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Acquatic Rare Species Habitat Detection and Tracking

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***Abstract**: Computer vision has gained paramount significance in recent times due to the increased use of cameras as portable devices and their incorporation in standard PC hardware, mobile devices, machines etc. Computer vision techniques such as detection, tracking, segmentation, recognition and so on, aim to mimic the human vision system. Humans hardly realize the complexities involved in vision, but in fact, our eye is more powerful than it seems. It processes around 60 images per second, with each image consisting of millions of points. Computer vision is still a long away from its goal of replicating the human eye, but in the meantime various computer vision techniques are being applied to complex applications. The proposed algorithm is resistant to small illumination changes and also involves a module that reduces effects of camera movement. . In this system four static cameras are used to capture the moving objects. Background subtraction method subtracts the moving object from static underwater place. This procedure is done by pixel by pixel. Area of the species is also main consideration. Once the species are detected from static underwater place, using background subtraction method tracking is done on each of the four sides. Gaussian mixture model (GMM. and BLOB analysis method is applied for counting the rare species. Gaussian mixture model gives the better segmentation to the original images. BLOB analysis produces the bounding boxes to the species.*

***Index Terms**: Blob analysis, Gaussian Mixture Model, MATLAB.*

I. INTRODUCTION

Now a days detecting and tracking of marine animals are become very important for several large-scale scientific projects has begun to investigate the condition of the marine environmental aspects. Our proposed work contributes the important emerging technology for the management of marine environments and resources. Output data will be required to solve the issues where detecting and counting of the marine species is important. There are three main factors that affect visibility underwater; often, they are directly related to one another. These factors are: suspended particulate matter, biological species or lack thereof, and light penetration. Sunlight plays an incredibly important role in our ability to see what is around us. When the sun is shining, visibility tends to be better than on cloudy days, and when the sun is overhead, visibility is better than it is when the sun is at an angle. In addition, when the surface is glassy, it allows sunlight to penetrate better. Another major issue in underwater imagery is visual clarity of underwater decreases with the increase in capturing distances, as photons are absorbed and scattered by water and floating particles.

By segmenting image, regions are grown by grouping neighbouring pixels that have similar properties such as intensity, gray level texture, and color…etc. Then each regions are differentiated by applying pseudo colors.

The red color typically disappears Further orange, yellow and g Because of its shortest visible wavelength, blue color travels the longest, i.e., about 30m depth in water. The various steps in detection and tracking is shown in Fig. 1.

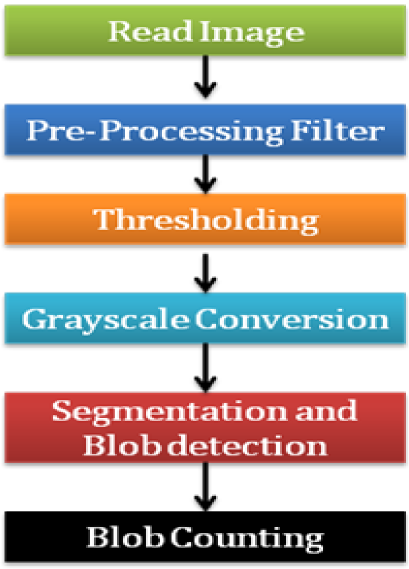

Fig. 1 Steps Involved In Counting Blobs

Underwater images are dominated by blue and green color, since they has the higher wavelength in underwater. Because of this nature of underwater artificial light is required on images.

II. PROPOSED SYSTEM

In this paper we have analysed the existing pre-processing filters and proposed a method that best ensembles to enhance the delectability of objects in underwater images. Tracking of marine species is done by Gaussian Mixture model using Computer Vision toolbox.

A. Pre-processing Filter

The Sobel operator does this in a rather clever way. An image gradient is a change in intensity (or colour) of an image (I'm over simplifying but bear with me) . An edge in an image occurs when the gradient is greatest and the Sobel operator makes use of this fact to find the edges in an image.

