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ESTIMATION OF ERROR PROBABILITY FOR MULTI-DIMENSIONAL GAUSSIAN MAXIMUM LIKELIHOOD CLASSIFIERS USING A CONTROLLED SPACE QUANTIZATION TECHNIQUE

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Probability of correct classification is generally agreed to be the most important criterion in evaluating the performance of a classifier. At LARS, a maximum likelihood classifier based on Gaussian statistics for the data is employed for classification of remotely sensed data. Being a multiple-category classifier, its performance cannot be analyzed as comprehensively as that of a two class classifier. In fact, the only practical method known to carry out such an analysis is an empirical determination based on the Monte Carlo technique. The method described here is an attempt to provide an alternate method of making such an analysis.

In the new approach described here, the feature space is quantized and the appropriate density function is integrated over the correct decision domain, thereby yielding the conditional probability of correct classification for that class. In a more detailed manner, the process proceeds as follows. An orthonormal transformation is applied to the density functions such that the pdf of the class under consideration is located at the origin of the coordinate axes and has a diagonal covariance matrix. The space is then quantized, using a binomial approximation to a normal random variable. The correct decision domain is determined by testing each grid point in the discriminant functions. Then the conditional probability of correct decision is the sum of multiple integers over the cells residing in the correct decision domain. The problem is considerably simplified because of the aforementioned orthonormal transformation results in separable density functions, thereby reducing the multiple integrals to a product of several one dimensional integrals (tabulated values). This process is carried out for each class and the overall PCC then given as

$$PCC = \sum_{i=1}^{M} (PCC|\omega_i)P(\omega_i) \quad P(\omega_i)\text{: A priori}$$

class probability
Results for a multi-dimensional, multiple class classifier are presented.