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Professor Heung-No Lee's research team improves ultrasonic imaging techniques four times by utilizing wavelength interference and mathematical optimization

- GIST (Gwangju Institute of Science and Technology, President Kiseon Kim) School of Electrical Engineering and Computer Science Professor Heung-No Lee's research team developed a new ultrasound imaging technique that is four times higher than the previous one by utilizing random wavelength interference and mathematical optimization techniques.
 - With this research result, it is possible to capture high-resolution ultra-sonic images that can distinguish nylon wires with 0.25mm intervals.
- The diagnostic ultrasound system is widely used in hospitals as it can acquire long-term images inside the human body more inexpensively than other diagnostics such as MRI (Magnetic Resonance Imaging) and CT (Computed Tomography).
 - The ultrasonic wave from the transducer * of the ultrasonic system device is transmitted to the human body and is partially reflected by the tissue of the human body. By measuring the reflected wave and converting it to an analog-to-digital converter, ultrasound images can be stored as digital images.

* transducer: a device designed to convert energy from one form to another

- In general, the beamforming * method, which focuses ultrasound on a local area, is widely used for the imaging method, and the latest ultrasound imaging equipments can utilize this method to provide ultrasound images with a resolution of up to 1mm.

* beamforming: A technique used in array imaging to create focused pulses. The conventional ultrasound imaging method uses beamforming to separate the region of interest into individual scan lines. By transmitting the beamformed pulses, an image of each scanline is formed. In this case, the resolution of the image is considered equal to the width of the focused pulse.

- The research team achieved high spatial resolution by using random interferences and mathematical optimization methods of artificially generated ultrasonic waves rather than conventional beamforming methods.
 - Ultrasound waves radiated from various times with various random patterns generate various random patterns when they encounter a material that reflects them. The random pattern generated in this way can be recovered as an image image by using a pre-measured impulse response and a recovery method using mathematical optimization.
- This study used this method to simulate a resolution of 0.25mm, which is four times greater than the traditional beamforming based method, and it was proved by experiments that the proposed method can successfully distinguish nylon wires with 0.25mm spacing.
- Professor Heung-No Lee said, "This study is one of the 'Seeing Through Computation' technology proposed as a leap research that can see things better when viewed through computation, and it is applied to the ultrasound imaging field. Most significantly is that we have developed a new basic technology that greatly improves the resolution of images. In the future, it is expected to greatly contribute to making a clearer and cleaner image quality of ultrasound imaging devices."
- This research was led by GIST Professor Heung-No Lee and conducted by integrated student Pavel Ni with support from the National Research Foundation of Korea for the Leap Research Project and was published on April 8, 2020, in *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*.

