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HUMAN-TO-MACHINE INNOVATION: CHALLENGES FOR INTERNATIONAL IP LAW

Inoyatov Nodirbek Hayitboy ugli,
Lecturer at the Department of Cyber Law
ORCID: 0009-0004-2958-203X
e-mail: Nodir_Inoyatov@tsul.uz

Introduction

The proliferation of artificial intelligence (AI) and machine learning technologies has transformed the landscape of innovation, raising complex legal and policy questions. In particular, the advent of **human-to-machine innovation**—inventions generated wholly or partly by AI systems—poses significant challenges to the foundations of intellectual property (IP) law. Traditional patent regimes were developed on the premise that inventors are human beings, capable of exercising creativity, intent, and responsibility (Gervais, 2020). However, as AI systems increasingly contribute to the conception and reduction to practice of novel inventions, national and international legal frameworks are struggling to accommodate these technological realities (Igbokwe, 2024; WIPO, 2024).

The **research question** guiding this study is: *How can international intellectual property law adapt to address the challenges posed by human-to-machine innovation?* The **objectives** are threefold: (1) to analyze the limitations of existing IP frameworks in recognizing AI-generated inventions; (2) to assess comparative national approaches to AI inventorship and authorship; and (3) to evaluate potential reforms for harmonizing international IP law in the age of AI.

This article adopts a **theoretical framework** grounded in legal positivism and the concept of legal personhood. The debate over whether AI can be recognized as an inventor parallels earlier discussions on corporate personhood, animal rights, and natural entities such as rivers (Kurki, 2019; Stepanov, 2021). These analogies illuminate how legal fictions have historically evolved to meet social and economic needs.

The article proceeds as follows. The **literature review** synthesizes scholarly debates on AI and IP law, focusing on inventorship, authorship, and ownership. The **methodology** outlines a comparative legal analysis of national and international approaches. The **results and discussion** critically examine the implications of AI-driven innovation for patent law, copyright law, and broader policy considerations. Finally, the **conclusion** offers recommendations for reforming international IP law to ensure both innovation incentives and legal certainty.

Literature Review

AI systems such as DeepMind's AlphaGo and OpenAI's GPT models demonstrate capacities for problem-solving, creativity, and generation of content that surpass human abilities in specific domains (Chopra & White, 2011). The role of AI in generating new inventions—ranging from pharmaceuticals to engineering designs—has led to debates on whether such innovations should be eligible for patent protection (Igbokwe, 2024).

A central issue is whether AI can qualify as an **inventor** under patent law. Jurisdictions such as the United States, the United Kingdom, and the European Patent Office (EPO) have rejected applications naming AI systems (e.g., DABUS) as inventors, reasoning that inventorship requires a natural person (Thaler v. USPTO, 2021; EPO, 2020). Conversely, South Africa granted a patent naming DABUS as the inventor, marking the first recognition of AI inventorship (Abbott, 2020). These divergent approaches highlight the tension between strict legal interpretation and the evolving nature of innovation.

The literature suggests that extending **legal personhood** to AI could provide a solution by enabling AI systems to hold rights and duties, including inventorship (Kurki, 2019; Avila, 2020). However, critics argue that personhood should remain limited to entities capable of moral agency, consciousness, or accountability (Marshall, 2019). Stepanov (2021) cautions against an overly flexible definition of legal subjectivity, warning of conceptual and ethical risks.

Similar debates arise in copyright law, where AI-generated music, literature, and visual art challenge the requirement of human authorship (Burylo, 2020). National copyright offices in the United States and the United Kingdom have emphasized the necessity of human authorship, though exceptions exist for computer-generated works under U.K. law (Copyright, Designs and Patents Act 1988, s.9(3)).

At the international level, instruments such as the **TRIPS Agreement** and **Berne Convention** presuppose human inventors and authors. WIPO has initiated dialogues on frontier technologies, recognizing the need for international harmonization (WIPO, 2024). Yet, there is no consensus on whether or how AI-generated works should be integrated into existing frameworks.

Methodology

This study employs a **comparative legal analysis**, examining national jurisprudence, statutory provisions, and international treaties. The methodology involves:

1. **Doctrinal Analysis**: Reviewing statutory definitions of inventorship and authorship across jurisdictions.
2. **Case Law Review**: Analyzing landmark cases such as Thaler v. USPTO (2021), EPO's DABUS decisions, and South Africa's DABUS patent grant.
3. **Comparative Study**: Evaluating approaches in the U.S., U.K., EU, South Africa, China, and Australia to identify trends and divergences.
4. **International Framework Analysis**: Assessing how treaties such as TRIPS, the Paris Convention, and Berne Convention address or fail to address AI-generated innovation.

