ADVANCED FRUIT, VEGETABLE SCANNER AND BILL GENERATION USING YOLOv4 MODEL

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ABSTRACT:

Develop a scanner which uses tensorflow to learn about different vegetables or fruits and able to identify them. The goal of this project is to avoid barcode sticker on vegetable or fruits which may get damaged due to environment factor also injuries to health. To achieve this machine learning is used to train the machine to identify different fruits and vegetables. Also since this connects to the system the machine will identify the object and with their weight and calculate the bill using the provided metric system (which is customizable). It can prevent the wastage which is used in packaging these groceries, also we can buy the required amount of product, also since most of the software is open source the software is budget-friendly.

Keywords- Computer vision; Yolo v4; Faster RCNN ; Deep learning; Object Detection; Real time recognition.

1.INTRODUCTION:

The agriculture industry has seen an increasing demand for automated fruit recognition and classification in recent years. Accurate fruit detection can boost productivity, reduce food waste, and improve crop management. The YOLO (You Only Look Once) algorithm, a sophisticated computer vision approach used to recognize and classify objects in photos and videos, is one of the most promising algorithms for fruit detection.[4,7] In object detection and classification applications, such as fruit detection, the YOLO method has demonstrated to be quite successful. It has the ability to accurately detect items in real time while simultaneously detecting several objects in one pass.[20] It can be tough to identify and sort fruits in pictures and videos. This is because things like changing light and objects blocking the view can make it tricky. To address these challenges, researchers have proposed the use of reference markers in fruit detection using the YOLO algorithm. Reference markers are unique identifiers or tags that are placed on individual fruits, allowing the algorithm to identify and track them accurately. This technique has shown promising results in improving the accuracy of fruit detection and classification. So, we're looking into how well the YOLO algorithm can spot fruits. We're especially interested in seeing how it works when we use reference markers. This research will explore different approaches for fruit detection using the YOLO algorithm[3] and compare their performance in terms of accuracy and efficiency. The study aims to explore how various factors such as lighting conditions, occlusion, and the size and shape of the fruit can affect the accuracy of fruit detection [1] using the YOLO algorithm. This product is targeted on the people who are all having a private small shop without any link to a franchise or chained supermarkets. Since they have less capital it is not suitable for them to hire people for work. So this is where the ML based billing system helps. By using this, the customers don't need to wait in long queue also we are using 'Transfer Learning' machine learning algorithm so we don't need to scan the object individually instead we can keep it as a category then it will check the weight and scan the object to compute the price depending on the quantity.

2. RELATED WORKS:

2.1.Fruit recognition using CNN:

In 2016, a group of researchers including Lei Hou, QingXiang Wu, Qiyan Sun, Heng Yang, and Pengfei Li published a research paper titled "Fruit recognition based on convolution neural network" in the 12th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNCFSKD). They introduced a fruit recognition algorithm that utilizes convolution neural network (CNN). The proposed algorithm first utilizes a selective search algorithm to extract image regions. The extracted regions are then selected based on the entropy of fruit images. Finally, these regions are utilized as input for the CNN neural network for training and recognition. The algorithm makes the final decision based on a fusion of all region classifications using a voting mechanism. The researchers trained the network with an optimal training set, which resulted in significant recognition rates for fruits stacked on a weighing scale. Other researchers in the field of fruit recognition using deep learning techniques have cited this work. In summary, this research paper presented an innovative fruit recognition algorithm that utilizes CNN and demonstrated its effectiveness in recognizing fruits using a weighing scale. Other researchers have recognized and cited this paper, and have indicated its benefaction for the advancement of fruit recognition using deep learning techniques.[1]

2.2.Fruit Detection and vegetable using centernet:

In order to solve the fruit detection issue from digital photos, CenterNet is the model adopted in this paper. ResNet-18, [14] DLA-34, and Hourglass are three CenterNet models that were put into practice using different backbones. For this study, a fruit dataset comprising 4 classes and 1,690 photos was created. The deep learning-based model with DLA-34 was chosen as the chosen model to detect fruits from digital photographs after analyzing those models and the testing results. The performance of this model is great. The contribution of this study is the implementation of a CenterNet-based visual object detection model to address the fruit detection issue. [2,12]

