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Optical Tracking Method based on Clustering Technique under Ocean Water Cleaning System

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Abstract:
Usage of sea for dumping garbage is a serious concern in today’s world. Removing the garbage’s which are clandestinely dumped in the ocean floor pose an environment threat and needs immediate concern. The increase in plastic particles in fishes and other planktons in the ocean is increasing alarmingly. In this paper we are envisioning a robot fish which will feed on plastic and non living organism which pollute the environment. The real challenge lies in identifying the movement of the living organism and differentiating with non living movement in a hostile environment. We propose an optical flow method using CAMShift algorithm with Kalman Filter for tracking a moving target. In order to confirm the moving object is alive we forage the image area by adjusting the window size to find the shape and orientation changes using background weighted histogram. The final stage is the use of universal Kalman filter to avoid being trapped in a loop of searching the plastic and detecting live organism.

Keywords: *Plastic pollution, CAM Shift, Kalman Filter, Background Weighted Histogram.*

I. Introduction

Plastic pollution in ocean plays a major threat to the environment. It is estimated that 4 to 12 million metric tons of plastic are dumped in oceans every year. These figures keep on increasing as the year passes. This paper focuses on creating a device that removes plastic from the ocean. This paper deals with the major problems such as tracking the live object so that the device does not harm the living creatures. The major difference between the fishes and plastic is that fishes get alarmed due to the devices that cleans the water and moves away. The device must track the plastic and waste products and must not pursue after living creatures.

The paper focuses on a detailed description of tracking and differentiating the living and non living system. The device focuses in contributing its part for protecting environmental community. This algorithm is tailor made for low quality camera, tracking the plastic waste. Accurate tracking can be difficult to achieve when the target being tracked and platform tracking the object are experiencing dynamic motion coupled with low quality camera, background clutter in the scene, lighting variation under the sea.

II. Literature Review on Tracking Methods

Tracking the garbage in ocean can be a tedious task. We can track the garbage based on tracking algorithms. A robust segmentation algorithm [1] is proposed for extracting objects and their corresponding shadows in sonar images. The algorithm is a combination of Normalised Least Mean Square filter (NLMSF) and Region Scalable Fitting (RSF) model, where the coarse segmentation using k-means clustering and fine segmentation combining an edge-drive is used. The NLMSF

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effectively produces a clean and accurate segmentation for fine and coarse segmentation. The need for combining the edge driven RSF model is to reduce the iteration time and robust in dealing with homogeneity intensity.

The paper [2] proposes a neural network based model which has a better target detection with dynamic backgrounds, shadow cast, robust against false detections. The paper [3] proposes vehicle recognition and tracking system using Gaussian mixture model. This method is robust for low and medium traffic and during the high traffic it is not efficient to obtain best results. The paper [4] proposes a fuzzy method, maximum entropy and uses temporal information to identify the moving target without prior knowledge of the background and works well in low resolution and camera jitters. This model has a negative aspect of misinterpreting the shadow as object itself.

In this paper [5], traffic surveillance using a combination of Bayesian fusion method for background modeling and Gaussian formulation for foreground modeling is used. This method has low latency time and works well for rapidly and slowly changing background. The issue in this algorithm is that if the object feature is identical then it will yield poor results.

In paper [6], five frame differential approaches combined with background subtraction is used to track objects. This method is robust for dynamic targets but prone to noises and it cannot eliminate the noises. In this paper [7] fast illumination variations along with Gaussian model for object identification is used for object detection without any training sequence. The results of this method degrade in complex environment. In paper [8], they have used RGB color space model using chromaticity and brightness ratio model combined with edge ratio to detect object, shadow and background. This method can be used for real time analysis. The results with darker shadow and moving target having similar color information leads to failure.

Thus from the above mentioned paper and in the paper [12-15] it is clear that in order to obtain a real time working system significant amount of tuning of algorithm is required. We propose an optical flow method using CAMShift algorithm with Kalman filter for tracking a moving target.

In order to confirm the moving object is alive we forage the image area by adjusting the window size to find the shape and orientation changes using background weighted histogram. The final stage is the use of universal Kalman filter to avoid being trapped in a loop of searching the plastic and detecting live organism.

III. Proposed System

The Model considered for image processing is a normal video file with low quality image. The video resolution is considered as 640x480 pixels and the frame rate is 30fps and the images are animated at the rate of 15 frames. The Camera is set up in front direction to imitate eyes of the device. High resolution video or image is not required because the purpose of the device is to locate the specific area and objects location. Restricting the resolution lowers the textures hence less noise and less details.

