, p. 141.

83 *Ibid.*

84 *Ibid.*, p. 142.

85 Schmidt-Tedd & Mick, 2009, p. 157.

86 Hertzfeld, 2021, pp. 238–240.

Article VIII thus has important implications for threats to human lives arising from space objects. These can be positive if States use the jurisdiction and control conferred on them by Article VIII in a way that mitigates such threats, but can also be negative if states decide to use their jurisdiction and control in the opposite way, for example to block the process of removing a dangerous space object or space debris.

2.8. Principles of Co-operation, Mutual Assistance and Due Regard and Prohibition of Harmful Contamination

Article IX of the OST provides several principles relevant to minimising threats to human lives arising from space objects. Firstly, it dictates that in the exploration and use of outer space, states shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space with due regard to the corresponding interests of all other states. Secondly, states shall conduct exploration of outer space, including the Moon and other celestial bodies, so as to avoid their harmful contamination. Thirdly, it provides for consultations in case of potentially harmful interference with the activities of other states in the peaceful exploration and use of outer space.

It has been explained that the principle of co-operation and mutual assistance is not to be construed as a strict obligation but rather as a general principle that needs to be further detailed based on other international instruments dealing with the co-operative behaviour of states.[87] In doing so, special attention needs to be paid to the threats mentioned above. The Kosmos 954 incident can, in this regard, serve as a case study to establish a more efficient co-operation forum and to prepare better for similar future incidents.

The principle of due regard is connected to the freedom of exploration and use of outer space, which is limited by the freedom of other states to do the same. In that sense, it implies a certain standard of care, attention, or observance with which a state must act when conducting space activities.[88] A state must, therefore, manage its space objects in a way that does not impair the corresponding interests of other states. It is unlikely that ASAT tests and especially cyber or terrorist attacks could ever fulfil this criterion, especially as such activities can endanger or cause the loss of human life.

Lastly, the prohibition of harmful contamination is an important contribution to protecting human lives. It has been established that this provision is to be understood broadly, covering all possible kinds of harmful interference in outer space, irrespective of whether such interference is deliberate or unintentional.[89] The question is, however, where the line should be drawn. Is every space object sent into outer space already harmful interference, or only those with nuclear components or radioactive materials

87 Marchisio, 2009, pp. 174–175.

88 *Ibid.*, p. 175.

89 *Ibid.*, p. 176.

on board? It has been argued that space debris may fit under the definition of harmful contamination.[90] Even though such a view remains disputed—since it has often been highlighted that none of the space treaties explicitly prohibits space debris[91]—it is plausible, at least in certain cases of disproportionately large contamination, for example, in events that deliberately cause an explosion resulting in massive amounts of space debris, such as ASAT tests.

It can be concluded that while Article IX contains important provisions that can contribute to the safety of space operations and, consequently, to the protection of human rights, its reach in achieving this goal is limited due to the openness of its terms as well as the absence of an enforcement mechanism.

3. Evaluation of the Legal Framework

As can be observed from the previous section, the legal framework applicable to outer space activities and particularly to space objects contains several safeguards aimed at ensuring the protection of human lives from threats arising out of space technology. However, several of the abovementioned principles are written in a broad and vague manner, which, on the one hand, ensures their broad acceptance as well as their flexibility, but on the other hand, lacks precise obligations and, therefore, allows for different interpretations. The possibility of different interpretations creates an issue in terms of legal predictability and legal safety. Another issue regarding the legal framework is related to its enforcement and the absence of compulsory jurisdiction in international law. Thus, it can be concluded that the applicable legal framework alone is not sufficient to ensure maximum protection from threats to human lives arising from space objects. New, more concrete and more easily enforceable legal rules will need to be adopted in order to increase the effectiveness of the legal framework.

The legal sphere, however, can only be part of the solution. The other part will have to come from improvements in the material and technical sphere, amongst which one of the most promoted is the inclusion of AI mechanisms into space technology.