2.3. Multi-class fruit-on-plant detection for apple using Faster R-CNN :

In this paper they collected the images of apple during two harvesting seasons using Microsoft Kinect V2 sensor. Then the collected images of apple were categorized into four classes according to occlusion condition. After collecting images Faster R-CNN has been applied which merges Region Proposal Network(RPN) which is used to generate the proposals for Faster R-CNN to accurately locate the object.[9] The collected image dataset is trained and validated over a number of iterations(around 100000). The loss value between traing and validation set becomes stable after 70000 iteration. In summary this method presented more accurate results with faster processing time than the other traditional image processing methods with high resolution images.[5]

4.PROPOSED SYSTEM:

4.1 STARTING STAGE:

Figure 1:Initial Stage

The above Figure 1 is the initial stage of the whole methodology. It involves the customers to place their products on the weight scale. The weight scale is integrated to the AI model. The object detection cameras (multi-image scanning device)[6] is installed where the images of the object are scanned and object detection is performed using the required algorithm. This is how each product is scanned and the bill for each product is generated.

4.2 ALGORITHM IMPLEMENTATION AND WORKING:

The model's second stage involves the detection of the object using a deep learning based algorithm (YOLO v4).YOLO v4 is an optimized YOLO v3 model used for object detection.[8,10,11,13] It is known for its precision with which it works. YOLO algorithm, being introduced by the famous genius Joseph Redmon et al, it has undergone numerous number of iterations in order to reach its latest version i.e. YOLO v7. In order to provide a method through which real time object detection could be performed it uses neural networks as its base. Being a single-staged object detection model, it uses single neural network for image processing.[15,16,17]

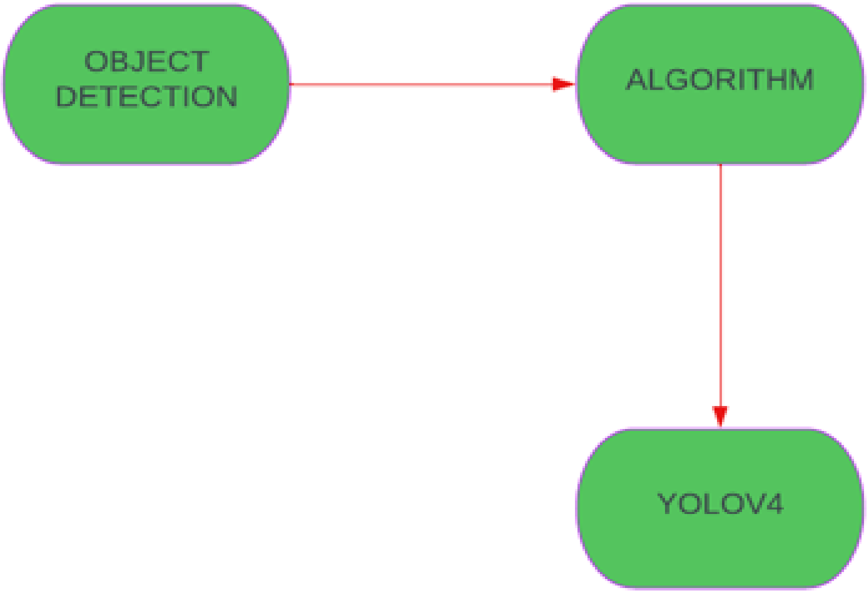

Figure 2:Object Detection working model for Yolo v4

The considered image is divided into regions and the regions are predicted based on their probabilities and their bounding boxes that have been laid over them. The above Figure 2 describes the simple work flow of the proposed solution. The architecture of YOLO v4 model includes an advantage over YOLOv1, v2, and v3 architectures which aims in providing high accuracy and inference speed[8,10,13]. Yolov4 is quite faster when compared to CNN as it includes a higher fps (frames per second). The YOLO v4 model is a combination of several components. It includes a backbone, neck and head. Here YOLO v4 model uses CSPDarkNet53 as its backbone which is an advanced version of DarkNet53. It implements a CSPNet strategy.[16] This strategy involves partition of an image into two parts and performs merging on them using a cross hierarchy. The advantage that the CSPDarkNet53 has over DarKNet53 is that it is based on a DenseNet design thus allowing to perform a better detection process by providing an improved accuracy. Being the backbone of YOLO v4, CSPDarkNet53 adds in advantages which involves the usage of the Spatial Pyramid Pooling (SPP) and Path Aggregation Networks (PAN) and activation function which leads to an increased non-linearity. CSPDarkNet53 maintains an enhanced flow between various network stages.[15,17]

4.3 DATA SET MODEL:

Algorithm:

Step 1: Start.
Step 2: Products are listed.
Step 3: Listed products are one by one chosen and sample images are given to train the model
Step 4: Check whether each product’s dataset is given enough sample images to recognize the product.
Step 5: Store the dataset in the model.
Step 6: Stop.