In this paper we have used subtraction method [10] on the current and the previous image to identify moving objects. This is iterated on every frame of the video sequence the idea can be mathematically implemented as difference between current frame, Ci(x,y) and reference frame Ri(x,y) to obtain the required frame details.

$$Fi(x,y) = Ci(x,y) - Ri(x,y).$$

The difference between these pixel values suggests the amount of motion within the region. The more the changes the more living organism in the region and we can move to the other area.

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The paper [2], proposes a method to detect moving and stationary objects. We also use similar type of classification of pixels like background, mid ground and foreground. In order to achieve microscopic precision the classification is categorised as small, medium and large changes. We have used matched mode in the algorithm to classify pixel. The classification is done by comparing the pixel distance from the centric value. Then, the parameters such as mode age and mode observation density are computed to compliment the identification of objects. These parameter pay a way to avoid killing or hurting the fish of same variety found in the sea. The algorithm is set to classify the pixel by comparing the age and distance. If the age is in permissible range then is considered as mid ground.

If age is less than permissible threshold then it is classified as foreground term and if age is larger than threshold then it is assumed as background. Similarly based on difference between distance and threshold reference it is classified as small, medium, large changes.

Pixel classification in this paper uses age as a parameter to remember the type of fishes of same variety.

We also note the time during which the pixel is absent from the screen, during which the device collect garbage from the ocean. Usage of age and time is done by foreseeing that the fishes will be more than one variety or number of fishes in the same variety. As a mode becomes older and older the same variety of fish has not yet captured.

A mode moves from short-term to medium-term memory based on its age and with the absence of moving object time can used do the major objective of collecting garbage.

We also check the neighbor of the current pixel, if the number of moving pixel is less than threshold value then it is marked as mid-ground model. Thus it yields good performance in case of foreground aperture

In our work, we have employed phase correlation to calculate the relative offset to estimate the global displacement in consecutive video frame as frequency domain analysis is more robust[11] in presence of noise, occlusion etc. The pseudo code for the tracking object is as follows.

Table 1: Pseudo code for tracking object

for t = _ + 1 to T do
Let vt be the current frame
for index = 1 to _ do
Calculate vt index from vt index
Calculate Q index from Hindex
end for
Interconnect each pair of Hindex's and unite them
Generate history of dissimilarity and weight matrix
Generate foreground and detect moving objects in foreground
Refine object regions
if f == first operating frame of V then
Initiate each of the Track's for each of the detected Object's
else
Calculate cost matrix
Call Algorithm using resultant cost matrix as argument
Interpret the frame vt using the results returned by Algorithm
end if
end for

The CAM Shift algorithm[9] majorly undergo three process. The major step is to apply Mean Shift search and identify the object position. So we change the image of frame into probability density distribution and feed it to CAM Shift algorithm. Once the search results are obtained it will serve as the initial value to next frame.

Repeating this steps we can detect the object continuously.The reason for choosing CAM Shift is that the information is lossless and stable. In our real time processing system of DSP platform it will reduce the complexity and pre processing algorithm.

We in our paper we have modified the CAM Shift algorithm. The algorithm flow chart of improved CAMShift is as follows

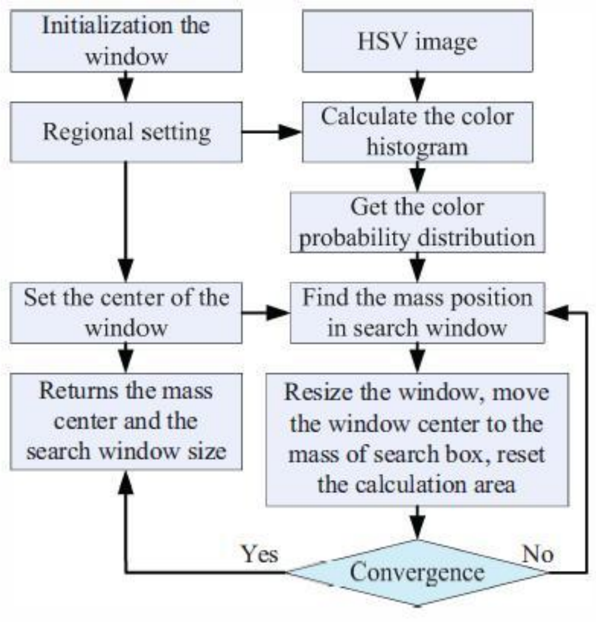

Figure 1: Algorithm of Improved CAMShift

1. Initial location of search window is based on the fore, mid, background segmentation of the target.

2. The weighted image of the 2D region centered at the search window and the neighboring pixel if found.

3. Use the mean-shift method to find the new location of the target.

4. Use the weighted image value and obtain binary fore, mid, background of the target and update the fore, back, midground colour histograms.

