The Future of Military Robotics Looks Like a Nature Documentary

Gregory C. Allen July 21, 2017



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BBC has followed up 2006's *Planet Earth*, perhaps the greatest nature documentary of all time, with an even greater sequel. This past week, *Planet Earth II* received 10 Emmy Award nominations. If you haven't seen it, join the tens of millions of enraptured viewers and watch the story of a marine iguana's mad dash through a den of snakes. I'm sure you'll be hooked. In capturing the swimming sloth's endearingly persistent search for love and the bird of paradise's bizarre and beautiful courtship dance, BBC has composed a nearly perfect ode to the wonder and beauty of life on earth. Most viewers of *Planet Earth II* will come away with a sense of nature's majesty and awe.

I'm a little different.

I, too, felt that majesty and awe, but I also happen to have just completed a study titled "Artificial Intelligence and National Security" on behalf of the U.S. Intelligence Advanced Research Projects Activity (IARPA). IARPA is the main sponsor of the U.S. government intelligence community's advanced research and development efforts. Like its military counterpart, DARPA, folks at IARPA are tasked with anticipating how advancements in science and technology will transform the future of espionage and warfare.

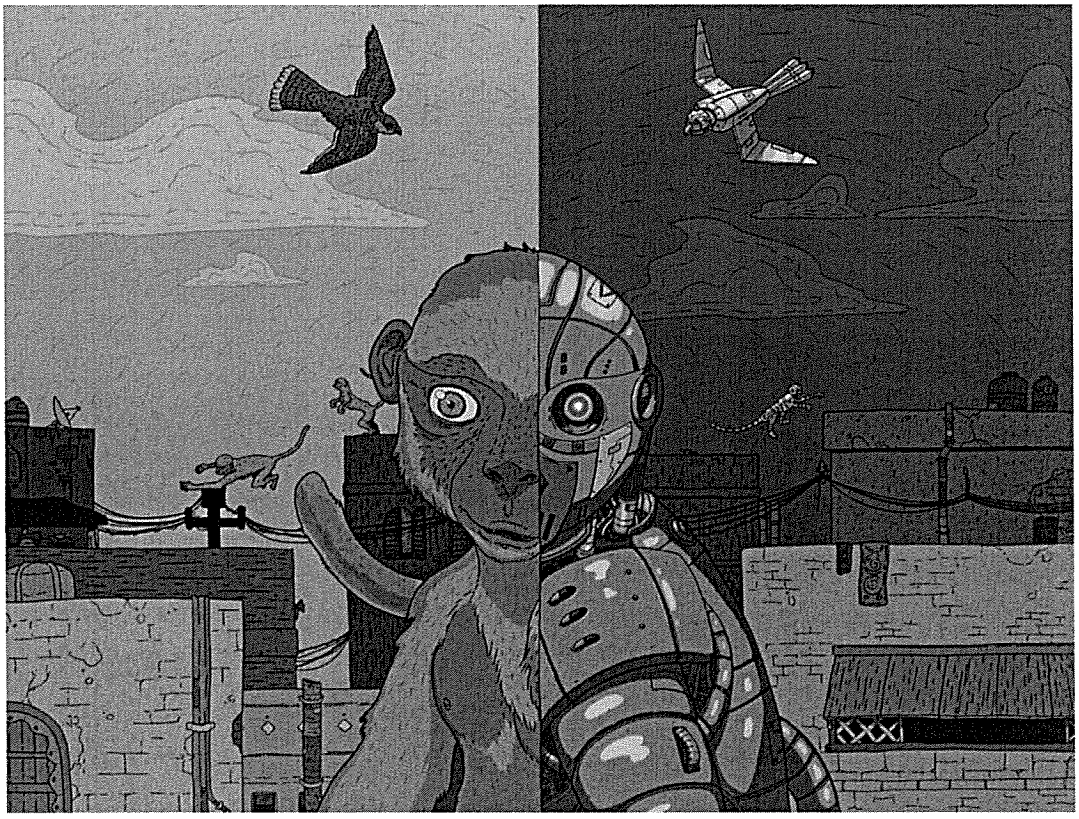
Which brings us back to *Planet Earth II*. In each of the documentary's profiles of monkeys, birds, and lizards, I saw what technologists refer to as an "existence proof." Existence proofs are the simplest way to resolve an argument about what is technologically possible. Before 1900, people argued whether building a human-carrying powered airplane was possible. In 1903, the Wright Brothers ended the debate with an existence proof. As I watched *Planet Earth II*, I saw existence proof after existence proof of technological capabilities that, applied to warfare and espionage, would make

global militaries and intelligence agencies significantly more powerful – but also significantly more vulnerable.

