Deep Learning-based Ultrasonic Testing for Porosity Evaluation of Metal 3D Printed Parts

Sungho Choi[1], Seong-Hyun Park[2], Kyung-Young Jhang[3]

[1]LANL-JBNU Engineering Institute-Korea, Jeonbuk National University, Republic of Korea, [1]Department of Mechanical Engineering, Stanford University, Republic of Korea, [1]Department of Mechanical Engineering, Hanyang University, Republic of Korea

In the field of metal 3D printing, one of the current issues is to evaluate porosity that can occur during the 3D printing process. Ultrasonic testing is a well-known method for porosity evaluation since ultrasonic parameters are sensitive indices to the variation of porosity. In this work, deep learning-based ultrasonic testing was applied to porosity evaluation of metal 3D printed parts. Metal 3D printed samples containing various levels of porosity content were fabricated under various 3D printing conditions that include laser power and laser scan speed. First, the quantitative porosity content of the samples was evaluated using scanning acoustic microscopy. Based on the results of porosity content evaluated, the samples were divided into six classes. These six classes corresponded to outputs in deep learning model. Then, ultrasonic data were acquired from the samples by a pulse-echo mode using a contact transducer. These time-domain signals were used as inputs in deep learning model. Lastly, a deep learning model was developed based on a fully connected deep neural network and then was trained on the ultrasonic signals measured in the 3D printed samples. The deep learning results showed that the porosity content evaluated by the deep learning model matched well with that measured by scanning acoustic microscopy, which demonstrated the feasibility of deep learning-based ultrasonic testing for porosity evaluation of metal 3D printed parts.