Development of a novel postprocess for improving spatial resolution of electrical impedance tomography

Keiya Minakawa[1], Keigo Ohta[1], Hiroaki Komatsu[1], Tomoko Fukuyama[2], Takashi Ikuno[1]

[1]Department of Applied Electronics, Tokyo University of Science, Japan, [1]College of Science and Engineering, Ritsumeikan University, Japan

Non-destructive testing (NDT) is important to detect cracks and corrosion in the interior structure of buildings. Electrical impedance tomography (EIT) is one of the simplest and lowest cost of NDT. EIT is a technique that measures the surface potential of a material and visualizes the internal conductivity distribution. However, EIT has low resolution because the problem to be solved is nonlinear and ill-posed. We proposed a new post-process of EIT to improve the spatial resolution of conductivity distribution in terms of visualization in precise position and size of embedded objects in specimen. To obtain the internal conductivity distribution, sixteen electrodes were attached around the sample surface and the surface potential was measured when current was injected into arbitrary electrode pair. Conductivity distribution was visualized from a single surface potential using two methods. One visualization method is a mathematical method using software (EIDORS) based on the regularization method. The other is a computational method using machine learning models. The spatial resolution of the conductivity distribution was improved by logical conjunction of the two conductivity distributions obtained from the above methods. The specimen is composed of a cylindrical base object, which is made of cement, and a cylindrical foreign object, which is made of metal or insulator. The diameters of the base and foreign objects were 89.5 mm and ranging from 2 to 30 mm, respectively. The distance between center positions of the base and foreign object was fixed at 15 mm. The cross-sectional surface areas of the foreign object and base object, and the size ratio were defined as S1, S2 and p=S1/S2, respectively. The error between true position and solved position, Δr, and the error between true size and solved size of the foreign object, φf, were evaluated as a function of p. The regularization method, machine learning method, and proposed method were compared in terms of Δr and φf relative to the size ratio p. For all p, the machine learning method had a precise size compared to the regularization method. For p less than 0.008, the proposed method showed improvement of Δr and φf by more than 10% and 25%, respectively, compared to the machine learning method.