A PATTERN RECOGNITION TECHNIQUE AND ITS APPLICATION TO HIGH-RESOLUTION IMAGERY

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SCOPE OF THE PROGRAM

The purpose of this project was to extend the study of the feasibility of automatic TIROS photograph analysis. A specific objective was to arrive at the design specification for a feasibility model of an automatic vortex recognition system.

The study had four main phases: 1) the development of logical design techniques applicable to the analysis of TIROS photographs, 2) experimental investigations of selected design parameters on a simplified problem, 3) the simulated design of a vortex recognition system using actual TIROS photographs, and 4) the consideration of suitable hardware for implementing the system.

In the study of the design approach, a variation of the discriminant analysis-iterative design technique was developed. A description of this technique is given in the next section along with a discussion on discriminant analysis, in which alternative pattern differences are assumed. Only one of these, one in which differences in covariance matrices of the pattern distributions are exploited, is suitable for the cloud pattern analysis. This discriminant analysis yields a quadratic discriminant surface and requires complex hardware for mechanization of the resulting first layer logic units. To simplify the implementation of the system, an approximation to the quadratic unit was developed. The approximate unit is derived from a principal axis solution, and substitutes a pair of parallel hyperplanes for the quadratic switching surface of the more complex unit. Methods have been developed to make the system invariant to changes in the brightness and contrast of the input patterns. This invariance is considerably more effective than a simple normalization of the input pattern, as it is achieved by making each logic unit invariant to such changes. The iterative design process itself is a means for assigning output weights to the logic units, and for emphasizing the difficult patterns. In common with the popular error correction methods, iterative design will find a solution whenever it is possible to assign these output weights to give perfect performance on the sample patterns. Unlike error correction, iterative design provides an "optimum" set of weights when no solution exists, and maximizes the switching surface to pattern distances when one does exist.

A portion of the experimental program was performed on a simplified problem using low-resolution, hand-printed alphabetic characters. These studies were used to investigate selected aspects of the design technique, rather than its application. The simplified problem permitted a very much more extensive investigation than would be possible on the cloud patterns. The average computer simulation time (IBM 7094) to design a recognition network for cloud patterns was five hours—for the alphabetic characters, five minutes. Two sets of