The Future is Embedded: The Persistence of Physical Systems in the Age of Artificial Intelligence

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Abstract: Artificial intelligence (AI) has been accelerating the automation of tasks once performed exclusively by humans, especially in programming, where AI assistants are already writing code with high efficiency. This progress raises questions about the obsolescence of the traditional programmer. On the other hand, embedded systems due to their interaction with the physical world, sensors, actuators, and unpredictable conditions remain essential. This article, of bibliographic and critical nature, analyzes how the rise of AI is redefining work in technology while preserving the relevance of intelligent physical systems. It also discusses emerging professions in this field and the social and educational impacts, with a focus on Latin America. The conclusion highlights that professionals capable of integrating hardware and software the so-called "orchestrators of reality" will play a leading role in a scenario of hyperautomation.
Keywords: Embedded systems; Artificial intelligence; Automation; Emerging professions; Latin America.

I. INTRODUCTION

The revolution driven by artificial intelligence in recent decades has been redefining professional skills across multiple fields. In particular, software development is undergoing paradigm shifts: advanced language models are now capable of generating code snippets and solving programming problems with unprecedented speed. Tools such as GitHub Copilot, the AI-powered coding assistant, can already produce code for typical projects, now widely adopted by programmers in collaborative work. This accelerated progress has sparked discussions about the possible obsolescence of the traditional programmer, since knowing how to code is no longer an exclusive differentiator but rather a nearly basic skill increasingly assisted by machines.

However, amid growing automation, a question arises: which skills will keep professionals irreplaceable? In this context, this article argues that embedded systems, an area that directly deals with the physical world remain not only relevant but crucial. While many strictly digital functions can be taken over by algorithms, working with embedded systems involves interacting with sensors, actuators, and real-world conditions that are not confined to code on a screen. The complexity inherent in the physical-digital interface grants embedded specialists an adaptive advantage: they act as a bridge between AI abstractions and the tangible realities of devices. Finally, this study adopts a bibliographic and critical approach, based on institutional reports, scientific articles, and market analyses published between 2020 and 2025.

A. The Rise of AI and the Decline of the Traditional Programmer

In recent years, artificial intelligence has reached remarkable levels in autonomous code generation. Large language models trained on software repositories can not only suggest snippets but also write entire functions and even complete programs from natural language descriptions. Zhang et al. [1] demonstrated that models such as Codex (the basis of GitHub Copilot) can solve competitive programming problems with considerable accuracy. Practical tools derived from these advances are already accessible: Copilot, for example, integrates into development environments by automatically suggesting lines of code. In addition, more advanced models such as DeepMind's AlphaCode have achieved results equivalent to an average programmer in coding competitions, ranking among the top 54% of human participants in Codeforces challenges [2]. Tasks that once consumed hours of an engineer's time can now be solved in minutes with the help of AI.

Recent data indicate that 75% of programmers already use AI-based coding assistants [8]. This reinforces the trend that routine coding tasks, such as standardized functions or syntax review, no longer depend exclusively on humans, making the skill of "knowing how to code" increasingly close to a basic technical literacy. This leap in productivity and autonomy of AI in programming has ambiguous consequences. On one hand, it democratizes access to software development, allowing less experienced individuals to create programs with the help of intelligent suggestions, potentially broadening the base of technology creators. On the other hand, it challenges the position of the programmer as indispensable and irreplaceable. The ability to program loses part of its status as a professional differentiator, becoming comparable to a basic technical literacy in a context where the machine already knows patterns and syntax. This phenomenon raises a warning: if anyone can generate code using natural language, what is the future of the professional who once held the monopoly on programming knowledge?

Some specialists have even proclaimed "the end of code" as we know it, envisioning a future in which we will not program computers but rather teach them through examples and successive adjustments [3]. Although this vision remains prospective, it is already a reality that routine coding tasks are being automated. Simple scripts, format conversions, standardized functions. All of these can now be generated almost instantly through AI assistants. Major technology companies have indicated plans to reduce part of their development teams in basic functions, reallocating efforts to more complex activities that still require human creativity. According to a report by the McKinsey Global Institute, a significant disruption is expected in the technology job market: globally, up to 800 million jobs may be eliminated by automation by 2030, including traditional office and information technology roles [4].

