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Advanced Stereo Correlation Research

The research is addressing problems of correlation over cultural sites and in featureless areas.

The Defense Mapping Agency (DMA) is involved in some basic research on stereo correlation dealing with some problems which are currently encountered when using automated systems, namely, the correlation over cultural sites and in featureless areas. There is interest in extending the capabilities of automated stereo correlation, both to improve the current production posture and to accommodate the increasing demand for higher detailed products.

Cultural sites have characteristics which include surface discontinuities, occlusion, steeply-inclined surfaces (including the vertical), thin objects, ambiguous levels (such as trees and ground), and repetitive textures (such as roofs). Featureless areas include water, sand, and large man-made areas such as concrete objects. The basic approach that is being investigated involves a departure from the traditional method of computing an elevation for a point. Instead, an elevation would be assigned to some area, which normally would correspond to an object. This should not be confused with the concept of area correlation which used the gray shades in an area to determine the elevation of a point. The elevations which result from this new approach would apply to the entire area. This approach enhances the correlation process by utilizing the inherent structure. Obviously, this would not result in a universally applicable approach. This area elevation assignment would have to be used in conjunction with traditional point methods in order to do an entire area. This new method would be used in urban areas and other man-influenced areas, and in featureless areas, including bodies of water. Some kind of point method, perhaps traditional correlation, would be used over natural terrain of sufficient character. This research is at a very basic stage; however, it is already clear that there will be some interesting questions which will have to be answered. For example, what elevation is being used for an object with a sloped roof?

DMA is currently involved in two efforts addressing this problem. These are with Stanford University and the Pattern Analysis Recognition Corporation (PAR). These two efforts are briefly discussed below.

The effort with Stanford is an outgrowth of their work in image understanding and is a cooperative effort involving DMA, the Defense Advanced Research Projects Agency (DARPA), the Air Force, and NASA. It involves examining correspondence of intervals (or sections) at epipolar lines and then extending edges between epipolar lines. It uses geometric constraints to determine edge correspondence with epipolar lines. It will use a rule-based approach to control the assembling of pieces into the objects to be measured. The research effort started in 1981 and involves two phases. The first phase covers developing the algorithms for stereo correspondence and creating a conceptual design for rule-based stereo mapping. The second phase would result in the design and implementation of an engineering prototype which would serve as a feasibility demonstration for an actual production capability. Further information can be obtained from two papers by Arnold and Binford, (1980) and Binford and Baker (1981).

The PAR work, which will be implemented on DMA's remote work processing facilities, also began in 1981. This effort involves segmenting each image of a stereo pair. These two-dimensional areas (segments) are then "matched" to determine corresponding areas. The word "match" has a simplistic connotation which is unfortunate, as a semantic network is used. Many of the "descriptors" of an area could be used in the matching process, including classification, position, shape, and relationship to other areas. Any segmentation scheme could be used, and there is a large body of research which has and is being conducted in the area of image segmentation. This approach can take advantage of any

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Photogrammetric Engineering and Remote Sensing,
Vol. 49, No. 4, April 1983, pp. 533-534.

0099-1112/83/4904-0533$02.25/0

resultant breakthrough. It is possible to easily imagine that the two images used need not be a conventional stereo pair but could come from different sensors or even from two sets of multispectral imagery. This capability results from the correspondence being performed on two segmented images, and what formed that segmentation does not directly get involved in the "matching." That is, two sets of multispectral images could be used to come up with two segmentations. These segmentations would then conceptually function the same way as each image of a stereo pair currently does. Actually, what you're doing is matching knowledge. Two very dissimilar images could, therefore, be used. Even a conventional monochrome image and a multispectral set of images could be used. The catch is that the results of the segmentations have to be similar enough to lend themselves to serving as the basis for stereo correspondence. Further information on this work is available from a paper by John Lemmer (1982).

In summary, DMA is looking to extend its automated stereo correlation capabilities by utilizing the correlation of areas. This should not be confused with the traditional area correlation which results in the elevation for a point. The result of this research uses methods which results in elevations being assigned to entire areas. Ultimate implementation of such methods would be combined with point methods where the appropriate type of correlation would be used at different portions of the Earth's surface.

References

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2nd Annual Workshop

Remote Sensing for Cultural Resource Management

Albuquerque, New Mexico
1-3 June 1983

This workshop—being held on the University of New Mexico campus—introduces managers to the applications of remote sensing data for the study and management of cultural resources. Case studies ranging from the use of large-scale photographs to satellite images will be presented. Participants will also be instructed in utilizing ancillary information with remotely sensed data. Those attending will have an opportunity for hands-on inspection and use of photographic materials. A complete set of examples will be included in the handbooks.

For further information please contact

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