AUTOMATED VIDEO-IMAGE ANALYSIS FOR THE ANALYSIS OF THE BEHAVIOUR OF DEEP-WATER LOBSTERS (NEPHROPS NORVEGICUS)

Sergi Pons[1], Jacopo Aguzzi[2], Jaume Piera[1]
1UTM-CSIC, CMIMA - Passeig Marítim de la Barceloneta, 37-49. E-08003 Barcelona (Spain)
2ICM-CSIC, CMIMA - Passeig Marítim de la Barceloneta, 37-49. E-08003 Barcelona (Spain)

Abstract - In this study, we show the results of applying automated data processing to a set of videos previously used to manually monitor the period and the phase of activity rhythms of the deep-water Norway lobster Nephrops norvegicus. Resulting data are consistent with published findings on Nephrpos norvegicus activity rhythms both in the laboratory and the field.

Keywords – Video-Image Analysis, Automation, Signal Processing, Behaviour, Laboratory Applications.

I. INTRODUCTION

Video-image analysis can be used to disclose the period and the phase of activity rhythms in relation to the day-night cycle in laboratory controlled conditions [2]. In fact, the expression of rhythmic behaviour can be considered as the phenotype of biological clocks regulation (reviewed by [3]). Biological clocks drive the internal biology of organisms and the overt change in activity rate strictly depends and hence coincides, with their mode of functioning. In this sense, neuroethology studies behaviour to understand the neuronal regulation and video-image analysis can be a very efficient tool [4].

The traditional method of turning data into knowledge relies on the manual analysis and interpretation [5], [6]. For long-term monitoring applications, this form of proceeding is inefficient and expensive. When data volumes grow dramatically manual analyses become completely impractical in many domains. Hence, analysis requires automation [7]. The video-image analysis of footages depicting the behavioural pattern of species in relation to time is to date of growing interest for neuroethology and biomedicine [1] but not yet fully exploited for the large augmnt of frames it produces (from several-days experiments). In this study, we show the results of applying automated data processing to a set of videos previously used to manually monitor the period and the phase of activity rhythms of the deep-water Norway lobster Nephrops norvegicus, a species of elevated commercial fishery value. These data consist on video images taken from above of clusters of tanks, where each specimen remains isolated from the others.

II. METHOD 1: MOTION QUANTIFICATION BASED ON BACKGROUND SUBTRACTION

The method exposed focuses on how to isolate objects from the rest of the image. Because of its simplicity and because camera locations are fixed in many contexts, background subtraction (i.e. differencing) is the simplest approach to quantify motion. In order to do it, we first must configure a model for the background. Once configured, that model is compared against the current image and then the known background parts are subtracted away. The objects left after subtraction are converted into a binarized image, with background in black and foreground in white. The subtraction of two consecutive binarized images corresponds to the amount of motion of the foreground object, the animal (Fig. 1, upper diagram).

III. METHOD 2: MOTION QUANTIFICATION BASED ON BACKGROUND SUBTRACTION AND CONTOUR FINDING

This method is similar to the previous one but in addition, the binarized image is preprocessed, in order to find the position of the greatest foreground object (which should correspond to animals) by using contour finding techniques and the computation of its summary characteristics. The difference between the centre of the objects of two consecutive frames corresponds to the amount of motion of the object of interest (Fig 1, lower diagram).

IV. RESULTS

The main issues of the proposed methodologies are allocated on the phase of background modelling. In contrast to other motion detection applications such as surveillance cameras, the background has a great variability in time. Intrinsic phenomena from aquatic installations, produced by moving water (e.g., bubbles), and illumination (e.g., reflexes in superficial waves) increase the difficulty for automated systems to distinguish background from foreground objects.

sampling for a given individual. In order to qualitatively appreciate the activity periods, the automated data has been processed and smoothed to a sampling rate of 30 minutes (the raw data has a sample per frame, with a frame per 41 seconds). Figure 2 (next page) is the cross-correlation of the original manual sampling with itself, and the two methods against the original. Cross-correlation is a measure of similarity of two waveforms, therefore can be used to validate the methodologies and extract additional conclusions (e.g., the periodicity of the autocorrelation is an indicator of the periodicity of the original signal).