4. AI as a Solution to the Threats to Human Lives Arising from Space Objects

Recently, AI has often been presented as a solution to the threats stemming from various types of technology, including space technology. In this section, I will present the ways in which AI is proposed and planned to be used to increase safety and resilience or

90 See, for example, Alby *et al.*, 2001.

91 Diaz, 1993, p. 377; Dennerley, 2018, p. 286.

to improve the operation of space objects, as well as the ways in which AI is already used for such purposes. AI solutions were, to this day, proposed for all of the abovementioned threats stemming from space technology.

Regarding the threat of space objects falling on Earth, AI technologies can be used for recognising and identifying various artificial objects in the sky, as well as distinguishing them from each other. In this way, they can contribute to the foreseeability of potential accidents, identifying the approximate place of the crash, and can thus serve as a basis for creating an evacuation plan, if required. AI has already been used for the recognition of artificial objects such as airplanes, as well as some natural occurrences or even objects in outer space.[92]

Secondly, AI could be used to prevent collisions between space objects. Namely, AI is said to be able to contribute to more effective monitoring of space objects—their positioning, communication, as well as their end-of-life management.[93] Furthermore, AI is becoming an important tool for keeping a constant watch on satellites' equipment and functioning and consequently promptly alerting in case of its malfunction or a threat of collision, and in certain cases even directly mitigating this risk.[94] SpaceX claimed it had already installed such an AI collision-preventing system on some of its satellites. However, subsequent reports put its efficiency into question, as they describe incidents of near crashes with other space objects.[95] AI has additionally ascribed an important role in space debris remediation. The European Space Agency (hereinafter: ESA) announced its plan to develop and launch the first space mission aimed at removing space debris, named ClearSpace-1, in 2026, which is going to be equipped with an AI camera used for locating debris.[96]

Regarding the misuse of space objects, the role of AI can have contradicting effects. On the one hand, AI can improve efficiency and accuracy in detecting and preventing cyber-attacks; on the other hand, it can be exploited so as to make the attacks more efficient and accurate, and consequently also more devastating.[97] Thus, it acts as both a means of conducting and a means of combating cyber or similar attacks.

Against this background, it can be observed that AI is being increasingly deployed in space technology and that it is planned to play a role in ensuring greater safety for human lives. However, even if these technologies are developed and deployed accordingly, and they function as envisioned, the use of AI in space activities is going to open several new legal questions within a legal framework that already contains many rules open to

92 Bobrovsky *et al.*, 2019, pp. 1–2; Amster, 2022; Instituto de Astrofísica e Ciências do Espaço, 2022.

93 Bratu, Lodder, & van der Linden, 2021, p. 427.

94 Schmelzer, 2020; Miller, 2022.

95 Chatterjee, 2022.

96 ESA, 2020; Macaulay, 2020.

97 Zekos, 2022a, p. 368.

interpretation. Therefore, to evaluate whether AI is indeed an effective solution to the threats arising from space objects, the use of AI in mitigating space objects must also be examined in light of the legal challenges it could bring. Through those identified legal challenges, a better evaluation of the overall effectiveness of AI in combating the threats arising from space technology can be conducted.

5. Some Legal Challenges Stemming from the Use of AI in Preventing Threats to Human Lives

This section aims to outline some legal challenges stemming from the previously described uses of AI in space activities.

The first legal challenge is related to the fact that AI necessarily entails a certain level of unpredictability.[98] To that end, it can negatively affect the predictions and early detections of threats to human lives arising from space objects, especially in light of the fact that humans are prone to being overly trusting of decisions made by technology, based on a generalised, often unsubstantiated perception of its capabilities (the so-called machine heuristics).[99]

The second issue related to AI used in space technology is liability. The concept of liability in space law is related to damage caused by space objects, and, as mentioned above, the term space object includes its component parts as well as the launch vehicle and parts thereof. It is unclear, however, whether this would cover situations where damage would occur due to the AI connected to the functioning of such a space object. Would such damage still be recoverable under Article VII of the OST and the provisions of the LIAB? The answer to this question depends on whether AI can be considered a "component part" of a space object. In other words, must a "component part" of a space object necessarily be a physical component, or can it be "intangible" software? For now, the opinion that AI as software should be considered a "component part" of a space object has been expressed.[100] In that case, damage is recoverable under these legal rules. If the opposite interpretation, namely that AI is not to be considered a component part of a space object, is accepted, the fact that AI was used in the functioning of a space object that caused damage will make it more difficult to establish causation, as a convenient argument that the damage was caused by AI, not by the space object itself, will be available. In order to avoid such a situation, this dilemma must be resolved and liability for damages caused by AI must be established as well.