5. In the next image frame, the search window is moved to the new target location.The process is iterated starting from step 2.

We in our paper we have modified the CAM Shift algorithm[16].

It is being complimented along with tracking and image subtraction method to create a hybrid variety of algorithm which yields better result than CAM Shift algorithm.

IV. Results

The Results are simulated and the algorithm is based on simulated results. The figure 1 is considered as a screen shot of the live fish on the device.

Figure 1: Feed Data of live fish

An RGB color space will produce a different color in terms of the Red, Green, and Blue. The RGB color space is sensitive to color changes, but it is not adjustable to changes of the intensity. In real time it is difficult to correct the object tracking if it has large impact in lighting and the external environment. To solve this problem, the RGB is converted to HSV. The figure 2 shows the hue Saturation value of the image.

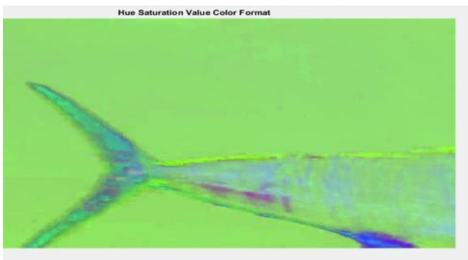

Figure 2: Hue Saturation of image

The video is made of frames and it is converted in RBG format. The RGB image is again converted into the HSV format, as it similar to way to human eye working. Using the converted HSV image, the (V) Value part is eliminated because it keeps varying as light variation changes. From figure 3 we obtain

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the value of HSV separately and eliminate the value (V).

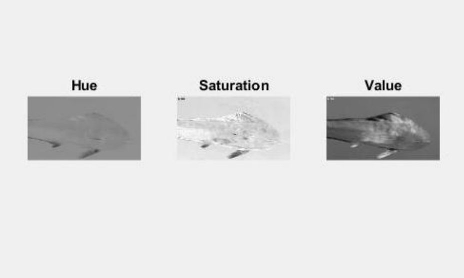

Figure 3: HSV of the image

Let us consider that a row of 256 buckets which as labeled from 0 to 255. The histogram of an image such as figure 1 is computed by examining each of its pixels one at a time and passing it to bucket which corresponds to its brightness level and count the pixels in each bucket.

Histograms of the HSV values are shown in figure 4. The graph in the figure 4 is plotted against grey scale value and number of pixels.

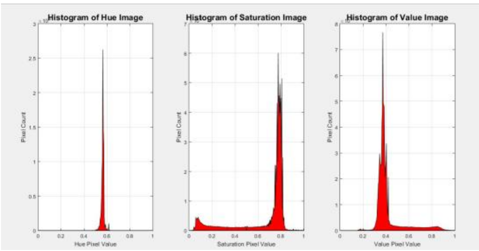

Figure 4 : Histogram of HSV of image

CAMSHIFT uses the value of figure 4 to evaluate the probability that each pixel in a region belongs to background or foreground or midground. The figure 5 shows a case in which a small size target is being tracked.

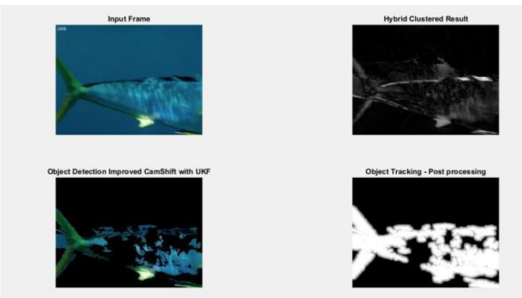

Figure 5: Output image with background

The initial size of the search window is deliberately set to be larger than the target`s size to contain some background pixels. The background is removed as much as possible and in the dark environment of the sea we have detected the motion of living elements. The device will collect all the garbage and dirt and help in cleaning of the ocean or a water body.

The simulation result was able to distinction a live object under different background. The simulation result yields the required results

V. Future Works

We will improve the CAMSHIFT algorithm by implementing the clustering algorithm using machine learning and form a wireless networking of devices which co operate among themselves in collecting the garbage from the ocean. Thus we can have multiple devices performing the single target tracking function. The important task in the current paper is to differentiate the living and non living. In the future apart from the differentiation the purpose of the object tracking is to keep the area of plastic depositing and transfer the data of plastic acculumating among themselves and remove the pollutants from the area.The object identification method added to the future method should have low latency rate and work faster in removing the pollutants.

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