Chapter 48
New Neural Buildings Stereo Matching Method Applied to Very High Resolution Ikonos Images

E. Zigh
National Institute of Telecommunications and Information Technologies and Communications of Oran, Algeria

ABSTRACT

The author introduces a new neural stereo matching method using very high resolution IKONOS images. They do not have the parameters of the images acquisition system or other technological resources like digital elevation model, Lidar, or Laser data. These images contain dense urban scenes including various kinds of roads, cars, vegetation, and builds. The author is interested by buildings; they have different shapes, positions, and intensity levels or colours, so they make a lot of "false matches." To solve this issue, the authors extracts regions of buildings at first; after that, she proposes a neural stereo matching method. A neural field is chosen due to its good management of imprecision and uncertainty relatives to real problems in general and to this one in particular. To show the effectiveness of a proposed method, the chapter contains at first details about encountered problems, and secondly, it explains the stereo matching process, its different kinds, and a chosen approach; thirdly, it gives obtained results using panchromatic and colour images.

INTRODUCTION

Stereo matching consists in finding homologous primitives using two images of the same scene. It is a crucial step in many applications like in telerobotic to assist a human operator in judging distances, marking landmarks for localization purposes, and identifying desired objects in the environment, also in medical images registration to compare or integrate the data obtained from different measurements and in remote sensing field to construct three-dimensional models very useful to monitor cities evolution, to manage risks (floods and earthquakes) and to improve telecommunication networks.

DOI: 10.4018/978-1-5225-5204-8.ch048

The construction of three-dimensional models needs generally four main steps: calibration, primitives extraction, stereo matching and reconstruction.

The result of each step influences on the next one, the goals of this chapter are: firstly, to deal with primitives extraction step and stereo matching processes, we operate on stereo panchromatic and stereo colour remote sensing images. These images are characterized by a very high spatial resolution equal to one meter, it means that each image pixel represents a land surface of 1 meter by 1 meter.

Also, the pairs of images are obtained from Ikonos satellite, they are delivered alone without parameters of the images acquisition system or another technological resources like digital elevation model, Lidar or Laser data.

The second goal of this chapter is to achieve reliability, automaticity, and low solution cost.

For that, we have proposed two methodologies, the first one is applied on panchromatic images, it consists of primitives extraction step including three stages: pre-processing, split-merge segmentation technique and thresholding. A pre-processing stage allows us an equitable illumination of a pair of images in order to make easier a next treatment, it is done using an histogram modification technique. Concerning segmentation step, we know that it is always difficult, even impossible to segment in a bi-univocal way two images of the same scene in order to match them, it does not exist an universal segmentation method which can apply to any image successfully (Chehata, 2006), so, we have tried to choose a method that can be adapted to our type of images and considered to be "satisfactory" if it realized a "good" compromise between algorithmic cost and segmentation quality. It is the Split-Merge method which consists in dividing the initial image into quadtree, after, we split or merge these regions according to logical predicates including some criteria like the grayscale homogeneity. We have obtained from this step a segmentation of all primitives of image, nevertheless, we are interested only by buildings primitives, for that, we have applied at next a thresholding technique.

After that, to find automatically correspondence buildings, a neural stereo matching technique is proposed, it is based on new constraints. Generally, previous stereo matching researches used some known constraints like epi-polar, fronto parallel, ordering and uniqueness constraints, however, satisfying all these constraints in our stereo images isn't a simple task, because they cover urban dense scenes with variable inclined buildings from right to left image covering the same scene, so, we couldn't often check ordering constraint for example, also, epi-polar constraint couldn't be checked because we haven't had the parameters of images acquisition system.

The originality of a proposed neural stereo matching technique is the use of new constraints having two main advantages: a good description of extracted primitives and a simplicity of implementation, there are

surface, elongation and gravity centers coordinates as new geometrical constraints and an average of intensity as new photometric constraint. A proposed neural network is a Hopfield type, it solves the optimization problem by minimizing a cost function whose minimum value represents the best solution, the nodes are the assumptions (the possible correspondences) and the connections between them are the constraints.

The extension of the first methodology on colour images has been encountered by several issues. A split merge segmentation used technique became time expensive because we had to operate on three colour components red, green and blue, also, predicates and thresholds adjustment haven't been suitable in this case. For that, a second methodology is proposed, it consists in new fuzzy extraction technique able to realize at the same time image segmentation and thresholding in order to extract buildings with no need of any post treatment, it is tolerant for imprecision in order to achieve robustness and low solution cost. After that, a Hopfield neural technique is used in stereo matching step, it is nearly as same as