V. DISCUSSION

Present data are consistent with published findings on Nephrpos norvegicus activity rhythms both in the laboratory and the field (reviewed by [4]). The specie show diel peaks of locomotion phased at night-time. The observation that automated video image analysis reporpose behavioural pattern similar to what observed by [2]) indicates the viability of the used automated protocol.

The implementation of automated protocols for the processing of large augment of video information is to date a challenging topic for the exploration of the sea. Automated object tracking and object classification developed in the laboratory represent important steps to investigate poorly accessible environments.

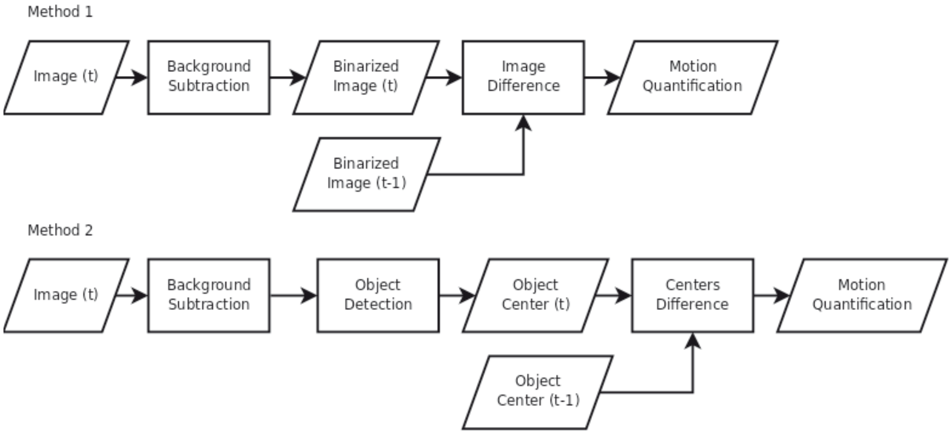

Fig. 1: Work flow of the two methods.

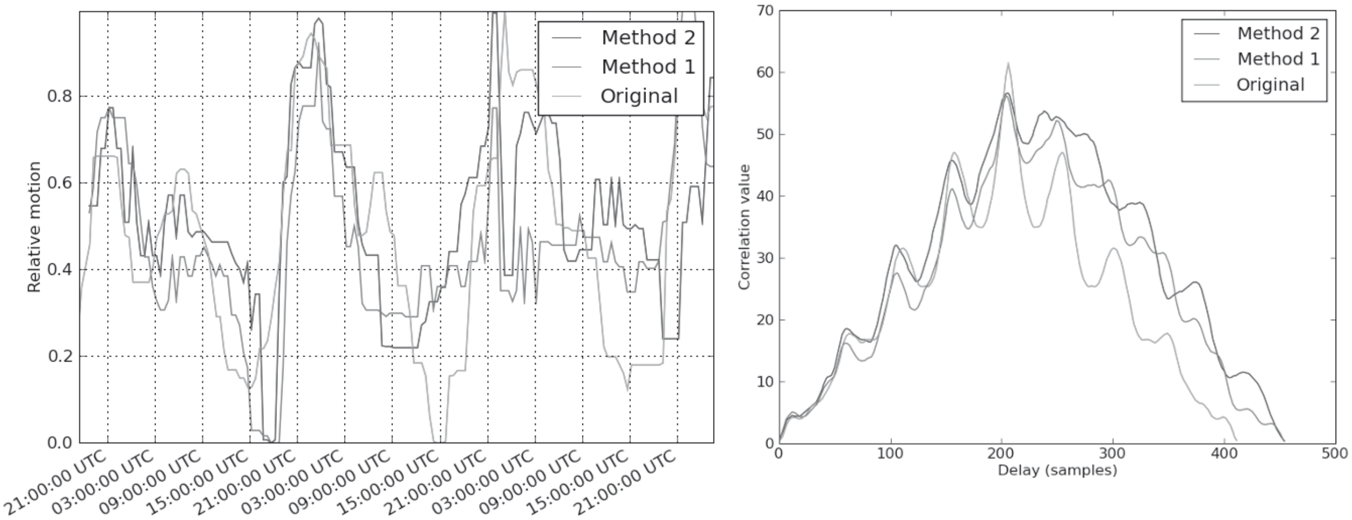

Fig. 2: (left) Monitored activity for a single specimen, with the manual samplign and the automated methods. (right) Cross-correlation of the manual (original) method with itself, and the manual method versus the automated methods.

