The Governance Gap:

Why Humanoid Robotics Needs Its Chicago Convention

Mitar Marinović

Metropolitan University, Belgrade

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Abstract

Humanoid robots are entering commercial deployment at a moment when the international community possesses technical standards for them but lacks any governance layer above those standards. This paper argues that the emerging patchwork of national frameworks and voluntary standards, however rigorous each may be individually, cannot deliver four functions that only a treaty-level institution can provide: verifiable machine identity across borders, mutual recognition of safety certification, distributed emergency-control guarantees, and evaluation of the embodied intelligence operating each unit. Humanoid robots are treated throughout as the sharpest and best-documented case of a wider class — machines that think and act, from autonomous home robots already mapping private interiors to bipedal and quadrupedal platforms entering public space — to which the same four functions apply. The argument draws on the precedent of civil aviation, where abundant technical standardization proved insufficient until the Chicago Convention of 1944 created a binding intergovernmental framework — a treaty that governed not all transport but its sharpest case — and it proposes the convening of a Universal Intelligent Robotics Authority before national certification regimes harden into incompatible blocs.

Keywords: humanoid robotics; embodied intelligence; AI governance; international institutions; treaty design; robot safety; technology standards

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Author contact: Prof. Mitar Marinović, Rector, Metropolitan University, Belgrade. Correspondence: mitar@mitarmarinovic.com • mitarmarinovic.com. Initiative: embodiedcoalition.org. Faculty profile:

I. THE MISSING LAYER ABOVE THE STANDARDS

Humanoid robotics is often described as a regulatory vacuum, and the description no longer fits. The International Organization for Standardization has modernized its industrial robot safety requirements[1] and is developing a dedicated standard for dynamically stable robots.[2] The IEEE has published a coordination roadmap for humanoid standards development, prepared by more than seventy experts, and ASTM International is producing test methods.[3] In early 2026, China introduced the first comprehensive national standard system covering the full lifecycle of humanoid robots and embodied intelligence, with the explicit ambition of shaping the international standards that follow.[4] The United States, Japan, South Korea, and the European Union are advancing parallel regulatory tracks of their own.[5]

The real deficit lies elsewhere. Rules exist in growing numbers, but nothing makes them interoperable, binding, or enforceable across borders. A humanoid robot certified in one jurisdiction carries no recognized identity, no valid certification, and no guaranteed override mechanism the moment it crosses into another. Every transformative technology of global reach has passed through this same phase, with competent national regimes multiplying in parallel until it became clear that competence without coordination was itself a hazard. Aviation, nuclear energy, and telecommunications each learned the lesson at their own cost.

Aviation remains the instructive case. By the 1940s, aeronautical engineering standards existed in abundance, yet the skies stayed legally fragmented until fifty-two states signed the Chicago Convention in 1944 and created the International Civil Aviation Organization.[6] ICAO writes no engineering of its own. It adopts technical standards produced elsewhere and gives them force across every

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[1] ISO 10218-1:2025 and ISO 10218-2:2025, Robotics — Safety requirements, Parts 1 and 2 (Geneva: International Organization for Standardization, February 2025). The revision incorporates the collaborative-application requirements formerly contained in ISO/TS 15066 and introduces cybersecurity provisions relevant to robot safety.

[2] ISO/CD 25785-1, Robotics — Safety requirements for dynamically stable industrial mobile robots (legged, wheeled, or other forms of locomotion) — Part 1: Robots, under development within ISO/TC 299; committee draft registered May 2026.

[3] IEEE Humanoid Study Group, A Pathway Study for Future Humanoid Standards (IEEE Standards Association, September 2025), a report developed by more than seventy robotics experts to coordinate prospective ISO, IEEE, and ASTM workstreams.