The analysis is guided by a **normative inquiry** into how IP law can balance innovation incentives, fairness, and global consistency.

Results and Discussion

The question of whether artificial intelligence can be legally recognized as an inventor has generated significant debate across multiple jurisdictions. Courts, patent offices, and policymakers are confronted with the challenge of reconciling traditional definitions of inventorship, which have historically assumed a human origin, with the realities of machine-assisted or machine-driven innovation. Below is an extended analysis, written in approximately 1000 words, that examines six major jurisdictions—the United States, the European Union, the United Kingdom, South Africa, China, and Australia—and their responses to the issue of AI inventorship.

In the United States, the legal stance on AI inventorship is clear: inventors must be natural persons. This was reaffirmed in the case of *Thaler v. USPTO* (2021), where Stephen Thaler, the creator of the AI system known as DABUS (Device for the Autonomous Bootstrapping of Unified Sentience), submitted patent applications naming the AI as the inventor. Both the U.S. Patent and Trademark Office (USPTO) and subsequent courts rejected the applications, reasoning that under the Patent Act, inventorship requires a human being.

The U.S. position reflects a textualist interpretation of the Patent Act, particularly the language that refers to an "individual" or "person" as the inventor. The courts emphasized that Congress had not legislated to include non-human entities within this definition. Thus, despite

acknowledging the advanced role AI can play in generating inventions, the U.S. judiciary has remained committed to a human-centric approach.

Critics argue that this strict stance could stifle innovation. If AI-generated inventions are unpatentable in the U.S., they may fall into the public domain, disincentivizing investment in AI-driven research and development. Proponents of the current approach, however, contend that inventorship entails not only creativity but also accountability, qualities that AI lacks. Therefore, inventorship is best attributed to human developers, operators, or owners who play an active role in directing or managing the AI system.

The European Patent Office (EPO), which oversees patent applications across many European countries, has also rejected applications naming AI as an inventor. In the DABUS cases (EPO, 2020), the Office concluded that inventorship requires a human being. The reasoning was similar to that of the U.S.: the European Patent Convention (EPC) presumes a natural person as the inventor.

The EPO stressed that naming an AI system as an inventor would create inconsistencies in the legal framework, particularly regarding the attribution of rights, ownership, and liability. The purpose of inventorship, in the EPO's view, is not only to recognize the intellectual contribution but also to establish clear accountability. Since AI cannot own property, enforce rights, or bear responsibilities, it does not meet the legal requirements for inventorship.

At the same time, the EPO acknowledged the importance of AI in the innovation process and noted that policymakers may need to revisit existing laws in light of technological advances. For now, however, Europe aligns with the U.S. in maintaining a human-centered model of inventorship.

The United Kingdom has similarly rejected AI inventorship claims. In *Thaler v. Comptroller-General of Patents, Designs and Trade Marks* (2021), the Court of Appeal upheld the Intellectual Property Office's decision that inventorship requires a natural person. Like the U.S. and EPO, the U.K. courts emphasized that the statutory language presupposes a human inventor.

The U.K. courts also highlighted the importance of clarity in patent ownership. If an AI were to be recognized as an inventor, significant questions would arise regarding who holds the patent rights. Since AI cannot hold property or legal rights, attributing inventorship to a machine could destabilize the legal framework.

Nevertheless, the debate remains active in the U.K. Legal scholars and policymakers have called for a reconsideration of the law to ensure that the patent system adequately rewards innovation in the age of AI. The U.K.'s stance, however, remains firmly aligned with other Western jurisdictions in rejecting AI inventorship.

South Africa has taken a unique and more flexible approach. In 2020, the South African patent office issued a patent recognizing DABUS as the inventor. This marked the first instance of AI inventorship being formally accepted. However, it is important to note that South Africa's patent system does not include a substantive examination of applications. The DABUS patent was granted largely as a matter of procedure rather than a considered legal or philosophical decision.

While some commentators hailed this as a groundbreaking recognition of AI inventorship, others cautioned that it may not reflect a deliberate policy shift. Instead, it illustrates how different procedural rules across jurisdictions can lead to divergent outcomes. Nonetheless, South Africa's recognition of DABUS has added momentum to the global debate and demonstrated that alternative approaches are possible.