REFERENCES

[1] J. Aguzzi, C. Costa, P.Menesatti, J.A. García and F. Sardà, "Monochromatic blue light entrains diel activity cycles in the Norway lobster, Nephrops norvegicus (L.) as measured by automated video-image analysis," Scientia Marina, 2009.

[2] J. Aguzzi, J.B. Company and P. Abelló, "Locomotor activity of continental slope Nephrops norvegicus (Decapoda: Nephropidae)," Journal of Crustacean Biology, vol. 24(2), pp. 282-290, 2004.

[3] R. Reffinetti, Circadian physiology, 2nd Ed, Taylor & Francis, Boca Raton, FL.

[4] J. Aguzzi, D. Sarriá, J.A. García, J. del Rio, F. Sardà and A. Manuel, "A new tracking system for the measurement of diel locomotor rhythms in the Norway lobster, Nephrops norvegicus (L.)," Journal of Neuroscience Methods, vol. 173, pp. 215-224, 2008.

[5] D. Walther, D.R. Edgington and C. Koch, "Detection and tracking of objects in underwater video," in IEEE International Conference on Computer Vision and Pattern Recognition (CVPR), Washington, D.C., 2004.

[6] D.E. Cline, D.R. Edgington and J. Mariette, "An Automated Visual Event Detection System for Cabled Observatory Video," in 3rd International Conference on Computer Vision Theory and Applications, Funchal, Madeira Portugal, January 2008

[7] U. Fayyad, G. Piatetsky-Shapiro and P. Smyth, "From Data Mining to Knowledge Discovery in Databases," AI Magazine, vol. 17, pp. 37-54, 1996.

FISH TELEMETRY AND POSITIONING FROM AN AUTONOMOUS UNDERWATER VEHICLE (AUV)

Grothues, Thomas M. and Joseph A. Dobarro
Institute of Marine and Coastal Sciences, Rutgers University Marine Field Station, 800 c/o 132 Great Bay Blvd. Tuckerton, NJ 08087 USA 609 296-5260 FAX 609 296-1024
grothues@marine.rutgers.edu

Abstract - We explored telemetry of transmitter tagged fishes from an autonomous underwater vehicle with a hydrophone/ datalogger processing code-division-multiple-access acoustic signals. Geolocation estimates used synthetic aperture and relative sound strength mapping. Signal reception patterns from tagged Atlantic sturgeon were similar to that of moored reference tags but those from tagged winter flounder were reduced in range due to burying behavior.

Keywords-AUV; telemetry; sturgeon; flounder; synthetic aperture; habitat mapping

I. INTRODUCTION

Autonomous underwater vehicles (AUVs) are attractive as a complement or alternative to surface vessels for mobile telemetry of marine macrofauna. Robots, in general, excel at deep or tedious missions such as tracking fish in continental shelf waters. AUVs in particular can simultaneously and continuously sample hydrography and benthic sidescan data for habitat delineation at depths relevant to the animals under study. Freedom from a cable allows signal reception and processing at depth, below interfering thermoclines, without line-associated signal attenuation or vehicle pitch. However, AUV users are challenged by a lack of real-time data for en-route decision making and potential conflicts in choosing paths for best sampling of different variables. We explored the signal reception patterns of an AUV telemetering moored reference transmitters and two species of fish to develop bounds of expectation useful for mission planning and data interpretation.

II. METHODS

The Remote Environmental Measuring Units (REMUS-100, Hydroid Inc.) is an autonomous, propeller-driven AUV. The 36 kg (1.6 m length by 0.19 m diameter) vehicle hosts a conductivity/temperature/depth sensor (CTD, Yellow Springs Instruments), a rapid response oxygen optode (Aanderaa Data Instruments), port and starboard sidescan sonar (Marine Sonic Technology, Ltd.) and upward and downward looking acoustic current Doppler profilers (ADCPs, Teledyne RD Instruments) [1].

REMUS follows a user programmed path. Navigation may apply dead-reckoning, transponder-based trialateration, calibrated by global positioning satellite (GPS) fixes. Ballast is static. Depth and trim is achieved dynamically by control surfaces. REMUS has an endurance of 14 h at 1.5 m/s velocity or approximately 9 h at 2 m/s. It may thus supply a near-synoptic view of mesoscale hydrography [2]. REMUS AUVs are deployed worldwide in various scientific and naval mis-