“FIRST DISCOVERED LIVING ROBOTS- XENOBOTS ORGANISMS”

Abstract

The Xenobots were invented in 2020. The Inventors of the Xenobot were Sam Kriegman, Douglas Blackiston, Michael Levin, and Josh Bongard.
In size, they are less than a millimeter, around 0.039 inches.
It is the next step in nanobots using organic matter as the body and making a robotic bot which can do simple things like move, crawl and some complex things as dropping, swimming etc
Researchers use stem cells harvested from the embryos of the African Clawed frog and a sophisticated computer algorithm, they generated a blueprint design that allowed the team to then build a new form of life that has never existed before.

We report here a method for generation of in vitro biological robots from frog (*Xenopus laevis*) cells. These xenobots exhibit coordinated locomotion via cilia present on their surface. These cilia arise through normal tissue patterning and do not require complicated construction methods or genomic editing, making production amenable to high-throughput projects.. We show that the xenobots can navigate aqueous environments in diverse ways, heal after damage, and show emergent group behaviors. We constructed a computational model to predict useful collective behaviors that can be elicited from a xenobot swarm, soft-body living machines for numerous practical applications in biomedicine and the environment.

INTRODUCTION

Xenobots have been “novel living machines” and “living robots”. A co-author said “They are neither a trational robot nor a known species of animal. (they are a new class of artefact; a living, programmable organism”. With all these

features, xenobots have been described as ″novel living machines″ by Joshua Bongard.

“These are entirely new lifeforms. They have never before existed on Earth,” said Michael Levin, the director of the Allen Discovery Center at Tufts University in Medford, Massachusetts. “They are living, programmable organisms.”

The robots, which are less than 1mm long, are designed by an “evolutionary algorithm” that runs on a supercomputer. The program starts by generating random 3D configurations of 500 to 1,000 skin and heart cells from frog *Xenopus laevis*. Each design is then tested in a virtual environment, to see, for example, how far it moves when the heart cells are set beating. The best performers are used to spawn more designs, which themselves are then put through their paces.

they behave like miniature engines that drive the robots along until their energy reserves run out. The cells have enough fuel inside them for the robots to survive for a week to 10 days before keeling over.

BODY

The red/green coloured organism pictured above is about 0.7 millimetres. It was carved from a 10000-cell sphere, and its final geometry contains about 5000 cells.

“These are very small, but ultimately the plan is to make them to scale,” said Levin. Xenobots might be built with blood vessels, nervous systems and sensory cells, to form rudimentary eyes. By building them out of mammalian cells, they could live on dry land.

One of the most successful creations has two stumpy legs that propel it along on its “chest”. Another has a hole in the middle that researchers turned into a pouch so it could shimmy around with miniature payloads. When damaged, living robots can heal their wounds, and once their task is done, they fall apart, just as natural organisms’ decay when they die.

MOVEMENT

After extracted embryonic stem cells have been cultured, microsurgery tools help “glue” the naturally sticky cells together in a range of simple organismic configurations, for example, with molar tooth- shaped or kidney- shaped appearances. By then, the stem cells have become skin cells, which provide scaffolding, and heart cells, which spontaneously contract, giving the xenobots locomotion. Both were derived from cells harvested from blastula stage Xenopus laevis embryos. These tissues naturally develop cilia (waving hairs which enable swimming), but the cilia were removed in the green/red colored organism to producing a walking (instead of swimming) organism.

The organisms live in standard freshwater and can survive in temperatures ranging from 40 degrees to 80 degrees Fahrenheit.

1. Scientist use an evolutionary algorithm to create thousands of random designs, simulating passive skin cells and heart cells which contract
2. The algorithm asks the design to achieve a task designed by the scientist- like walking in one direction
3. The most promising designs are built from living cells scraped from frog embryos.

Prior to biological assembly, in silico design models are generated by supercomputer with an artificial intelligence (AI) algorithm. Primed with relevant biophysical principles, the evolutionary algorithm predicts which of innumerable possible cellular configurations will produce desired functions. In vivo testing results can then be looped back into algorithm to generate new bespoke design models.

LIVING

Their design determines their autonomous functional capacities, which include being able, in aqua, to move linearly or circularly, swarm, “explore”, push small objects, and hold objects in a “pouch”.

USES OR APPLICATIONS

Their unique features mean that future versions of the robots might be deployed to clean up microplastic pollution in the oceans, locate and digest toxic materials, deliver drugs in the body or remove plaque from artery walls, the scientists say. Studies say that xenobots could be used to clean our polluted oceans by collecting microplastics and cleaning up radioactive waste.

Since they can survive in an aquatic environment for a week without any additional food, they could be suitable for internal drug delivery. Given their biodegradable nature, they would also have an edge with technologies made of metal and plastic.

