FUSION OF HIGH RESOLUTION OPTICAL AND SAR IMAGES WITH VECTOR DATA BASES FOR CHANGE DETECTION

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1. INTRODUCTION

With the recent (or in the very next future) availability of High Resolution (HR) optical and radar satellite sensors, such as in the ORFEO program, the need of multi-sensor image processing chains that are able to assist a human operator in scene interpretation is increasing.

In this work, we focus on the problem of cartography creation/update, and more precisely on built-up areas. Often, existing methods are specific to one sensor in one mode. We propose a more generic image processing and interpretation chain for cartography creation/update that is able to deal with HR (around 1 meter) optical and radar satellite sensor images and exogenous data (typically a digital map). Several scenarios are possible according to available images and data.

2. PROCESSING

Our processing chain is presented in figure 1. The goal of this chain is to update a vector database representing buildings. Our approach consists of 2 steps: first we consider each database object and we check if the object is effectively present in SAR and optical images, second we detect buildings which are missing in database. To do so we apply operators whose goal is to provide evidence on the presence of building. A combination of those operators is then performed to reduce uncertainty and imprecision.

Operators characterizing buildings are implemented. Their goal is to bring evidence on the presence of buildings. Those operators indicate the presence of: edges, SAR bright lines [1], shadows, vegetation, line segments [2].

The goal of the fusion is to exploit redundancy and to reduce uncertainty. Various frameworks are adapted to information fusion, like bayesian probability theory, possibility theory or Dempster-Shafer theory. Probability theory is a classical method for data fusion but it requires a considerable amount of a priori knowledge and cannot easily model imprecise, incomplete and not totally reliable information. Possibility theory is based on fuzzy logic and is more adapted to imprecise information, it is a more flexible framework. For our application the Dempster-Shafer [3] framework seems to be the best adapted method, because it is a generalization of probability theory for uncertain information processing. This method is based on belief functions and on plausible reasoning. The output of each operator is modeled as a mass that will be assigned to any hypothesis. Dempster-Shafer theory allows one to assign a mass to $A \cup B$, where A and B are two hypotheses that cannot be distinguished, contrary to Bayesian probability theory.

Considering the focal element model built according to operator imprecision, masses assigned to sets included in (resp. containing) the building set will consitute the belief (resp. the plausibility) of building hypothesis. After the definition of focal elements for each operator, the fusion of information is performed thanks to the Dempster-Shafer orthogonal rule. A decision can then be taken. For each object the probability of being a building is represented by the belief and the plausibility.

3. RESULTS

The method was tested using a multispectral 70-cm resolution image, and a SAR 2-m resolution image acquired over Toulouse, France. Also, a vector database (French IGN BDTopo) was used. Figure 2 highlights the features chosen to characterize buildings. The outputs of operators are fused and for the case represented in figure 2, we obtain $belief(building) = 0.882728$ and $plausibility(building) = 1$. This processing chain has been implemented using CNES ORFEO Toolbox free software `http://otb.cnes.fr`.

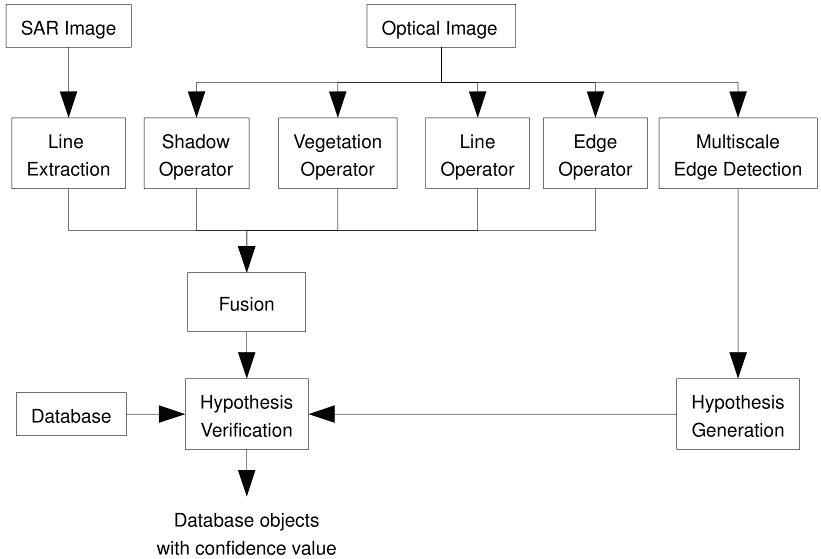


Fig. 1. Processing chain

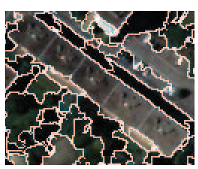
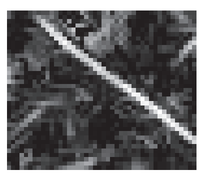
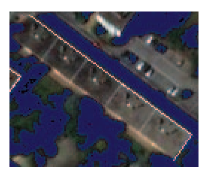
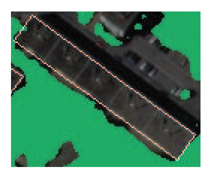
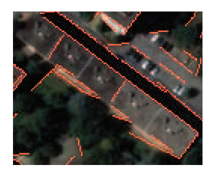
	Operators				
Database	Edges	SAR line	Shadows	Vegetation	Line segment
					

Fig. 2. Example of operator processing

4. REFERENCES

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