[4] Ministry of Industry and Information Technology of the People’s Republic of China, Humanoid Robot and Embodied Intelligence Standard System (2026 Edition), unveiled in Beijing on 28 February 2026; drafted by more than 120 research institutions, manufacturers, and industrial users under the MIIT Humanoid Robot and Embodied Intelligence Standardization Technical Committee, constituted in December 2025.

[5] In the United States, ISO 10218:2025 is adopted as ANSI/A3 R15.06-2025. In the European Union, Regulation (EU) 2024/1689 (Artificial Intelligence Act) and Regulation (EU) 2023/1230 (Machinery Regulation) constitute the principal legislative track applicable to embodied autonomous systems.

[6] Convention on International Civil Aviation, signed at Chicago on 7 December 1944, 15 UNTS 295 (ICAO Doc 7300).

contracting state, which is why an aircraft certified in one country is recognized across more than 190 contracting states. That architecture, standards bodies below and a treaty body above, has never been built for humanoid robotics. The field has its standards bodies. It has no ICAO.

II. FOUR FUNCTIONS ONLY A TREATY LAYER CAN DELIVER

Machine identity. No global registry of deployed humanoid units exists today, and nothing ties a physical machine, verifiably and in real time, to its manufacturer, operator, insurer, and jurisdiction. Aviation solved the equivalent problem with nationality and registration marks under a treaty framework, and finance solved entity-level identity with the cooperative Legal Entity Identifier system.[7] For machines that cross borders and walk among people, a national database will never suffice: identity has to live in a federated, mutually recognized registry, and only an intergovernmental framework can host one.

Mutual recognition of certification. Without it, manufacturers face a separate certification regime in every market, deployment costs multiply, and states come under pressure to accept foreign certifications they have no way to verify. Mutual recognition, unlike a test method or a specification, is a legal act between states, and it can only be created by agreement. The aviation precedent is explicit on this point: Article 33 of the Chicago Convention obliges contracting states to recognize certificates of airworthiness issued by the state of registry, provided they meet the treaty's minimum standards.[8]

Distributed emergency control. Every serious safety architecture for autonomous embodied systems requires a guaranteed, hardware-level human override at the level of the individual unit, the fleet, and the swarm. A universal shutdown capability, however, is itself a critical attack surface and a sovereignty question, since no state will accept an external authority holding the keys to machines on its territory. The workable design pairs a common protocol with distributed custody: each jurisdiction holds its own activation keys, while an international body maintains the standard, the interoperability requirements, and the audit regime. Separating the protocol from the custody of its keys is a problem of institutional design more than engineering, and no single state or company can solve it alone.

Evaluation of embodied intelligence. Existing standards regimes certify hardware: stability, force limits, functional safety. The IEEE's own study group observes that the current standards framework was not designed for humanoids, whose dynamically unstable locomotion and complex human interaction fall

[7] For aircraft nationality and registration marks, see Convention on International Civil Aviation (n 6), Articles 17–21. For entity identity in finance, see the Legal Entity Identifier system established under the 2011 G20 mandate and administered by the Global Legal Entity Identifier Foundation (GLEIF).

[8] Convention on International Civil Aviation (n 6), Article 33.

outside the assumptions of existing robot standards.[9] Yet most of the risk in a modern humanoid now resides in the model controlling it, an intelligence that may be updated over the air long after the hardware was certified. A governance layer therefore has to define behavioral evaluation requirements for the controlling model, with mandated re-evaluation after material updates, as a condition of deployment. Nothing in the current international standards landscape imposes such a requirement.

III. THE COST OF WAITING

The deployment has not waited for governance. Autonomous robots already operate inside tens of millions of private homes, sold as vacuum cleaners and welcomed without scrutiny; their premium models navigate by building persistent maps of the household's interior — the most intimate geography a family has.[10] The word robot attaches to them stripped of its weight — a robot vacuum is a robot nobody thinks twice about — and that is precisely how they crossed the threshold unexamined. The next generation will be harder to overlook: bipedal and quadrupedal machines entering schools and hospitals with the momentum factory floors have already absorbed, deciding a share of their own actions and reacting to their surroundings in real time.