The biological and computational scientist who created xenobots acknowledge both possible benefits and potential ethical issues. To better understand these ethical issues, to better understand these ethical issues, we should be aware of technology context first. In synthetic biology scientists have engineered functional E. coli bacteria with entirely human made genomes that have much larger strands of DNA than in earlier efforts. Genomes in microbes can be chemically engineered to produce drugs, biofuels, and now nutritious proteins, raising the promise of replacing environmentally damaging agriculture.

Now considering ontology. Being composed entirely of cells, xenobots are, in fact, not robots or machines in any traditional sense. So, xenobots "organisms". The glued- together cells survive for a week or so on embryonic energy reserves, although they live longer in nutrient rich liquid. Xenobots function (e.g., swimming) as an autonomous unit or assemblage. Their cells self- repair and reattach when cut.

However, xenobots cannot reproduce reproduce. More importantly for the ontological question, xenobots apparently lack the corporeally integrated and more extensive autopoietic (self- maintaining) functions characteristic of organism. Assuming major advances in AI and Biology, though, that might change. Suppose, for instance, that future biobots were to become more biologically integrated, complex, and even capable of reproduction.

The xenobots design have applications both outside and inside the body. Xenobots are layered heart and skin tissue robots built from frog stem cells. The observed tasks that have been published are organizing microplastics, self-healing and chemical communications with pheromones. There have never been invention lie xenobots before, which is why they are paving a revolution as the fact 'living robots'. These applications include micro- sculpting nerve tissue inside the body and virus detection/ monitoring outside the body.

Inside the body, microbots or xenobots working together can represent an effective new treatment against peripheral and diabetic neuropathy, preventing paralysis. Bolstering the body's response to neural damage by clearing the restrictions of natural neural growth would allow neurons to regrow and connect much faster. Xenobots alone can be injected into the

traumatized area to decompose myelin sheath if this process is accessible within a few hours of serious nerve damage.

Outside the body, xenobots will monitor virus concentrations with a virus stimulus and fluorescent light indication. Can determine how long a particular virus has resided on a surface, giving information about when people could be infected. horizontal gene integration from synthetic RNA and DNA origami mechanisms gives xenobots sensitivity to viruses.

EXPERIMENT

Using VoxCraft software, several variations of xenobot designs can model the behaviour of xenobots inside the body. Beginning with evolutionary algorithms to evolve an optimised quadruped microbot we can also model the microrobots grabbling the end of the neuron tails to promote neuron growth with phototactic sensing.

FUTURE ASPECTS

In future clinical applications, such as targeted drug delivery, xenobots could be made from a human patient's own cells, which would bypass the immune response challenges of other kinds of MICRO-ROBOTIC delivery systems. Such xenobots could potentially be used to scrape plaque from ARTERIES, and with additional cell types and bioengineering, locate and treat disease.

FAQs

How do you compare the similarity of the computer's design with the actual organism that is built?

The behavior of organisms was traced and compared with the virtual design. To determine whether the organisms' movement was a result of chance or due to the design's evolved geometry and tissue placement, geometry and tissue distribution was altered by rotating the design 180° about its transverse plane (flipping it over onto its "back"). The shape and tissue placement of the built organism was compared using computer vision.

Couldn’t these constructs start evolving beyond our control?

There is no evolution here: these CDOs have no reproductive organs. They simply degrade and become non-functional after about seven days. However, living organisms (those made by human-guided mating, bacteria and viruses generated by human travel and impact on the foodchain, etc.) do evolve beyond our control all the time; the best way to deal with this fact going forward is to understand it and learn to guide it.

If an AI did indeed design these organisms, couldn’t an evil (or ignorant) AI design harmful (or unintentionally harmful) organisms?

An AI intent on causing harm seems unlikely, but designing organisms with unintentional side effects is a possible outcome for this technology. We thus believe that all computer-designed technologies — including organisms — require human verification before being created physically, let alone deployed to perform (hopefully) useful work. Further, regulation of such technology is an important next step in the policy space. Regardless, the potential of harm in these kinds of creations is infinitely smaller than current efforts in the virology, bacteriology, and genome editing spaces.

Couldn’t someone program the AI to design weaponized CDOs?

In theory, yes. At the moment though it is difficult to see how an AI could create harmful organisms any easier than a talented biologist with bad intentions could. Despite this, we believe that, as this technology matures, regulation of its use and misuse should be a high priority. Again though, the possibility of misuse is much, much smaller than what is being done with self-reproducing agents like bacteria, viruses, and gene drives.

CONCLUSION

“The aim is to understand the software of life,” Levin said. “If you think about birth defects, cancer, age-related diseases, all of these things could be solved if we knew how to make biological structures, to have ultimate control over growth and form.”

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