مجلة العلوم البحتة والتطبيقية
Journal of Pure & Applied Sciences
www.Suj.sebhau.edu.ly ISSN 2521-9200
Received 20/05/2019 Revised 19/08/2019 Published online 17/11/2019

Automatic Fish Tracking by Kalman filter

Nawal Eldrogi[1], Idris altherany[2], *Sultan Alqaddafi[2]
[1]LIUPPA Computer laboratory, University of Pau & Pays de l'Adour UPPA /2ES, Anglet, France
[2] Computer department, Faculty of Arts and Sciences, Omar Al-mukhtar University, Libya
*Corresponding author: jabo_sul@yahoo.com

Abstract One of the phases of research is the computer vision for automatic tracking and acquisition of knowledge about the migratory behavior of fish. For that purpose, some fishes are marked, then introduced into an experimental medium. Thus, throughout all observations, a big video database of sequences is collected the background subtraction method is used to detect the fish then we apply the labelling of connected components for extracting all information about fishes. The tracking of fish will be obtained by Kalman filtering.
Keywords: Background Subtraction, labelling, tracking, Kalman filter.

التتبع التلقائي للأسماك بواسطة مرشح كالمان

نوال الدروقي[1] و إدريس الذرعاني[2] و *سلطان القذافي[2]
1 مختبر الكمبيوتر LIUPPA ، جامعة باو وباي دو لادور UPPA / 2ES ، آنجليه ، فرنسا
2 قسم الحاسوب- كلية الآداب والعلوم القبة- جامعة عمر المختار، ليبيا
*للمراسلة: jabo_sul@yahoo.com

ملخص واحدة من محاور البحث الحالية هي استخدام الرؤية بالكمبيوترفي التتبع التلقائي وذلك من اجل اكتساب المعرفة حول سلوك الأسماك المهاجرة. لهذا الغرض، يتم وضع علامات توسيم لعينة من الأسماك المهاجرة (سمك الأنقليس) ، ثم توضع في وسيط تجريبي يحاكي نفس الوسط المائي الذي تعيش به من حيث درجة حرارة والاضاءة وغيرها، ويتم جمع كل الملاحظات في قاعدة بيانات فيديو كبيرة، والتي ستتم معالجتها بواسطة طرائق معالجة الصور، في هذا البحث تستخدم طريقة طرح الخلفية لفصل الأسماك عن الخلفية الساكنة ومن ثم يتم توسيم جميع المكونات المتصلة لغرض استخراج المعلومات المتعلقة بالأسماك. (مركز الثقل، الطول، العرض، اللون، ...) والتي سيتم استخدامها في تتبع الأسماك عن طريق مرشح كالمان.
الكلمات المفتاحية: طرح الخلفية، وضع علامات التوسيم، التتبع، مرشح كالمان.

Introduction

In biology, tracking the movement of animals sometimes techniques, related to the characteristics of species and stages of development. Biologists use sequencing video to identify and quantify fish in order to study their behavior and their migration patterns. Usually, these videos are analyzed manually by experts. However, manual analysis is a tedious process that takes several hours to analyze a video.

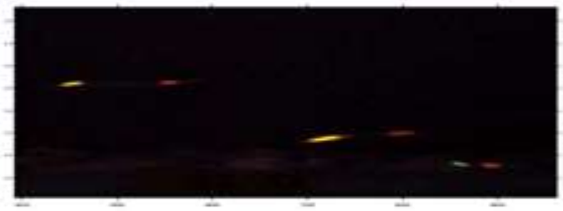
In our study, to study the estuarine migration of fish, it is possible to reproduce in channel the currents and the tides to which would be subject fish in the wild. Thanks to this device. Biologists can observe and study the behavior of swimming of individuals. To follow fishes, each fish is marked by VIE Tag (Visible Implant Elastomer) [1]. Individual tracking is done on video recordings [2], but it is a tedious job because it is currently not automated. Parameters that are of interest to biologists are mainly the sense of movement of the fishes (in the direction of the current or the counter current) and their speed. The automation, at least partial, of this process will allow to save a lot of time in video analysis. Many searches use computer vision for detect and track fish in order to characterize their behavior and their trajectory [3]. The most traditional methods to detect and track fish automatically are the contour's detection [4] as well as the model of the mixture Gaussian [5]. The work of [6] uses Canny filter for detecting the fish as well as a blob analysis of the color and texture to automate the processing of videos. In [7], tracking is done by the CamShift algorithm, a computer vision system capable of analysing video underwater to detect, track and count fish. The methods on which this article focus is capable to treat the video directly while the other methods need to transform it into an image to treat it [2]. In our article, a system is presented to automatically detect the fishes. First, we have used the background subtraction method to detect the eels followed by a component labeling operation related. Next, generate tracking of fishes by Kalman filter. The article is structured in the following way: first place our methodology and results obtained and then finish with the conclusion and perspective.

