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Review on Object Counting System

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Abstract – *Image processing and computer vision are two essential components of object identification. It is utilized in a variety of technological and economic domains, including laboratory, agriculture, research, and manufacturing, as well as medical diagnosis. In this work, we discussed the various strategies as well as the issues encountered in picture categorization and object counting. It is a difficult technique that is dependent on a variety of circumstances. Our goal is to investigate various approaches utilized in perception and item counting. Furthermore, we addressed specific use cases of this module in real-world applications.*

Key Words: **Image Classification, Object Counting, Object Detection, Deep Learning, Edge detection, object localization.**

1. INTRODUCTION

Object detection takes place in our day-to-day life and it is constantly happening, humans from very young age have tendency to distinguish various objects; with enhanced and precise visual system human brain can accurately classify objects and count objects. For a small set of data counting can be easily done by human eyes but after certain limit as the objects/crowd increases it becomes difficult and impossible for the human beings to detect and keep track of each and every object. This may lead to hindrance in the accuracy of the result and may strain human eyes. To overcome this barrier computer systems can be used for detecting and counting objects. Just like humans object detection can be achieved in computer systems by training certain algorithms, but it is not easy for computer system to recognize objects and hence it requires a lot of pre-processing and algorithm training. Manual counting and detection can take lot of time to give a result and that may not be 100% accurate, so the manual method must be replaced by computer systems to get accurate and error free result.

So, to make computer systems able to classify objects in an image and count it, different algorithms are used such as traditional machine learning based SVM [1] also deep learning based further classified into two staged detection algorithms such as CNN, R-CNN, Faster-RCNN, Fast-RCNN, Mask R-CNN, R-FCN; Anchor based single shot detection algorithms such as MultiBox, SSD, YOLO[9] and versions of YOLO[8][10][11][5].

Nowadays we hear that many adventure tourists, mountaineers, hikers are being lost in the forests or mountains and finding them is a very difficult task. So, object detection and counting algorithm applied on drones can help to find such lost or injured people very quickly in short period of time as it can cover a large area [10]. Traffic is a major problem in most of the metropolitan regions so to deal with this situation traffic monitoring system can detect the vehicles and count them to reduce the amount of traffic on road [8]. This system can be useful in real time situation to help people so that they can avoid roads with traffic and they can go by some other road. By this, traffic can be controlled. Object counting is also helpful in some other fields like agriculture where objects cannot be sorted out with naked eye and the elements 'time' and 'correctness' matter [8]. Just like detecting the leaves of crops, fruits [11] and counting active bodies in smart farms [5].

Presently many researches are being made for object detection and counting. This literature reviews on some of the methods of object counting is presented in this paper.

2. LITERATURE SURVAY

1. S. Y. Chaganti, I. Nanda, K. R. Pandi, T. G. N. R. S. N. Prudhvith and N. Kumar, they focuses on image classification [1]. The authors of the paper went through many research papers which were related to image classification, to get a different perspective. They initially decided to implement the image classification algorithm on a very small sized data set with limited hardware. When they implemented image classification using SVM they got the accuracy of 93%. They realized that they got such a high accuracy because of the small size of the dataset. So, using data augmentation they tripled the size of the dataset and when they implemented the same algorithm on a larger size dataset, they observed a significant decrease of 11%. They were unsatisfied with the results therefore they decided to move to other deep learning algorithms. So, they came up with CNN a deep learning algorithm which when they used on the same large sized dataset, they got the accuracy of 93.57%.

2. F T. Stahl, S. L. Pintea and J. C. van Gemert proposed end-to-end deep learning generic counting method, which is based on unsupervised uniform grid cell division information of image that predict global image-level counts using inclusion-exclusion principle from

set theory [2]. In this paper, author introduced the method deals with a counting layer that predicts counts of an object in the entire image, by carrying out constantly in counts when handling overlapping regions of image. The given proposed method evaluation takes placed on not only generic object dataset which was Pascal-VOC2007 and the large scale MS-COCO but also UCSD pedestrian ,CARPK and PUCPR+ car datasets which were class-specific datasets.

3. C. Pornpanomchai, F. Stheitsthienchai, S. Rattanachuen developed a system for detecting and calculating objects with image processing [3]. The purposed method is divided into small parts like- acquisition, enhancement, segmentation, examination, calculation, and reports. The system was designed to showcase usability, to show that the system can detect and count objects under specific conditions, and to show that system has high accuracy. It has a hardware requirement of pc and a web camera. They used data as input for a system performing experiments; various photos were taken from different angles and different heights of people moving in front of the camera. Later the output was compared with the actual number; hence its efficiency was proven.

4. Jung Uk Kim and Yong Man Ro focused on the concept of object localization in object detection, localization uses a feature map for working [4]. A feature map works on the entire region of the object. They created a network for recognizing objects, this network has 2 components first one is network attendant which generates object-specific maps second one is Layer separator for separating layers of an image. Six experimental results were generated by using Pascal Datasets and coco datasets, which gave outstanding results in comparison with other methods. They concluded that classification works only in a specific region and not the entire area of an image, hence they introduced an attention network to generate attention-specific maps. The layer separator was provided with the image input and the two simultaneous tasks are performed, which resulted in the encoding of each layer, which proved that the proposed method outperformed the current methods.

