New machine learning model can provide more accurate assessments of hurricane damage for responders

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Emergency crews responding to hurricane-damaged areas may soon get an assist from a machine learning model that can better predict the extent of building damage soon after the storm passes.

The model uses remote sensing from satellites that can generate building footprints from pre-hurricane images and then compare them with images taken after the storm.

While some previous models could only tell if a building was damaged or not damaged, this deep learning model can accurately classify how much damage buildings sustained—key information for emergency responders, said Desheng Liu, co-author of the study and professor of geography at The Ohio State University.

"Often it is difficult or impossible to rapidly assess the impact of a hurricane or other natural disaster from the ground," Liu said. "Our goal is to be able to provide near real-time information about building damage that can help emergency crews respond to disasters."

Liu conducted the study with Polina Berezina, a graduate student in geography at Ohio State. Their results were published earlier this year in the journal *Geomatics, Natural Hazards and Risk*.

The researchers tested their new model on data from Hurricane Michael in 2018 and found that its overall damage assessment was 86.3% accurate in one region of Florida—an 11% improvement over one current state-of-the-art model.

The research study area included Bay County and parts of neighboring Calhoun, Gulf, Washington, Leon and Holmes counties on the panhandle of Florida. Panama City is the major metropolitan area included in the study.

The National Oceanic and Atmospheric Administration estimated the total damage to the U.S. economy from Hurricane Michael to equal $25 billion. Of that amount, $18.4 billion worth of damage occurred in Florida.

The researchers obtained commercial satellite images for the study area. Pre-hurricane images were from October or November 2017. Post-event imagery was obtained on cloud-free days directly after the hurricane impact, mostly on Oct. 13, 2018. The hurricane had made landfall on Oct. 10.

Within the dataset the researchers used, the study area included 22,686 buildings.

Berezina and Liu used a type of machine learning called convolutional neural networks (or CNN) to first generate building footprints from the pre-hurricane satellite imagery and then classify the amount of damage after the storm. Their model classified buildings as undamaged, minor damage, major damage or destroyed.

Overall, the new model has an overall accuracy of 86.3%, improving upon the 75.3% accuracy of the support vector machine model (or SVM) to which it was compared.

"The SVM struggled to distinguish between minor and major damage, which can be a major issue for teams responding after a hurricane," Liu said. "Overall, our results for Hurricane Michael are promising."

In live hurricane situations, Liu said the model could be used to rate the probability that individual buildings are in a certain damage class—such as minor damage or major damage—to help direct emergency management and first responders to where they should check first.

More information: Polina Berezina et al, Hurricane damage assessment using coupled convolutional neural networks: a case study of hurricane Michael, *Geomatics, Natural Hazards and Risk* (2022). DOI: 10.1080/19475705.2022.2030414

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