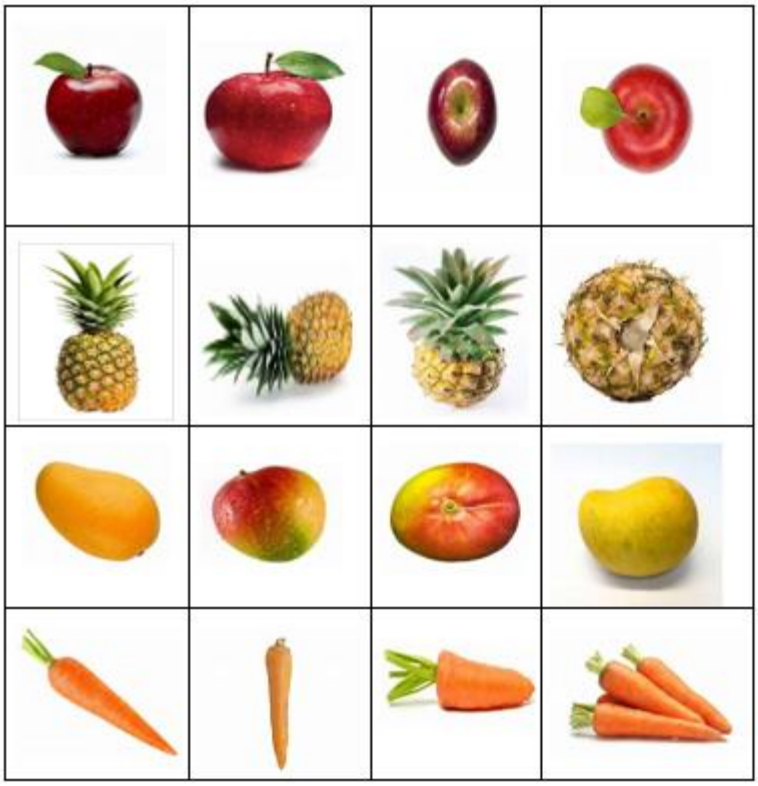

Figure 3:Sample Fruit and Vegetable Dataset

Deep learning is applied for identification and classification of products. [19]The dataset consists of images that include various products. For each and every product, required images are taken and the model is trained. The software is trained and the accuracy of the model is checked. Large number of images are given to the model in order to increase the accuracy. By this way the dataset is created to the shop owners. The above Figure 3 is the sample fruit and vegetable dataset for training and validation. Rate attribute is left empty for all the products, the rate is fixed by the shop owners as the price of the product varies each day. When the software is bought by the shop owners, all the products dataset is provided.[18] The shop owners should select which product they need in their system. It is not possible to sell every product in the market by one salesman. But it is possible to update the system, if they upgrade their store. By using this developed data model and by image processing, the particular data is selected and the rate is generated for the selected product.

4.4 CALCULATION OF PRICE AND BILLING:

Step-1: Identified product is labelled and named.
Step-2: The AI-Integrated model evaluates the price.
Step-3: The number of products is checked and,

if more > 1 then,

whole process is repeated again,

else,

bill is generated.

