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BUILDING DEVICES TO DETECT AND TRACE BIRDS

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ABSTRACT— Today, with the strong field of AI, identification technologies have developed diverse applications. In this paper, the authors refer to bird identification by Yolo technology, thereby providing statistics on birds in agricultural areas and warning and repelling pests by laser. Different from radar, operating at high and long distances, it detects only flying objects; The camera system uses object detection algorithm that can flexibly detect close-range objects, and 3D camera technology combines the motion angle of the turntable system, which can accurately know the object in space.

KEYWORDS: Object detection, object tracking, yolo.

1. INTRODUCTION

Stemming from the need for statistics, identification and repelling pests, the authors applied the Yolo algorithm, a fairly powerful algorithm in identification, to collect data samples of birds, incorporating a motion detection algorithm to avoid missing unidentified flying objects or omission of recognition algorithm.

Here are some related studies:
Identifying bird species on edge using the Amazon SageMaker built-in Object Detection algorithm and AWS DeepLens [1]: In this article, the research team builds bird species identifiers based on annotated public datasets. This type of model can be used on the AWS DeepLens platform. You can use it to automate environmental studies for construction projects, or it can be used by bird enthusiasts when it comes to bird watching.

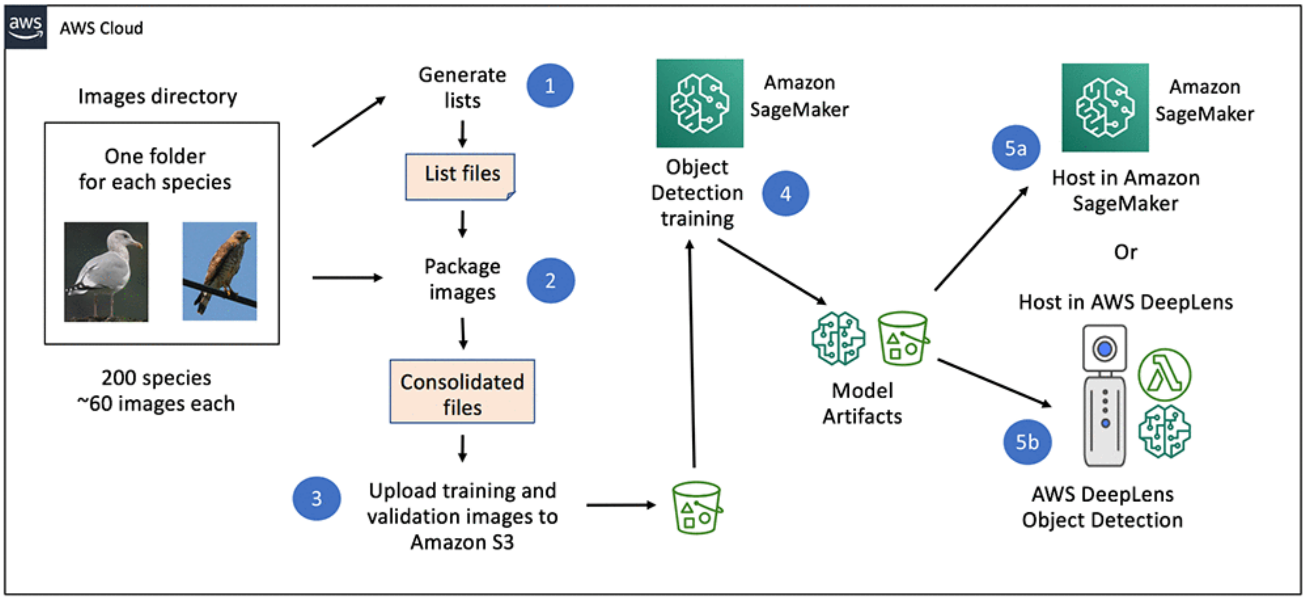

Figure 1. Systematic diagram of the research team (*)

Bird Image Retrieval and Recognition Using a Deep Learning Platform Y. -P. Huang and H. Basanta, in IEEE Access, vol. 7, pp. 66980-66989, 2019, doi: 10.1109/ACCESS.2019.2918274 [2]. Another study used a CNN network for training and recognition. The proposed CNN model with reduced connections achieves 99.00% higher accuracy compared to 93.98% from CNN and 89.00% from SVM for training images. The mean sensitivity, specificity, and accuracy for the experimental dataset were 93.79%, 96.11%, and 95.37%, respectively.

