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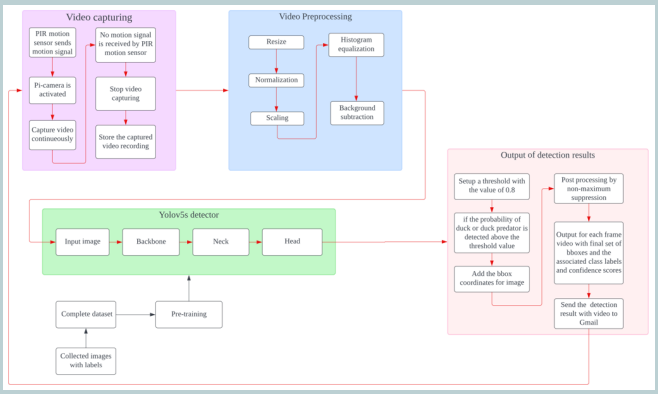
An intelligent detection device on the duck farm

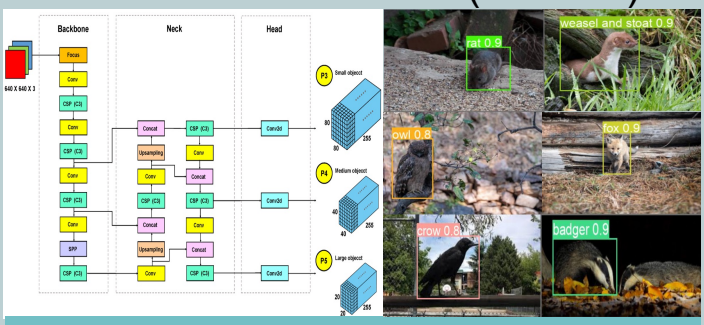
Objectives and Aims

This project aims to use the Raspberry Pi system to develop an intelligent monitoring portable device capable of protecting duck eggs, ducklings and adult ducks from their main aerial and terrestrial predators on the farm, creating a detection model in Raspberry Pi system, which can detect main aerial and terrestrial predators of duck eggs, ducklings and adult ducks, including crow, hawk, eagle, owl, fox, rat, weasel, stoat and badger with high precision.

Overall System Architecture

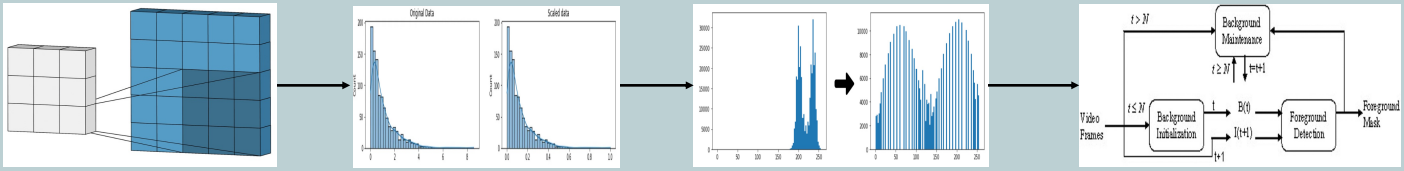


CNN-Based Detector (Yolov5s)



Backbone extracts the features of the input image segments to form the learnable feature maps. Neck aggregates and integrates the feature map. Head is used to output class probabilities with the bounding boxes. The sigmoid function is used to activate conv layers: $f(x)=1/(1+e^{(-x)})$.

Video Preprocessing



$(w_{new}, h_{new}) = (\frac{M}{\max(w,h)}) \times (w,h)$
Resizing of each frame

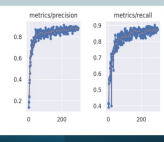
$normalized\_image = \frac{image}{255.0}$
Normalization

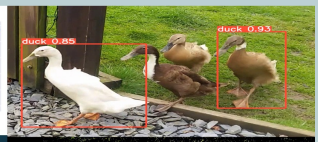
$s = T(r) = (L-1)\int_0^r p_r(w)dw$
Histogram equalization

$p(x \mid \mu, \sigma^2) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right]$
Background subtraction

Detection results in Raspberry Pi

- The 80% of collected images in dataset are used for training, the remaining 20% images are used for validating the model performance.
- The result of validating is shown at right, the overall precision and recall can reach more than 86% at the final point.

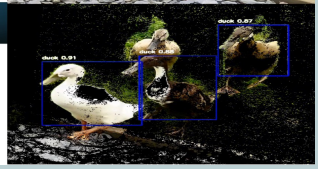




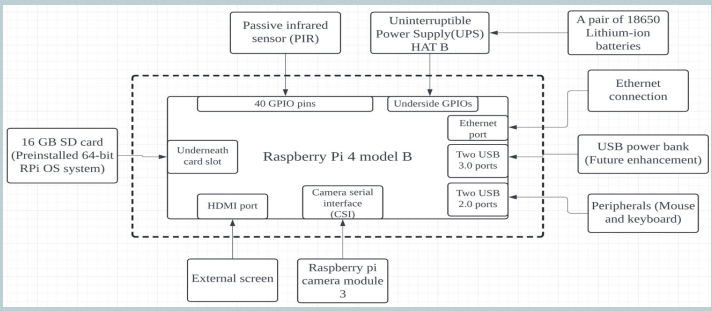
Detection result of dataset

The overall detection results about each class is demonstrated below.

Class	Images	Instances	P	R
all	262	299	0.867	0.885
duck	262	49	0.888	0.857
crow	262	32	0.984	0.938
hawk and eagle	262	55	0.861	0.764
owl	262	21	0.759	0.905
fox	262	38	0.895	0.893
rat	262	43	0.895	0.795
weasel and stoat	262	20	0.799	1
badger	262	41	0.935	0.927



Hardware architecture



Conclusion

All hardware components are integrated into the waterproof Naturebytes wildlife casing to support work outdoors, the Yolov5s detection model is loaded into the Raspberry Pi by converting the format to TensorFlow lite, which forms a smaller model size without significantly reducing the accuracy. The preprocessing of video can largely enhance the detection model performance.