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YOLO SERIES APPROACHES FOR YIELD ESTIMATION FROM CUCUMBER FLOWERS

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Abstract

In today's modern world agriculture plays an important role. By considering efficient crop management yield estimation is required for maximizing productivity. This project automates the process of cucumber flower detection and subsequently predicts the total yield based on detected flowers The primary object of our project is to propose a computer vision-based web-based application that precisely detects cucumber flowers from two different stages within the agriculture field. The YOLO algorithm mainly used for real-time object detection is used to identify and locate cucumber flowers in images. With the help of this algorithm, we can get valuable information regarding the different stages of flowers which is the main influencing factor for yield prediction. Once we are able to detect and locate flowers, the project extends its focus to yield estimation The total count of the flowers from different stages is the main key for predicting the potential yield in the entire field. On the basis of historical data and statistics system estimates the weight of cucumbers that can be harvested from the farm. This predictive model will help farmers and stakeholders make important decisions regarding resource allocation for optimized yield, harvest planning period and market strategies. Our proposed system offers several advantages which include real-time flower detection, total yield estimation from the entire field based on total plant count and resource optimization. By emerging computer vision with the agriculture industry, this project increases the accuracy of yield estimation and lowers the labor-intensive work. The outcome of this research can significantly increase agriculture production, optimize resources and suggest some advice to farmers.

Key words:- cucumber detection,Yolo

INTRODUCTION

Agriculture plays a vital in the entire world for sustaining human life. In recent years technology has been introduced in farming, which has helped farmers in various ways such as more product yield. It has also reduced human interaction because of computer vision. Among various crops, cucumber has a great income and is also good in the diet. Cucumber yield estimation is a critical decision-making process for farmers and distributors. If we accurately predict the yield we can properly prepare a harvest plan and marketing strategies. The cucumber flower detection and estimation project is build by using YOLO algorithm. YOLO algorithm is basically a cutting edge computer vision technique. The algorithm is used to create advanced and automated system for detecting the cucumber flowers and fruit total yield. The process is divided into two forms : firstly to develop an accurate cucumber flower detection system, which identifies buds, flowers, faded flowers and fruits. Secondly to gather information about the total yield from the cultivation. These processes are very helpful for farmers in real world for making decisions about cultivation and harvest. The project can help enhance the efficiency and productivity for cucumber harvesting and cultivation, can also reduce wastage and can contribute in considerable agricultural practice.

