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Georeferenced Photo-Mosaicing of the Seafloor

R. Garcia, X. Cufí, R. Prados, A. Elibol, J. Ferrer, M. Villanueva, T. Nicosevici

Computer Vision and Robotics Group, University of Girona,
Campus Montilivi, Edif. P-4, Girona, Spain, E-17003. Tel. +34 972 418881.
E-mail: rafa@eia.udg.es.

1. Introduction

Optical imaging provides to scientists high level of detail of the ocean floor. Unfortunately, underwater imaging has to face the problems related to the special transmission properties of the light in the aquatic medium, namely absorption and scattering [1]. These transmission properties of the medium cause blurring of image features and limited visual range [2, 3], restricting the practical coverage of a single image to only a few square meters.

Seafloor imagery is routinely acquired in near-bottom geophysical surveys with AUVs, ROVs or submersibles. Due to the large number of images and the lack of adequate tools to properly visualize these data, they are often under-utilized. If images are systematically acquired and properly aligned, a composite image that combines the set of frames taken from the camera can be built. This composite image is known in the literature as photo-mosaic, and can be used as a visual map for undersea exploration and research [4]. Seafloor photo-mosaicing is an important tool to study the structure and characteristics of the seafloor, providing a “panoramic” view of the interest area. They also provide the basis to carry out temporal studies of the floor, by comparing photo-mosaics taken at different times.

FOTOGEO is a research project funded by the Spanish Ministry of Science and Technology with the aim of developing new algorithms and techniques to build seafloor photo-mosaics. Specifically, the test bed of the project will be processing a large set of seafloor images collected over the Lucky Strike site during the LUSTRE’96 cruise [5]. This is one of the hydrothermal vent sites in the MOMAR area that is the focus of integrated studies to characterize active processes and their interactions at the axis of slow-spreading ridges. An ARGO II survey was carried out over the vent field (map), with N-S and E-W tracks spaced at ~50 m, with closer spacing over particular vent fields. A total of 20.000 black and white, electronic still images where recorded. At the same time, navigation data of the vehicle Argo II was acquired by means of an acoustic transponder network (LBL).

2. The challenge

Building photo-mosaics of the Mid-Atlantic Ridge has to cope with a series of problems. First, photographic still cameras are frequently used in scientific surveys to get information from the ocean floor. However, the acquired images normally exhibit a low overlap, making the process of image alignment difficult. Additionally, artificial light sources tend to illuminate the scene in a non-uniform fashion. Therefore, application of image processing techniques to underwater imaging requires dealing first with this added problem. On the other hand, previous works in automatic construction of photo-mosaics have been limited to processing planar environments of small-sized areas (<20×20m), while most of the regions of interest for the scientific community are spread over larger areas (>1 Km2) with 3-dimentional (3D) relief. Moreover, even with small 3D terrain relief, a rigid motion of the light source and camera set (due to vehicle motion) creates a shift of the shadows induced in the scene. These shadows generate an apparent motion in the image sequence in the opposite direction to the real motion.

On the other hand, none of systems described in the literature is able to automatically build large-scale photo-mosaics, due to the accumulated drift as the mosaic increases its size. In this project we propose to develop a library to handle very big images. Moreover, the system should take advantage of all the information available from the on-board sensors to automatically build bigger and more reliable photo-mosaics. Finally, the proposed system should be modular and flexible, to adapt to a wide diversity of underwater vehicles equipped with various types of sensors. Such a system will allow the analysis of the temporal evolution of both existing ecosystems and morphology of the underwater terrain.

3. Preliminar Results

A feature-based mosaicing algorithm has been implemented. The creation of the mosaic is accomplished in 5 stages: feature selection and matching, detection of points describing the dominant motion, local homography computation, global alignment and mosaic rendering. Figure 1 illustrates the obtained photo-mosaic at different resolutions.

4. Conclusions

We have presented a photo-mosaicing technique which allows building mosaics of more than one square kilometer at full resolution. A georeferenced mosaic is obtained through the optimal combination of computer vision and sensor fusion techniques. An image viewer was developed to facilitate efficient navigation over the surveyed area. Mosaicing results were presented for a set of 20,000 images of the Lucky Strike area.

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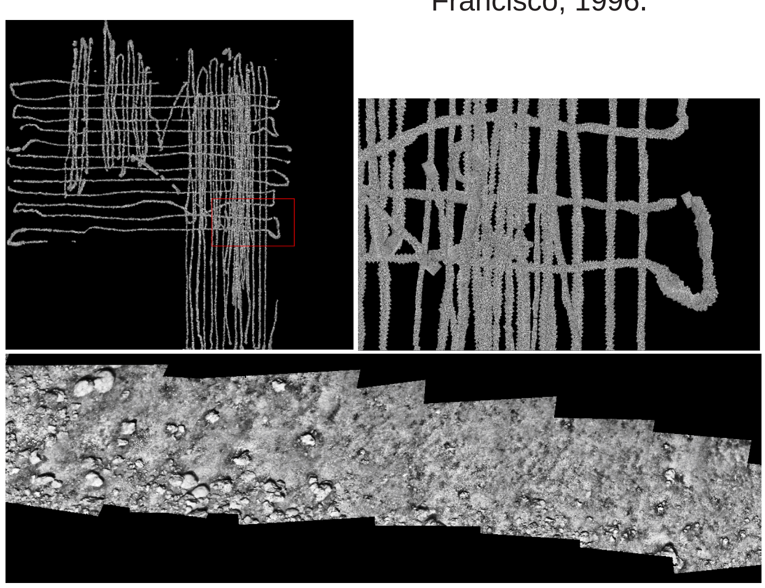

Figure 1. Photo-mosaic of the Lucky Strike area, Mid-Atlantic ridge. (top) panoramic view; (bottom) zoom of a selected area.