Development of AR system to visualize electromagnetic fields based on numerical analysis results

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Osteoarthritis of the knee is a progressive degenerative disease in which abnormalities in cartilage and bone tissues occur as the lesion progresses. One of the low invasive methods to control the progression of the disease is thermal rehabilitation. This study focuses on a microwave diathermy system used in clinical practice. This treatment method radiates electromagnetic waves of 2.45GHz toward the diseased part and heats it without physical contact. However, electromagnetic waves leak out around the device and affect the surrounding people.
We developed a visualization system with AR technology that enables us to display the electromagnetic field distribution around the device in real time. The displayed electromagnetic field area is based on the results of FDTD analysis.

The leaked electromagnetic waves affect medical practitioners, patients and another device placed around the diathermy system. For this reason, the limiting exposure to electromagnetic fields is decided by ICNIRP guidelines. We developed the visualization AR system to observe the limiting electromagnetic fields easily.

At first, we calculated the electromagnetic fields distribution around the device with FDTD methods. Second, 3D models of limiting fields were made with CAD software based on the calculated results. Third, the 3D limiting fields were overlapped to show the real world perspective, using AR technologies.
This visualizing system was developed by Unity systems that is a 3D application development engine and AR development engine Vuforia. In this system, the camera recognizes a marker put on the medical device and gets the global coordinate. Concurrently, the 3D fields models adjusted size were overlapped with the coordinate.

By using our system, the image of the synthesizing screen that visualized the electromagnetic fields was displayed on the monitor in real time. In the monitor the occupational limiting fields and the general public limiting fields were emphasized. It can help doctors and patients check EM exposure fields.

In this study, we developed the AR system to visualize EM fields around the microwave diathermy devices. It can synthesize the calculated results to the real world. In the future, we plan to apply this system to other EM medical devices.