Sinkhole Detection Using Wireless Sensor Networks and Structural Health Monitoring

Wang, Sophia (School: Amity Regional High School)

Currently, the only sinkhole detection technique is by interferometric synthetic aperture radar (InSAR), which is both costly and inefficient. This project aims to provide more efficient sinkhole detection. It was hypothesized that designs derived from the structural health monitoring system (SHMS) and the wireless sensor network (WSN) will be used to more efficiently detect sinkholes. MPU 6050 accelerometers were used and WSN establishment allowed for real-time data access via wireless connection. WSN establishment was created through connection to a private IP address with an Arduino Ethernet Shield. Accelerometer data was on a webpage in the localized system. The accelerometer was coded to provide four sets of data outputs regarding angular orientation and acceleration. The angular orientation data was transformed using Processing and coded to provide a Teapot module to visualize orientation in three dimensions. To test the approach, a cover-collapse sinkhole was created. The sensor data throughout was recorded. The sensors were placed in set locations to determine different activity. This system located areas of activity, indicating a sinkhole. The data was then analyzed for patterns and its connection to sinkhole development. The results showed a significant change in the X, Y, and Z axes in angular orientation and acceleration prior to total collapse. The application of WSN and SHMS is a major development in sinkhole detection as the design provides cost effective and efficient data communication in real-time compared to current methods. In the future, this system can be transformed into a complex 3D module using the Finite Element Method. If successful, these designs have the potential to save thousands of lives affected by such catastrophic cavities.

Awards Won:

Third Award of $1,000

Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Intel ISEF Category

Society for Experimental Mechanics, Inc.: Third Award of $1,000