REVIEW OF LITERATURE

In this scientific article author [1] proposes a computer vision-based solution for cucumber flower detection. Researchers used two datasets to perform this experiment. In this paper they have compared SE, CBAM, CA and SimAM algorithms are compared for accuracy and they are integrated into YOLOv5s for better results. Results showed that the SE layer of the YOLO algorithm which is also known as the 7th layer of the algorithm has maximum accuracy for the detection of small flowers with noisy background images. With the help of SE7, this model improved its accuracy by 3.5% as compared to traditional single-layer algorithms. The cucumber flower has three stages bud, bloom, and fade. This model gives the highest accurate results with the bloomed stage of flowers which is around 0.847 mAP which shows the model has a good effect in agricultural applications. Due to the environmental noise, the accuracy of the detection of the flowers decreased considerably this problem can be overcome by using the latest version of the YOLO series algorithm. • In this base paper [2] The author is attempting to use intelligent harvesting to improve cucumber detection's capacity to happen quickly and accurately. In order to improve the cucumber recognition algorithm, he is attempting to address issues with branch and leaf occlusion, near-color background interference, and scale variety in greenhouse settings. Thus, he has put out the YOLOv5s-Super model, a lightweight version of the YOLOv5s model. First, he updated the YOLOv5s-Super model using a bidirectional feature pyramid network (BiFPN) and a C3CA module. Capturing long-distance dependent cucumber shoulder traits and dynamically fusing multi-scale data in the near background were the objectives of this technique. Second, he has accelerated the floating time computation speed and inference time by adding the Ghost module to the YOLOv5s-Super model. Ultimately, each process separately created the C3SimAM module and visualized several feature fusion techniques for the (BiFPN) module. The YOLOv5s-Super model achieved mAP of 87.5% as a consequence of all the preceding operations, which was 1.9% higher than the YOLOv8s model and 4.2% higher than the YOLOv7-tiny model. Additionally, the enhanced model became more reliable and accurate in its ability to fully identify multiscale elements in intricate near-color backgrounds. Additionally, the model satisfied the need to be lightweight. Technically, the findings would be in favor of choosing cucumbers with intelligence. In the end, he has come to the conclusion that identifying cucumbers against near-color backgrounds presented some challenges. The F1 score and mAP score of the YOLOv5s-s model were 84.7% and 87.5%, respectively. Additionally, the detecting speed was raised to 0.013 s per frame for a solitary picture, and 11.6 MB was found to be the model size. • In this base paper [3] author is trying to identify cucumber fruit in a greenhouse automated harvesting which is an essential process. The Author has enhanced the identification ability for cucumber fruit harvesting by constructing an extended RGB image dataset. They first compared channels through the Relief method to choose the channel with the highest weight. Then the author has converted the RGB image dataset to a pseudo-color dataset of the selective channel(Cr channel) to pre-train the YOLOv5s model before formally training the RGB image Dataset. After all the process, the result came out was that cucumber fruit recognition of enhanced YOLOv5s model was increased by 83.07% to 85.19%. By comparing the original YOLOv5s model, the average value of recall rate, AP, F1 and mAP were also increased by 8.07%, 8.03%, 7% and 8%. The final results of the study indicate that the Cr channel pre-training method is most likely promising to enhance fruit detection in near-colour backgrounds. Finally, the author has concluded that all the process has worked properly in the identification of cucumber fruit detection by providing us with an increased rate of AP, recall rate, mAP and F1. He has also promised to work on enhancing the enhanced YOLOv5s model's precision by applying the multi-channel parallel convolutional neural network technique. • This paper [4] presents an application for flower identification that makes use of an anchor-based technique. With the help of a mix of attention processes, this application may quickly and reliably identify flowers in an agricultural region or garden. The author of this foundation study attempted to address the issue of flower detection, which was mainly disregarded and for which several researchers had to pay a hefty price. A novel end-to-end flower recognition anchor-based technique has been introduced by the author into the network architecture. The technique will make apps faster and more