Market projections for humanoid robotics diverge widely. Goldman Sachs Research has projected a global market of thirty-eight billion dollars by 2035,[11] other estimates run considerably higher, and the most careful expert review to date concedes that no consensus sizing yet exists.[12] Deployment itself, however, is not in dispute: commercial contracts and pilots are already operating across logistics and manufacturing.[13] The standard-setting race, meanwhile, has begun in earnest and is fragmenting along national lines. Every month of fragmentation raises the cost of eventual convergence: certification regimes calcify, installed bases grow, and whoever moves first in technical vocabulary converts standards into geopolitical leverage. Aviation converged only after decades and considerable loss, and nuclear

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[9] A Pathway Study for Future Humanoid Standards (n 3): existing robot standards assume fixed or statically stable systems and do not address the dynamically unstable locomotion of humanoids nor the full complexity of their interaction with people.

[10] iRobot Corporation, the largest manufacturer of autonomous home robots, reports more than 40 million units sold worldwide; its premium models build and retain interior maps of the home as a core navigation feature.

[11] Goldman Sachs Research, "The global market for humanoid robots could reach $38 billion by 2035" (February 2024).

[12] A Pathway Study for Future Humanoid Standards (n 3) finds no consensus market sizing for humanoid robots, while noting that all major estimates project a multibillion-dollar market within five to ten years.

[13] See, e.g., the multi-year robots-as-a-service deployment of Agility Robotics' Digit with GXO Logistics (announced June 2024) and the commercial agreement between Figure AI and BMW Manufacturing (announced January 2024).

governance arrived only after the technology had been used. The compressed timeline of humanoid deployment affords no such luxury of delay. The realistic window for convening the treaty layer is the period in which the first humanoid-specific international standards move from draft to publication and national adoptions crystallize around them — on present trajectories, roughly two to three years.

IV. THE INSTITUTIONAL ANSWER

This paper proposes the convening of a Universal Intelligent Robotics Authority: a compact intergovernmental institution, launched by a small coalition of founding states, whose mandate is to make humanoid robotics — and the wider class of machines that think and act — governable across borders. The name is offered as a working designation; founding states have always christened their own creations, as Chicago christened ICAO. The design principles follow directly from the analysis above.

A complement to the standards bodies. Like ICAO, the Authority adopts proven technical standards by reference and gives them binding force across signatory markets, maintaining formal liaison with ISO, IEC, IEEE, and ASTM. The engineering stays where the expertise already sits.

A civil mandate. Military systems fall outside its scope, on the precedent of the Chicago Convention, whose Article 3 excludes state aircraft from its application.[14] History suggests this carve-out is the price of signature from the states whose participation matters most.

The keys stay national. Emergency-control custody remains with each jurisdiction, while the Authority maintains the standards and the audits. Sovereign control of machines on national soil stays sovereign.

Royalty-free by design. All protocols are published as open standards. An institution that profited from licensing the very technology it mandates would forfeit its claim to neutrality, and neutrality is the asset on which everything else depends.

Enforced through market access. The founding coalition pairs a neutral convener with major deployment markets whose procurement rules reference the common certification, which is what turns market access from rhetoric into an enforcement engine.

V. A CALL TO CONVENE

[14] Convention on International Civil Aviation (n 6), Article 3(a): “This Convention shall be applicable only to civil aircraft, and shall not be applicable to state aircraft.”

Every transformative technology is eventually governed, and humanoid robotics will be no exception. The open question is whether governance arrives by design, before the market hardens, or by reaction, after the first systemic failure. The instruments and precedents already exist. What the moment lacks is a convener: a state, or a small group of states, willing to do for embodied machines what Chicago did for the skies. The author invites governments, standards bodies, and research institutions prepared to engage with this agenda to open that conversation.

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