To treat cancer, is the force strong with nanorobots?

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Professor Dinos Mavroidis and graduate student Mãni Ahmadniaroudsari are optimizing MRI-guided drug delivery through computer simulation. Credit: Brooks Canaday.

(Phys.org) —Every day, more than 20,000 people around the world succumb to cancer, according to statistics compiled by the World Health Organization. Thousands more continue to suffer through treatment and its side effects.

Since the drugs used to kill cancer cells are just as toxic to neighboring healthy cells, researchers have long coveted a drug delivery method that targets cancer cells alone, while bypassing the healthy ones.

One of these methods utilizes functional Magnetic Resonance Imaging, or fMRI, to steer drug-filled magnetic nanoparticles directly to tumor masses where they can safely discharge their contents. "Even now, magnetic drug delivery is being done," said Dinos Mavroidis, Distinguished Professor of Mechanical and Industrial Engineering at Northeastern. "It's an actual clinical procedure."

The problem, he said, is that controlling the nanoparticles' course is still more an art than a science. To combat that problem, Mãni Ahmadniaroudsari, a graduate student in Mavroidis' lab, is spearheading the creation of a better approach to MRI-guided drug delivery with support from a National Science Foundation grant.

Mavroidis and his team of robotics engineers are control experts. "In one sense, this nanoparticle is like a robotic system, a nanorobot," Mavroidis said. Whereas the traditional robot has a motor incorporated inside the system, here the nanoparticle's motor is the magnetic field itself. Their hope is to use their understanding of robotics to develop a reliable method for changing the forces applied to the nanoparticle by the MRI during drug delivery.

Mavroidis and Ahmadniaroudsari are collaborating with researchers at the Ecole Polytechnique de Montreal in Canada and the University of Orleans in France to make this vision a reality. The international researchers are experts in the experimental side of nanoparticle drug delivery, having carried out extensive investigations in the human body.

"Experimental results require time and money, and are also harmful to test subjects, so we created a simulation platform that actually models the movement of particles inside the body," explained Ahmadniaroudsari, who has a strong background in physics, mathematics, and computer science. The simulation software he developed, called Magnasim, incorporates the physical laws of magnetic force to accurately guide imaginary magnetic nanoparticles through a simulated environment the same way MRI does it in real life.

According to Mavroidis, simulating a magnetic field through the computer is a challenging task. Since there was previously no need to do so, no software currently exists to magnetically guide theoretical particles through a space. With Ahmadniaroudsari's program, clinical researchers would have the opportunity to more quickly realize MRI-guided drug delivery for mainstream cancer treatment.

Provided by Northeastern University