It is important to note, however, that obsolescence will not be uniform. Areas of purely abstract software or graphical interfaces may be strongly automated, but even within software development niches are emerging where humans are reinventing themselves. For example, there is growing demand for prompt engineers professionals who know how to extract the best from AI systems through well-crafted commands as well as human validators who review and ensure the quality of automatically generated code. Furthermore, tasks that involve a deep understanding of business requirements, system architecture, and user experience design still require human discernment. AI provides syntactic solutions but often lacks semantic intuition: it can suggest how to do something, but not always discern what should be done or why issues tied to context, purpose, and ethics.

Recent studies show that automation by artificial intelligence will have a profound, though heterogeneous, impact on different professions. On one hand, projections indicate a massive replacement of human tasks by machines: for example, a World Economic Forum report predicts the disruption of 22% of global jobs by 2030, with 92 million positions eliminated. On the other hand, 170 million new jobs are expected to emerge in the same period, resulting in a net gain of about 78 million jobs globally [9]. These new roles will tend to demand skills that complement AI, while jobs based on repetitive or predictable tasks face a higher risk of extinction.

In summary, the rise of AI in the professional sphere especially in programming represents a watershed moment. The traditional programmer, defined as one focused on manually writing code for any problem, tends to become less valued. In contrast, the AI-augmented programmer emerges, collaborating with algorithms to direct, supervise, and refine generated solutions. Most crucially for our argument, it should be emphasized that professionals whose work transcends code itself integrating software with hardware and the real world hold a distinctive advantage that keeps them relevant. In the following section, we will examine precisely this dimension, exploring why embedded systems remain a bastion of resistance against complete automation.

B. The Importance of Embedded Systems in the Face of Automation

While much of software development takes place in virtual and controlled domains, embedded systems stand out for operating at the intersection between the digital and the physical. This fundamental characteristic the need to interact with a real world full of continuous variables, noise, and unpredictability makes full automation of this field a formidable challenge.

Unlike a purely virtual algorithm, an embedded system must sense and act upon the environment: measuring temperatures, detecting motion, activating motors, communicating via radio waves, among others. This dialogue with the physical world implies dealing with phenomena that escape perfect simulations. For example, an LDR light sensor does not respond linearly to light intensity, and electromagnetic noise can distort signal readings. Thus, understanding and mitigating these effects requires knowledge of electronics and applied physics. Work with embedded systems goes far beyond programming logic: it involves prototyping, soldering components, analyzing circuits, and debugging with multimeters and oscilloscopes in hand.

The limits of automation become evident when perfectly generated AI code fails due to a concrete detail: a loose wire, unexpected electromagnetic interference, or a defective component. At such times, the presence of an experienced human hardware professional makes all the difference. Embedded systems require empirical experimentation and real-world iteration activities in which purely digital algorithms still cannot replace human intuition and creativity. An embedded systems project constitutes a unique discipline, as it combines two distinct dynamics: the continuous (from the physical, analog world) and the discrete (from digital software). This duality introduces complexity that is not trivial to automate. For instance, designing the control of a mobile robot involves both differential equations for motor control (continuous) and computational logic for decision-making (discrete). The optimal synthesis of these layers still depends on human engineers who understand both realms.

Additionally, the current context of hyperautomation only increases the demand for reliable and innovative embedded systems. These devices from smart lightbulbs to industrial sensors must be designed, programmed, and maintained. Embedded systems require engineers capable of integrating wireless communications, cybersecurity, and human-machine interaction. It is no surprise that the World Economic Forum has listed IoT specialists among the fastest-growing occupations of this decade [5]. In other words, as automation advances, instead of diminishing the importance of working with physical systems, it amplifies their importance: every new smart factory, autonomous vehicle, or smart city requires a robust embedded infrastructure.