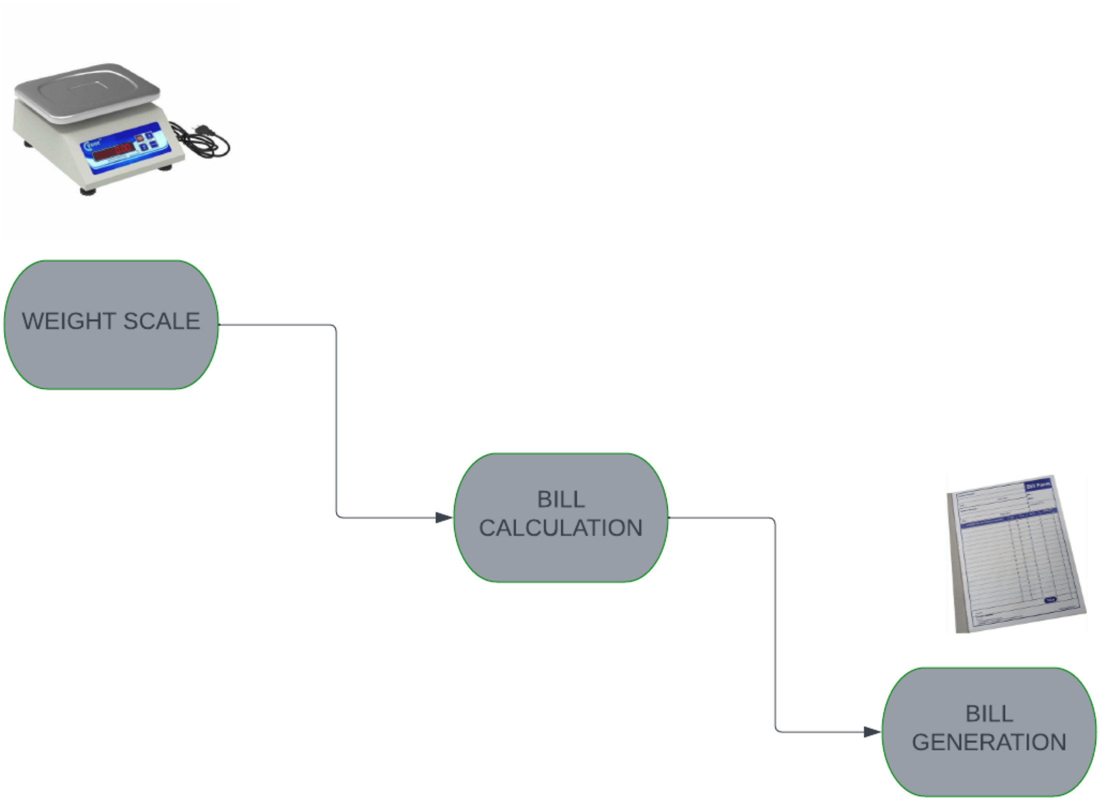

Figure 4:Billing work Flow

The product is arrived at the final stage of the work flow. The above Figure4 is the workflow of billing mechanism for the proposed solution. The trained model identifies the product with the help of the Yolov4 algorithm. Identified product is labeled and named. The corresponding cost of the product is searched from the list that contains cost of each and every item present in the shop. The dataset is updated on a daily basis by the shopkeeper on account of the fluctuating cost of the products in the market and the availability of stock, in the shop.

calculated cost= calculated weight*standard cost

The AI-Integrated weighing scale calculates and returns the cost for the respective amount of weight of the product, carries. The weighing scale searches for the labeled name in the list that features the cost for a standard weight. The scale, then evaluates the bill amount in correspondence with its weight.

The weighing scale then moves forward with the process. At this situation, the process reaches a situation very much similar to a check point. The process now checks for the number of products. If there is a product more than the currently handled product, then the process is performed again.

The process is repeated until there are no other products to be billed. The process is finally exited after all the products are billed and a physical bill, made up of paper, is printed using a printer.

5.CONCLUSION And DISCUSSION:

In this paper, we proposed YoloV4 neural network based object detection by using CSPDarknet53 as it's backbone with implementation of CSPNet strategy for detecting and identifying an object. Yolo network processes images using a single neural network. Some limitations for this solution is the need of more computational power and also maintaining a large dataset of trained fruit and vegetable model for validation. In order to accurately identify items in real-time, this network is trained utilizing complete pictures of the objects and Spatial Pyramid Pooling (SPP) and Path Aggregation Networks (PAN). For product labeling and identification, we employ the Yolo4 algorithm. The model uses deep learning to accurately identify and differentiate between products as some products could be looking similar, so the model is trained very efficiently and gets fed numerous amount of images of products to accurately identify the product. In order to compare the weight of the object with the retail dataset used for object pricing, the weight of the object is detected using an embedded AI model, and the weighing scale creates a bill amount based on that weight. The bill is generated after weighing the product and the customer pays the finalized amount.

6. REFERENCES:

[1] Lei Hou, QingXiang Wu, Qiyan Sun, Heng Yang, PengFei Li, Fruit Recognition Based on Convolutional Neural Network, 2016 12th International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD).

