

1-1-1977

# Estimation of Error Probability for Multidimensional Gaussian Maximum Likelihood Classifiers Using a Controlled Space Quantization Technique

G. Mobasseri

C. D. McGillem

Follow this and additional works at: [http://docs.lib.purdue.edu/lars\\_symp](http://docs.lib.purdue.edu/lars_symp)

---

Mobasseri, G. and McGillem, C. D., "Estimation of Error Probability for Multidimensional Gaussian Maximum Likelihood Classifiers Using a Controlled Space Quantization Technique" (1977). *LARS Symposia*. Paper 230.  
[http://docs.lib.purdue.edu/lars\\_symp/230](http://docs.lib.purdue.edu/lars_symp/230)

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact [epubs@purdue.edu](mailto:epubs@purdue.edu) for additional information.

Reprinted from

**Symposium on  
Machine Processing of  
Remotely Sensed Data**

**June 21 - 23, 1977**

The Laboratory for Applications of  
Remote Sensing

Purdue University  
West Lafayette  
Indiana

IEEE Catalog No.  
77CH1218-7 MPRSD

Copyright © 1977 IEEE  
The Institute of Electrical and Electronics Engineers, Inc.

Copyright © 2004 IEEE. This material is provided with permission of the IEEE. Such permission of the IEEE does not in any way imply IEEE endorsement of any of the products or services of the Purdue Research Foundation/University. Internal or personal use of this material is permitted. However, permission to reprint/republish this material for advertising or promotional purposes or for creating new collective works for resale or redistribution must be obtained from the IEEE by writing to [pubs-permissions@ieee.org](mailto:pubs-permissions@ieee.org).

By choosing to view this document, you agree to all provisions of the copyright laws protecting it.

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

G. MOBASSERI AND C. D. McGILLEM

Laboratory for Applications of Remote Sensing  
Purdue University  
West Lafayette, Indiana 47906

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.