Our methodology and results obtained:

First, our database contains 239 videos in RGB system. Each video sequence contains 225 at 425 images, the size of an image is 1280X 960 pixel (Fig.1).

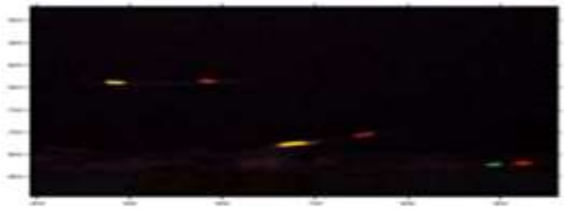
Background Subtraction Method:

In this article, the detection of the fish is done by two modules. The first one is based on the background subtraction followed by a morphological operation and the second is to perform the analysis of the related components on the resulting image to extract its geometrical information.



(a)

(b)



(c)

(d)

FIGURE 1 - Zoom on 4 consecutive images of a video, images including three fishes with double marking.

Background subtraction is widely used for detecting moving objects in video. This method has been used and proven in many studies [8]. She is considered as the simplest method that gives full details about the object compared to other methods of motion detection as the method of differentiation of images or optical flux.

Creation of the reference image

The background image of the video is obtained by calculating the arithmetic mean of the video (equation 1) with N = 10 and I (x, y, k) the value of the pixel (x, y) of the k image, this model has the advantage of requiring few resources in terms of calculation and little memory space.

$$I_{ref}(x,y) = \frac{1}{N}\sum_{k=1}^{N} I(x,y,\text{k}) \qquad (1)$$

A simple difference between the current image and the reference image is applied in order to get the binary mask of the foreground for a single image plane as indicated by the equation:

$$I_{curr} - I_{ref} > threshold \qquad (2)$$

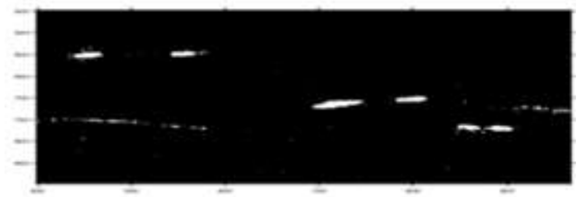
The operation is repeated for all RGB plans. These binaries are then combined with the aid of a logical OR operator (Fig. 2c). A threshold of this difference then gives a mask with the objects in the foreground. In this article, to determine the threshold, several thresholds have Tested in order to obtain an optimal threshold for all videos. Following, a morphological operation is necessary on the foreground binary mask to eliminate the noise and remove false detection. Here two morphological operations are used: dilatation and erosion (Fig.2.d).

Related component labeling

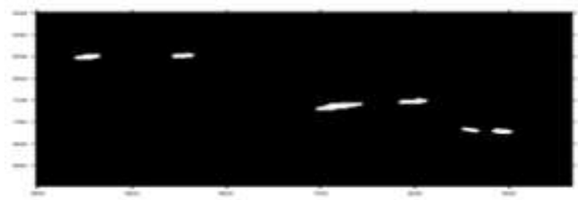
To obtain all the geometrical information of each object, a related component analysis or labeling pixels are made. The technique consists in grouping neighboring pixels in a set called the connected component. Each set is disjointed from the others and can then be easily isolates. This operation extracts the information of each object as: the representation of objects, counting moving objects in each video and extraction of the dimension of the objects in order to use them in the algorithm of tracking. Here, this operation has been applied to the image of the first plane detected by 4-connectivity and removed all objects that contain less than 100 pixels.

(a)

(b)



(c)



(d)

FIGURE 2 - Background Subtraction Algorithm: (a) Image original, (b) Reference image, (c) Binary image from the front plane, (d) Image filtered by morphology.

Object tracking by Kalman filter

Many tracking algorithms have been proposed in the Literature [9]. Some methods are dedicated to tracking objects specific [10] and other methods are based on a more general way [11]. Here, we are interested in the use of the Kalman filter which allows us to reduce the complexity of identifying objects and get the best estimate of the trajectory. In our method, equation 3 represents the state equation. it makes it possible to predict the evolution of the object observed. Equation 4 models the measurement vector.

$$X_k = AX_{k-1} + W_k \quad (3)$$
$$Y_k = HX_k + V_k \quad (4)$$

Where (A) and (H) respectively represent the transition matrix and measurement matrix, the vectors W_k and V_k are the noise of state and measurement noise, these noises are considered as white. The principle is applied to the center of gravity of each object to detect. Thus, the state vectors are:

$$X_k = [C_x , C_y , l_k , h_k , v_x , v_y]$$

Where (C_x , C_y) the center of gravity, (l_k, h_k) half-width and half height of the tracking window and (v_x, v_y) the center of gravity speed.

