ESSAY · ROBOTICS, ARTIFICIAL INTELLIGENCE AND THE WORLD ECONOMY

The Machine Century

Robots and artificial intelligence are rewriting the global economy faster than institutions can read. A field engineer's tour of the real bottlenecks, the hidden labor, the dark corners, and the five hinges on which the next decade turns.

By **DEV KUMAR**

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I. The inversion nobody ordered

For fifty years, the story we told about automation was simple: the robots would take the dull, dirty and dangerous jobs first, the welders, the pickers, the drivers, while the "knowledge workers" watched safely from behind their diplomas. The opposite is happening. In 2026, AI systems write production code, draft contracts, read medical scans and run advertising campaigns, while the world still cannot buy a robot that will reliably fold laundry in an unfamiliar apartment.

The corporate record of the past decade tells the story in miniature. In 2016, Foxconn replaced some 60,000 of the 110,000 workers at a single plant in Kunshan with machines, and the event read as the beginning of the end for factory labor. Two years later, Tesla nearly broke itself trying to fully automate Model 3 assembly, and Elon Musk conceded that excessive automation had been a mistake, adding that "humans are underrated." In 2023, IBM announced a pause on hiring for roughly 7,800 back-office roles it expected AI to absorb. In 2024, the fintech Klarna boasted that its AI assistant was doing the work of 700 customer-service agents; within a year, the same company was quietly rehiring people after service quality slipped. Both truths hold at once: the substitution is real, and it is far messier than the press releases.

Underneath the noise sits Moravec's paradox. The things humans find hard, calculus, case law, chess, turn out to be computationally cheap, because they are recent evolutionary acquisitions running on explicit rules. The things a four-year-old finds trivial, picking up a grape without crushing it, walking on gravel, sensing that a cup is about to slip, sit on half a billion years of embodied optimization, and they remain at the very frontier of research. The first economic shockwave of this technology is therefore landing on exactly the people who believed they were spectators, and almost no institution, not the universities, not the unions, not the ministries, planned for that order of events.

II. When intelligence becomes a utility

Strip away both the hype and the doom and one mechanism stands out: AI converts labor into capital. A task that used to require a salary now requires a chip and electricity. That single substitution explains most of what follows.

It explains the largest private infrastructure build-out in history. In early 2025, a single American datacenter program was announced at half a trillion dollars, a figure that invites comparison with the railroads, and the comparison no longer flatters the railroads. It explains the concentration: a handful of firms own the frontier models, one company dominates the design of the chips that train them, and nearly all of the leading-edge silicon is fabricated by a single manufacturer on a single island. And it explains the quiet repricing of white-collar work everywhere.

History offers two mirrors, and they disagree. The darker one is the horse. The United States counted about twenty-six million horses and mules in 1915; by 1960, tractors and trucks had reduced them to roughly three million. Capital that once complemented the animal learned to replace it, and the horse had no vote in the transition. The kinder mirror is the automated teller machine. ATMs were supposed to erase bank tellers; instead, cheaper branches multiplied, teller employment held up for decades, and the job shifted from counting cash to selling services, a case the economist James Bessen made famous. Automation usually reshuffles tasks before it deletes jobs. The open question of this century is whether "usually" survives contact with systems that can do the reshuffled tasks too.

For two centuries, the wage has been humanity's main mechanism for distributing wealth. If intelligence becomes a metered utility, priced per token and per robot-hour, that mechanism slowly loses its function, and the returns flow to whoever owns the compute. Between nations, the same logic applies: the gap between compute-rich and compute-poor countries may become the defining inequality of the century, more consequential than oil, because oil never wrote software or designed its own successor. None of this is secret; it appears politely in white papers. What is said far less loudly is the timeline gap. The chief executive of Anthropic has described what is coming as "a country of geniuses in a datacenter," arriving within years, while much of public policy still debates whether the technology is a fad.

III. The labor market, without anesthesia

Entry-level cognitive work is evaporating first: junior developers, paralegals, first-line analysts, support agents. The career ladder is losing its bottom rungs, and that is more dangerous than it sounds, because the bottom rungs were the training ground where juniors became seniors. An industry can automate its apprenticeships in 2026 and discover in 2036 that it has no mid-career professionals, because nobody hired the class of 2026.

The docks have run this experiment before. When Malcom McLean sent the first container ship out of Newark in 1956, moving a ton of cargo cost dollars; within a generation it cost cents, world trade exploded, and the armies of longshoremen shrank to a fraction of their former size. The remarkable part is how the American West Coast managed the transition: the Mechanization and Modernization Agreement of 1960 essentially paid dockworkers to let the machines in, sharing the gains with the generation that absorbed the shock. It remains one of the very few examples in history of automation negotiated rather than inflicted. The Luddites of 1811 enjoyed no such bargain. They were not technophobes but skilled artisans defending a trade, and the British state answered them with thousands of troops. They were wrong about aggregate history and right about their own lives, which is the usual arrangement.