Consider, for example, autonomous and electric vehicles, another area ranked among the top 10 emerging global professions [5]. Such vehicles are essentially robots on wheels, filled with sensors (cameras, LIDAR, radar), mechanical actuators, and embedded control software for safe navigation. Despite the enormous advances in AI for computer vision and decision-making, practical challenges remain: how to ensure safety under all weather conditions? How to react to unexpected events on the road? These questions touch upon physical and legislative boundaries, and embedded systems engineers are at the core of the solutions calibrating sensors, designing redundant braking systems, and optimizing battery energy consumption. AI can assist in the cognitive aspects (pattern recognition, route planning), but material execution braking the car in time, steering precisely is anchored in real-time circuits designed by humans.

Moreover, there is a factor of responsibility and certification. In domains such as medical devices or embedded aeronautical systems, there are rigorous safety certification processes. To date, there is no regulatory trust for AI systems to design mission-critical equipment independently, precisely because it is not easy to audit the decision-making of a neural network. In these sectors, embedded systems engineers play irreplaceable roles, conducting formal analyses, exhaustive hardware testing, and ensuring reliability.

Market data corroborates the ongoing importance of hybrid specialists (hardware + software). Estimates suggest that by 2030 there will be around 40 billion IoT devices connected worldwide, all requiring design, programming, and maintenance. In practice, every new smart factory, autonomous vehicle, or connected city demands robust embedded infrastructure and professionals capable of "orchestrating reality," integrating sensors, actuators, wireless networks, and control algorithms. Unsurprisingly, the World Economic Forum listed IoT and autonomous vehicle specialists among the fastest-growing professions of this decade. In a recent ranking of the ten global careers with the highest projected growth by 2030, "Autonomous and Electric Vehicle Specialist" and "Internet of Things Specialist" appeared alongside big data and AI roles [11], signaling that engineering skills in the physical-digital realm will be increasingly valued. In other words, while traditional software developers see their demand attenuated by the massive use of AI, IoT, robotics, edge computing, hardware maintenance, and industrial automation engineers are riding the wave of employability.

Therefore, we argue that embedded systems remain resistant to complete automation because they simultaneously require mastery of software and hardware, and because they operate in an environment where pure AI still has limited reach. As companies pursue efficiency, industrial automation, and smart products, professionals able to navigate sensors, actuators, and microcontrollers in addition to programming are increasingly valuable. Rather than being replaced, they become protagonists: it is they who enable "cities, factories, hospitals, and farms to become smart." In the next section, we will explore how this professional profile has evolved and what new careers have emerged at this convergence of the physical and the digital.

B. Emerging Professions in the Age of AI and Intelligent Physical Systems

In today's context, where AI excels at performing repetitive cognitive tasks, a new profile of technology professional is emerging: the hybrid specialist. This professional is neither just a software developer nor merely an electronics engineer, this professional unites competencies from both domains. They grasp sensors, circuits, and communication protocols while also mastering data structures, algorithms, and embedded systems programming. These individuals serve as a bridge between digital abstractions and tangible realities, becoming highly valued in strategic sectors such as smart cities, precision agriculture, Industry 4.0, and connected healthcare. In practical terms, this is the kind of expert capable, for instance, of designing a sensor network across a farm while also developing artificial intelligence to analyze the collected data and optimize irrigation integrating agronomic expertise, IoT hardware, and machine learning algorithms.

Beyond this broad cyber-physical profile, however, a range of specialized careers is emerging from the convergence of AI and intelligent physical systems. The *Future of Jobs 2025* report by the World Economic Forum highlights that roles like "IoT Specialist" and "Autonomous and Electric Vehicle Engineer" rank among the ten fastest-growing occupations worldwide this decade [9]. This projection has been echoed by outlets such as the *Hindustan Times*, further strengthening the visibility of this trend [7].

