Real-Time Sinkhole Detection Using Civil Engineering Techniques, the Internet of Things (IoT), and Artificial Intelligence

Wang, Sophia (School: Amity Regional High School)

In the United States, 20% of land is susceptible to sinkholes. Designs derived from civil engineering (structural health monitoring system (SHMS) and wireless sensor network (WSN)) and computer science (the Internet of Things (IoT) and Artificial Intelligence/Machine Learning (ML)) were used to more accurately and efficiently detect sinkholes compared to current methods, which are single frame detections and inapplicable to the most dangerous sinkhole type (cover collapse). SHMS and WSN were used to create a sensor network that could diagnosis underground structural state in real time. A sensing device which modeled the limestone dissolution process was used to encapsulate the sensor network. IoT was applied to create a user friendly interface, and ML algorithms were developed to analyze data in realtime. ML allowed for system automation. To test the system, a cover collapse sinkhole was physically modeled using karst geology. The sensing devices were placed in set locations prior to simulation. The sensor data was recorded during simulation and ML analyzed. The ML Algorithms (Neural Network, Naive Bayes, K-Nearest Neighbor, Random Forest, SVM) had high testing accuracy, with Random Forest obtaining a 93% testing accuracy after training. The Algorithms provided for a significant detection period prior to collapse and served as a prediction model, while also determining the sinkhole location. The detection system accurately and efficiently detected future sinkhole occurrences in real time, and when advanced, these designs have the potential to not only reduce property damage, but more importantly, eliminate the massive public health threat that sinkholes pose.

Awards Won:

First Award of $3,000

Geological Society of America &amp

American Geosciences Institute: Second Award of $1500