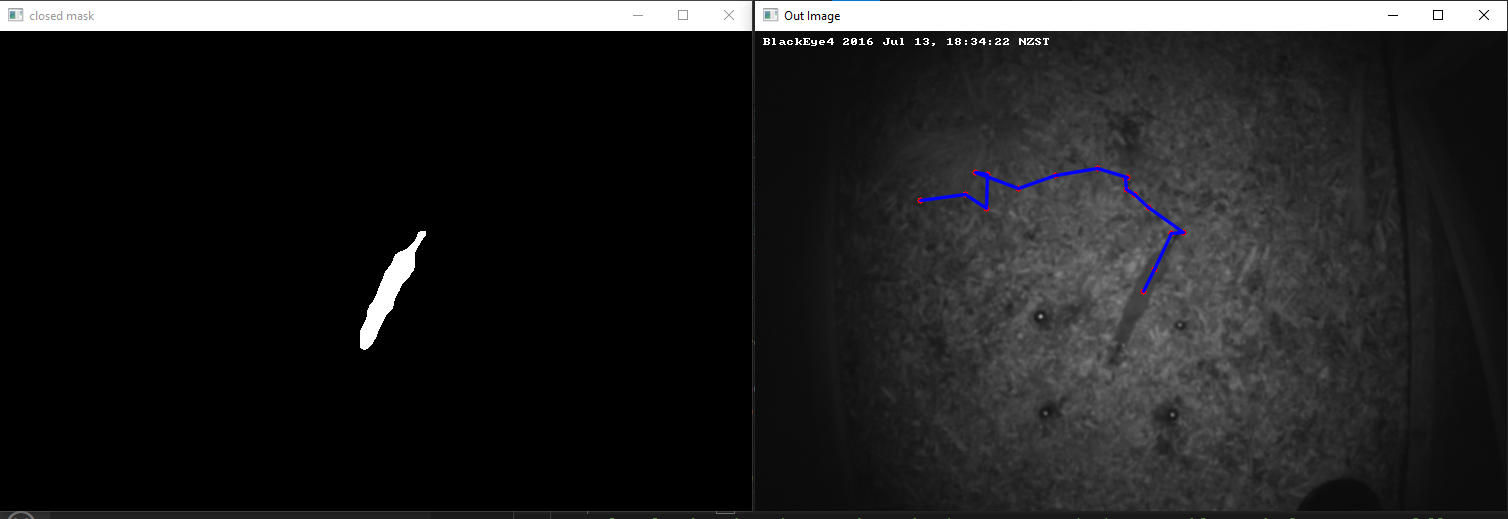
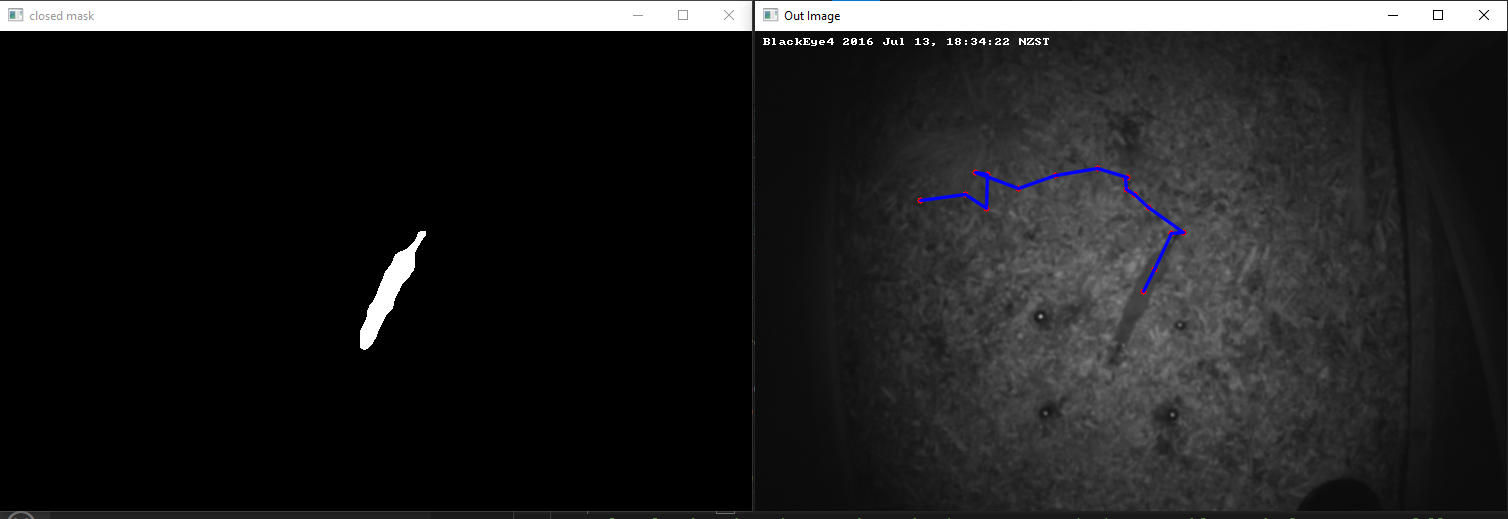
281.756 Image and Video Processing

