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Abstract

Electrical Resistivity Measurement for Detecting Subterranean Cavities

The electrical resistivity of soil, under static electrical potential, is sensitive to various parameters such as density, material composition, temperature and humidity. Electrical resistivity has been used for many years to monitor hydrological and geological parameters, and commercial systems are available for near-surface measurements. This concept can be adapted to detect subterranean cavities.

One main challenge, in detecting cavities by electrical resistivity measurement, is the unknown spatial distribution of electrical resistivity in the medium surrounding the cavity. Different realizations of the unknown electrical resistivity of the medium introduces uncertainty in the interpretation of the measurements and can mask the presence of a cavity. Uncertainty in the cavity size, shape and location may be relevant as well.

Info-gap decision theory emerged 35 years ago from the study of assaying unknown spatial distributions.[1] Since then, info-gap theory has developed from a theory of mechanical design and analysis,[2] to a non-probabilistic theory of mechanical reliability,[3] to a full-blown decision theory under severe uncertainty[4] with applications in many disciplines, including economics,[5] and is applied by scholars around the world.[6]

Info-gap theory is especially suited to representing severe uncertainty in spatial variability. The basic design methodology in info-gap theory is to prioritize design alternatives according to their robustness against uncertainty while achieving specified goals. The goal is detection of cavities exceeding a given size. The uncertainty is the unknown spatially varying electrical resistivity of the medium (and perhaps also the cavity geometry). The best design is the one that detects cavities over the widest range of unknown electrical resistivity. The design parameters are the number and spatial deployment of current and voltage electrodes and strength of the applied current.

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[1] Yakov Ben-Haim, 1985, *The Assay of Spatially Random Material,* Kluwer Academic Publishers.

[2] Yakov Ben-Haim and Isaac Elishakoff, 1990, *Convex Models of Uncertainty in Applied Mechanics,* Elsevier Science Publishers.

[3] Yakov Ben-Haim, 1996, *Robust Reliability in the Mechanical Sciences,* Springer-Verlag

[4] Yakov Ben-Haim, 2006, *Info-Gap Decision Theory: Decisions Under Severe Uncertainty,* 2nd edition, Academic Press, London

[5] Yakov Ben-Haim, 2010, *Info-Gap Economics: An Operational Introduction,* Palgrave-Macmillan.

[6] See info-gap.com