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Section of Public Relations	Hyo Jung Kim Section Chief 062-715-2061	Nayeong Lee Senior Administrator 062-715-2062
Contact Person for this Article	Professor Jungwon Yoon School of Integrated Technology 062-715-5332	
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Professor Jungwon Yoon's research team develops a navigation system that can freely control nanoparticles in the body

□ GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Integrated Technology Professor Jungwon Yoon's (Intelligent Medical Robotics Lab) research team has developed a magnetic particle imaging (MPI) device* that can acquire high-resolution biometric images at high speed using superparamagnetic nanoparticles** as a tracer, and a nanoparticle intuitive navigation technology that can move nanoparticles with a joystick

* magnetic particle imaging (MPI): It can operate without radiation and can provide a three-dimensional distribution image in real-time proportional to the concentration of nanoparticles, so it can be used in a variety of medical applications such as cardiovascular or cerebrovascular diagnosis, cell labeling and tracking. It also has the advantage of being able to generate signals at all depths within the body.

** superparamagnetic nanoparticles: Iron oxide nanoparticles typically become superparamagnetic when the size of the particles is smaller than 128 nm, and it shows magnetic behavior only when an external magnetic field is applied, preventing magnetic aggregation, and, when the external magnetic field is turned off, residual magnetism returns to zero.

◦ In this study, the researchers succeeded in implementing the world's first integrated navigation technology that allows the concentration and location of nanoparticles to be obtained in real-time images using MPI imaging devices and to move nanoparticles to desired locations through user interaction.

□ Magnetic particle imaging technology was first developed by Philips Research Institute in 2005 and commercialized in early 2010 as a next-generation medical imaging device. It is a medical imaging system that provides a 3D GPS (global positioning system) function for nanoparticles that can determine the position of nanoparticles in the body in real-time.

◦ The MPI device generates a field-free point (FFP)* in a three-dimensional space so that the nanoparticles output a signal for the wireless magnetic field, and it measures this signal to obtain a three-dimensional distribution image of the nanoparticles.

* field-free point (FFP): A sloped magnetic field is applied to magnetize most particles in the space so that only the unsaturated particles whose excitation field is near the FFP will emit a signal. Moving the FFP in space along a sufficiently dense trajectory scans the region of interest.

□ In this study, using an intuitive MPI-based navigation platform featuring real-time (2Hz) MPI image acquisition and user-led virtual FFP manipulation (via a computer mouse or joystick), the trajectory of the grouped nanoparticles is converted into user interaction. It was confirmed that the position of the nanoparticles can be adjusted by directly controlling or monitoring the nanoparticles.

◦ In particular, through the MPI-based navigation platform, users can effectively guide nanoparticles with real-time visual feedback so that this can be applied to target drug delivery. The direction and magnitude of magnetic force can be controlled by adjusting the position of the FFP, and, when combined with MPI, it can be used to control and track the trajectory of magnetic particles.

□ Professor Jungwon Yoon said, "The MPI device, a next-generation medical imaging device currently sold for billions of won, was developed with domestic technology to control the movement of nanoparticles injected into the human body while monitoring nanoparticles in real-time to improve the effectiveness of treatment using nanoparticles. This is expected to contribute to the development of a new drug targeting system medical device by applying it to the medical field where automatic control for targeting in the human body is difficult, such as target drug delivery."

□ This research was carried out with support from the Ministry of Trade, Industry and Energy's robot industry core technology development project, the Ministry of Science and ICT's Human Plus Convergence R&D Challenge project, and the Ministry of Health and Welfare's micro medical robot commercialization technology development project and was published in the online edition on November 24 in the IEEE (International Institute of Electrical and Electronic Engineers) *Transactions on Industrial Electronics*, the world's most prestigious journal in the field of measurement.