Algorithm Development Project

Predator Detection Project





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# Abstract

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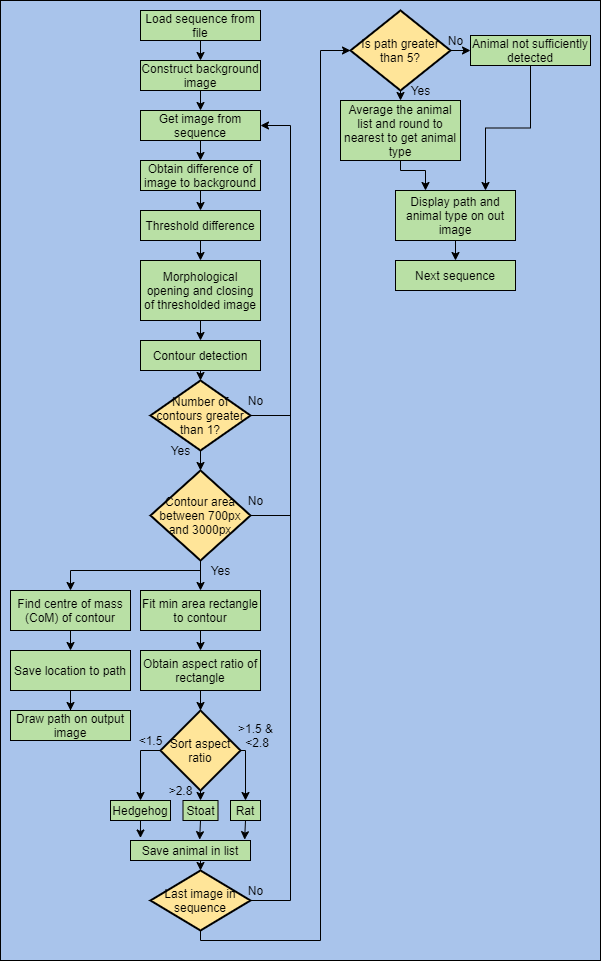
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# Introduction

# 2.0 Algorithm

## 2.1 Block Diagram



## 2.2 Background Image Creation

To create the background image of the sequence, a 75th percentile of the entire sequence is used. In NumPy, the percentile function looks at each pixel in the images and sorts them in order from dark to light. It then takes the value 75% of the way up that list. In the sequences of images provided, the animals in the image appear to be darker than the background. This means pixels in images where the animal is present, are more likely to be at the bottom of the sorted list. Therefore, the animals are not included in the background model. This allows the difference between the background image and the current image to show mostly just the animal.

## 2.3 Animal Mask

### 2.3.1 Difference Calculation

Some sequences have been captured at daytime. These have shadows to deal with. To prevent shadows from being detected as animals, only the positive difference is measured. This means only regions which are brighter than the background will appear in the difference image.

The other sequences have been captured at night-time where shadows are not such an issue. For these sequences, the absolute difference is used. This way, even regions that are darker than the background will appear in the difference image.

To determine if a sequence is day or night, the average pixel value of the image is measured. Daytime images had a higher average pixel. If the average pixel value was above 80, then the image was assumed to be a daytime image.

### 2.3.2 Threshold

To create a binary image containing the animal, the difference between the background and current image is thresholded. If the difference between the pixels is greater than a certain value (8), then that pixel is shown as white in the binary image. If not, it shows as black.

### 2.3.3 Morphological Operations

After thresholding, there was still some unwanted pixels in the image because of noise. To help remove unwanted information, a series of morphological opening and closing operations are used.

First, a closing operation, with a small (3,3) kernel, is used to help join some chunks of “animal” that may be separated by just one or two pixels. The small kernel size helps to prevent the closing operation from joining chunks of noise together.

Next, an opening operation, with a small (5,5) kernel, is used to help remove any noise in the image. The small kernel size helps to ensure that the larger chunks, corresponding to potential animals, are not accidently removed.

Finally, a closing operation, with a large (40,40) kernel, is used to help join chunks of potential animals. Some parts of the animal get lost because of the thresholding. This closing operation attempts to recover that information.

The result is a black and white image that shows potential animals in the image.

## 2.4 Detecting and Identifying Animal

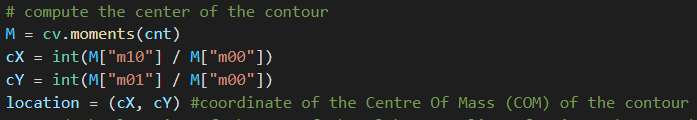
To detect and identify the animal, the size and aspect ratio of the contours are measured. The centre of mass of the contour was used to identify the location of the animal in the image

### 2.4.1 Contour Area

For each image, the contour with the largest area is found. Due to the previous morphological operations, this contour is likely to be the animal in the image. If the area of the contour is less than 700px, it is ignored. This is because anything smaller than this is not likely to be an animal. If the area is greater than 3000px, it is also ignored. This was done to reduce the number of false detections because of rain or bugs flying across the screen close to the camera. Objects close to the camera appear larger so adding this condition helped to remove those detections without removing animal detections.

