MARINE COSERVATION ZONE SURVEILLANCE USING IMAGE PROCESSING

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Abstract

In this paper we state a cost efficient method for Marine Protection zone (MPZ) surveillance using image processing where we detect the presence of ships entering an MPZ by wake detection. The frames containing the ship along with its coordinates are presented to the security personnel. If it's deemed a threat the corresponding personnel are sent to handle the situation.

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1. Main text

The exponential increase in the population of man poses a huge threat to the entire ecosystem. Man's influence with the advancements in technology has extended into even the depths of the oceans. In this paper we propose an algorithm for Marine Protection Zone (MPZ) surveillance, which is cost efficient and more effective than the existing methods. MPZs are regions identified by the government as a bio reserve because it serves purposes such as mating grounds or living habitats of highly endangered or threatened species. Protection of the species residing in these zones gives them a chance to recover and regenerate their population. Dolphin and whale population though are severely threatened by environmental deterioration, deliberate hunting and the risk of accidental drowning in the fishing net also poses an equivalent threat. Seals and sea-lions are endangered by commercial sealing operations. Seals and dolphins are considered a liability by local fishermen as they compete with humans for fish, their staple diet. Hence they are weeded out as pests

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regularly. Manatees are extremely vulnerable because they are slow moving animals. Major manatee deaths are a result of accidental bumping and battering by speed boats that tourists use and fishnet drowning. Kemp Ridley, the most endangered turtle species are driven to the brink of extinction by dredging and trawling ships and pollution. The species mentioned above are a few of the many endangered marine animals that inhabit an MPZ. Thus in summary failure of an MPZ is majorly due to overfishing, illegal poaching and ill- planned tourism. Hence an efficient surveillance technique which can be implemented in various regions by a single government without excessive expenditure can help solve this problem. Here we propose an image processing solution which can be implemented in an unmanned aerial vehicle (UAV).

2. Existing methods of surveillance

A marine reserve spanning across 40 to 50 nautical miles usually has its reserve administration planning its patrol activity. On an average the reserve employs three to four naval vessels for long range operations, one or two vessels for medium range operations and a number of small speed boats for catch and rescue operations. Though this method significantly reduces the illegal fishing and poaching activities, it involves a lot of man power and resources such as boats and fuel expenditure.

3. Image processing

The image processing section involves the detection of wake in the frame that is sent from the camera fixed in the aircraft. The live video stream is converted into frames at the rate of 24 frames per second which is the frame rate that is suitable for human eye. This is done by the Matlab coding which is used to convert videos into frames and save the individual frames in a separate folder. Then the frames are checked for the existence of wake to confirm the presence of the ship. This is done by using the process of edge detection.

3.1. Edge Detection

The wakes can best be detected by using the edge detection algorithm. The edge detection basically involves filtering out useless information from the image and preserving only the structural information. The edge detection can be done by using any one of the following methods which includes Sobel, Prewitt, Roberts and Canny edge detection method. Each method has its own significance. We use canny edge detection method for this application.

3.2. Canny edge detection

The canny edge detection involves the use of threshold values which is used to separate the edges from the rest of the image. The final output appears as a binary image with the edges indicated by a continuous stream of white pixels. The general expression used for canny edge detection is

Obj = edge (img,'canny', MAX,MIN,SIGMA)

The canny edge detection involves 3 steps. First the image is leveled by the Gaussian convolution. Then the image is subjected to 2D differentiation which produces high first spatial derivatives. This gives rise to a gradient magnitude image. Due to the differentiation applied, ridges are produced on the points with high first spatial derivatives. Then the algorithm sets the pixel values other than the ridges to zero so that a thin line which indicates the edge appears in the image. The production of ridges can be controlled by using the two threshold values which in this case is named as MAX and MIN. These threshold values controls the number of edges that appear on the image. By altering the value of the MAX and MIN the desired number of edges can be filtered out from the image. The third threshold value present in the expression stands for the standard deviation of the Gaussian filters that is used in the differentiation. By using these values the desired edges of the image can be produced. The MAX values and MIN values must be set in an optimal way such that the output does not contain any noise. If the MAX value is set low, then the noise interference occurs. If the MIN value in high then it results in the breaking of the edge contours. Both these features are not desirable for the output image. So the best threshold values must be set for the image. The values of SIGMA can be made greater in order to reduce more noise from the image.