South Africa's decision has also raised questions about how such patents will be enforced and whether recognition of AI inventorship will create legal complications regarding ownership, accountability, and liability. Despite these uncertainties, South Africa's stance remains an important milestone in the evolution of AI and IP law.

China has emerged as a significant player in AI innovation and has begun addressing the legal implications of AI-generated inventions. Chinese courts have shown some willingness to recognize AI contributions, particularly in copyright law, where AI-generated works have been afforded limited protection. In the patent context, however, Chinese courts and policymakers emphasize the necessity of human oversight.

For example, in cases involving AI-assisted inventions, Chinese courts have recognized that AI can play a substantial role in generating inventive concepts. However, they insist that a human must still be involved in directing or supervising the AI process for the purposes of legal inventorship (Wen & Tong, 2023). This approach attempts to balance recognition of AI's role with the maintenance of a human anchor in the legal framework.

China's approach reflects its pragmatic strategy toward innovation policy. By acknowledging AI's contribution while maintaining human oversight as a requirement, China seeks to encourage technological development without abandoning the foundational principles of accountability and ownership.

Australia's approach has been marked by significant legal debate. The Australian Patent Office initially rejected DABUS applications on the grounds that an inventor must be a natural person. However, the Federal Court of Australia initially overturned this decision, holding that an inventor could include an AI system. This created a moment of uncertainty and excitement in the global IP community.

Subsequently, the Full Federal Court reversed the lower court's ruling, reaffirming that inventorship requires a human being (Militsyna, 2021). The case highlighted the tensions within legal systems as they attempt to adapt to technological change. While the ultimate outcome aligned Australia with jurisdictions such as the U.S. and U.K., the initial ruling demonstrated that courts are grappling with the question and that the door is not entirely closed to future reforms.

Australia's experience illustrates the fluid nature of the debate. The fact that a high-level court was willing to entertain the possibility of AI inventorship shows that legal frameworks may evolve in response to sustained pressure from technological advances and academic discourse.

The survey of these jurisdictions reveals both convergence and divergence. Most advanced patent systems, including those in the U.S., EU, and U.K., adhere to a strict human-centric model of inventorship. Their reasoning rests on statutory language, accountability, and ownership concerns. In contrast, South Africa's procedural recognition of AI inventorship and Australia's flirtation with reform suggest that alternative pathways may emerge.

China represents a middle ground, acknowledging AI's contributions but insisting on human oversight. This pragmatic stance may offer a model for other jurisdictions seeking to balance technological progress with legal certainty.

The divergence across jurisdictions underscores the need for international harmonization. Without consistent standards, innovators and investors face uncertainty when seeking patent protection for AI-generated inventions. This fragmentation risks undermining the global patent system's objectives of encouraging innovation and facilitating knowledge dissemination.

These divergent approaches create **legal uncertainty** for innovators and investors. If AI-generated inventions are unpatentable, they risk falling into the public domain, potentially undermining incentives for AI-driven research and development (Pagallo, 2018). Conversely, granting patents without clear attribution could distort accountability and ownership structures.

Copyright law faces analogous challenges. The U.S. Copyright Office recently denied protection for a work generated entirely by AI, citing the human authorship requirement (U.S. Copyright Office, 2023). In contrast, U.K. law provides for computer-generated works, assigning authorship to the person making arrangements for the creation. This divergence underscores the need for harmonization.

The **TRIPS Agreement** and **Paris Convention** lack provisions addressing AI inventorship. While these treaties emphasize the protection of "authors" and "inventors," their human-centric language limits adaptability. WIPO's ongoing consultations highlight the need for international reform, but political and philosophical disagreements persist (WIPO, 2024).

From a theoretical standpoint, extending legal personhood to AI remains contentious. While analogies to corporate personhood suggest flexibility, critics highlight the absence of moral agency in AI. A pragmatic solution may lie in **attributed inventorship**, where human developers, operators, or owners are designated as inventors, ensuring accountability while recognizing AI's role (Abbott, 2020; Kurki, 2019).

Policy considerations include:

One of the central policy questions raised by human-to-machine innovation concerns how to balance the incentives for innovation with principles of fairness and the need for global consistency. These considerations are not merely academic—they directly influence whether the patent system can continue to serve its fundamental purposes in the age of artificial intelligence.