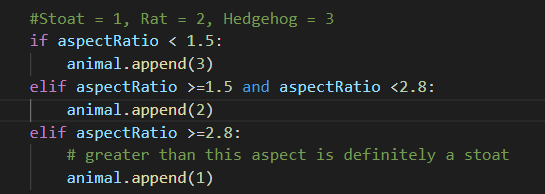
### 2.4.2 Centre of Mass (CoM)

Once a contour has been identified as an animal, its location needs to be recorded. This will later be used to plot the path the animal takes through the image. To find the location of the animal, the CoM of the contour is used. This is done by finding the M0,0, M1,0 and M0,1­ moments of the contour. These are then used to find the X and Y location of the CoM of the contour.



### 2.4.3 Aspect Ratio

To help distinguish between a rat, stoat and a hedgehog, the aspect ratio of the contour is used. Stoats have a long, thin body while hedgehogs are squarer in shape, with rate being somewhere in between. To find the aspect ratio of the contour, a minimum area rectangle was draw around the contour. The length of its longest and shortest sides was used to calculate the aspect ratio (long/short). An aspect ratio of 1.0 represented a square, while greater than 1 indicated a rectangular shape. By looking at the aspect ratio of the animals identified in the sequences, it was observed that hedgehogs had an aspect ratio around 1.0, stoats about 3.0, and rats about 2.5. From this information, the animal could be classified based on its aspect ratio.



### 2.4.4 Other Features

To improve the ability to distinguish different animals, additional contour features were looked at. The area, convexity and solidity were looked at.

Area was not a good choice as in some sequences, the camera was closer to the animal. This would increase the size of the animal contour, making it hard to distinguish a close-up rat and a faraway stoat.

Convexity was looked at as it was thought that the different animals would have differing convexities because of their tails or lack thereof. However, upon investigation, there was no obvious trend between the convexity and the type of animal.

Solidity was also investigated, but it too did not show any relation to the type of animal in the sequence.

### 2.4.5 Averaging Animal Identification Over the Sequence

In some frames of the sequence, the animal was only partially detected. To prevent these incomplete detections from affecting the final animal identification, an average over the sequence. This average was rounded to the nearest animal. If there were less than 5 animal detections in the sequence, then the no animal was reported to have been found in the sequence.

## 2.5 Assumptions

### 2.5.1 One Animal Per Sequence

The algorithm has been developed on the assumption that there is only one animal in each sequence. This is valid, for the sequences provided, as the is only a maximum of one animal per sequence. However, in a real situation it cannot be guaranteed that there is only going to be one animal per image.

### 2.5.2 Good Contrast

The algorithm assumes there will be good contrast between the animal and the background. If the animal is not sufficiently different, the background subtraction will not show a difference. This will result in the animal not being detected. This assumption is not completely valid. Most of the sequences provided do show good contrast between the animal and the background. However, there is one sequence (Seq4) where the animal is very similar to the background. As a result, the algorithm struggles with this.

### 2.5.3 Lens Distortion Insignificant

The algorithm assumes that the lens distortion at the edges of the frame is not significant enough to stretch or change the aspect ratio of the animal. This is a valid assumption as the sequences provided show the animal mostly in the centre of the frame. However, real situations there would be times where the animal may only appear in the edge of the frame. In those cases, this assumption would not be valid.

### 2.5.4 Only Rats, Stoats and Hedgehogs

Another assumption made is that only rats, stoats, and hedgehogs are going to be present in the sequences. For the provided sequences, this is valid. However, in a real-world situation there will be other animals, such as birds, appearing in the frame.

### 2.5.5 Good Difference in Aspect Ratio

Another assumption is the difference in aspect ratio between animals. This is not completely valid as for some sequences, the aspect ratio of the detected animal is very similar to the aspect ratio of another animal, resulting in the animal being misidentified.

### 2.5.6 The Background Does Not Change as the Animal Moves Through

It is assumed that the background does not change as the animal moves through. This is invalid as the animal can move sticks and leaves on the ground. Most of these small movements can be removed by the morphological operations and area size condition. However, there is one example in sequence 7 where the hedgehog moves some sticks as it moves. This movement get picked up and alters the result of the tracking.

# 3.0 Results

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sequence Number** | **Animal Present** | **Animal Detected** | **Frames with Animal** | **Frames with Animal Detected** |
| 1 | Stoat | Stoat | 10 | 8 |
| 2 | Stoat | Stoat | 54 | 39 |
| 3 | None | None | 0 | 3 |
| 4 | Stoat | Rat | 63 | 44 |
| 5 | Rat | Rat | 96 | 96 |
| 6 | Stoat | Stoat | 66 | 57 |
| 7 | Hedgehog | Hedgehog | 24 | 23 |

Detections less than 80% shown in red. False Positives also included in the red.

# 4.0 Discussion

## 4.1 Misidentification of Stoat/Rat

## 4.2 False Positive Detection of Animal

## 4.3 Missing Detection of Animal

## 4.4 Overall Detection Rates

## 4.5 Why do Some Sequences do Better Than Others

# 5.0 Conclusion

# 6.0 Appendix

## 6.1 Code