I realized Hollywood has it all wrong. The future of military robotics doesn't look like *The Terminator.* It looks like *Planet Earth II.*

Every type of animal, whether insect, fish, bird, or mammal, has a suite of sensors (eyes, ears, noses), tools for moving and interacting with its environment (arms, beaks, wings, fins), and a high-speed data processing and decision-making center (brains). Humans do not yet know how to replicate all the technologies and capabilities of nature, but that these capabilities exist in nature proves they are indeed possible.

Consider the common city pigeon. The pigeon has significantly more flight maneuverability, better sensors, faster data-processing capability, and greater power efficiency than any drone. The combination of a pigeon's brain, eyes, and ears is also superior at navigation and collision avoidance to the computer and sensors of any autonomous car, despite requiring less than one watt of power to function. And pigeons, fueled by garbage, are cheap.



Artwork by Ian O'Neill, used with permission

Humans do not know what the ultimate technological performance limit for autonomous robotics is. But it can be no lower than the very high level of performance that nature has proven possible with the pigeon, the goose, the monkey, the mouse, or the dolphin. With each, it's as though an alien spaceship has crash-landed on earth with super-advanced alien technology. We don't know how to build the technology that gives these incredible capabilities. Right now, they're too advanced. We know, however, that these capabilities are possible. We see them at work right in front of our eyes.

The capabilities on display in *Planet Earth II* will be very, very useful in warfare. The Tomahawk missiles that the United States fired at Syria in April can deliver explosives from hundreds of miles

away, but such missiles cost $1.5 million per shot. Highly capable commercial flying drones, by contrast, can be had for under $500. Such drones currently face significant range and payload limitations, but they become cheaper and more capable every year.

Imagine a low-cost drone with the range of a Canada goose, a bird that can cover 1,500 miles in a single day at an average speed of 60 miles per hour. *Planet Earth* profiled a single flock of snow geese, birds that make similar marathon journeys, albeit slower. The flock of six-pound snow geese was so large it formed a sky-darkening cloud 12 miles long. How would an aircraft carrier battlegroup respond to an attack from millions of aerial kamikaze explosive drones that, like geese, can fly hundreds of miles? A single aircraft carrier costs billions of dollars, and the United States relies heavily on its ten aircraft carrier strike groups to project power around the globe. But as military robots match more capabilities found in nature, some of the major systems and strategies upon which U.S. national security currently relies – perhaps even the fearsome aircraft carrier strike group – might experience the same sort of technological disruption that the smartphone revolution brought about in the consumer world.

Leading roboticists have long been attempting to copy nature's A+ homework. MIT, UC Berkeley, and dozens of other universities boast biology-inspired robotics laboratories. The Department of Defense, especially DARPA, has been instrumental in funding much of this research. DARPA-funded programs have produced robotic hummingbirds, cheetahs, and pack mules that – while not yet battlefield-ready – clearly illustrate how biology-inspired robotics will be an integral part of future warfare. The former head of DARPA's robotics program, Gill Pratt, recently argued that three technological trends mean that roboticists are finally ready to stop admiring nature's incredible technology and start matching it: (1) plummeting costs and soaring performance of computation hardware, (2) the rise of cloud networked robotics, and (3) major advances in machine learning and artificial intelligence.

The United States is far from the only country interested in these capabilities. In 2015, Russian scientists celebrated their development of a robotic "cockroach," which they said would be an ideal platform for secretly recording conversations and taking photographs. One can easily imagine such a cockroach being outfitted with venom and an injector needle, making it an ideal platform for covert assassination as well.

Autonomous robots are unlikely to match all the technology and performance of nature in the next decade or two. Some of these capabilities may remain completely out of reach until scientists can achieve the technological miracle that is cellular manufacturing. No one can say for certain how long that will take. Nevertheless, at the pace robotics and artificial intelligence technologies are currently making progress, the systems that engineers do devise will be plenty disruptive enough to reshape global power. After all, human-developed technology can do things that nature's evolutionary engineering approach cannot, such as adapting capabilities from one system to another: A hypothetical robotic "bird" could possess human-developed technologies that do not exist in nature, such as radar, explosives, ballistics, and digital telecommunications.

The national security community wants to make sense of how technology will transform the future of warfare. My advice? Watch *Planet Earth II.*

Gregory C. Allen is an adjunct fellow in the Technology and National Security Program at the Center for a New American Security. His report, "Artificial Intelligence and National Security," was published by the Harvard Belfer Center for Science and International Affairs in July 2017. Follow him on Twitter: @Gregory_C_Allen.