Damage Detection and Safety Diagnosis for Immovable Cultural Assets Using Deep Learning Framework

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Cultural assets are recognized as having cultural values among the products of the cultural activities our ancestors carried out and of great historical or artistic value as well. Since cultural assets, which are also those of the nation, cannot be restored once damaged, both preservation and transmission of the cultural assets are critical. When some changes occur in cultural properties by any chance, if they can be identified as quickly as possible by using Deep Learning, rapid initial response and management will be possible, which will significantly help the management and preservation of cultural properties. This paper aims to create a Deep LearningFramework that can effectively detect minute inclinations that may be difficult to identify with human eyes. For Heunginjimun, the No.1 national treasure of South Korea, four types of pretraining-based Deep Learning models were used, which were EfficientNetB0, EfficientNetB2, ShuffleNet_v2, and AlexNet. The experiment was conducted using a typical dataset in the environment constructed by using Heunginjimun CCTV images, and then an abnormal dataset was regenerated based on the typical dataset. As a result of applying the Deep Learning model to each environment we have built, the average prediction accuracies of EfficientNetB0, EfficientNetB2, and ShuffleNet_v2 among the four models were 99.69%, 99.66%, and 93.46%, respectively, showing high prediction accuracies. Therefore, it is judged that the results of the experiment will be of great help in the field of management and preservation of cultural properties in the future.

Keyword— **Deep Learning, Cultural Heritage, Machine Learning, Anomaly Detection, Displacement detection**

Sang-Yun Lee(B'94–M'96–D'07) is a principal researcher at Police Science & Public Safety ICT Research Center of Intelligent Convergence Research Laboratory in ETRI. He has been working at ETRI since 1999. In 2008, he received Ph.D. in Electronics and Telecommunications Engineering at the University of Hanyang(Rep. of Korea). He has been developing technologies in the fields of Broadcasting Communication, System Software, Embedded Software, Artificial Intelligence, and etc. His main research interests have been in Computational Sciences. Currently, he is involved in developing a technique to detect displacement using Artificial Intelligence technology for CCTV images of cultural assets. He also leads several projects including disaster management for cultural heritage. Since 2016, He acts as an editor of the Study Group 16 (SG16) in the ITU-T and has been developing international standards. He is an international standards expert at TTA and a member of the Korean ITU-T Research Committee. He has been carrying out more than 10 government-funded projects. He is author of more than 70 scientific papers and has registered more than 10 patents.

Ho-Hyun Cho (B'20) was Born in Bucheon, Gyeonggi-do, South Korea. graduated from high school in Daejeon and majored in Business Administration at Korea University. After graduation, he got interested in both blockchain and artificial intelligence. He is currently working for Season, Inc. located in Sejong. His main studies are as follows. First, load cell sensor data analysis was performed by using t-SNE, isolation forest clustering algorithm. Second, antibody analysis modeling for corona kit was performed by using OpenCV and MaskR-CNN. Next, plasma sensor data analysis and visualization were performed. At the moment, he is contributing to the discovery of new preservation methods for cultural properties by combining artificial intelligence with elements of cultural heritage management. In addition, in his recent studies, he showed interest in the application of artificial intelligence algorithms related to image processing and hopes to continue further research on these in the future.