Computer Vision 600100

Counting Starfish

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ACW REPORT

Introduction

This report covers the pipeline that has been developed for the recognition of starfish in distorted images. The pipeline was developed in a single MATLAB .mlx script which takes in a path to an image file and outputs the bounding box locations and the count of the starfish in the image. The pipeline also outputs the image with the bounding applied to them.

Image Processing Pipeline

The pipeline is broken down into stages. There are two stages and an output stage.

Section 1

This stage is intended to take in the original image and then perform enhancements on the image to get it to a state where detection can take place.

1.1 Median filter

A median filter is applied to each of the channels of the original image. A median filter works like a sliding window over the image and takes the median of all the values. This creates a smoother looking image. This removes a large portion of noise from the image and it is very effective at it. It also preserves edges of objects in the image. Chosen due to not destroying detail.

1.2 Removal Of Salt And Pepper Noise

The median filter is effective with the removal of Salt and pepper noise but in some cases a more specialized way of utilising the median filter and the use of a mean filter is also done. A mean filter is only applied if there is residual noise left on the channel this is checked by getting the bin count of each channel then comparing the means of the bin count to the count of the first and last channel, if they are higher then there is most likely still noise on the channel and the mean filter is applied to the channel. This does come with a loss of detail.

1.3 Increase The Saturation

To help the saturation is increased by converting the processed image so far from RGB color space to HSV. The processed image is boosted in saturation by 3 times. Then converted back to RGB color space for more processing. Chosen because it’s the easiest way to increase saturation

1.4 UnSharp Mask

A Unsharp Mask is then applied to the image. This is to increase the clarity and contrast of edges of the objects in the image. First a blurred image is produced by performing a spatial

convolution filter on the image so far. This is then subtracted from the image so far then it is combined back to the image so far with some coefficient in fraction form. The formula is sharpened image = original image + coeficient (original image - blurred image). Chosen because it's relatively simple to implement and gives a good output.

1.5 Binarizing

The image so far is then processed to a binary form then the complement is then taken and used as the output image for the morphology. The way it is binarized is by converting the image to grayscale then converting the 0 - 255 values to either 0 or 1 depending on what side i lies on.

1.6 Morphology

This step is designed to remove small holes and reduce the amount of protrusions from the objects so far. First a close is performed with a disk of size two, this is an erosion followed by a dilation that is designed to smooth foreground objects while breaking any thin protrusions. A erosion is done to get a more solid object. Finally a second close is performed with a more severed disk to get the last output. This sequence was chosen due to trial and improvement, this gives a good output in most cases.

Section 2

Now the pipeline has got the preprocessed image and is ready to try and find starfish in the image.

2.1 Removing Large And Small Objects

From the processed image all objects larger than a certain amount of pixel and less than a certain amount of pixel are removed from the mask, it's done on a pixel base due to it being the most reliable form of removeall.

2.2 Active Contouring

This stage uses MATLAB built in active contouring algorithm to separate images from the foreground to the background. The MATLAB function uses the snake method. This is a super powerful tool that means a lot of the high noise images are able to be recognised. The maximum amount of iterations is set to be 70 due to the fact if the image has a lot of noise then the contouring sometimes picks up the noise and 70 was the sweet spot.

2.3 MSER Regions And Properties

MSER features detection is applied to the mask so far to get all the objects in the image. Bounding box, eccentricity, solidity, Circularity, and Extent are pulled from the generated

regions. Using MSER features is the best way to detect objects in an image that are a certain shape.

2.4 MSER Regions And Properties Filtering

To find the shape of a starfish in the image the MSER features that have been gathered. The best way that was found to detect stars from these features were to test that the eccentricity was less than .7, the extent was less than .4 and the solidity was less than .6. This gave the best percentage of scusess.

Section 3

This section just outputs the amount of starfish detected in the scene as well as the bounding boxes. An image is also outputted with the bounding boxes drawn over the original image.

Results

When the original image is put through the pipeline all five of the starfish (Fig. 1). The noise is filtered out well and the bounding boxes for the most part are accurately around the starfish in this image. Higher noise images such as noise 10 (Fig. 2) also have all 5 starfish recognised in the image.

Fig. 1

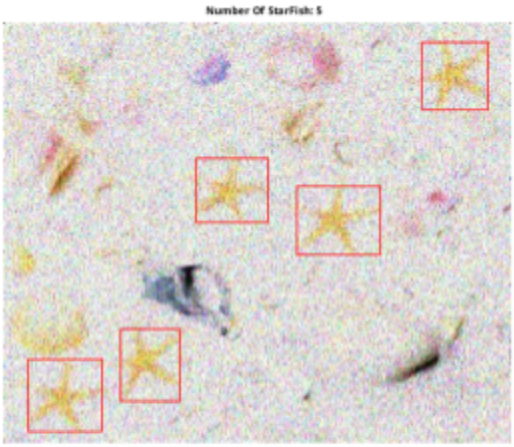


Fig. 2

As well as working well on different noise types and levels the pipeline copes well with different color variations. Fig 3 and 4 show that even when the color is changed the pipeline has the flexibility to allow the detection of the starfish with good accuracy.