3.3. Working

The first part of image processing is the conversion of the RGB image obtained from the camera to a grayscale image. This is accomplished by rgb2gray function which is in built in matlab. It involves the setting of threshold values which determines the intensity of black and white pixels in the image. The threshold value for this process is given by

$$Y=0.3R+0.59G+0.11B$$

The grayscale image is then subjected to edge detection algorithm which in this case is Canny edge detection. The output image after the edge detection consists of the edges indicated by thin white lines. During edge detection there is a possibility that the line indicating the edges might be discontinuous. In order to avoid this discontinuity, image dilation is performed. This is done by using the imdilate () function. This function requires a structuring element using which the dilation has to be performed. We use square as a structuring element in this case. The image dilation closes the discontinuities in a line. This gives an edge that is detected from the frame which indicates the presence of a ship. The number of connected components is calculated by using the bwconncomp () function which gives the number of individual line segments in the image. We can use this value as threshold to indicate the presence of the ship. For example if there are 3 line segments detected in a frame then there is a possibility of a naval vessel. Depending on the noise factors and accuracy the threshold is estimated to six.

Fig. 1. RGB image.

Fig. 2. Grey Image

Fig. 3. Edge detected by Canny Edge detection.

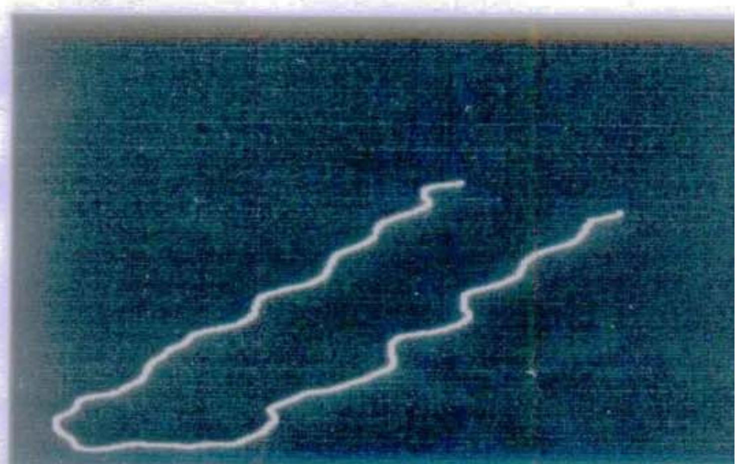

Fig. 4. Dilated Image

Once the ship is detected in the frame, an alert is given to the base station r
RGB image which contains the GPS co-ordinates of the vessel can be obser
station. If the object of interest observed by him in the RGB frame is deemed

send a convoy of security personnel. Our method surveillance involves only a team of UAVs equipped with our image processing algorithm, this is by far much more economical and efficient compared to manual patrolling.

4. Collegial Surveillance

The co-operative implementation of multiple UAVs is required for effective surveillance. The entire area under surveillance is provided with a base station to which the data is transmitted by the aerial vehicle.

