Will Robots Replace Humans?

A Roboticist's Perspective on What Machines May Replace, What They Still Cannot Reproduce, and Why Coexistence May Be the Better Future

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Why I Am Writing This

I hear some version of the same question almost every time I demonstrate a robot to the public: "Are robots going to replace us?" It is a reasonable question. When people watch a robot manipulate an object, coordinate with a human partner, or complete a complex sequence of tasks, it can look as though machines are getting very close to doing everything we do. What the audience usually does not see are the hours of programming, calibration, integration, safety testing, and troubleshooting that made those few minutes possible.

That difference matters. In the laboratory, a robot can look remarkably capable under controlled conditions and still struggle with something a person would consider ordinary. Move an object, place an unexpected obstacle in its path, change the floor surface, or ask it to recover from an unfamiliar failure, and a simple demonstration can quickly become a difficult engineering problem. We saw the same contrast at the recent World Humanoid Robot Games in Beijing, where impressive speed, balance, and coordination appeared alongside falls, failed motions, and awkward recoveries.

For years, my answer has been consistent: robots will replace many human tasks and will outperform us in some areas by a wide margin. However, I do not expect robots to replace human beings in the broad sense within my lifetime. That conclusion does not come from underestimating robotics. Having spent much of my career in robotics and human-robot collaboration, I have seen how quickly the field can advance. My view comes from considering both what machines already do extremely well and how much humans accomplish every day without noticing the complexity involved.

Figure 1. An illustrative image which shows various human-robot collaboration cases, created with ChatGPT.

Robots Will Replace Some Human Work

It would be a mistake to defend human superiority by pretending robots are not already extremely capable. In structured environments, machines have clear advantages. Industrial robots can repeat movements thousands of times with remarkable precision, lift heavy loads without fatigue, work around hazardous materials, and continue performing long after a human worker would need a break. Artificial intelligence extends these advantages by allowing machines to search enormous amounts of information, recognize patterns, analyze images, generate software, and coordinate complex processes at speeds no individual person can match.

When a task is narrow, measurable, repetitive, and well defined, there is little reason to assume that a human will remain the best performer forever. A warehouse robot does not need broad common sense if its job is to move packages. An inspection system does not need to understand human emotion if it can detect defects more consistently than a person. A surgical system does not need to become a physician in every sense if it can assist with a particular procedure with very high precision. Robots will replace people in some jobs, and that process has been underway for decades. What is changing is the range of tasks machines can perform as robotics, sensing, computer vision, AI, language models, and control systems increasingly work together. However, ***replacing a task is not the same as replacing the person who performs it.***

The Human Body Sets a Very High Standard

The real difficulty begins when we move from replacing a task to replacing the person. A human being is not simply an intelligent computer attached to a mechanical body. We are integrated biological systems in which intelligence, perception, balance, muscle control, metabolism, healing, memory, emotion, and social understanding operate continuously together.

Consider energy and movement. The human brain performs perception, planning, language, memory, movement control, and social reasoning while consuming roughly as much power as a small household light. At the same time, the body walks, regulates temperature, digests food, repairs tissue, and keeps itself alive. A robot depends on batteries, processors, sensors, power electronics, cooling, charging, and an infrastructure that can manufacture and maintain those components. Robots may be extraordinarily efficient in individual functions, but the comparison becomes much more interesting when we consider the entire system.

Walking illustrates the point. A person can enter an unfamiliar room, avoid obstacles, carry an object, respond to another person, recover from a stumble, and adjust immediately when conditions change. A robot must sense the environment, estimate its own body state, predict the effect of its movement, and correct quickly enough to remain balanced. None of these abilities is impossible for a robot. The challenge is doing all of them reliably in the same machine, particularly in an environment that was not prepared for it. A polished demonstration shows what a system can accomplish under particular conditions. Everyday life asks what happens when those conditions change.

The human hand creates a similar challenge. Opening a jar, tying a shoelace, turning a key, picking up a grape without crushing it, or handling a wet glass requires touch, force sensing, fine motor control, vision, and rapid correction. Robotic hands are improving quickly, especially with better tactile sensors and learning methods. Yet engineers are still trying to reproduce abilities biology provides in a compact and self-adjusting package. One practical solution may be to change environments as well as robots. Factories already organize tools, parts, and workspaces around robotic capabilities, and other settings may gradually do the same.

Self-Maintenance and Survival

When people imagine intelligent robots, the discussion usually centers on intelligence and mobility. I think we sometimes overlook something more basic: survival. Humans heal. Cuts close, bones repair, the immune system responds to infection, and the body regulates temperature, fluids, blood pressure, and energy without conscious supervision.

Robots do not yet have anything comparable at the whole-system level. If an actuator, circuit, gearbox, or sensor fails, the machine generally needs someone, or eventually another machine, to diagnose and repair it. Research in self-healing materials, fault tolerance, and autonomous maintenance is promising, but repairing a component is still very different from the biological self-maintenance of a living organism. A robot may function very effectively inside a civilization that provides electricity, networks, spare parts, factories, and maintenance. That is not the same as independent survival.