Automation, moreover, extends well beyond programming: many repetitive administrative functions are also being reduced. Studies indicate that nearly 70% of daily stock market transactions are already performed by AI algorithms, and organizations have reported call center cost reductions of up to 23.5% after adopting virtual assistants [8]. In essence, roles founded on clear procedures, standardization, and routine whether in programming, spreadsheet analysis, or scripted customer support are rapidly being automated. This shift compels professionals to transition toward higher-value activities or to merge their existing knowledge with emerging abilities (such as prompt engineering or AI systems management). Below are some of the professions gaining momentum with the progress of artificial intelligence:

Edge Computing and Embedded AI Specialist: With the expansion of IoT, the demand for processing data locally directly on the device instead of transferring everything to the cloud is increasing. This approach minimizes latency and saves bandwidth. Hence arises the specialist in edge computing and TinyML, capable of optimizing AI models to operate efficiently on microcontrollers or low-power embedded systems. A practical example is integrating voice recognition algorithms into household devices (like smart speakers) without depending on external servers a challenge that requires precise balancing between memory, processing power, and energy consumption. Such professionals must possess a deep understanding of both machine learning and embedded hardware architecture to design effective and efficient solutions.

Cyber-Physical Security Systems Engineer (IoT Security): As physical devices become widely interconnected, cybersecurity gains a new level of importance. The market increasingly seeks professionals capable of protecting embedded systems from attacks and malicious faults. These engineers combine expertise in cryptography, networks, and computer architecture with knowledge of how devices function internally from firmware to sensors and data buses. An IoT Security Engineer, for instance, might test the vulnerability of a connected medical device such as a pacemaker or design secure architectures for smart energy meters. Research consistently ranks cybersecurity among the most promising areas for the future, often mentioned alongside AI and big data in the top ten emerging professions [5].

Digital Twin Specialist: This new role focuses on developing detailed virtual replicas of physical systems such as factories, cities, or engines to simulate and optimize their behavior. A digital twin specialist must understand the real-world operation of these systems (for instance, an industrial production line) and translate them into accurate computational models that integrate live sensor data. This enables virtual testing of scenarios before implementing changes in the physical environment. Major industrial players already recruit these experts to improve predictive maintenance and reduce operational costs through advanced simulation. Although still a developing field, it blends competencies in computational modeling, data analytics, and practical engineering, representing a frontier of convergence between the digital and physical worlds.

IoT Engineer: Responsible for designing and implementing solutions with connected devices. This specialist deals with sensors, network communication (Wi-Fi, 5G, IoT protocols), and cloud data platforms. As mentioned, "IoT Specialist" is among the ten fastest-growing careers through 2030 [5]. Advanced manufacturing companies, logistics firms, and smart city initiatives already hire such professionals to develop connected infrastructures for instance, sensor networks to monitor bridge structures and prevent disasters, or intelligent real-time fleet tracking systems.

Autonomous Vehicle and Robotics Engineer: Encompasses everything from mobile robotics engineers to specialists in autonomous vehicles (cars, drones, collaborative industrial robots). These professionals integrate AI algorithms for vision and navigation with mechanical actuators and real-time control systems. Demand for these specialists is expected to grow exponentially, with "Autonomous and Electric Vehicle Specialist" listed among the top ten emerging global careers [5]. In the automotive sector, for example, engineers are developing autonomous buses for campuses and factories; in agriculture, autonomous robots for selective fruit harvesting are moving from the lab to the field. Each project requires engineers who understand both AI software and embedded mechanics and electronics.

These are only a few notable examples. Others could be mentioned, such as smart energy systems engineers (who combine power electronics and AI to manage electrical grids with renewable sources) or augmented reality specialists (integrating physical environments with digital information for industrial maintenance or training applications). The common thread is clear: all these emerging professions require multidisciplinary knowledge encompassing both the physical and the digital worlds. This reinforces the idea that while AI is making some highly focused and repetitive jobs obsolete, it is also creating demand for versatile professionals capable of designing, implementing, and managing complex systems where algorithms and devices interact.

