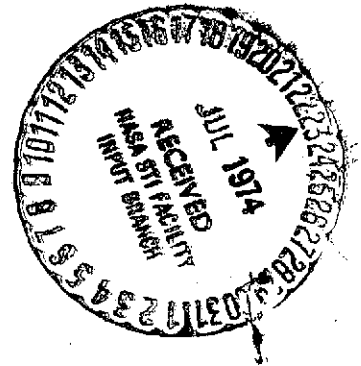University of Maryland
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Techniques for the Processing of
Remotely Sensed Imagery

Final Technical Report
covering the period
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This project was concerned with the development of image processing techniques applicable to the analysis of satellite imagery. Further detail as to the specific areas investigated are given in the abstracts of the technical reports listed below.

1. A comparison of techniques for the classification of low resolution satellite imagery

    N. J. Belknap

    (Computer Science Center Technical Report 215)

    December, 1972

    The work presented here investigates the use of a variety of techniques which might be used in the classification of low resolution satellite imagery. Broadly speaking, these consist of gradient operations, histogram methods, gray level detection, and frequency domain operations. The techniques are first examined on a local basis within images (Phase I). Those found useful are then used in the global classification scheme (Phase II) in that the results derived locally are used to guide the global classification decision which is finally based upon the type of interface between two possible classes. The resulting approach is applied to satellite imagery containing considerably complex visual information from the photointerpreter's point of view. As anticipated only partial classification of images was possible for reasons which are discussed. It is concluded that factors entirely external to the image (e.g., season) must be employed in order to achieve superior classification.

2. On the use of the Hadamard transform in digital image matching

    E. S. Deutsch and Z. F. Wann

    (Computer Science Center Technical Report 216)

January, 1973

The use of Hadamard transform filtering in
digital image matching applications is described.
In most applications of Hadamard transforms emphasis
has been placed upon the fidelity of the reproduced
image; typically, the objective was to minimize the
amount of information required to represent an image.
In image matching applications -- here one wishes to
establish whether two given images are largely the
same -- it turns out that the opposite is the case
since in initially establishing the possible exis-
tence of a match, or a mismatch, one is no longer in-
terested in minute detail. Because it is usually
costly in terms of computer operations to determine
the potential of a match between two images, the
matching philosophy adopted here is one whereby a
coarse matching criterion is sought first. Only
thereafter should a finer matching process be under-
taken. This approach will find applications in the
analysis of satellite imagery when temporal change is
to be detected. Indeed the large size of the images,
as well as their overwhelming number, seems to dic-
tate such an approach.

Hadamard domain filtering to an excessive degree
has been found to be extremely useful in coarse image
matching. Since one is interested in global matching
first, the problem becomes one of how much filtering
can be tolerated before the images are rendered use-
less at this level. The paper shows that compared to
conventional matching methods, this technique reduces
the average number of operations required to establish
a match criterion, thus giving an overall reduction
in the time taken to produce a match or mismatch de-
cision. It also reduces the positional error of mis-
match.

In situations in which one of the images contains

noise, the matching problem is aggravated still
further. The paper will show that the approach
adopted is useful under these circumstances, too.

3. On the quantitative evaluation of edge detection
schemes and their comparison with human performance
J. R. Fram and E. S. Deutsch
(Computer Science Center Technical Report 221)
March, 1973

A technique for the quantitative evaluation of
edge detection schemes is presented. It is used to
assess the performance of three such schemes using
a specially-generated set of images containing noise.
The ability of human subjects to distinguish the
edges in the presence of noise is also measured and
compared with that of the edge detection schemes.
The edge detection schemes are used on a high-
resolution satellite photograph with varying degrees
of noise added in order to relate the quantitative
comparison to real-life imagery.

4. Digital matching using the Hadamard transform:
further experiments
Z. F. Wann and E. S. Deutsch
(Computer Science Center Technical Report 222)
May, 1973

Further work in image matching using the Hada-
mard transform is presented. It is shown that low
pass filtering the imagery initially, produces
superior matching results all round. It is shown
that simple remapping of gray levels, while increas-
ing the number of operations required to produce a
match, does not increase the mismatch error. Some
equivalences between image averaging and low pass
filtering in the Hadamard domain are also shown.

5. A quantitative study of the orientation bias of some
edge detection schemes

J. R. Fram and E. S. Deutsch
(Computer Science Center Technical Report 285)
January, 1974

Further work on the evaluation of a particular
set of edge detection schemes is described. The re-
sults obtained are compared with those obtained from
an edge detection scheme using a texture oriented
approach. The orientational bias of these schemes
is addressed in particular. Improved qualitative
observations are reported and a comparison of the
evaluation method discussed here with another edge
detection evaluation method is presented.

6. Edge and line detection in ERTS imagery: a compara-
    tive study
    R. Eberlein, G. J. VanderBrug, A. Rosenfeld, and
    L. S. Davis
    (Computer Science Center Technical Report 312)
    June, 1974

Several local edge detection operators were
applied to a set of ERTS pictures of the Monterey,
Calif. area. Gradient operators performed consis-
tently better than Laplacian operators in detecting
edges. It was also found that if a grayscale normali-
zation operation, "histogram flattening," was applied
to the pictures first, the edge detector outputs were
greatly enhanced. The use of interpolation for more
accurate location of edges on a digital picture was
also briefly investigated. Curve detection operators
were applied to the edge detector outputs; this had
the effect of enhancing the edges while suppressing
noise.