valuable. Additionally, in order to ignore insignificant details, lost function and attention methods are implemented. In order to demonstrate how important the flower identification approach is, the author then implemented the flower detection algorithm into the mobile device. This approach has a substantially higher detection accuracy and faster detection speed. Thus, the author's final conclusion is that flower identification using cutting-edge techniques is highly significant. They have acknowledged that the algorithms have certain limits, though. Additionally, he said that intelligent gardening may actually exist in the future and lower human and financial costs. • This paper [5] proposed an effective Flower detection by lightening the algorithm. They improved the lightweight Parameter network which includes the backbone network design and modified neck architecture. In this base paper author was trying to overcome the Problem of slower flower detection and complicated computations. This is helpful for mobile pollination robots which require Flower detection with less computational Power. Improved parameter networks have faster interference speed and higher maps than Yolo V4. updated parameter network is better than other algorithms Which are used in previous papers. It helps in the estimation of a strawberry in the natural environment. • In this paper [6] author proposed a improved YOLOv5-Based Lightweight Sea Cucumber Recognition Network. They introduced an improved version of the YOLOv5 for object detection and image recognition. The researchers faced problems in identifying sea cucumbers in the sea. In this paper, the authors suggest a modified YOLOv5 that is used for light-weight processing, It is useful in real-time recognition. They make improvements in the YOLOv5 version to increase its performance and accuracy in detecting sea cucumbers. The author gives information about training way, dataset series, and improving strategies used to train the version. They also give comparative information of their lightweight YOLOv5 version versus other modern item detection methods in terms of accuracy and computational power. • In this base paper [7] the algorithm for sea cucumber detection is proposed and this algorithm is implemented using MobileNetv1. According to this paper, the traditional SSD algorithm is not capable for detection of the sea cucumbers. Therefore they proposed an improved algorithm for the same. The algorithm performs better, as seen by the performance comparison with the YOLOv4 and R-CNN algorithms. Future studies on the issues based on the sea cucumber's ability to change color due to environmental factors can be conducted since underwater sea cucumbers have this characteristic. • In this base paper [8] the improved version of YOLOv4 is proposed. YOLOv4 is incapable of recognition of objects underwater, therefore YOLOv4-tiny is the solution for the issue of recognition of the images underwater. As the data set is small in the project, transfer learning is used to train the model. The data augmentation method is used to improve the performance of the detection Model on real-world underwater datasets. YOLOv4-tiny The model is initially trained on the COCO dataset, and then it is applied to our sea cucumber dataset for training using the transfer learning technique. Park and Kang proposed a method based on YOLO to classify objects and count their number by analyzing and comparing the results of previous frames to the current frame. This was done, according to the author of the paper, when they constructed an underwater feature extractor of fish images. One of the most crucial features for the small dataset is data augmentation. Simple augmentation techniques to expand the dataset's size include rotation, flipping, cropping, contrast, saturation, and hue. Augmentation is very useful to provide more learning samples. This research paper proposed that the YOLOv4 version is old and that accuracy can be improved using YOLOv5. • Conclusion:- AI and ML can be used to improve manual flower counting and prediction yield. In the earlier versions of YOLO and RCNN algorithms accuracy decreased due to environmental noise and similar color appearance by using the latest version we can increase the accuracy rate. The latest YOLOv5 model may show better robustness, higher accuracy and higher speed in identifying the flower in three different stages i.e. bud, bloom and faded. Subsequently, we can predict the harvesting period and total yield from the total plant count which helps farmers schedule harvesting plans and suggest some actions to improve total yield. Hence to overcome the above-stated problems we come with our system. Which uses the latest YOLOv5 and above algorithms decreases manual efforts for counting cucumber flowers and also predicts the total yield.