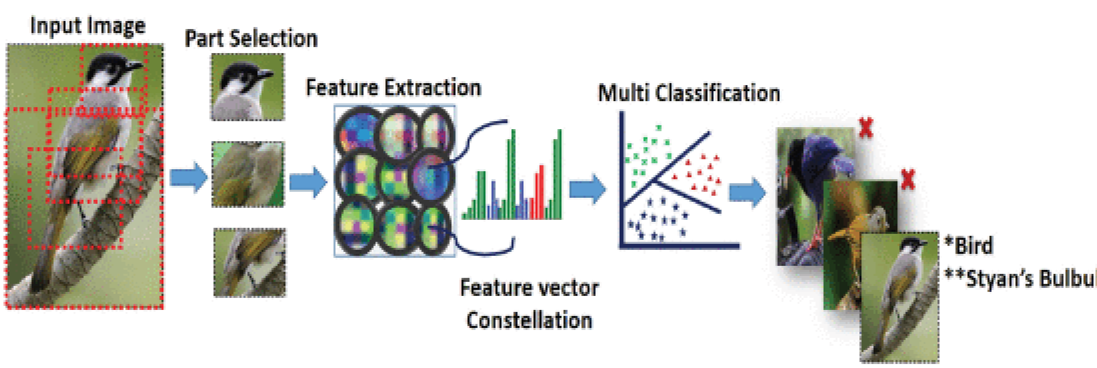

Figure 2. Systematic diagram of the research team (**)

Talking about the recognition model, there are now a lot of various algorithms from CNN, F-RCNN, Yolo... however, each solution has advantages and disadvantages. The authors propose combining classical and modern methods, using motion analysis and remote motion recognition combined with close-range object recognition to verify the results.

2. Build the solution

The system proposed by the research team is as follows:

- 01 Camera 360 o, helping to observe the whole scene, recognize motion, and interpolate coordinates.
- 01 Camera area helps to observe the bird's appearance accurately and implement an object tracking algorithm
- 01 Laser used to repel birds

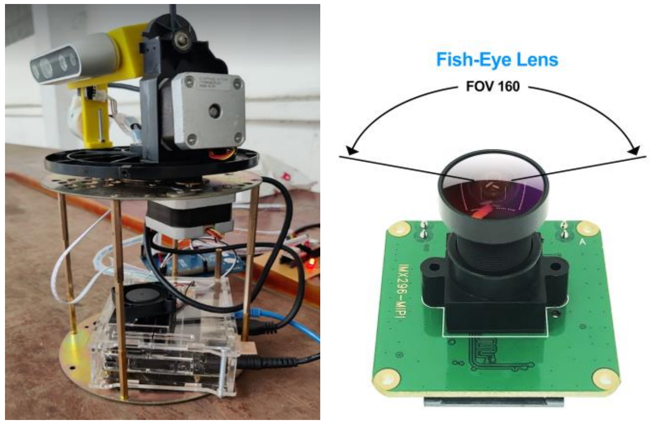

Figure 3. Motion Area Surveillance Camera System

To detect motion on the fish eye camera, we implement the algorithm Optical flow in OpenCv. Optical flow is the apparent movement of an image object between two consecutive frames caused by the movement of the object or camera. It is a 2D vector field where each vector is a displacement vector representing the motion of points from the first frame to the second frame. Expand the Taylor series $I(x, y, t) - I(x + \Delta t, y + \Delta t, t + \Delta t) = 0$as $I'_x u + I'_y v = -I'_t$at $u = dx/dt$& $v = dx/dt$[3].