Recent data confirm this trend in the labor market. According to the Future of Jobs 2025 report by the WEF [6], roles such as Big Data Specialists, AI and Machine Learning Specialists, and Process Automation Specialists are among those projected to grow the most by 2030. Yet alongside them explicitly appear IoT Specialists and Autonomous Vehicle Engineers on the global list of top ten emerging careers [4]. Moreover, at the regional level, Latin American countries already present specific needs: in Colombia, for instance, renewable energy engineer positions are expected to grow by 22% in the next five years, while sustainability specialists are projected to increase by 21%, highlighting the value of physical technologies (solar panels, wind farms) integrated with intelligent management systems [7].

In Mexico, a manufacturing hub, 63% of companies project that robotics will transform their operations during this decade [7], suggesting strong demand for automation and robotics engineers. And transversally, both globally and in Latin America, professionals combining hard and soft skills will be highly sought after: creativity, critical thinking, and complex problem-solving abilities are among the skills expected to grow most in importance by 2030, alongside technological expertise [7].

Data-intensive sectors with structured routines are already experiencing strong adoption of AI, leading to the accelerated automation of various traditional roles. According to the World Economic Forum, industries with large volumes of well-structured data such as finance, IT, and customer service are among those adopting AI on a large scale (with rates of 60–70%), while areas with fragmented or scarce information are advancing more slowly (below 25%). This explains why finance, administrative support, translation, and even software programming stand out among the fields most impacted by AI [8].

In summary, the age of AI does not eliminate the need for human professionals it transforms it. Emerging careers indicate that value will lie in the ability to integrate artificial intelligence into practical contexts, solving concrete problems. The "professional of the future" is very likely the one who can both speak the language of intelligent machines and understand the nuances of the physical and social world in which those machines operate. This realization points to challenges and changes that go beyond the labor market itself, extending into the social, economic, and educational spheres.

D. Trends in Latin America: AI Adoption vs. Workforce Preparedness

In Latin America, the dynamics between automation and labor present particularities that reinforce the thesis of the resilience of physical-digital professions. World Bank data reveal that, in the current context, only 2% to 5% of jobs in the region are at risk of total replacement by AI [12]. In other words, despite technological advances, the vast majority of Latin American occupations are not fully automatable with current AI capabilities. This is partly because about 60% of jobs in Latin America and the Caribbean today are "shielded" from AI's impacts typically informal, manual functions, or those requiring physical presence and interpersonal skills [13]. While in advanced economies one in four jobs may be complemented by AI, in Latin America this ratio is only one in eight [13], reflecting both lower digitalization in certain regional sectors and a higher share of practical work that is less trivially automatable.

On the other hand, as digital transformation accelerates in the region, there is a growing demand for talent trained in emerging technologies. Eighty-four percent of Latin American employers plan to train or reskill their workforce to meet the need for high-demand digital and technological skills [7]. This includes preparing hybrid professionals capable of handling AI, IoT, and automation. In fact, the adoption of the Internet of Things has been growing rapidly: in 2023, 58% of companies in Latin America already had IoT initiatives, nearly double the 31% observed in 2019 [10]. In the rest of the Spanish-speaking region, this figure reaches 61%, indicating that more than half of Latin American organizations are already experimenting with or implementing IoT solutions in their operations. However, 60% of respondents outside Brazil and 73% in Brazil admitted they did not have dedicated AI teams internally [10], highlighting specialized talent gaps. These data reinforce the need for investment in education and technical training: societies that produce engineers and technicians for this new physical-digital era will be better positioned to reap the benefits of automation, rather than merely consuming imported technology.

It is important to emphasize that even with greater incorporation of AI in Latin American companies, human presence remains indispensable to orchestrate and supervise automated systems. For example, 81% of companies in the region view the acceleration of automation as a solution to productivity gaps, but acknowledge that people will be necessary to manage machines and ensure reliable operations [9]. Thus, soft skills such as leadership, creativity, adaptability, and resilience (cited by more than 70% of Latin American employers) become even more in demand in the context of smart factories and automated cities. In short, hyperautomation in Latin America does not eliminate humans it redefines their role: there is less tedious work, but a greater need for qualified professionals to install, program, and monitor new technologies in the field, ensuring that digital transformation translates into gains for society as a whole.

