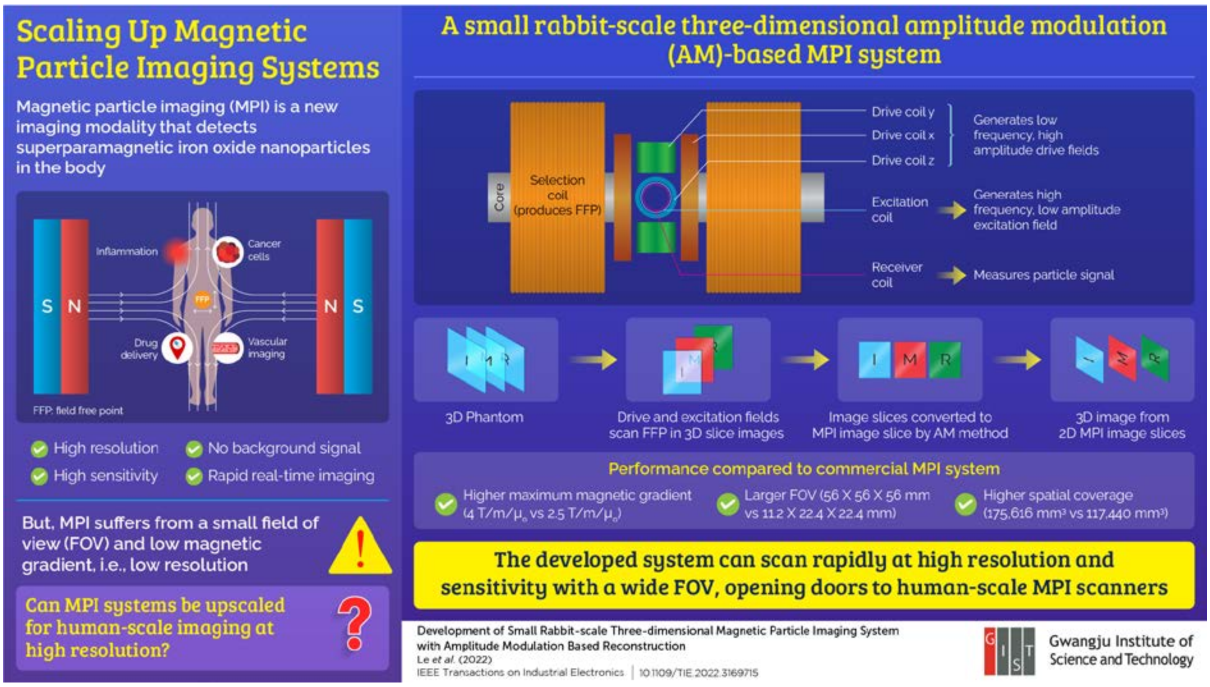
PRESS RELEASE

Gwangju Institute of Science and Technology Researchers Improve the Scanning Capability of Magnetic Particle Imaging Systems Used for Medical Imaging

The low-cost, rabbit-sized scanner has a higher resolution and field-of-view than commercially available scanners

Magnetic particle imaging (MPI) is a highly sensitive emerging medical imaging technique. However, currently available scanners suffer from poor resolution and small field of view. Now, in a new study, researchers from Gwangju Institute of Science and Technology in Korea have developed an inexpensive, small MPI system with a high magnetic gradient and coverage volume that enables scanning of human-scale objects at high resolution.



Magnetic particle imaging (MPI) is an emerging imaging modality that is based on the detection of superparamagnetic iron oxide nanoparticles that have been injected into the body. The magnetic particles act like tracers and are detected in response to a moving magnetic field free point (FFP), which changes their magnetic direction. As these particles do not naturally exist in the human body, it makes MPI highly sensitive and free from background noise. MPI could potentially transform medical imaging. However, currently available commercial scanners often compromise between coverage volume and imaging resolution.

In a new study published online on 29 April 2022 in *IEEE Transactions on Industrial Electronics*, researchers from Gwangju Institute of Science and Technology (GIST) in South Korea have now addressed this issue. They have developed a rabbit-scale three-dimensional (3D) MPI system that can scan a large volume at a high resolution. *"For a large bore size of MPI, it is important to achieve a high magnetic gradient for high image resolution along with a large field-of-view (FOV), while allowing fast scanning and high sensitivity,"* explains Prof. Jungwon Yoon, the corresponding author of the study.

This had to be done without increasing the magnetic field strength or the size of the system, since high magnetic fields can cause undesirable peripheral nerve stimulation in the patient's body and large systems incur higher cooling expenses. To realize this feat, the researchers turned to a technique called "amplitude modulation" (AM), which uses low-amplitude, high-frequency excitation fields in combination with low-frequency, high-amplitude drive fields to quickly scan the FFP and detect the magnetic nanoparticles. "*The AM MPI can enable a large FOV and good resolution while minimizing the peripheral nerve stimulation constraint and hardware requirements*," says Tuan-Anh Le, a postdoctoral researcher at GIST who was involved in the study.

To this end, they developed an AM MPI system with a bore size of 90 mm and seven coils that included selection coils, drive coils (along x, y, z), excitation coil, receiver coil, copy of drive-z coil, copy of the excitation coil, and a cancellation coil. In this configuration, the selection coils generate magnetic fields that produce an FFP, while the drive and excitation coils produce the drive and excitation fields that scan the FFP and generate signals from the magnetic tracer, which are then measured by the receiver coil. A 3D image is created by converting the 3D slice images obtained from scanning the FFP to MPI images using the AM technique.

By testing the imaging capabilities of their system with a 3D phantom, the researchers demonstrated that it had a higher magnetic gradient scanner (4 $T/m/\mu_0$ vs 2.5 $T/m/\mu_0$) and a larger coverage volume (175,616 mm^3 vs 117,440 mm^3) than commercially available MPI scanners. Using the AM technique, they developed a low-cost, small MPI scanner to demonstrate the method's potential for enabling high-resolution 3D human-scale scanners.

Hopefully, it won't be long before such MPI scanners are realized in practice!

Reference

Authors:	Tuan-Anh Le*, Minh Phu Bui, and Jungwon Yoon*
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About the Gwangju Institute of Science and Technology (GIST)

The Gwangju Institute of Science and Technology (GIST) is a research-oriented university situated in Gwangju, South Korea. Founded in 1993, GIST has become one of the most prestigious schools in South Korea. The university aims to create a strong research environment to spur advancements in science and technology and to promote collaboration between international and domestic research programs. With its motto of “A Proud Creator of Future Science and Technology,” GIST has consistently received one of the highest university rankings in Korea.

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Tuan-Anh Le received his Ph.D. degree in the School of Integrated Technology at Gwangju Institute of Science and Technology, Korea, in 2021, where he is currently a Postdoctoral Researcher. His current research interests include electromagnetics, magnetic particle imaging, bio-nano robot control, magnetic hyperthermia, and medical imaging.

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