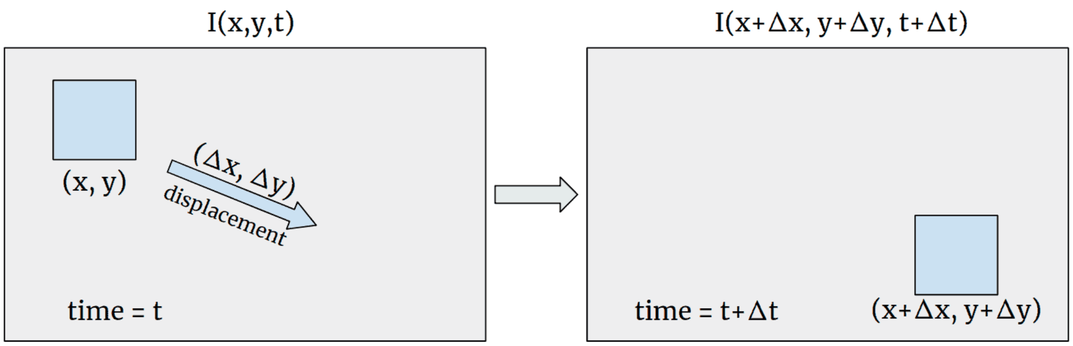

Figure 4. Description of Optical flow mechanism

Today, based on the Optical Flow platform, many research groups are developing advanced algorithms such as Dense Pyramid Lucas-Kanade, Farneback, PCAFlow, SimpleFlow, RLOF, DeepFlow, DualTVL1.

With data from the fish eyes camera, we can quickly analyze the movements and make predictions with the Particle filter [4]; the filter helps to predict the subsequent trajectory to allow the camera area to move to the right spot to observe. This can also apply directly to the camera area. Some other studies [5] use Kalman for prediction.

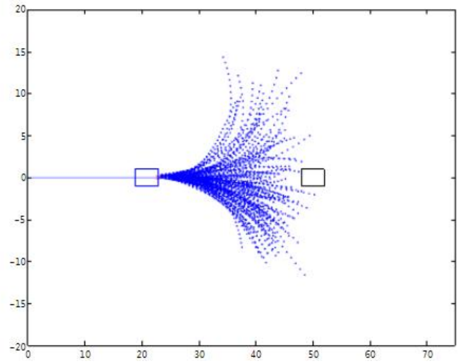

Figure 4. Trajectory Prediction with PF [4]

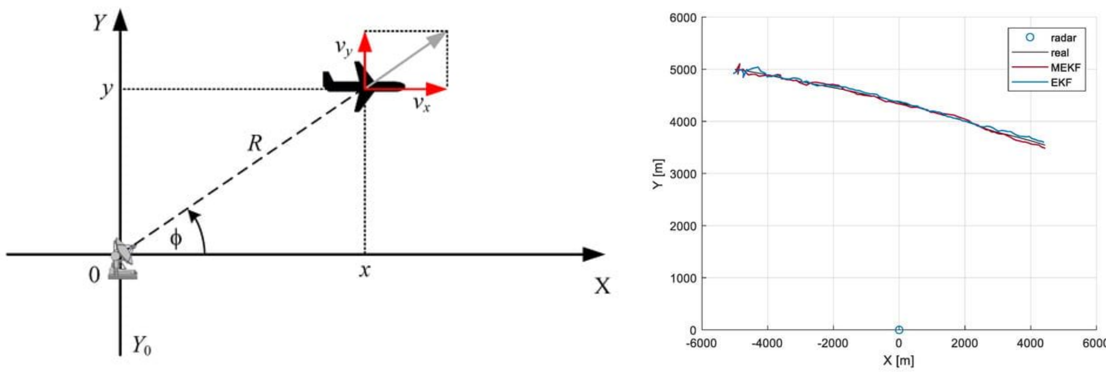

Figure 5. Orbit prediction with KL [5]

Here, the authors only apply the PF & KL algorithm, not giving an evaluation to compare which model is more effective. In the following study, the team will make a specific comparison.