98 Chatzipanagiotis, 2020, p. 2.

99 On machine heuristic, see, for example, Sundar & Kim, 2019.

100 Chatzipanagiotis, 2020, p. 3.

Furthermore, AI will also affect the notion of "fault" in particular cases of damage occurring in outer space.[101] Fault is established when states fail to perform the required amount of due diligence.[102] Therefore, in establishing the diligence standard, AI will make it more difficult to decide which risks were foreseeable and what kind of due diligence was, therefore, required. The proposed solution to this issue is the establishment of international rules of conduct.[103]

As AI could also be used as a weapon (or at least a part of it),[104] the issue of the need for reinterpretation or rewriting of Article IV of the OST arises. Currently, Article IV(1) of the OST explicitly prohibits only nuclear weapons and weapons of mass destruction, but not autonomous weapons utilising AI. In any case, additional safeguards regarding the latter are needed, such as, for example, the obligation that, in cases involving the use of AI in autonomous weapons, the final decision in activating such a weapon should always remain in the hands of a human.[105] However, even keeping the human in the loop can be insufficient when humans do not critically examine algorithmic suggestions but merely act as a "stamping machine".[106] Therefore, significantly more attention has to be put into stricter regulation of such uses of AI, and the accountability for the loss of life it causes. Furthermore, the use of satellite data for powering AI tools which result in breaches of human rights, international humanitarian law, or other rules of international law, (re)opens the question of the (il)legality of space activity producing such data.

Another issue related to the use of AI is that there are currently no comprehensive "rules of the road" governing traffic in outer space, including space objects. The drafting of these principles is currently ongoing, but the authoritative version of the rules has not yet been adopted. Therefore, in establishing these traffic rules, AI will make the process more challenging for lawmakers, as it will bring a new component to an already complex issue.

The last issue concerns the delicate relationship between transparency and the security of AI. As AI can be used to both improve and harm the security of space objects, concrete rules need to be developed in order to strengthen the security aspect of AI systems used for space objects, as in this way, the space objects will become more resilient to terrorist and cyber-attacks.[107] On the other hand, however, the regulation of AI technology must be mindful of the transparency requirement, to ensure the trustworthiness of AI systems.

101 *Ibid.*

102 *Ibid.*

103 *Ibid.*, p. 7.

104 For an example of how AI (utilising, *inter alia*, satellite data) can be used as a weapon, see the report on algorithmic weapons Lavender, Gospel and where is Daddy?, developed by Israel and used on its onslaught on Gaza. Abraham, 2024.

105 Martin & Freeland, 2020, p. 6.

106 For more on the dangers of the lack of critical assessment of AI-produced decisions, see Abraham, 2024.

107 *Ibid.*, p. 7.

6. Conclusion: An (Im)perfect Solution

The brief analysis conducted throughout this article demonstrates that there exists a need to further mitigate threats to human lives arising from space objects, as the legal framework, despite containing several safeguards, can only play an effective role to a certain extent, but often falls short of addressing concrete issues. AI is often presented as a promising technology to address this gap and improve the protection of human lives; however, the analysis shows that it cannot in itself be perceived as a complete and comprehensive solution, and that can even, in certain cases, bring more issues than it actually solves.

Firstly, most of the AI technologies planned to be used to enhance the capabilities and safety of space technology are still being developed and are not yet completed. They are expected to be subject to several changes and improvements. In most cases, there is currently a lack of relevant data to test their efficiency.

Secondly, the use of AI in mitigating the risks posed by space objects will open new legal dilemmas, some of which were identified in the previous section, which will add to those already present in the existing legal framework. The danger is that the legal framework could become even less effective in ensuring that technology is used in a human-friendly manner, which we can already observe in some of the current[108] examples of the use of AI technologies as a weapon in war. Thus, AI solutions have to be consciously considered from all possible perspectives and then carefully implemented.[109] Its potential effects have to be examined and the legal framework amended accordingly.