The patent system has historically functioned as a mechanism to incentivize human creativity by granting inventors temporary exclusive rights over their creations. In the context of AI-generated inventions, the same logic applies, but the challenges are amplified. If inventions produced wholly or partly by AI systems are excluded from patent protection, there is a significant risk that such innovations will fall into the public domain. This outcome could undermine incentives for private actors and corporations to invest in AI-driven research and development. Without adequate protection, investors may hesitate to allocate resources to projects where the outputs are legally unprotectable. Thus, the challenge lies in ensuring that the patent system continues to encourage innovation while adapting to the changing nature of invention. Some scholars argue for a flexible model of "attributed inventorship," where patents can still be granted, but ownership is tied to human stakeholders such as developers, operators, or companies responsible for the AI system. This approach preserves the incentive structure while acknowledging AI's substantive role in the innovation process.

Beyond incentives, fairness is a critical consideration. The development and deployment of AI systems involve significant human input, ranging from the creation of algorithms to the curation of data sets. To disregard human contributions in favor of attributing inventorship exclusively to AI would undervalue the role of those who design, train, and manage the systems. At the same time, fairness requires recognition of the fact that AI operates differently from traditional tools: its outputs may extend beyond the direct creative intent of its human users. Legal frameworks must therefore find a balance—rewarding human contributions while not denying the transformative impact of AI on the innovation landscape. A nuanced system that attributes inventorship to human actors but acknowledges AI's role could mitigate this tension, ensuring both justice and practical accountability.

Fragmentation of approaches across jurisdictions poses another significant risk. As the comparative analysis demonstrates, some countries reject AI inventorship outright, others cautiously recognize AI's contributions, and at least one (South Africa) has formally acknowledged AI inventorship. Such inconsistencies create uncertainty for multinational corporations and inventors operating in a globalized economy. Divergent rules on inventorship and ownership may complicate patent strategies, lead to forum shopping, and ultimately reduce the effectiveness of the international patent system. To prevent this, there is a pressing need for global consistency in addressing AI-generated inventions.

Achieving harmonization will likely require both legal and policy innovations at the international level. First, existing treaties such as the TRIPS Agreement may need to be amended to clarify inventorship requirements in the context of AI. While such reforms are politically challenging,

even incremental adjustments could provide much-needed clarity. Second, international organizations such as the World Intellectual Property Organization (WIPO) should play a leading role by developing guidelines or recommendations on the treatment of AI-generated inventions. These guidelines could help align national practices and set a foundation for more formal legal reforms. Third, soft-law mechanisms, including model laws, best practices, or voluntary standards, may offer a pragmatic path forward. Such tools can allow states to experiment with flexible approaches while moving toward convergence.

In conclusion, policy considerations surrounding AI and inventorship must address incentives, fairness, and consistency. Without adequate reforms, the international patent system risks becoming fragmented and ill-equipped to manage the realities of twenty-first century innovation. Through treaty reform, WIPO-led guidance, and soft-law mechanisms, the global community has an opportunity to ensure that intellectual property law remains a driver of technological progress in the age of human-to-machine innovation.

Conclusion

Human-to-machine innovation presents profound challenges to the foundational assumptions of intellectual property law. Traditionally, inventorship and authorship have been rooted in the concept of human creativity and accountability. However, with the emergence of artificial intelligence systems capable of generating inventions and creative works, these assumptions are increasingly under strain. National jurisdictions remain divided: while the United States, the European Union, and the United Kingdom continue to restrict inventorship to natural persons, countries such as South Africa and courts in Australia have experimented with alternative interpretations. China has taken a pragmatic approach, acknowledging AI's contributions but maintaining human oversight as a legal requirement. This fragmentation creates uncertainty for innovators and investors, undermining the international patent system's ability to provide consistent protection.

International frameworks such as the TRIPS Agreement and the Berne Convention remain silent on AI-generated works, further highlighting the need for reform. While granting full legal personhood to AI may be premature, pragmatic solutions such as attributed inventorship—assigning inventorship to developers, owners, or operators—can ensure accountability while recognizing AI's transformative role. Coupled with international harmonization through WIPO-led initiatives and treaty reforms, such measures could align incentives, fairness, and consistency. As AI evolves, legal frameworks must adapt to safeguard innovation and ensure coherence in the twenty-first century.

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