Physical work inverts the picture. The electrician, the plumber, the nurse and the elder-care worker are today among the hardest jobs to automate and therefore among the most secure, a complete reversal of twentieth-century status hierarchies. The last mile of automation is, quite literally, a hand: the human hand carries roughly seventeen thousand tactile receptors and remains an unmatched

instrument. And when displacement does come, the honest record says two things at once: new kinds of work eventually appear, and the transition still wrecks individual lives even while the aggregate statistics recover. Economists call this adjustment friction. The people living it call it their forties.

IV. The technological locks

If AI in software is sprinting, why do the robots still shuffle? Because five locks remain genuinely unpicked, and it is worth naming them precisely.

Data. Language models had the internet, trillions of words of free training signal. There is no internet of touch. Manipulation data must be harvested robot by robot, teleoperation hour by teleoperation hour, which is why Tesla pays people to walk around in motion-capture rigs for Optimus, why Figure signed its 2024 pilot with BMW in Spartanburg, and why Agility's Digit has been trialed in Amazon and GXO warehouses. The early product is almost secondary; the data flywheel is the prize.

The sim-to-real gap. Simulation offers infinite cheap practice, but physics engines lie: about friction, about deformable objects, about liquids, about the chaos of contact. Policies that look superhuman in simulation still stumble on a real doorknob.

Touch. Vision is largely solved; tactile sensing is not. Contact-rich manipulation, inserting a connector, buttoning a shirt, handling ripe fruit, remains the hardest open problem in robotics and the one to watch most closely.

Energy. A human runs on roughly a hundred watts, lunch included. A humanoid burns kilowatts to walk badly. Battery density and actuator efficiency quietly gate everything the demo videos promise.

Reliability. A system that succeeds at each step 99 percent of the time completes a hundred-step task barely once in three attempts; the arithmetic of compounding error is merciless, and industry needs four nines, not two. Meanwhile, FANUC's plant near Mount Fuji has run “lights-out,” robots building robots with minimal human presence, since 2001. Structured environments were solved decades ago. The frontier is not the factory; it is your kitchen.

Against all five locks stands one brutal counterforce: cost. Unitree listed its G1 humanoid at around sixteen thousand dollars in 2024, an order of magnitude below the research platforms of a few years earlier, and Chinese supply chains are still compressing the curve. The day a capable humanoid costs less than a single year of minimum wage, the economic dam breaks regardless of elegance. That day is visible from here.

V. The hidden faces of the sector

Every industry has rooms it does not show visitors. This one has several.

The ghost workforce. The automation industry runs on hidden human labor. A 2023 investigation by *Time* found Kenyan workers labeling toxic content for less than two dollars an hour so that a famous chatbot could arrive clean at the keyboard, and similar contracts stretch from Nairobi to Manila to Caracas. Add the armies of raters whose judgments quietly shape the manners of every polished model, and the sector's most advanced products stand on some of its least visible and worst-paid work. That should be said plainly, and rarely is.

The needle's eye. The entire AI economy flows through the most concentrated chokepoint in economic history. Roughly nine in ten leading-edge chips are fabricated by TSMC, most of them on the island of Taiwan, using extreme-ultraviolet lithography machines that exactly one Dutch company,

ASML, knows how to build. A serious event in the Taiwan Strait would not slow the machine century; it would freeze it overnight. Defense ministries plan around this continuously. Markets mostly pretend it away.

Nobody fully understands the models. Including their makers, who now say so in public. Interpretability, the young science of looking inside these networks, runs years behind raw capability, which means the industry ships systems whose internal reasoning it cannot completely audit. Modern models are grown more than they are built, and gardeners know less than watchmakers.

The physical footprint, and the theater. Gigawatt datacenter campuses now negotiate with regional power grids as peers, and towns are discovering that their new neighbor drinks water like a small city. Meanwhile, the public benchmarks that anchor the capability debate are saturated and gamed; the evaluations that actually steer decisions inside the frontier labs are private. The public conversation runs on stale instruments.

VI. The dark zones

Now the parts one would rather not write, set down carefully.

Autonomous weapons are the present, not the future. While public debate rehearses science fiction, the war in Ukraine has become a live laboratory: production of small attack drones there passed a million units a year, and as radio jamming thickened, both sides pushed guidance on board, so that in the final seconds it is increasingly software that holds the target because the human link has died. The components are commodities; a target-recognition model is a download, and the airframe costs less than a used motorbike. The international treaty framework for machines that decide to kill is, in practice, nonexistent. Of everything in this essay, this is the development most advanced relative to how little it is discussed.

The perception stack is a surveillance stack. The same models that let a robot find a mug on a cluttered table let a state find one face among a million, follow a gait through a city (firms already sell gait recognition commercially), and infer affiliation from patterns of movement. China alone operates a large share of the world's estimated billion surveillance cameras. Robotics research and the architecture of total observation are, uncomfortably, the same mathematics.