Table 1: Algorithm update formula (description of Figure 6 implementation)

Algorithm	Kalman Filter	Particle filter
Time update	$x \coloneqq Ax + B_u u$ $P \coloneqq APA^T + B_{fT} Q$	$f^i \sim P_f$ $x^i \sim \coloneqq Ax^i + B_u u + B_f f^i$
Measurement update	$K = PC^T(CPC^T + R)^{-1}$ $x \coloneqq x + K(y - Cx)$ $P \coloneqq P - KCP$	$w^i \coloneqq w^i P_e(y - h(x^i))$

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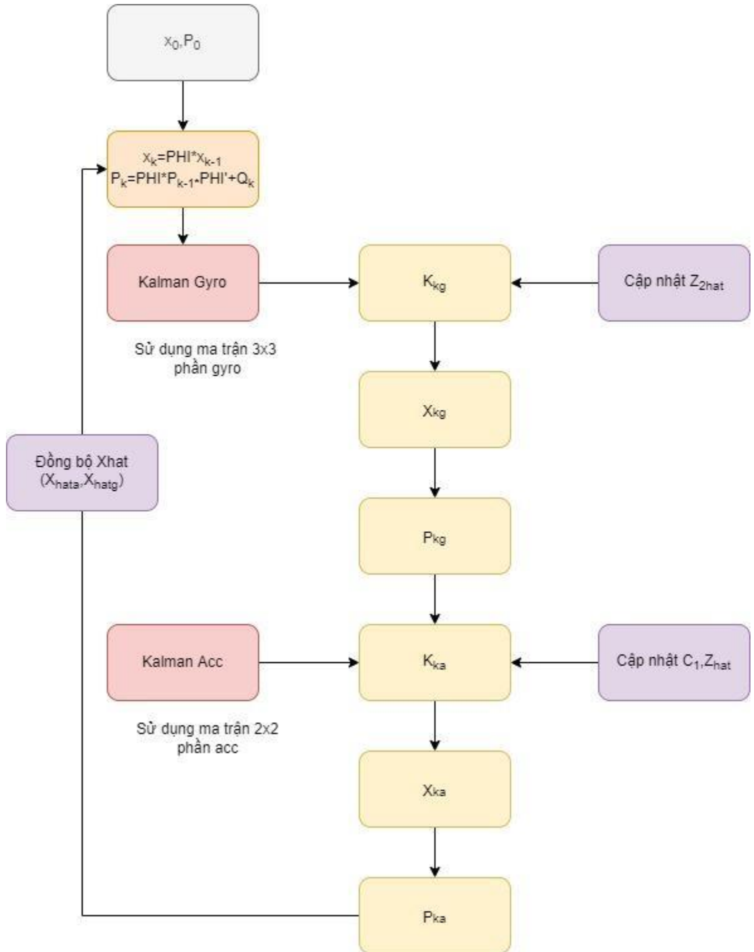

Figure 6. Kalman algorithm & canonical update rule

Bird identification by Yolo, a robust and open algorithm, using available image sources, the research team uses the Yolo 5s kit, which has a fast speed (Figure 7) that responds well to bird flight speed. Regarding the labelling, training & identification, the steps are similar to the previous versions; the research team did not delve into Yolo's identification problem but focused on a total solution.