PROPOSED METHODOLOGY

In today's world to increase productivity and get sustainable food production, crop management and yield estimation is necessary. Among all other crops, cucumber stands out due to its nutritional and economic perspectives. Currently manual monitoring of cucumber flowers and predictive harvesting period is labour-intensive and time-consuming work as well as it may not be accurate due to several factors. Also due to poor harvest plans and resource wastage the profitability of crop farming reduced considerably. Furthermore, the lack of automation and computer vision algorithms for detecting flowers and yield estimation causes error-prone estimation and prediction of yield. Due to all issues and for advancement in the agriculture industry, few solutions have been proposed. Existing models lack accuracy and real-time flower detection. Due to all this, we require an innovative approach to improve accuracy and involve the latest algorithms for cucumber flower detection and yield estimation. Henceforth, The primary issue addressed by our research is the accuracy and automation of cucumber flower detection subsequently yield estimation. This project aims to develop a web-based solution with the help of YOLO's appropriate series for detecting and localizing cucumber flowers. The project seeks to give an exact idea about flower status, harvesting period and yield to farmers with a high accuracy rate. From this farmers can plan the appropriate steps and subsequent decisions to be taken.

B. Architecture

Figure 1 below depicts the suggested architecture of the suggested methodology:

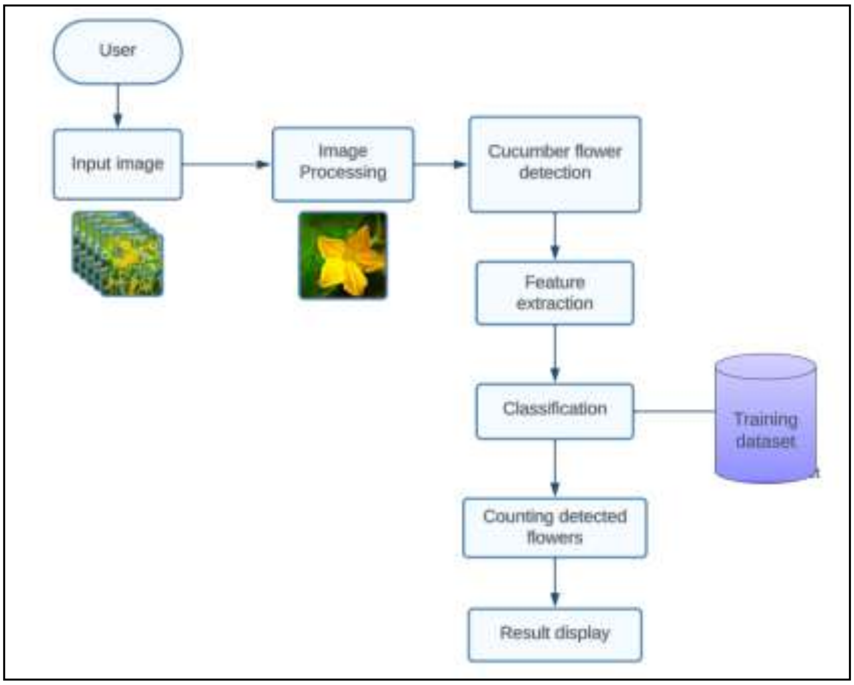

Fig. 1. System Architecture Suggestion

As shown in the figure, the input of our project is an image and the total number of plants in the field. The given input will follow the following steps: image processing, cucumber flower detection, feature extraction, classification, and finally detection followed by predicting harvesting period and yield in total area. For this entire model, YOLO series algorithms and other compatible algorithms are used to enhance the output and increase the accuracy of the system. After applying all this final output will be generated and delivered to the user through interactive UI.

C. Algorithms

• **YOLO:** For our project, we have decided to use YOLOv4, even if there are versions that are more recent. Though these advances are appealing, we have faced serious problems with segmentation issues, excessive CPU/GPU utilization, and slow loading times, particularly in real-world website setups. These obstacles have made it more difficult for us to take advantage of the most recent improvements.

We made the pragmatic decision to continue using YOLOv4 in light of the trade-offs between functionality and usefulness. Although more recent iterations could offer better functionality and accuracy, the technological limitations we confront exceed any possible benefits. YOLOv4 meets the needs of our present project by finding a compromise between efficiency and accuracy.

Table No 1. Method Comparison.

Metric	RCNN	Faster RCNN	SSD	YOLOv4
Architecture	Region-Based	Region-Based	Single Shot	Single Shot
Accuracy (mAP)	Moderate	High	Moderate High	High
Inference Speed	Slow	Moderate	Fast	Fast

Upgrading to newer versions would also need more development work and may cause problems with our current infrastructure in terms of compatibility. We minimize delays to our project timetable and preserve continuity in our development process by using YOLOv4.

The following image shows exact working of YOLO v4 working on white backgrounded image of cucumber plant.

Fig. 2. Working of implemented YOLO algorithm.

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YOLOv4 still has strong object identification capabilities in spite of its restrictions, which helps us successfully complete our project's goals. Furthermore, we have access to a multitude of resources and knowledge due to its broad acceptance and strong community support, which makes deployment and troubleshooting easier.

• Statistical analysis algorithms:
In this project, we can use various statistical techniques to correlate the yield estimation of the farm with the total number of plants. On the historical dataset, we can perform some operations to get precise predictions about the total yield production. Data smoothing and linear regression can be used for this purpose.

IV. RESULTS AND DISCUSSION

A personal computer equipped with the following specifications can be used for experiments: Windows, Python, MySQL backend database, Intel (R) Core (TM) i7-2120 CPU @ 3.30GHz, 8GB RAM, and Windows.

In the following figure cucumber plant blossom is detected and highlighted using a flower-detecting algorithm. Every attention is on the blossom found; the red bounding box is surrounded by it. The pixel data included with the box describes the importance of the flower by showing a bounding box. This technology provides more accurate identification of the identification of cucumber blossom which facilitates more research and comprehension.

Fig. 3. Detection of cucumbers flowers.