Association measures and prediction

One of the problems encountered in the implementation of tracking is the association of an object resulting from the prediction of the Kalman filter with an object detected by Subtraction of the background (measurements). To ensure this association, we used the nearest neighbor method: for each new set of observations, the goal is to find the most likely association (in terms of distance) between an observation and a trajectory existing or between a new observation and the hypothesis a new trajectory.

Occultation problem

During tracking, if an object is occluded with another object, for example, in figure 3 (a) we have two fishes with a double marking, one with double marking green where the first mark is associated to the trajectory (13) and the second is associated to the trajectory (14) and the other fish with double marking blue-green where the blue mark is associated to the trajectory (15) and the green is associated to the trajectory (16), these two fishes are crossing each other. Image (b) shows the first intersection between the two fishes on the mark green and blue of the trajectories (13) and (15). These two marks are merged in an entire mark, in this case, this mark will be associated with the trajectory the closest (15) and trajectory (13) follows the prediction of Kalman filter. The second intersection will appear in the image (C) between the two green marks of the trajectories (14) and (16) this intersection will be treated by the same principle. In image (d) the two fishes are separated. In this case, the Kalman filter will compare the features of the marks of this image with the characteristics of the marks in the image before of the occlusion to associate each mark with its trajectory.

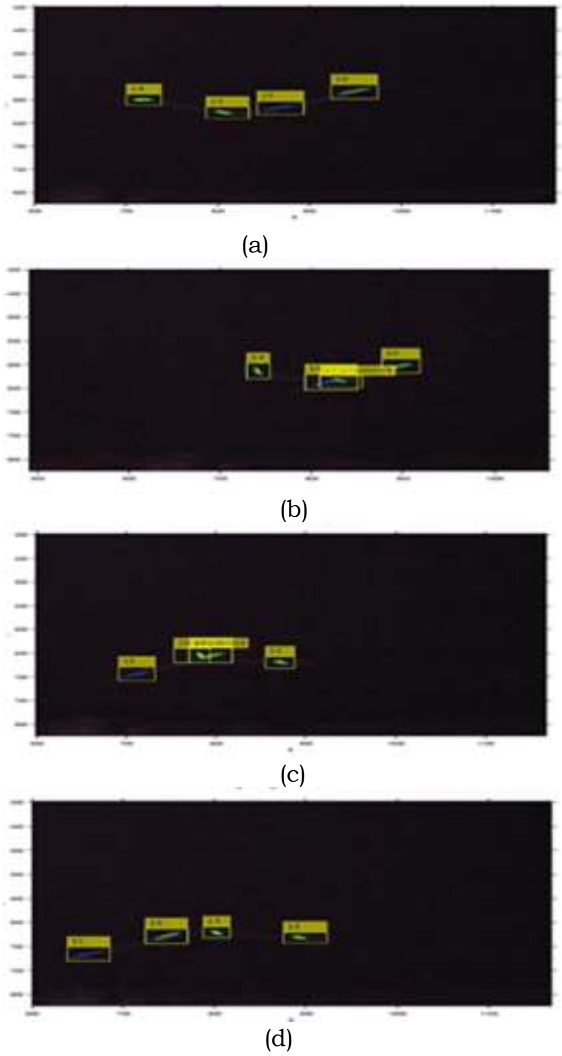


FIGURE 3 - Occultation problem: (a) two fishes before occultation, (b) the first occultation, (c) second occultation, (d) the separation between both fishes.

Figure (4) shows the trajectories of two fishes with double marking where one is moving in the direction oppose the other and the two are crossed at the frame 119. Considering the continuity of the speed of an object moving, we can match the detected objects after occlusion to that before occlusion. This is very important for resolving the ambiguity that exists in most object detection methods.

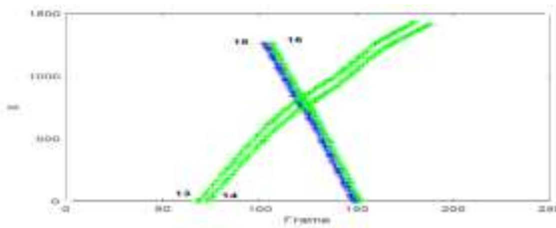


FIGURE 4 - Trajectory of two crossed fishes.

We show the speed information for each fish in Figure (5), in this figure we can see that the speed model of each fish is enough different from that of the other.

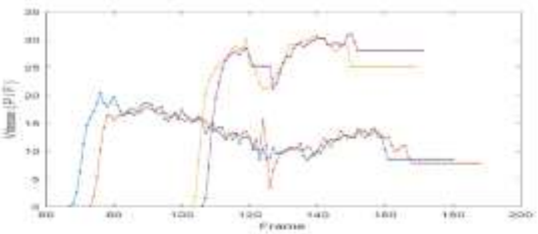


FIGURE 5 - Two fishes double marking speed information.

