Mangoes Detection in Gambia using Deep learning techniques

Fred Sangol Uche
fred.uche@utg.edu.gm
Computer Science Department
University of The Gambia

Abstract

Mango not only contains fundamental dietary nutrients but is an essential source of income in the Gambia. Unfortunately, farmers are unable to utilize its complete production due to among other things, the lack of technology that would allow them estimate production in advance. In an attempt to fill this gap, the YOLOv5 framework is used to detect a variety of mangoes in the Gambia. We implemented this by modifying the YOLOv5 structure to build a new backbone using Conv2D + Batch Normal + Swish (CBS). We further performed experiments by comparing our proposed system with models of existing frameworks such as Faster RCNN,YOLOv3,YOLOv4, EfficientDet. Experimental results show that our model performs relatively better compared to the other four models.

Introduction

- Mango is one of the main fruit produced, consumed, and exported in The Gambia. Currently, mango farmers incur many losses because there are no non-destructive ways for determining fruit output.
- Knowledge of the production of mango fruits can be a vital means to implement trading strategies. Taking a proper count of the number of mango fruits in an orchard leveraging deep learning techniques would be one of the most reliable methods of acquiring production statistics [1].
- In [2], the new version of Faster R-CNN and YOLOv3 are employed for the detection and comparison of oranges, mangoes, and apples on the same dataset. Experimental results reveal that YOLOv3 is at most 4% better than the usual Faster R-CNN through the recognition of roughly 90% of fruits. YOLOv3 had a 40ms average recognition time, compared to 58ms of the improved Faster R-CNN algorithm and 240ms for conventional Faster RCNN.

Methodology

Our System works by first getting video frames of mangoes from a camera feed. This frames are then fed into our Proposed YOLOv5 network and then inference is performed to produce an output of mangoes detected.

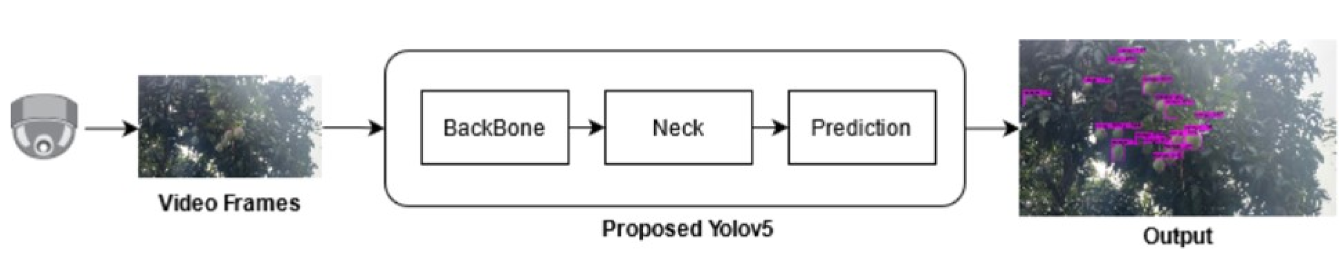

Figure 1: Proposed Yolov5

- For our experimental results, we use the mAP and FPS as the metrics to measure our models' accuracy and inference time.
- Fig. 2 shows our YOLOv5 network with Conv2D + Batch Normal + Swish (CBS) module.