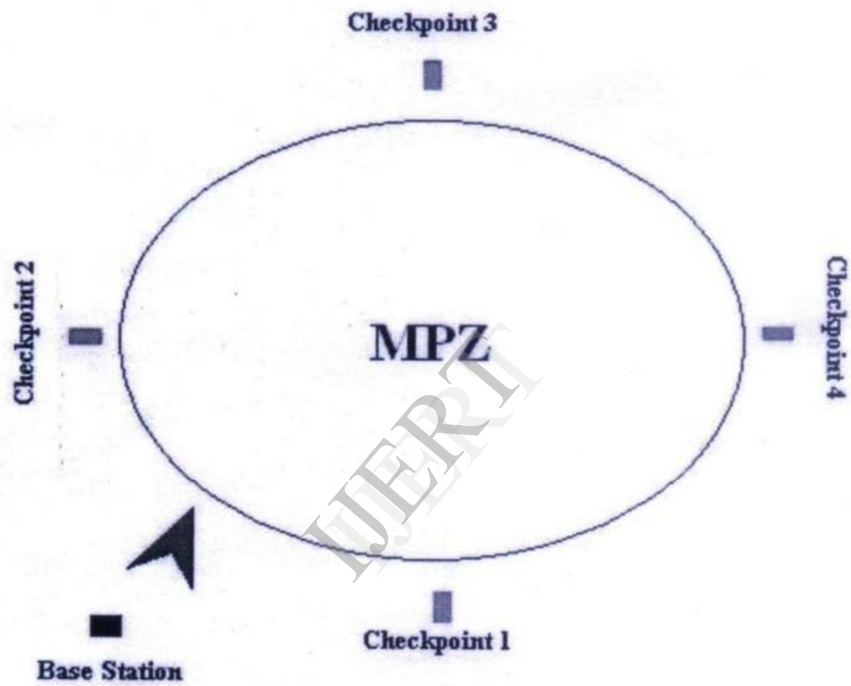

Fig. 5. Collegial Surveillance

The aerial vehicle is operated over the area in circular paths. The aerial vehicle transmits the data to the base station when it reaches the checkpoints. There can be any number of checkpoints depending on the volume of area covered by the aerial vehicle. By this process, the entire area of conservation can be brought under surveillance with high efficiency.

5. Glitches and elimination

Water surface behavior for different marine animals is unique; cetaceans often exhibit behaviors such as breaching or lunging, spy hopping and tail slapping. Whales exhibit throwing behavior. Since we employ wake detection as our principle method for detecting a ship, concern arises for the misinterpretation of the wakes created by whales and other large marine mammals. In order to avoid this, the frames sampled for processing are deferred by 50 frames. When two such frames are compared in the event of presence of a ship the trailing wake will mitigate at a rate which is approximately equal to the rate at which a new wake is being formed at the hull of the vessel as it courses through the water at high speeds. On the other hand if it is a whale present in a frame, the wake created by it is substantially smaller when it is calmly swimming on the surface because of its streamlined body and the wake disappears and appears in a much more random inconsistent fashion due to its surface behavior mentioned above. Only while exhibiting these kinds of behavior, wakes are observable. The processed output of the RGB images, showing such a behavior of a whale taken at an interval of two seconds between the frames is presented below.

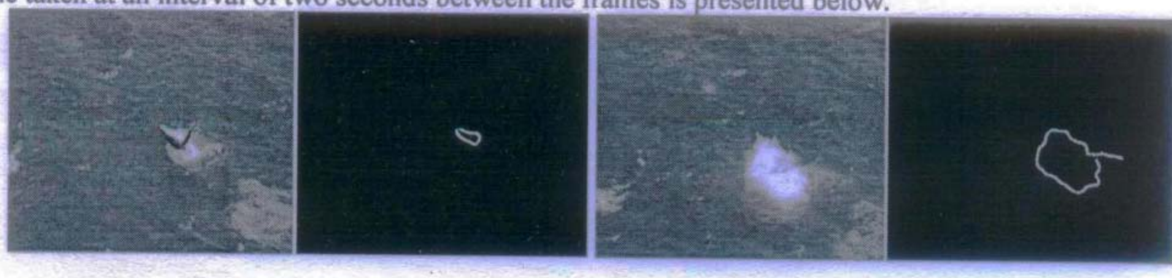

Fig. 6. a) Frame 1; b) Frame 2

Fig. 7. Frame 3

6. Conclusion

Thus we've proposed a model were we use a team of UAVs implementing the wake detection algorithm for successful and efficient surveillance of Marine Protection Zones.

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