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A Bayesian framework for forensic investigations involving lighting location system data

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Abstract

The work presented in this thesis extends and contributes to research into the forensic use of Lightning Location Systems and the uncertainty present due to location errors. While previous work in this area has produced some approaches that can be used in forensic investigations, there has not been a consistent, standardised approach to presenting Lightning Location System stroke reports as evidence in a legal environment. In the research presented, a Bayesian framework for representing Lightning Location System data as likelihood ratios and posterior probabilities is developed. The statistical models necessary for use of the framework are discussed and verified through ground-truth events and bivariate statistical analysis. Photographs of multiple lightning events to the Brixton tower in South Africa and current measurements at the Gaisberg tower in Austria are used as ground-truth data and bivariate statistical techniques are used to fit and evaluate different statistical models. It is shown that the bivariate Students' t-distribution is the best fit for Lightning Location System location errors, rather that the commonly assumed bivariate Gaussian distribution and that a bivariate Gaussian Mixture Model can be used to describe the prior probability of lightning occurrence in a region. It is demonstrated how the Bayesian framework can be used to present Lightning Location System data as evidence in a court of law. This represents a unique and valuable contribution to those working in the field of lightning location and, in particular, in forensic situations.