Improving Hyperspectral Change Detection Performance

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There is significant interest in the use of airborne hyperspectral imagery (HSI) to detect small, low-contrast changes in a scene at the pixel or subpixel level. Co-registered HSI data collected at two or more times provide a high-dimensional observation space that enables correlated changes in spectral radiance (due to environmental effects such as illumination and atmosphere) to be estimated and suppressed in favor of more subtle material changes with differential spectral content. To this end, a number of automated change detection algorithms based on statistical estimation and decision theory have been developed and refined over the past 15 years. The most common algorithms, such as chronochrome and covariance equalization, use multivariate linear prediction combined with spectral anomaly filtering of the prediction error to detect potential change targets. These algorithms have performed effectively on various data sets and have even been incorporated into an operational system (the Civil Air Patrol's ARCHER airborne search and rescue system).

While significant progress in HSI change detection has been made, there is still considerable room for improvement. Future algorithms must provide more effective suppression of localized "nuisance" changes due to variable shadowing, adjacency effects, viewing geometry and registration error, without compromising the ability to detect small physical changes. This paper will review recent investigations aimed at enhancing change target sensitivity and false change mitigation performance, relative to current baseline techniques. Concepts to be discussed include class-conditional change filtering, nonlinear prediction, model-based pixel normalization, hybrid change filters, and signature-based change analysis. Some of these ideas show considerable promise, while others appear less successful or in need of further study. Sample data collected by the CAP ARCHER sensor will be used to illustrate several new techniques and their performance, and to provide explanations for observed results.

Bibliography

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