Effect of deep learning network design and image pre-processing of ground penetrating radar (GPR) data for underground cavities

*磯 真一郎[1]、齋藤 章[1]、尾西 恭亮[3]、松岡 俊文[4]、高橋 亨[4]、戸部 征雄[2]
*Shinichiro Iso[1], Akira Saito[1], Kyosuke Onishi[3], Toshifumi Matsuoka[4], Toru Takahashi[4], Yukio Tobe[2]

1. 早稲田大学理工学術院　創造理工学部　環境資源工学科、2. 株式会社　ジオファイブ、3. 国立研究開発法人土木研究所、4. 公益財団法人深田地質研究所
1. Graduate School of Creative Science and Engineering Dept. of Resources and Environmental Engineering, 2. GeoFive Co. Ltd., 3. Public Works Research Institute, 4. Fukada Geological Institute

Background

For many years, GPR (Ground Penetrating Radar) systems have been used to detect cavities underneath the road surface. A system on a vehicle is available to acquire a significant amount of data with multi-channels, such as 21 channels, faster than about 40 km/h driving. Amount of the data has become larger and larger. The accumulated surveyed road path is supposed to be more than 150, 000 km.

Today, the experts spend a long time to inspect visually such massive data to identify cavities. It also takes years to become a skilled expert. These years, besides development of the new machine learning theory, the deep learning network design and computation technology, such as software frameworks and computer hardware show drastic improvement.

Deep Learning approach is supposed to work with the acquired data directly. It means that automation of recognition and classification of the types of reflectors with the simply pre-processed acquired data. Also, the “learning” can be improved continuously with the accumulated training data less computation resource. Such feature will fit the analysis of the GPR data for underground cavity survey.

Iso et al. presented “Processing of ground penetrating radar (GPR) data for underground cavity survey by deep learning,” at the 135th SEGJ (Society of Exploration Geophysicists of Japan) Conference in 2016 and “Processing of ground penetrating radar (GPR) data for underground cavity by Convolution neural network”, at JpGU-AGU Joint Meeting in 2017. It shows a Deep Learning approach is promising to distinguish cavities, metal pipes and others for GPR cross-section. In 2017 at the 28th JSTT (Japan Society for Trenchless Technology) conference, Suzuki presented the “method to automatically detect cavities from GPR images by applying artificial intelligence (AI) technology”, which is based on Deep Learning.

However, the network design and the parameters of the deep learning, and the suitable image pre-processing are not understood well how affecting the accuracy and efficiency of the underground cavity recognition.

Purpose of the new study

The aim of this study examines and evaluate how the network design and image pre-processing to optimize the entire automation process for the cavity recognition by GPR.

Conclusion / Discussion

The result is compared and discussed the recognition accuracy and efficiency with some of the network design with the parameters, and pre-processing method, such as noise reduction and offset removal

processing.

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