The following confusion matrix shows how well a classification model can tell apart the different parts of a flower and the background. Along the x-axis, it lists the actual parts like petals, stamen, and background, while the y-axis shows what the model predicts. The colors in each cell show how often the predictions match reality, with darker colors meaning more accurate predictions. Interestingly, the model is really good at recognizing petals but sometimes gets confused between stamen and background. This matrix helps us understand how well the model works and where it might need improvements for better flower classification.

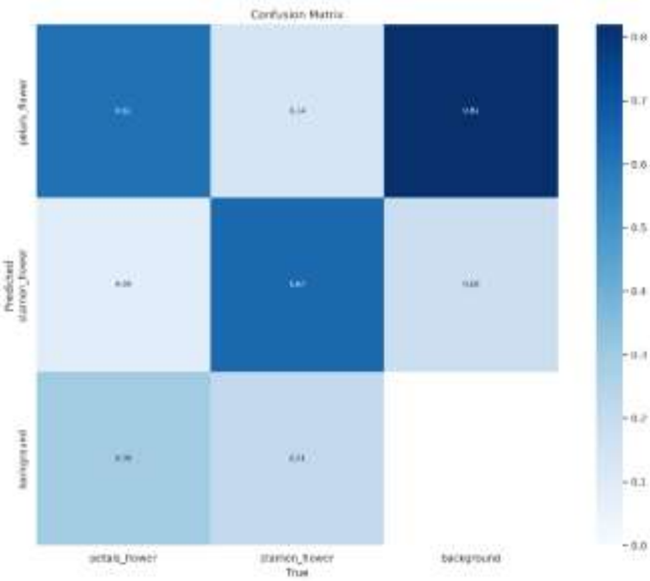

Fig. 4. Confusion matrix.

The following line graphs represent various metrics for the training and validation of machine learning models. Box loss, classification loss, differentiable loss, accuracy, recall, and mean average precision are the metrics that are being considered. The X-axis trains epochs and Y-axis trains metrics values. The graph describes fluctuating trends which indicates changes in model performance over time. We aim to decrease loss value and increase accuracy metrics while training the model.

The image depicts the performance metrics of a machine-learning model across 50 epochs. The train/box loss and val/box loss exhibit a decreasing trend, starting at approximately 3.5 and 3.2 respectively, and declining to near 0.5, indicating an improvement in the model's loss metric over time. Similarly, the train/cls loss and val/cls loss follow a similar pattern, starting at around 1.8 and reducing to about 0.4. In contrast, the metrics for precision@[.5:.95] and recall@[.5:.95] display an increasing trend; precision starts from nearly 0 and ascends to about 0.6, while recall initiates from approximately 0 as well but rises sharply after epoch 40 to reach close to 0.25. Overall, the model demonstrates favorable trends in loss reduction, precision, and recall, signifying its effectiveness over the training epochs.

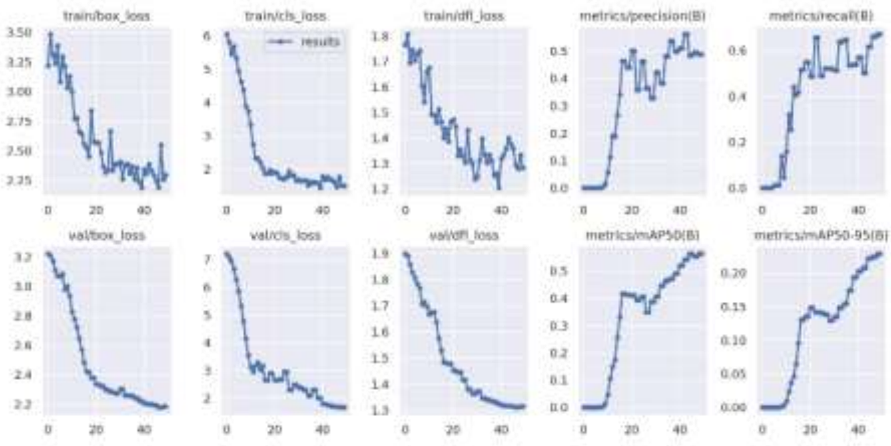

Fig. 5. Result graph.