Machines Also Have Unique Advantages

The comparison is not one-sided. Robots and AI systems have characteristics humans may never possess. Software can be copied, capabilities can be distributed across thousands of machines, and information can be exchanged electronically almost instantly. Robots can also be designed around a mission rather than around the human body. They can use infrared vision, radar, extra arms, wheels, extreme lifting capacity, or sensors outside the range of human perception.

For this reason, the future may not depend on building a single humanoid that can beat a human at everything. A more realistic and useful direction may be an ecosystem of specialized machines, each exceptionally good at particular tasks and connected to increasingly capable AI systems. Such a system could transform society even if no individual robot ever becomes a mechanical equivalent of a person.

What Would It Take to Approach Human Capability?

Closing the broader gap would require progress in several areas at once. Energy systems would need to become lighter and last longer. Computing would need to become more energy efficient. Actuators would need greater power density and durability. Robotic hands would need better touch and control, and perception would have to remain reliable in rain, glare, darkness, crowds, clutter, and other conditions engineers did not anticipate.

Learning is equally important. Humans learn while living. We combine memory, perception, physical experience, common sense, and feedback from other people without being completely retrained for each new environment. A general-purpose robot would need a comparable ability to adapt while remaining safe and reliable. Even if all of these problems improve individually, integration remains the systems challenge. A great battery does not make a great robot, and neither does an excellent hand, a powerful language model, or an advanced vision system. The real difficulty is making all of them work together. Much of human capability comes from that integration.

The Wrong Question May Be “Human or Robot?”

There is another reason I am uncomfortable with framing the future as robots either replacing humans or failing to do so. Major technologies rarely change society by simply replacing everything that came before. They change the division of labor.

The calculator is a simple example. Calculators became much better than humans at routine arithmetic, but they did not eliminate mathematicians, engineers, accountants, or scientists. They removed repetitive work and allowed people to concentrate on higher-level problems. Computers did something similar, and industrial automation transformed manufacturing without eliminating manufacturing itself. Robotics is likely to follow the same broad pattern, although its effects may be larger because intelligent machines can influence both physical and cognitive work.

Some jobs will disappear, many will change, and new roles will emerge in supervision, integration, maintenance, safety, system design, and human-robot collaboration. The more important question for society is whether education, industry, and institutions can adapt quickly enough for people to benefit from that progress.

The Future Is Coexistence

My answer therefore remains the same: robots will replace humans in pieces, not as a whole. They will replace many tasks, some occupations will shrink or disappear, and machines will outperform us in an expanding number of specialized abilities. However, that is different from replacing the human being. People remain extraordinarily

adaptable biological systems that reason, move, learn, interact socially, recover from injury, regulate themselves, and operate for long periods with relatively little external technical maintenance.

I would never bet against the progress of robotics. The field has surprised us too many times. At the same time, my years in robotics have taught me not to underestimate biology. Some of our most ambitious engineering goals still involve reproducing things humans and animals do naturally: moving efficiently, sensing the world, learning from experience, recovering from damage, and operating for long periods with limited energy.

For me, the more productive future is not human versus robot. It is human with robot. We should expect machines to take over work that is dangerous, excessively repetitive, physically punishing, or better suited to precision and automation. Humans should increasingly focus on work that depends on judgment, adaptability, responsibility, creativity, social understanding, and broad context. This is why I have long viewed human-robot collaboration as more compelling than simple replacement.

The calculator remains a useful analogy. We did not stop teaching mathematics because calculators could perform arithmetic faster than people. We changed what we expected people to do with mathematics. Robotics can do something similar. Its value should not be measured only by how many people it removes from a workplace, but by what people can accomplish when they no longer spend their time on work that is dangerous, exhausting, or endlessly repetitive.

This matters especially when we think about the world our children will inherit. Many will have little interest in jobs that are hazardous, ergonomically damaging, or unnecessarily hard on the human body. There is little value in preserving those tasks simply because earlier generations accepted them as normal work. Robotics should help make work safer, improve productivity, and allow people to spend more time on judgment, creativity, ingenuity, and human connection. Robots will certainly replace some of what humans do. I believe the more important story will be what humans and robots learn to do together.

Biography:

Dr. Ferat Sahin is Professor and Department Head of Electrical and Microelectronics Engineering at Rochester Institute of Technology (RIT), where he directs the Multi-Agent Bio-Robotics Laboratory and the Century Mold Collaborative Robotics Laboratory. He received his M.S. and Ph.D. degrees from Virginia Tech and joined RIT in 2000.

His research focuses on human-robot collaboration, collaborative and humanoid robotics, AI-driven manufacturing, physiological and affective computing, trust in automation, machine learning, and system-of-systems engineering. His recent work explores human-aware robotic systems, multimodal estimation of human comfort and workload, augmented reality and digital twins for industrial human-robot collaboration, and human-AI and AI-AI collaboration. He has published more than 165 scholarly papers, co-authored two CRC Press books and seven book chapters, and has participated in more than $7.6 million in externally funded research.

Dr. Sahin has also held numerous leadership positions within the IEEE Systems, Man, and Cybernetics Society (SMCS), including Student Activities Chair, Secretary, Treasurer, Vice President for Finance, and Vice President for Human-Machine Systems. He has received the IEEE SMCS Outstanding Contribution Award multiple times for his service to the Society.