

THE DESIGN AND IMPLEMENTATION OF A NOVELL OBJECT RECOGNITION METHOD BASED ON INFORMATION FUSION AND ARTIFICIAL INTELLIGENT I CONCEPT

^a Farhad Samadzadegan, ^a Ali Azizi, ^b Micheal Hahn

^a Department of Geomatics, Faculty of Engineering, University of Tehran, Tehran, IRAN

^b Applied University of Stuttgart, Stuttgart, Germany
samadz@chamran.ut.ac.ir, aazizi@ut.ac.ir

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ABSTRACT:

The idea of having a fully automatic three dimensional object recognition (OR) system to replace the human operator has been one of the main aspirations and the final goal of many photogrammetric and computer vision investigators. This would reduce the need for the human experts for object recognition and extraction and hence decreases the production time and leads to a more economical knowledge-based information extraction. Nevertheless, due to the tremendous complications and complexities associated with the natural objects appearing in digital images, fully automatic object recognition have faced serious obstacles and, thus, only in a relatively simple imaging environment or controlled laboratory conditions a reliable result is normally expected.

Regarding the human potentials in object perception and recognition, it seems that a comprehensive OR system should be able to integrate the following capabilities: (a) all available descriptive information components of an object (such as: structure, textural information and spectral responses) must be simultaneously taken into account, (b) a fuzzy formulation for the object definition, regarding its complexities, should be devised and (c) learning capabilities to modify the defects accompanied by the objects definition needs to be considered. This will enhance the recognition potentials when encountering new and undefined objects.

In this paper, for the first time, an attempt has been made to design a system that integrates all above features in a total and comprehensive solution. The approach presented here takes advantage of the concept of fusion in two levels of descriptive information and logical planes. That is, information fusion to exploit the multi-level characteristics of the objects and logic fusion for enhancing the learning and hence recognition abilities

of the system. The designed OR process comprises the following procedures:

Pre-processing

To facilitate the OR operations, a set of preprocessing modules are initially applied to the input data. These are basically fundamental radiometric and geometric corrections such as the gray scale filtering, the determination of the sensor attitude and altitude parameters, epipolar re-sampling and the generation of the image pyramids.

Object definitions

This stage starts with the definitions of the features (objects) and their corresponding classes according to the required map scale. It has been assumed that the objects can be described in an integral manner by three attributes of structural, textural and spectral (STS) components. Structural information express the 3D geometric characteristics of the objects surface. This parameter is indeed an efficient mechanism by which a quick recognition of many 3D objects can be conducted without further involvement with the textural complications. Nevertheless, the structural information alone, by no means, gives an exhaustive description of the objects. The textural information and spectral response attributes of the objects also play a decisive rule.

Rules generating engine

Based on the object and class definitions in the previous stage, linguistic variables, labels and membership functions are built for STS attributes of each object. These object descriptive parameters are made closer to the subjective perceptions of a human operator by an expert with a long experience in photogrammetric map compilation. Based on the previously defined descriptive

concepts, fuzzy rules are generated and the logical structures of the system are constructed.

Training engine

Due to the inevitable complications and ambiguities of the objects, in some conditions it is not possible to define the membership functions in a perfect manner. These functions will, thus, can be modified by the learning capabilities of the neuro-fuzzy system which adapts new descriptive information and re-adjusts the parameters of reasoning system.

Recognition engine

Based on the STS components extracted in stage “b”, a preliminary analysis is carried out to generate the following discriminative information: for the 3D structural information, dimension; height; and shapes are analyzed and quantified. The shape analysis is performed according to the dimensional compatibility of the three elements of the length, width and height. Textures are also quantified by a texture analysis approach by means of a mean curvature computation. If the extracted regions in image space do not demonstrate a homogenous texture (e.g. a planar facet having a rugged texture and/or with a

totally unexpected spectral response), the 3D structure will be divided into two or more objects according to the case. The full discriminative information accompanied by their corresponding spectral responses are, then, simultaneously fed into the fuzzy recognition module which utilizes the predefined rules to identify and recognize the objects. If the object recognition process for a feature is failed or if an object is flagged as unrecognizable, it may be transferred into the training engine by which either a new object is introduced or a better membership function is determined.

The proposed OR approach is implemented as a software package entitled ‘StereoMetrica’. This paper presents a detailed analysis of the individual components that govern the entire system. To verify the implemented approach a pair of large scale aerial photographs of an urban area of Stuttgart, Germany was selected. A detailed report of the tests conducted in this area is presented and discussed in the final section of this paper.