Result comparison with different datasets:

We carefully evaluate whether our version is doing well in our test cucumber. We first tested in snapshots where cucumber plants were placed against a white background, simulating controlled conditions similar to clinical placement. Furthermore, we tested the same model with real-world conditions where cucumber plants were placed in various noise exposures such as greenhouse backgrounds and other equipment.

Despite our good training and attempts, our truth is often rare when confronted with popular history. This decrease in accuracy reflects the complexity of real-world applications, where environmental changes can affect the performance of a version.

To solve this project, the fate of our model must benefit from improving performance with development information with different elements of the environment or include noise reduction algorithms at a certain level of prioritization. Additionally, using control of relevant roles or initial tuning of data involving multiple environments can improve the model's ability to span many domains. Also, collaborative research or hybrid models involving deep learning with visual techniques on a laptop can provide a good study of action for noise and improve the structure to adapt to different environments. In addition, ongoing efforts to develop design models specifically for agricultural contexts can be expected to provide insights to increase the robustness of model research in international relations.

In conclusion, our preliminary results show that cucumber searches not only solve the problems caused by environmental noise but also are responsible for other research and innovations to improve agriculture using such models.

V. CONCLUSION

In our web-based application user will upload an image and total plant count and get an estimated harvesting period, predictive outcome from the plant, and suggestions according to the growth of the plant.

VI. REFERENCES

[1] Xiangying Xu, Hongjiang Wang, Minmin Miao, Weijian Zhang, Yonglong Zhang, Haibo Dai, Zijian Zheng and Xiaoxiang Zhang "Cucumber Flower Detection Based on YOLOv5s-SE7 Within Greenhouse Environments" IEEE Access Year: 2023 Volume: 11 Journal Article DOI: 10.1109/ACCESS.2023.3286545

[2] Liyang Su, Haixia Sun, Shujuan Zhang, Xinyuan Lu, Runrun Wang, Linjie Wang and Ning Wang "Cucumber Picking Recognition in Near-Color Background Based on Improved YOLOv5" https://www.mdpi.com/journal/agronomy Agronomy 2023, 13, 2062. https://doi.org/10.3390/agronomy13082062

[3] Ning Wang, Tingting Qian, Juan Yang, Linyi Li, Yingyu Zhang, Xiuguo Zheng, Yeying Xu, Hanqing Zhao and Jingyin Zhao "An Enhanced YOLOv5 Model for Greenhouse Cucumber Fruit Recognition Based on Color Space Features" https://www.mdpi.com/journal/agriculture Agriculture 2022, 12, 1556. https://doi.org/10.3390/agriculture12101556.

[4] Zhibin Cheng and Fuquan Zhang "Flower End-to-End Detection Based on YOLOv4 Using a Mobile Device" Hindawi Wireless Communications and Mobile Computing Volume 2020, Article ID 8870649, 9 pages https://doi.org/10.1155/2020/8870649.

[5] BAO ZHOU , XUEYING LIN , JIE ZHOU , YUJIN WANG, AND FANGCHAO HU "An Improved Lightweight Parameters Network for Strawberry Flowers Detection" IEEE Access Year: 2023 Volume: 11 Journal Article https://ieeexplore.ieee.org/document/10159360.

[6] Qian Xiao, Qian Li, Lide Zhao "Lightweight Sea Cucumber Recognition Network Using Improved YOLOv5" IEEE Access Year: 2023 Volume: 11 DOI 10.1109/ACCESS.2023.3272558.

[7] Lan Zhang, Bowen Xing, Wugui Wang and Jingxiang Xu "Sea Cucumber Detection Algorithm Based on Deep Learning" Sensors 2022, 22, 5717. https://doi.org/10.3390/s22155717.

[8] Thao NgoGia, Yinghao Li, Daopeng Jin, Jinyuan Guo, Jiang Li, and Qirong Tang "Real-Time Sea Cucumber Detection Based on YOLOv4-Tiny and Transfer Learning Using Data Augmentation" ICSI 2021, LNCS 12690, pp. 119–128, 2021. https://doi.org/10.1007/978-3-030-78811-7-12.