II. RESULTS AND DISCUSSIONS

Throughout this article, we have examined the landscape of a future of work shaped by the strength of artificial intelligence, discussing in particular the fate of traditional programmers in the face of this advance and emphasizing the central role of embedded systems. The evidence points to an inevitable reality: purely intellectual and repetitive tasks are rapidly being absorbed by automation. AI writes code, analyzes data, and even makes basic decisions with increasing autonomy, rendering obsolete certain former “jobs of the future” that were listed in recent decades.

However, amidst this transformation, we identified a stronghold of resistance and renewal represented by intelligent physical systems and their professionals. Far from disappearing, careers linked to the integration between software and hardware tend to grow stronger. The reasoning is clear: while code itself can be generated by algorithms, the implementation of solutions in the real world demands a mixture of creativity, adaptability, and empirical knowledge that no AI has yet achieved.

Professionals capable of connecting “the invisible to the visible,” in the words of this article’s author, will be increasingly in demand. These individuals engineers, scientists, and highly skilled technicians are those who orchestrate reality using new intelligent tools. They are the ones who design the devices that collect the data for AI to process; who build the machines that execute the decisions recommended by algorithms; who ensure that all this infrastructure works reliably and ethically. For societies, especially in Latin America, the key message that emerges is adaptation and preparedness.

There is an urgent need to invest in the development of human capital aligned with this new era. This means reformulating educational systems, promoting a culture of continuous learning, and valuing science and engineering as drivers of development. Countries that can harness the talent of their youth by training them in these hybrid competencies will be able not only to consume imported technology, but also to create original solutions for their own challenges be it a low-cost agricultural monitoring system for small farmers, a hospital disinfection robot for public health facilities, or an adaptive learning platform for remote communities.

At the same time, it is essential to maintain a critical and humanistic outlook on this process. Automation and AI are not ends in themselves; they must be means to improve the human condition. This implies ensuring that productivity gains translate into collective benefits, reduced excessive working hours, safer jobs, and more accessible goods and services rather than simply income concentration and unemployment. It also requires establishing clear ethical boundaries: for example, to what extent should we delegate life-or-death decisions to autonomous systems? How can we ensure privacy in a world of ubiquitous sensors? These questions demand the participation of all of Society not only engineers, but also philosophers, lawyers, policymakers, and the general public so that the digital-physical era is also an era of social progress.

Finally, in the Latin American context, the World Bank estimates that only 2% to 5% of jobs are at risk of total replacement by AI. This is because 60% of the region’s work still involves practical or in-person activities, less susceptible to automation. In addition, 84% of employers already plan to retrain their employees in digital skills, including IoT and automation, indicating a strategic opportunity to prepare the region’s “orchestrators of reality” [9].

III. CONCLUSION

Returning to the provocative title of this article, *"The Future is Embedded"*, we may interpret it on two levels. First, in the literal sense, the future largely belongs to embedded systems and to the professionals who master them, for they are the ones who will ensure that the AI revolution has concrete and positive effects. Second, in a metaphorical sense: the future is embedded in ourselves in the choices we make today regarding education, investment, and the values that guide technology. The future does not simply happen, it is constructed.

In conclusion, we reaffirm that the age of artificial intelligence does not extinguish the need for the human, but rather redefines their role. Professionals who know how to position themselves at the interface between code and matter will be the protagonists of an increasingly automated and interconnected economy. In practice, these "orchestrators of reality" will take center stage, connecting the digital and the physical worlds and ensuring that the promises of technology are converted into tangible progress.

Thus, while purely digital professions face a real risk of automation, occupations linked to intelligent physical systems demonstrate not only resilience but also accelerated expansion in Latin America and globally. It is up to us, individuals, educational institutions, companies, and governments to embark on the future with preparation and vision, so that this transition results not only in efficiency but in a more prosperous, inclusive, and balanced society.

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