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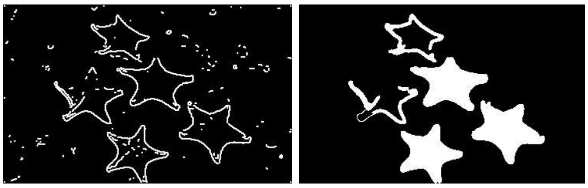
The Sobel operator calculates the approximate image gradient of each pixel by convolving the image with a pair of 3×3 filters. These filters estimate the gradients in the horizontal image (I'm over simplifying but bear with me). An edge in an image occurs when the gradient is greatest and the Sobel operator makes use of this fact to find the edges in an image. The Sobel operator calculates the approximate image gradient of each pixel by convolving the image with a pair of 3×3 filters. These filters estimate the gradients in the horizontal (x) and vertical (y) directions and the magnitude of the gradient is simply the sum of these 2 gradients.



(a) (b)

Fig. 2 (a) Edge extraction form gray scale using sobel edge detection. (b) Image filling by Matlab function to close object region

B. Blob Detection

Blob detection is an algorithm used to determine if a group of connecting pixels are related to each other. This is useful for identifying separate objects in a scene, or counting the number of objects in a scene. Blob detection would be useful for counting people in an airport lobby, or fish passing by a camera. Blob area – Area of a particle expressed in real units (based on image spatial calibration). This value is equal to Number of pixels when the spatial calibration is such that 1 pixel represents 1 square unit. Middle mass would be useful for a baseball catching robot, or a line following robot.

To find a blob, threshold the image by a specific range as shown in fig. 4(b), the centroid has been detected after labelling each region in an image. That represents the middle mass, or the average location of all pixels of the selected color. Steps involved in Blob detection algorithm:

1. If the pixel is a blob color, label it '1'
   otherwise label it 0
2. Go to the next pixel
   if it is also a blob color
     and if it is adjacent to blob 1
       label it '1'
     else label it '2' (or more)
3. repeat until all pixels are done

What the algorithm does is labels each blob by a number, counting up for every new blob it encounters. Then to find middle mass, also we can just find it for each individual blob. Blob detection is useful in finding blobs sizes, these are approximated values in pixels of an image. If we know difference between real size of starfish or shark, that can leads to predict original size of the species as illustrated in Fig. 6.

The Blob Processing block helps to find the number of objects (starfish) visible in the image. So an additional MATLAB function block is added to count the total number of cars that are passing. The result is displayed using the inbuilt display block as shown in figure 5(c).

C. Gaussian Mixture Model

A Gaussian Mixture Model (GMM) is a parametric probability density function represented as a weighted sum of Gaussian component densities. GMMs are commonly used as a parametric model of the probability distribution of continuous measurements or features in a biometric system, such as color based tracking of an object in video.

1) Background Subtraction

Temporal or spatial smoothing is used in the early pre processing stage to eliminate device noise which can be a factor under different light intensity. Smoothing technique also includes removing various other elements like environment such as rain and snow. In real-time systems, frame size and frame rate are commonly adopted to reduce the data processing rate. Another key factor in pre-processing technique is the data format used by the background subtraction model. Most algorithms can handle luminance intensity which is one scalar value per each pixel In the figure 3, shown are two images which shows snow on the left and whereas with the application of spatial and temporal smoothing on right image results in the elimination of snow producing an more clear and effective image for background subtraction.

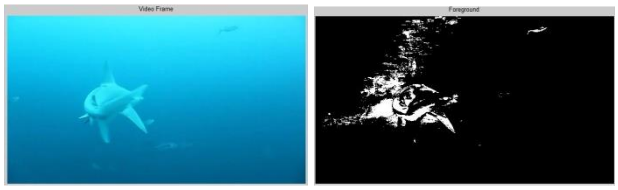


Fig. 3 Image on the left shows snowing and image on the right is a resultant of smoothing effect

2) Background Modelling

This step uses the new video frame in order to calculate and update the background model. The main aim of developing a background model is that it should be robust against environmental changes in the background, but sensitive enough to identify all moving objects of interest.