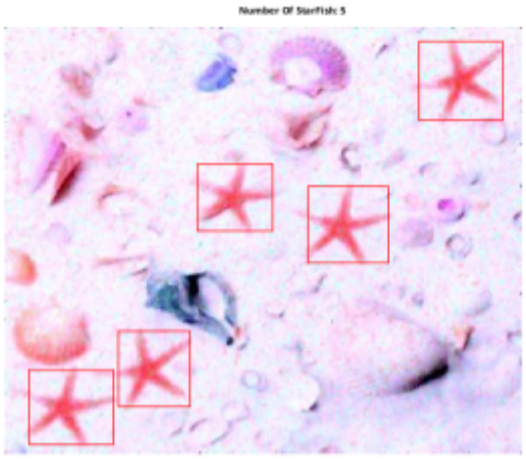


Fig. 3

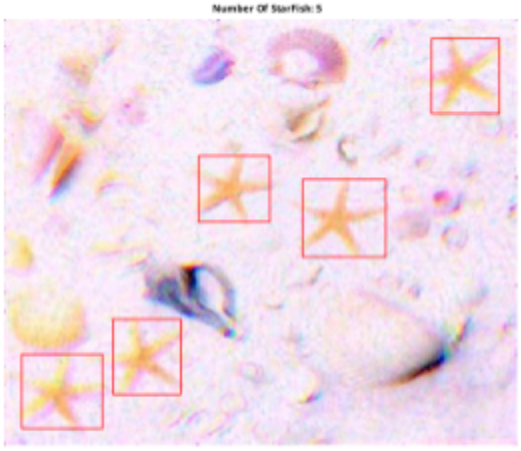


Fig. 4

The pipeline struggles with two of the noise images, that being noise 5 (Fig 5) and 9. The mask of the starfish is able to be generated but due to lacking morphologic functions the starfish shape is lost and not defined enough to be picked out reliably. Fig 7 shows that the starfish is recognised in the light green but one of the arms is not defined enough to allow for the accurate detection of the star shape from the MSER features.

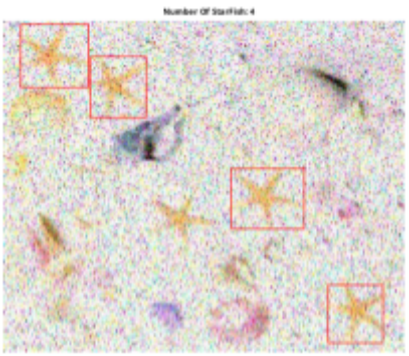


Fig. 5

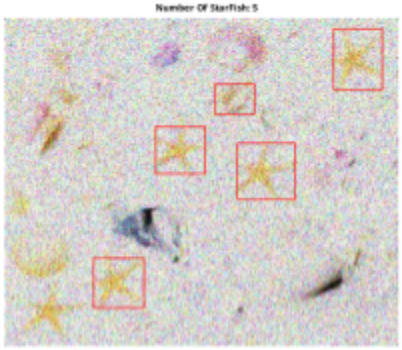


Fig. 6

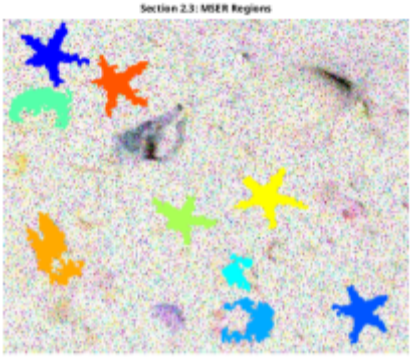
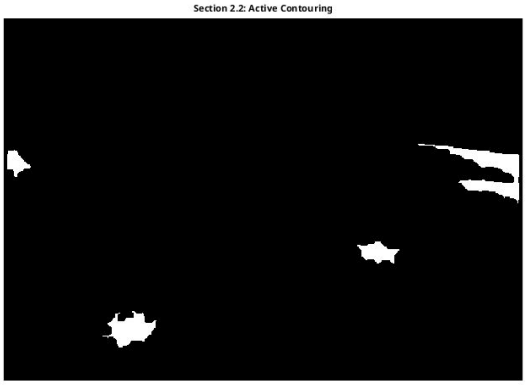


Fig. 7

Finally the alternative images aren't recognised, an attempt is made for most of them but starfish_5 is the most successful. Shown below is the rough estimation of two starfish in the scene. They aren't picked out correctly so they are not recognised at the end by the MSER features.



Discussion

The pipeline works effectively for most of the standard images but there is a lot of room for improvement. The two images that aren't recognised could be improved by a bit of tweaking in the morphological functions.

The median filter works extremely well, definitely being the best option to remove noise due to the fact there is no loss to the edges of objects in the image. The mean filter could be improved a bit by changing the size of the second input vector to get a more optimal noise reduction on the channel based on the input image. Using the mean count compared to the high and low values of the histogram means that no unnecessary functions are carried out on the image when the only thing it could do is hurt the clarity.

The saturation works well but it could be tweaked to change the amount the image is getting saturated by instead of a straight 3 times.

The unsharp filter could be improved by changing the coefficient that is applied to the sabtration of the mask. No method that was thought of that was tested to choose the coefficient was effective and the straight .5 times was chosen due to it being the most effective.

Morphological functions also could be better, this is what is hindering the two of the undetected images, the functions are too severe for them and a softer approach could be taken. Different patterns could be used for the sliding window.

Finally the MSER features that are filtered were the best middle ground that was found, going too severe meant that no starfish were recognised due to the fact they are not perfect stars. A bit of tweaking might help but the current state seems to be a good middle ground.

A feature that could have been added to increase the accuracy would be some color profiling. This could have helped with the overlaid starfish image, starfish a colored in the yellow, orange and red. Using these colors i could have been applied to the object to see if the object is the same object. This could separate the touching starfish.

Another feature that could be added would be a way to detect which channel has the best clarity and use that or use the convert to gray otherwise. This could be done by checking the mean of the bin count but it didn't work well also finding the edge cases when the gray image would be better was harder than anticipated so the decision to not use it was taken. Also checking if the compliment is better than the original mask could be done.

Overall the pipeline has a good success rate, with a bit more tweaking and a few more features it is possible that it worked with all of the given images.