Figure 6 provides interesting plots for video analysis. It contains the following information for each video: number of fishes, type of marking (single, double short, double long), marking color, direction of movement, beginning and end of each trajectory. In the FIG.6. The following information can be extracted:

- Number of fishes (11).
- Start and end of movement of each fish.
- Identification of each fish and determination of its color: fish with a single marking (1 B), fish with double marking (2 BGS, 1 ORS, 1ORL, 2 GRL, 1 BBL, 1 OBL, 1 GGL) and a not marked fish which is black (1 K).
- The swimming sense of each fish: four fishes swim with the current (ORS, BGS, B, GRS) and the seven others swim against the current.

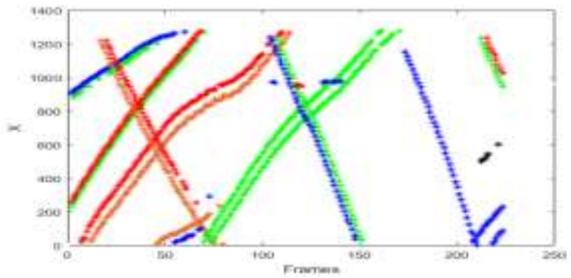


FIGURE 6 - Abscissa of the centre of gravity (Cx) according to the number of the image

Conclusion and perspective

In this article, the first results of detection and tracking, the fishes in a video have been presented. We let's start by applying the background subtraction method which allowed us to detect the fishes. Then, a tracking algorithm is applied to objects through their centers of gravity using a Kalman filter, this filter estimates the location and speed of moving objects (motion information) which will be used to solve the occultation problem, a method of association based on the nearest neighbor technique is applied in order to associate each object to its trajectory. Applying these developed methods results provide satisfactory results, we note that improvements can be made. Finally, the objective term of this project remains the automation of these measures to reduce the working time of the observer. For this, we have in perspective, thanks to the results obtained built a tool allowing biologists the automatic tracking of fish integrating a sense of swimming, speed and energy ripple.

References

[1]- Bolliet, V and Labonne, J, Individual patterns of rhythmic swimming activity in Anguilla anguilla glass eels synchronised to water current reversal. Journal of Experimental Marine Biology and Ecology, Vol.362, pp.125-130, 2008.

[2]- Delcourt, Johann and Ylieff, Marc and Bolliet, Valerie and Poncin, Pascal and Bardonnet, Agnes, Video tracking in the extreme: A new possibility for tracking nocturnal underwater transparent animals with fluorescent elastomer tags, Behavior Research Methods, Vol. 43, pp. 590- 600, 2011.

[3]- Bingshan Niu, Guangyao Li, Fang Peng, Jing Wu, Long Zhang and Zhenbo Li, Survey of Fish Behavior Analysis by Computer Vision, Journal of Aquaculture Research & Development, Vol.9 , pp. 1-15, 2018.

[4]- Shrivakshan, GT and Chandrasekar, C, A comparison of various edge detection techniques used in image processing, International Journal of Computer Science Issues (IJCSI), Vol. 9, pp. 269, 2012.

[5]- Zivkovic, Zoran, Improved adaptive Gaussian mixture model for background subtraction, Pattern Recognition, 2004. ICPR 2004. Proceedings of the 17th International Conference on, Vol. 2, pp. 28-31, 2004.

[6]- Suman Sharma, Aman Shakya, Sanjeeb Prasad Panday, Fish Counting from Underwater Video Sequences by Using Color and Texture, International Journal of Scientific & Engineering Research, Vol. 7, pp. 1243-1249, 2016.

[7]- Spampinato, Concetto and Chen-Burger, Yun-Heh and Nadarajan, Gayathri and Fisher, Robert B, Detecting, Tracking and Counting Fish in Low Quality Unconstrained Underwater Videos, VISAPP (2), Vol. 1, pp. 514-519, 2008.

[8]- Sobral, Andrews and Vacavant, Antoine, A comprehensive review of background subtraction algorithms evaluated with synthetic and real videos, Computer Vision and Image Understanding, Vol. 122, pp. 4-21, 2014.

[9]- Balaji, SR and Karthikeyan, S, A survey on moving object tracking using image processing, 11th International Conference on Intelligent Systems and Control ISCO, pp. 469-474, 2017.

[10]- Qian, Chen and Sun, Xiao and Wei, Yichen and Tang, Xiaoou and Sun, Jian, Realtime and robust hand tracking from depth, Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 1106-1113, 2014.

[11]- Zhang, Zhe and Hong Wong, Kin, Pyramid-based visual tracking using sparsity represented mean transform, Addison-Wesley, 2014.