3) Foreground Detection

In this step, it identifies the pixels in the frame. Foreground detection compares the video frame with the background model, and identify candidate foreground pixels from the frame. Commonly- used approach for foreground detection is to check whether the pixel is significantly different from the corresponding background estimate.

4) Algorithm of Gaussian Mixture Model:

- GMM compare each input pixels to the mean 'Threshold' of the associated components. If the value of a pixel is close enough to a chosen component's threshold, then that component is considered as the matched component.
- Update the Gaussian weight, threshold and standard deviation (variance) to reflect the new obtained pixel value. In relation to non-matched components the weights 'w' decreases whereas the mean and standard deviation stay the same.

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- It is dependent upon the learning component 'p' in relation to how fast they change.
- GMM identify which components are parts of the background model. To do this a threshold value is applied to the component weights 'w'.

Final step we determine the foreground pixels. Here the pixels that are identified as foreground don't match with any components determined to be the background.

III. RESULTS

Proposed work has useful in segmentation, detection, counting and tracking of marine species in underwater. A typical blob analysis process scans through an entire image and detects all the particles, or blobs, in the image and builds a detailed report on each particle. This report usually contains approximately 50 pieces of information about the blob, including the blob's location in the image, size, and shape, orientation to other blobs, longest segment, and moment of inertia which is shown in fig. 3. Input image and thresholding values are shown in Fig. 4(a) and 4(b).

Fig. 7(a) and (b) illustrates tracking and counting of marine animals in underwater. GMM tracking system takes first 70 frames to calculate blobs and foreground of the video that has been shown in the first among three images. Using blob analysis inbuilt function of Matlab will identify position changing if object in consecutive video frames. Foreground extraction in second image fig. 7(a) and (b) describes blobs detected regions. By applying boundary box block to all blobs detected throughout the video frames are counted and tracked. The detected object (shark) is demonstrated as yellow lined boundary box in third image in fig. 7(a) and (b).

```
Command Window                                  HDL Code Generation
  Running Object Detection and counting ....
  Object       Mean # Intensity # Area # Perimeter # Centroid # Diameter
  # 1          251.2    1039.0    487.1    110.6     128.1      36.4
  # 2          251.1    1136.0    453.2    147.7      44.9      38.0
  # 3          253.5    2991.0    306.2    167.9     193.6      61.7
  # 4          253.5    3473.0    329.2    195.7     103.4      66.5
  # 5          253.8    3678.0    332.4    268.7     163.5      68.4
fx >>
```

Fig. 3 shows parameters associated with each blobs in an image

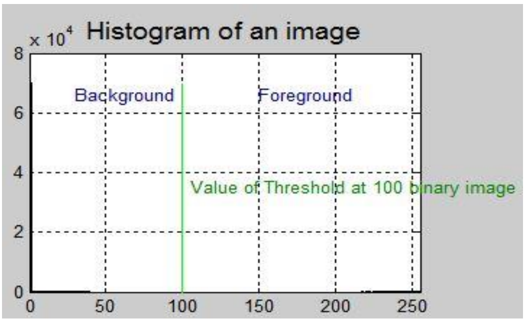
IV. FUTURE WORK

Performance improved with applying pre-processing filters before detecting blobs (sea stars) on the image. It tends to detect sea stars on clear ocean scenarios with binary format because blob detection is only applicable for binary images. If we want to count and track object passes through a frame or image only once in a time means, feature based on color segmentation could be added to address this issue. In future feature extraction based detection is helpful in differentiating sea stars and its 'footprints' and also in tracking system which tracks only one type of marine species, even though video capturing or imaging in a clumsy (more than one species in a scenario) environment.

V.CONCLUSIONS

This proposed work presents a system with optimized function for detection, segmentation, counting and tracking of sea stars and other marine animals like shark in underwater. Detection and counting is based on blob detection with combination of preprocessing filtering technique to exactly extract particular objects as being sea stars or other small species in underwater imagery. We also proposed object tracking and counting on video frames, based on GMM algorithm and blob analysis. On simulation boundary box (green and yellow colored) verifies the tracked object on a frame. This system achieves optimized detection, segmentation, counting and tracking of marine species.

