Detecting Potential Sinkholes Near Vehicular Roadways Using Remote Sensing

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Abstract
Sinkhole occurrence is caused by the hydrology of groundwater entrance into the carbonic bedrock, where it becomes acidic, and slowly dissolves soluble rock; ultimately forming a void suitable for a concave bowl-shaped depression. The purpose of this investigation is to identify methods capable of identifying sinkholes near vehicular roadways. Research shows that the airborne laser technique provides the most accurate data for locating potential sinkholes. The mechanisms ability to use inertial measurement unit as a rationale for the variations in angular dislodgment provides coverage for the differentiation in GPS coordinates provided by both airplane and satellite.

Mechanisms To Detect Sinkhole Formation
- Infrared Thermography
  Characterizes material properties through heat imaging
  Water contains a high heat emissivity content that ranges from 0.98-0.995
  - this aids in the search in terrain that contain high water content in soil
  Limitations include distinguishing reflected, or incident radiation cast on the surface of an object and the actual temperature of the object formulates a discrepancy. This means that all of the incident radiation on the surface of the object is absorbed, and results in an increase in temperature of the object (Lai, 2005)
  Passive Thermography
  - collects the temperature of the object without the need of an external heat source
  - any changes in temperature can result in either coring or ultrasonic frequency
  Active Thermography
  - heat is applied to the surface of an object to reveal defects in size or depth in soil variations
- Airborne Laser Technology
  Laser propulsion are fed through a fuselage, located at the inferior region of an airplane. Once the laser is over the designated area, computer programming is given to emit roughly 33,000 laser pulses per second to the ground in a saw-toothed pattern (Lai, 2005). The airplane then collects satellite GPS coordinates to assess orthogonal angle are maintained throughout flight. However, satellite GPS does not provide accurate coordinates due to the planes constant orthogonal rotation. Inertial measurement units calculate angular displacement as a percent error, and uses the percent error for correct trajectory laser points. The trajectory points are entered into the Digital Elevation Model (DEM) where low-lying circular depressions are inspected as potential sinkholes.
- Uninhibited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)
  Polarized waves are transmitted by the radar pod, located attached to the inferior region of the Gulfstream III, sending and receiving radio waves. The Gulfstream, in this instance, was flown for several trials over a particular area multiple times with the Precision Autopilot software controlling the airplane. The UAVSAR has the capability of measuring soil moisture, detecting heat activity underneath snow with depths between three to four feet, performing analysis of levees for flood control, identifying subsidence due to oil pumping, and ground movement functioning after earthquakes.

Sinkhole Discussion
Sinkholes originate in the lithosphere and asthenosphere due to the hydrology of groundwater causing erosion/dissolution to the cover layer of limestone bedrock, creating a void suitable for a concave bowl-shaped depression. The purpose of this investigation is to identify methods capable of identifying sinkholes near vehicular roadways. Research shows that the airborne laser technique provides the most accurate data for locating potential sinkholes. The mechanisms ability to use inertial measurement unit as a rationale for the variations in angular dislodgment provides coverage for the differentiation in GPS coordinates provided by both airplane and satellite.

Conclusions
Based upon the features and characteristics of these mechanisms, the airborne laser technique provides the most accurate data for locating potential sinkholes. The mechanisms ability to use inertial measurement unit as a rationale for the variations in angular dislodgment provides coverage for the differentiation in GPS coordinates provided by both airplane and satellite.

References

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