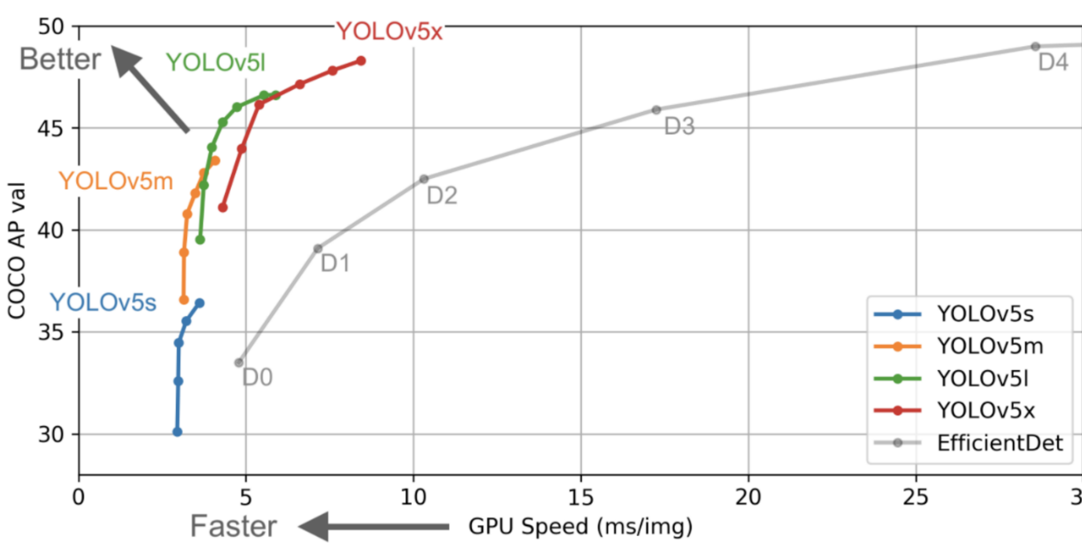

Figure 7. Comparing versions of Yolo v5

Below is the result of the identification and software interface:

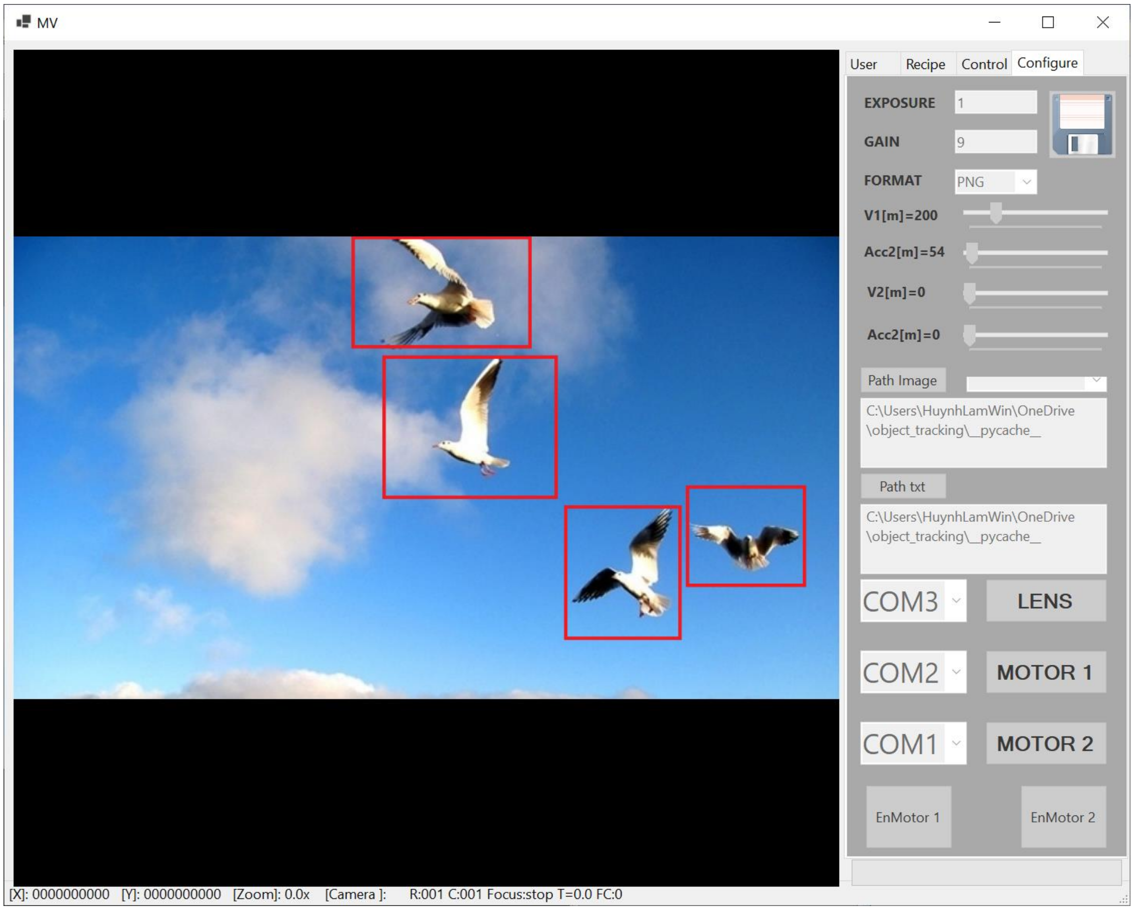

Figure 8. Identification software interface

The software controls the two motor axes via UART, and sets the desired speed, acceleration and position; in addition, the Lens can also control Zoom, and Focus to ensure fast image capture. Below is the flowchart of the processing algorithm (Figure 9):