(a)



(b)

Fig. 4 (a) shows input rgb image (b) Shows threshold value used to know object region in an image

(a) (b) (c)

Fig. 5 (a) Converting binary to gray scale image after thresholding, (b) Applying pseudo colour for detected blobs, (c) showing numbers on each blobs

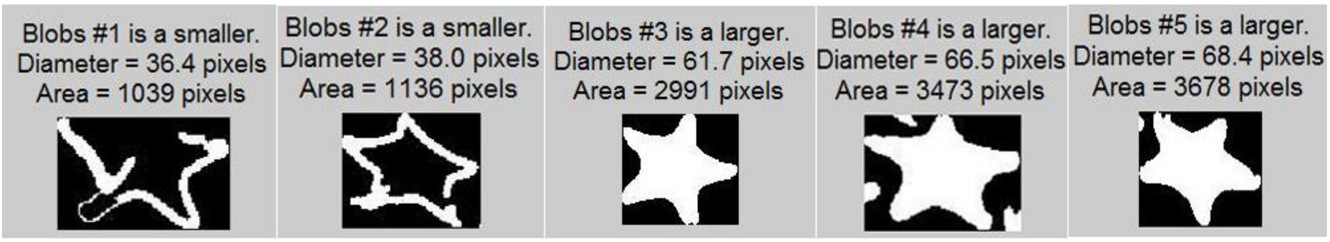


Fig. 6 Illustration of separated blobs and its properties

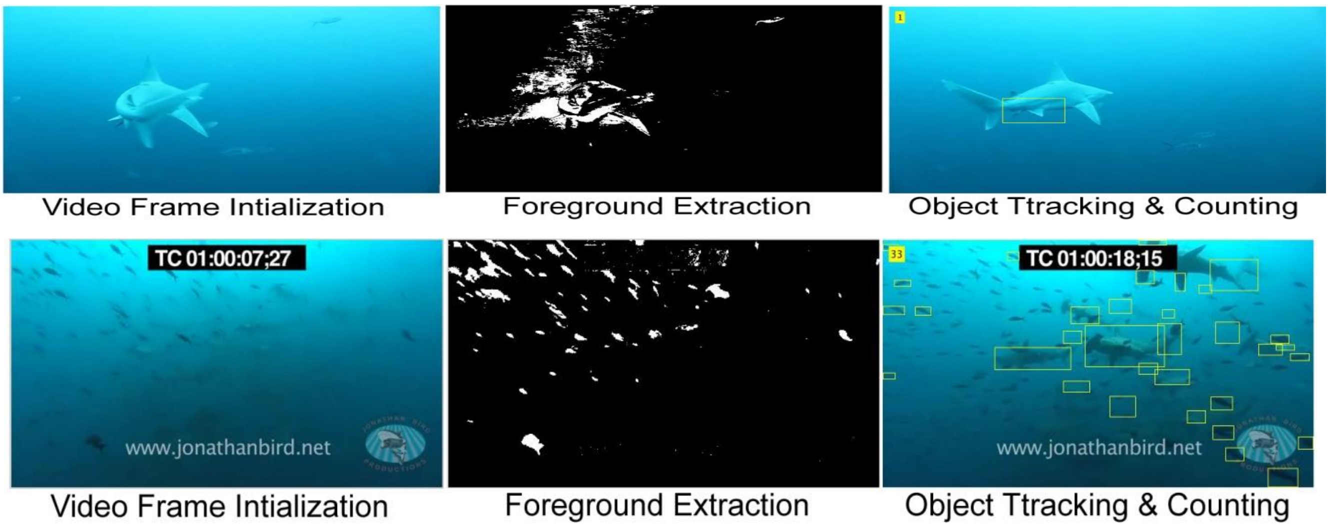


Fig. 7 Tracking and counting of shark in video frame using GMM algorithm (a) Tracking single object (shark), (b) Tracking multiple object

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