PAUT signal detection and evaluation technology based on deep learning for nuclear power piping welds

SeongJin Lim[1], HyeJin Park[2], InGon Jeong[3], Kwonill Kim[4], DongChan Kang[5], IkKeun Park[5]

[1]R&D center, Korea Inspection Eng Co., Ltd, Republic of Korea, [1]R&D Center, Korea Inspection Eng Co., Republic of Korea, [1]R&D center, Korea Inspection Eng Co. Ltd, Republic of Korea, [1]R&D center, C51 Inc., Republic of Korea, [1]SNDT center, Seoul Nat'l Univ.of Sci & Tech, Republic of Korea

In nuclear power plants, various types of piping play important roles such as transport and storage of fluids and gases. These pipes can be damaged or produce defects due to heat, pressure, and corrosion during long-term operation and operation. In this paper, PAUT technology was applied to improve the speed and accuracy of piping condition and diagnosis, and a deep learning algorithm was developed and applied to secure the soundness of nuclear power plant piping based on the objectivity and reliability of inspection results. To accomplish this, more than 5,200 reference standard data were acquired and stored through discontinuity indications or defects simulated in test specimens maked to produce artificial intelligence learning data, and 3D modeling was performed on major actual defects. The results here were compared with those obtained through simulation s/w (civa) and more than 57,000 big data were produced using virtual test specimens, a modeling technique similar to actual defects. More than 6,000 pieces of evaluation data were acquired, and more than 2,200 pieces of PAUT data were additionally produced/saved from pipes with austenitic structure. Based on this process, a defect detection deep learning model was established and the performance was confirmed by applying general-purpose object detection techniques, namely Faster R-CNN and DETR, which are standard models, for model learning. DefectDet, a model specialized for defect detection, was cracked. It was applied to improve processing speed and accuracy in defect detection. In conclusion, it was confirmed that this algorithm is excellent in terms of defect detection ability and defect evaluation performance by applying signal processing to extract features obtained through the defect signal classification and characterization process from PAUT data. In the future, we plan to expand and apply deep learning technology to PAUT to contribute to improving inspection reliability by optimizing quality control of nuclear piping and minimizing inspection errors.