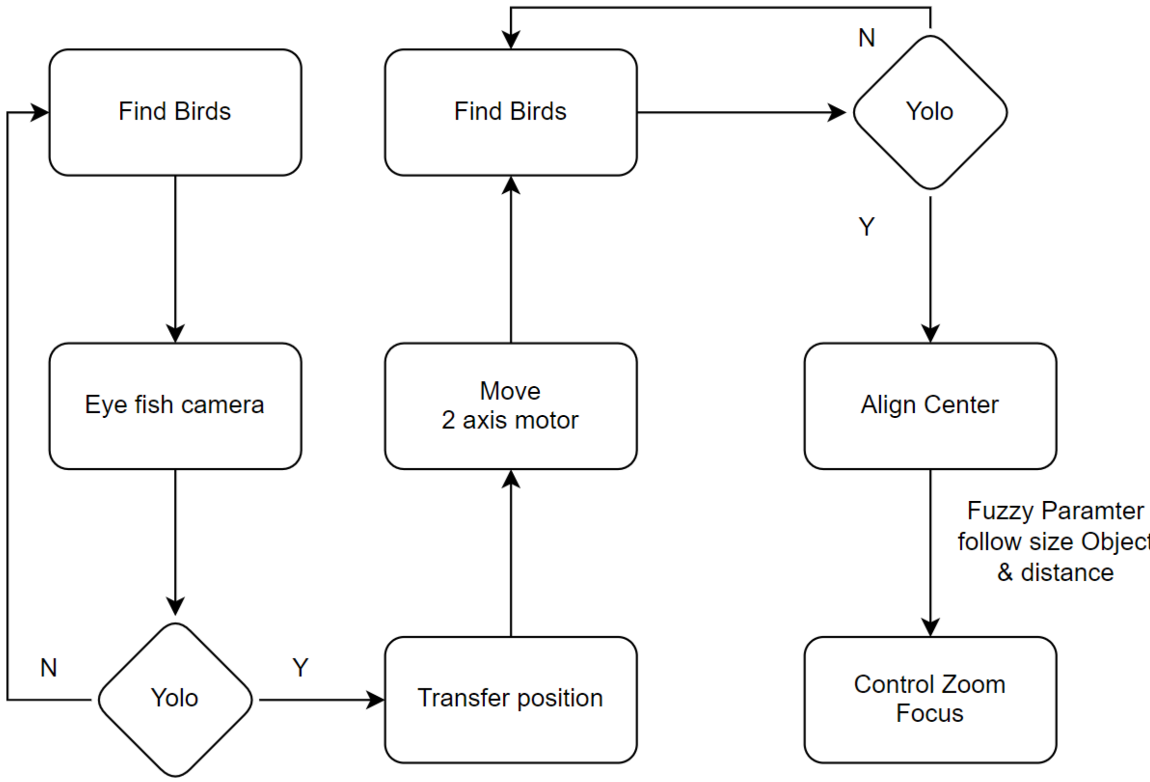

Figure 9. Process flowchart

3. Conclusion

Applying classical and modern recognition algorithms helps the research team collect many data samples missed by the Yolo recognition algorithm when the object is too far away or predicts the approaching object early. The authors also developed the Align algorithm and predicted Zoom and Focus information for the camera to respond to the system faster than the manual system could achieve. In the upcoming development, the research team will perform hardware upgrades to remove the limitations of civil cameras and lenses to observe further flying objects, improve the tracking algorithm with many objects flying simultaneously, and build a swarm algorithm to predict flight information. Currently, only fish eye camera can observe the whole scene. Still, with limited resolution, the camera area limits the viewing area.

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