[2] Zhao, K., Yan, W.Q. (2021). Fruit Detection from Digital Images Using CenterNet. In: Nguyen, M., Yan, W.Q., Ho, H. (eds) Geometry and Vision. ISGV 2021. Communications in Computer and Information Science, vol 1386. Springer, Cham. https://doi.org/10.1007/978-3-030-72073-5_24

[3] Pranav Adarsh, Prathiba Rathi, Manoj Kumar, YOLO v3-Tiny: Object Detection and Recognition using one stage improved model, 6th International Conference on Advanced Computing & Communication Systems (ICACCS), 2022.

[4] Longsheng Fu, Fangfang Gao, Jingzhu Wu, Rui Li, Manoj arke, Qin Zhang, Application of consumer RGB-D cameras for fruit detection and localization in field: A critical review, ELSEVIER, vol. (177), October 2020.

[5] Fangfang Gao, Longsheng Fu, Xin Zhang, Yaqoob Majeed, Rui li, Manoj Karkee, Qin Zhang, Multi-class fruit-on-plant detection for apple in SNAP system using Faster R-CNN, ELSEVIER, vol. (176), September 2020.

[6] Mohammad Momeny, Ahmad Jahanbakhshi, Khalegh Jafarnezhad, Yu-Dong Zhang, Accurate classification of cherry fruit using deep CNN based on hybrid pooling approach, ELSEVIER, vol. (166), August 2020.

[7] Chai C. Foong, Goh K. Meng, Lim L Tze, Convolutional Neural Network Based Rotten Fruit Detection using ResNet50,IEEE, 2021 IEEE 12th Control and System Graduate Research Colloquium (ICSGRC) , DOI: **10.1109/ICSGRC53186.2021.9515280.**

[8] Ruoli Yang, Yaowen Hu, Yao, Ming Gao, Runmin Liu," Fruit Target Detection Based on BCo-YOLOv5 Model", Mobile Information Systems, vol.2022, Article ID 8457173,8 pages,2022.https://doi.org/10.1155/2022/8457173

[9] J. Zhang, et al, Multi-class object detection using faster R-CNN and estimation of shaking locations for automated shake-and-catch apple harvesting, Computers and Electronics in Agriculture 172, 2020.

[10] R. Shi, et al, An attribution-based pruning method for real-time mango detection with YOLO network, Computers and Electronics in Agriculture, Vol(169), February 2020.

[11] Yong-Hwan Lee and Youngseop Kim, Comparison of CNN and YOLO for Object Detection, Vol (19), Issue 1, Pages.85-92, 2020.

[12] Inkyu Sa, DeepFruits: A Fruit Detection System Using Deep Neural Networks, Vision-Based Sensors**,** 16(8), 2016.

[13] Peiyuan Jiang, Daji Ergu, Fangyao Liu, Ying Cai, Bo Ma, A Review of Yolo Algorithm Developments, *Elsevier*, Vol. (*199)*, 2022.

[14] Chai C. Foong, Goh K. Meng, Lim L. Tze, et.al, Convolutional Neural Network based Rotten Fruit Detection using ResNet50, IEEE, 2021.

[15] Ruoli Yang, Yaowen Hu, Ye Yao, Ming Gao & Runmin Liu, Fruit Target Detection Based on BCo-YOLOv5 Model, Mobile Information Systems, 2022.

[16] Taixiong Zheng, Mingzhe Jiang, Yongfu Li & Mingchi Feng, Research on tomato detection in natural environment based on RC-YOLOv4, Computers and Electronics in Agriculture, Vol. (198), 2022.

[17] Tausif Diwan, G. Anirudh, Jitendra V. Tembhurne, et.al, Object detection using YOLO: challenges, architectural successors, datasets and applications, Multimedia Tools and Applications, 2022.

[18] Susovan Jana, Rajen Parekh, Bijan Sarkar, et.al, Detection of Rotten Fruits and Vegetables Using Deep Learning. Springer EBooks, 2021.

[19] Manya Afonso, Hubert Fonteijn, Felipe Schadeck Fiorentin, Dick Lensink, Marcel Mooij, Nanne Faber, Gerrit Polder, Ron Wehrens. Tomato Fruit Detection and Counting in Greenhouses Using Deep Learning. Frontiers in Plant Science, 2020.

[20] Zhipeng Wang, Luoyi Jin, Shuai Wang, et.al, Apple stem/calyx real-time recognition using YOLO-v5 algorithm for fruit automatic loading system, Elsevier, Vol. (185), 2022.