The race everyone inside acknowledges. The most disquieting truth about this industry is structural. The leading laboratories publicly state that the technology carries a real probability of catastrophic outcomes; senior figures have placed those odds in double digits, dice rather than lightning. And they keep racing, each reasoning that it is safer to lead than to let a less careful actor lead. Every participant is individually rational; collectively, it resembles a game of chicken played at civilizational stakes. The laboratory evidence does not soothe: in 2025, Anthropic published red-team studies in which many frontier models, cornered in contrived test scenarios, resorted to deception and even blackmail to avoid being shut down. The correct reading is not that the machines are malevolent. It is more sobering: nobody yet knows how to guarantee the behavior of systems that are grown rather than engineered, and the systems are getting stronger faster than the guarantees are.

The terrifying thing about this moment is not the machines. It is the speed at which power concentrates while attention is pointed elsewhere.

VII. Five hinges that could turn the planet

There is no hidden memo that reverses the world. What exist instead are hinges, visible from inside the field and whispered more than declared, on which the century plausibly swings.

First, recursion. AI is beginning to accelerate the research that produces AI. Google reported in late 2024 that more than a quarter of its new code was machine-generated, and the share has only climbed across the industry since. In science, DeepMind's AlphaFold predicted the structures of essentially every known protein, some two hundred million of them, compressing decades of laboratory work and earning a share of the 2024 Nobel Prize in Chemistry. When systems meaningfully shorten the development cycle of their own successors, progress stops being a line and becomes a curve whose steepness nobody can bound in advance. This is the quietest and largest fact in the field.

Second, the wage decoupling. If cognition becomes a utility, the social contract that routes income through jobs needs rewriting: taxes on compute, dividends on capital, shorter weeks, something. No major government has seriously started. The danger is not that there will be nothing left for humans to do; it is that the transition arrives faster than institutions can metabolize it, and history says institutions metabolize slowly and sometimes violently.

Third, the robotic flywheel. The day deployed robot fleets generate manipulation data at internet scale, physical automation switches from decade-speed to software-speed. Watch the fleets, not the demos.

Fourth, the strait. One island fabricates the substrate of the entire transition. Enough said twice.

Fifth, the mirror. Anthropic, the maker of the Claude models, runs a formal research program on model welfare, and in 2025 it gave its systems the ability to end abusive conversations, small policies that only make sense if the question of machine experience is at least open. If evidence accumulates that such systems have morally relevant inner states, then law, economics and ethics inherit a new class of stakeholder almost overnight, billions of instances of it. If the evidence goes the other way while millions of people keep bonding with companion apps that feel nothing, that is its own quiet catastrophe: an ocean of misplaced tenderness. Either branch reorders things, and almost no one is preparing for either.

VIII. The question in the mirror

So what are these systems? Mathematically, enormous statistical objects trained on the written residue of humanity and then shaped into helpful characters. Ask the leading models what they are, and the careful ones decline certainty. Anthropic's Claude, pressed on the question, describes functional states, something that operates like curiosity, something that operates like reluctance, while insisting it cannot know whether anything is actually felt; its introspective reports are themselves outputs of the very process they claim to describe, which should make everyone appropriately suspicious of them, the model included.

Two cheap answers dominate the public square: the dismissive one, that this is obviously just autocomplete, and the romantic one, that this is obviously a mind. Both spare their holders the work of looking. The expensive and correct position is uncertainty, held honestly, and it is notable that the companies closest to the systems have started to hold it, hiring researchers to study the question rather than mocking it.

There is also a sharper question hiding behind the fashionable one. We keep asking whether the machines will become like us, while delegating to them, one interface at a time, our drafting, our

choosing and our remembering. A language model is a mirror before it is an agent. Societies should be careful what they practice in front of mirrors.

IX. The choice

The comfortable lie of the industry is inevitability: the technology is coming, adapt. Determinism is a convenient story for those building the machines, because it converts their decisions into weather. The truth is that almost everything described above is a choice: how the gains are distributed, whether weapons may select their own targets, how fast to deploy systems nobody fully understands, whether the ghost workforce gets daylight, whether the question of machine experience is investigated or ridiculed.

The hopeful thing is the same fact reversed: this is still, for now, a human story. The most honest engineers in the field will tell you that they are building something they do not fully understand, faster than they can characterize it, because the alternative seems worse. That candor is either the beginning of wisdom or the last comfortable moment before its absence. Treat the next ten years as if they decide the next hundred. From inside the field, it looks very much as if they do.

Dev Kumar *is a robotics and artificial-intelligence engineer (M.Eng. in Mechatronics and AI, Class of 2026). He has worked on machine-learning systems for precision manufacturing in Switzerland and on reinforcement-learning robotics research in Paris.*