This means that the use of AI to mitigate the risks posed to human lives by space objects is not the end, but the beginning of what could lead towards a solution to the problem of dangerous space objects. While AI carries the potential to improve space technology in this regard, further critical research will have to be carried out in both technical and legal fields, to ensure that AI will indeed serve the purpose of protecting human lives. To fulfil this goal, the developing AI regulatory framework and international space law will have to evolve in strong co-operation.[110] Until then, space objects, even when enhanced or interacting with a certain type of AI technology, will remain a suitable "scary costume" for the Halloweens to come.

[108] Abraham, 2024.

[109] Zekos, 2022b, pp. 348–349.

[110] See Ramuš Cvetkovič & Drobnjak, 2023.

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Iva Ramuš Cetković

UI – možna rešitev za grožnje človekovemu življenju, ki prihajajo iz objektov v vesolju

Z izstrelitvijo satelita Sputnik I leta 1957 je prvi vesoljski objekt dosegel vesolje. Sledili so mu še številni drugi, danes pa vesoljske objekte obravnavamo kot nepogrešljiv del našega vsakdana. Satelite in podatke, ki jih zagotavljajo, uporabljamo za spremljanje okolja s pomočjo opazovanja Zemlje, urejanje podnebja in upravljanje naravnih nesreč, pa tudi za gospodarske dejavnosti, denimo kmetijstvo, promet, komunikacije in še številne druge. Kljub številnim koristim pa vesoljski objekti pomenijo grožnjo človeškim življenjem v vesolju, v zračnem prostoru in na Zemlji. Tehnološki napredek 21. stoletja, še zlasti čedalje pogostejša uporaba umetne inteligence, je vzbudil upanje, da bodo te grožnje zmanjšane, omiljene ali celo v celoti odpravljene. Avtor v članku presoja, ali je tako upanje razumno in upravičeno. Najprej opredeli nekaj primerov groženj človeškim življenjem, ki izhajajo iz vesoljskih objektov, ter navede primere, ko so se te grožnje že uresničile v praksi. Drugič, predstavi veljavni pravni okvir in ga nato v tretjem koraku oceni ter pokaže, da ne zadošča za obravnavo omenjenih groženj. V četrtem delu prikaže, kako je predvidena uporaba umetne inteligence za omilitev teh groženj. V petem delu oriše nekatere nove pravne izzive, ki bi se lahko pojavili ob taki uporabi umetne inteligence, in na tej podlagi končno presodi, ali bo taka omilitev groženj s pomočjo umetne inteligence res tako učinkovita, kot se trenutno napoveduje.

Ključne besede

umetna inteligenca, vesoljska tehnologija, vesoljski odpadki, vesoljski objekti, terorizem.

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AI—A Possible Solution to the Threats Against Human Lives Arising from Space Objects?

With the 1957 launch of the satellite Sputnik I, the first space object reached outer space. Many more followed, and today space objects are considered an invaluable part of our everyday lives. Satellites and the data they provide are used for monitoring the environment through Earth observation, climate regulation, and natural disaster management, as well as economic activities, for example, agriculture, transportation, communication, and several others. Despite these numerous benefits, however, space objects pose threats to human lives in outer space, in airspace, and on Earth. The technological advancement of the 21st century, especially the increased use of artificial intelligence, brought hope that these threats would be minimised, mitigated, or even completely resolved. In this paper, I am going to evaluate whether such hope is reasonable and justified. To do this, I will, first, identify some examples of the threats to human lives arising from space objects and provide examples when such threats already materialised in reality. Second, I will present the applicable legal framework and then, third, evaluate it and show that it falls short in addressing those threats. Fourth, I will demonstrate how AI is planned to be used in mitigating these threats. Fifth, I will outline some of the new legal challenges such use of AI would bring and, against this background, finally assess whether such AI threat mitigation is going to be as effective as currently predicted.

Key words

AI, space technology, space debris, space objects, terrorism.