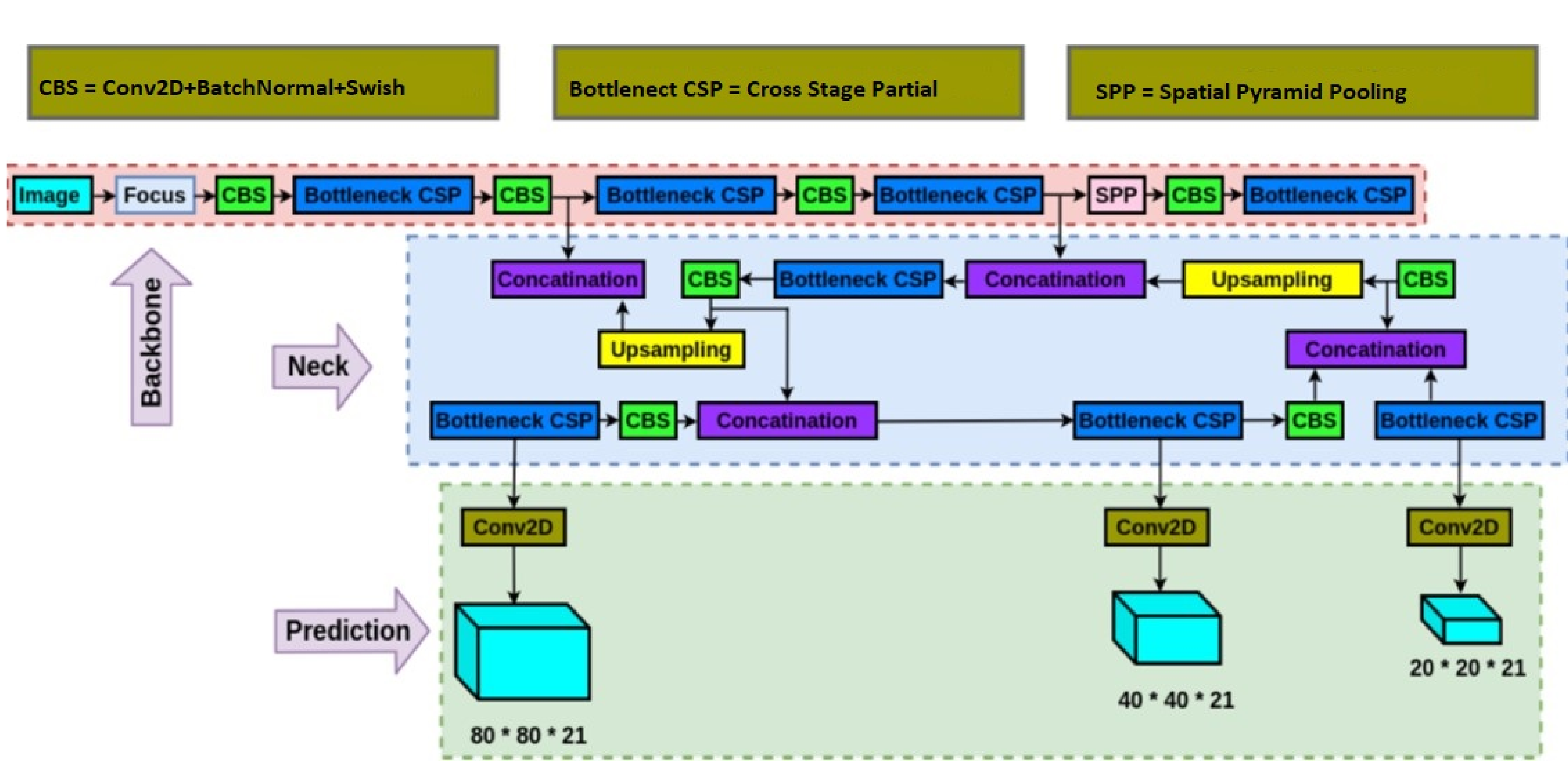

Figure 2: Modified Yolov5 Structure

Dataset

- We had over 5000 images of mangoes on the trees of one of the predominant mango varieties in the Gambia. We then annotated the images in the YOLO format using the labelImg tool and a single class, i.e. mango
- The annotated dataset was split into two sets named train-set and test-set in the proportion of 70 to 30, respectively.

Results and Evaluation

- To build our object detector based on YOLOv5, a single Nvidia GeForce RTX 1080ti GPU was used for training and testing. For network optimization, we utilize the Stochastic Gradient Descent (SGD) optimizer. During training, the batch size was 32 and the learning rate 0.001 with a 1.0 learning rate decay at each step.
- To visualize and understand the results of our experiment, we utilize some images from the test set. The different scenarios like two different colored mangoes, yellowish-green and green, occlusion of multiple mangoes and covered partially with leaves were detected efficiently.

Figure 3: Detected mangoes

- We evaluated the proposed methodology's performance using the accuracy and loss of our presented model and obtained a validation accuracy of 94.51 and a validation loss of 0.0273.
- We used the transfer learning technique and trained a different model on our generated dataset to compare with other state-of-the-art frameworks. As shown, our proposed model outperformed the rest of the models.

Models	Accuracy
Faster RCNN	90.30%
YOLOv3	89.64%
YOLOv4	88.27%
EfficientDet	91.4%
Proposed	94.51%

Table 1: Model Evaluation

Conclusion

We introduce in detail the YOLOv5 method of detecting objects, in our case to count mango fruits per tree. We also discuss the architecture of the YOLOv5 network, the setup of our proposed classifier, and dataset processing. Results show that the YOLOv5-based method of detecting mangoes achieved outstanding results in terms of speed and accuracy. We also generated a dataset for a local environment that is publicly available for researchers.

References

[1] International Trade Administration, Gambia, The - Country Commercial Guide. Accessed on: 2021. [Online]. Available: https://www.trade.gov/country-commercial-guides/gambia-agriculture

[2] Wan, S., Goudos, S.: Faster R-CNN for multi-class fruit detectionusing a robotic vision system. Comput. Netw. 168, 107036 (2020)