SEGMENTATION AND SHAPE ANALYSIS FOR TRACKING IN TV VIDEO

FINAL REPORT

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Abstract: Techniques of automatically segmenting tactical targets from their background in image data and then classifying the extracted shapes have been explored. The segmentation method uses grey level, edge content, and texture. Primary research emphasis has been on improving the method of shape analysis using Fourier descriptors. A new method of classification in Fourier descriptor space has been implemented which allows quicker and more accurate library searches while requiring less storage. Also the concept of partial shape description has been further developed during this research period.
1. PROBLEMS STUDIED

The purpose of this research was to develop improved algorithms and methods for automatically recognizing tactical targets in TV video imagery. This problem can be divided into two parts: (1) segmentation of objects from their background; and (2) recognition of the segmented objects. Although some work was done on improving segmentation methods, the major effort of this research was on the second problem, shape recognition, especially the use of Fourier descriptors for shape recognition.

II. IMPORTANT RESEARCH RESULTS

A. Adaptive Segmentation of Objects from their Background.

An approach was developed for locating and segmenting objects from their backgrounds. The objects were assumed to differ from the background in grey level, edge content, or texture. The algorithm locates unique regions of the image and then, using an expanding set of concentric annuli, locates the exact region of uniqueness, thus segmenting the object from its background. These results are reported more completely in Reference [1] which was included in the previous Progress Report submitted for this contract.

B. Fourier Descriptor Improvements

Prior work using Fourier descriptors has shown these to be particularly useful for recognizing the type and orientation of aircraft as seen in TV imagery. References [2] and [3] give details on this method. Reference [3] was published during this research period and
was included in the previous Progress Report submitted for this contract.

The Fourier descriptor method involves tracing the contour of an unknown object; filtering to remove quantization noise due to the finite resolution of the TV imagery; taking a Discrete Fourier Transform of the contour data; normalizing the Fourier coefficients with respect to scaling, translation, and rotation; and comparing the normalized coefficients (the Fourier descriptor) with library entries of known shapes. Two additional improvements were next made: (1) an eigenvector transformation which removes the redundancy in the coefficients and reduces the amount of data required for each library entry to 12 integers, and (2) the ability to interpolate between library entries so that classification accuracy is improved without adding additional library entries.

During this research period, much emphasis has been placed on improving the classification procedure. Based on work done originally by Kuhl [4] a new method of ordering and storing the library Fourier descriptors has been implemented. Since each Fourier descriptor is represented by 12 integers, it can be considered to be a point in 12-dimensional space. Each view of an object (caused by changes in yaw and roll) can be represented by another 12-dimensional vector. In fact as the object changes orientation, it sweeps out a surface in this 12-dimensional space which represents every possible Fourier descriptor vector which can represent this object. This surface is the "library" for this object.

Our research in this area has concentrated on finding good methods of representing this surface and searching an unknown vector to see if it is close to the surface. We have developed methods of sampling
the surface and ordering the samples so that the total Euclidean
distance in 12-dimensions between the ordered samples is almost
optimally minimum. The surface is then represented by a 12-dimensional
chain code representing the connection of sample points on the surface.
Initial experiments have found that this method of storing libraries
requires less memory than storing every 12-dimensional vector as
was done previously. The classification accuracy has increased
slightly (due to a more optimum surface sampling). The speed of the
library surface is improved because the distance measure can be
updated from one sample point to the next instead of having to be
entirely recalculated.

We feel this new method has good potential but needs additional
research before a final implementation method is fixed. One area
which needs research is the normalization methods. The technique of
normalization with respect to rotation has some ambiguities involved
and results in surface discontinuities in the 12-dimensional Fourier
space. Other normalization methods need to be considered which would
give fewer discontinuities and thus result in more compact library
representation.

C. Partial Shape Descriptors

Often either obscuration or a poor segmentation results in a
partial contour instead of a complete one. We have been developing
shape description methods which can recognize partial contours. The
first results of this are reported in Reference [5] which will be
published in May 1981. Work in this area is in progress but no
significant results have yet been obtained other than those in [5].
This reference describes a shape descriptor based on distances from
one point of maximum curvature to the next and total angle change from
one point of inflexion to the next on the contour.

D. References for Section II.
Unique Objects," Proc. Fifth Inter. Conf. Patt. Recogn.,
Aircraft Recognition Algorithm Using Normalized Fourier
Descriptors," Computer Graphics and Image Processing, vol. 13,
pp. 96-126, 1980.
Movement Using Fourier Descriptors," IEEE Trans. on Pattern
Analysis and Machine Intelligence, Vol. PAMI-2, pp. 583-588,
Nov. 1980.
[4] F. Kuhl and R. Covelli, "Object Identification by Multiple
Observations of the Scattering Matrix," Proc. of IEEE, vol. 53,
Shape Analysis Using Local Shape Descriptors," to appear in

III. Publications
Manuscripts published under ARO sponsorship during this period:
Movement Using Fourier Descriptors," IEEE Trans. on Pattern
Analysis and Machine Intelligence, Vol. PAMI-2, pp. 583-588,
Nov. 1980.
Inter. Conf. Patt. Recog., Miami Beach, FL., pp. 361-363,
IV. Participating Scientific Personnel

Graduate Students

S.M. Lutton
D.J. Charpentier

Faculty

O.R. Mitchell

No degrees awarded to these people during this time period.