5. Hao Shang; Rui Li; Xu He; Jilong Wang; Xinhui Peng have proposed video imagery based pipeline for accurate object counting in real time. To count the number of living bodies, now-a-days is very important for modern farms [5]. So, in this research they have proposed a solution to count the number of living bodies in smart farms in real time. Such system results low accuracy because of extreme overlapping of objects, size of the instances, etc. For this problem they have introduced a concept named (overlap degree of frame) ODF. After that they made a frame filtering algorithm to distinguish the frames in which objects are difficult to detect. After this, for the detection and counting of the objects they have used a deep convolutional neural network algorithm named Faster-RCNN. Then they fused the counting results to get an accurate number of objects detected. They have performed all of the above steps on a dataset consisting of frames from a video surveillance system in a livestock farm. The dataset consisted of 2500 images of piglets which were captured by the video surveillance system from 6 am to 6 pm. The average speed of detection was 40 frames per second and the total difference was 1.69% upon performing the steps on the dataset they used. These results indicate that the proposed solution is suitable for object counting purpose in smart farms.

6. Md. Bahar Ullah mainly describes CPU Based YOLO, a real time object detection model to run on Non-GPU computers that may facilitate the users of low configuration computer [6]. They have proposed a model named “CPU Based YOLO” to run YOLO algorithm on non-GPU computers which may help the users having low configuration computers. There are many object detection algorithms such as Faster R-CNN, Fast R-CNN, R-CNN, SSD, etc. YOLO is a deep learning algorithm for object detection which is fast and accurate than most of these algorithms. It is an algorithm for GPU based computers. To implement it for CPU based computers they optimized YOLO algorithm with OpenCV so, that it can be run on computers with CPU having less configuration. Their model was able to execute videos from external source or from webcam with minimum 10.12 – 16.29 FPS with 80-99% confidence and with 31.05% mAP that is suitable for real time application within low cost and less effort.

7. M. K. Vishal, B. Banerjee, R. Saluja, D. Raju, V. Chinnusamy, S. Kumar, R. N. Sahoo and J. Adinarayana focuses on a Deep Learning approach that counts the number of leaves in rice [7]. In this paper, authors have proposed a model which is based on YOLO algorithm that detect the leaves of the rice crop and the rice leaves tips considered as an object in it. They also did researched analysis on variety of similar crops like wheat, maize, sorghum, barley. The given proposed method contains the dataset which is collected from Nanaji Deshmukh Plant Phenomics Centre (NDPPC), Indian Council of Agricultural Research-Indian Agricultural Research Institute (ICAR-IARI), New Delhi, India with 150 variety of rice genotypes also conations 30 RGB images of wheat genotypes for addition train-test data having similar leaf tips like rice. They achieved an average accuracy of up to 82% and IOU around 0.53-0.60.

8. M. Fachrie, focuses on a Deep Learning implementation that creates a vehicle counting system without having to track the vehicles movements [8]. This research aims to create a simple vehicle counting system that help human to classify and count the vehicles that cross the street. They used model of YOLOv3 in their research due to its good performance and moderate computational time in object detection to enhance the performance of the system and also to reduce the time in deploying the deep learning model. The counting of the vehicles for this model was based on four types of vehicles that is car, motorcycle, bus and truck. The experimental results show their proposed system capable to count the vehicles crossing the road based on video captured by camera with the highest accuracy of 97.72%. Object 'car' got the highest accuracy followed by 'motorcycle' and 'bus' while 'truck' got the lowest accuracy, it can be because the frame rate of the video also give impact on the performance. But overall, the system can perform well to count the vehicles on the road.

9. Shaji Thorn Blue; M. Brindha, have proposed a solution to improve the precision of boundary boxes that is drawn on the objects detected after using an object detection algorithm in the image [9]. For this, they have gone through many algorithms such as SVM, RCNN, Fast RCNN, Faster RCNN, YOLO and SSD. Amongst all these algorithms they choose YOLOv3 as their base model which is an improvised version of YOLO. They have used pre-trained COCO dataset for object detection on YOLOv3 algorithm. Firstly, their system will take an image as an input, after that the image is given as an input to YOLOv3 algorithm. The result after applying the algorithm on the image gives an image with objects detected and boundary boxes around the detected objects. After this their system does pre-processing on the image and as a result an output image is generated with boundary boxes around the objects detected, but this time more accurately than the YOLOv3 algorithm. With the help of edge detection and pixel values in an area on the image the proposed system improves the precision of boundary boxes around the objects. The systems limitations were if there is sharp object or there is too much noise in the image, the accuracy was less for such images.

10. S. Sambolek, M. Ivasic-kos used yoloV4 for solving the problem of search and rescue operations (SAR) organization, drones are used for detection as they scan a large region in a short span of time [10]. They tested 4 algorithms R-CNN, YOLOV4, RetinaNet, and cascade R-CNN out of which yoloV4 was chosen as it gave more accuracy and less error. YoloV4 was tested with SARD datasets. YoloV4 mixes the localization and classification problems and converts them into a neural network. It divided an image into grid form with SXS size frame; the model used CSPDaekNet53 and spatial pyramid pooling. The ability to detect humans using computer vision helped SAR exponentially. For SAR detection is more important than accuracy, the trained model gave a 60% success rate in average precision when applied on a picture of 512 X 512 resolution for network resolution of 832 X 832. To further enhance the results thermal cameras will be used to amplify the performance.

11. Fu, L.; Duan, J.; Zou, X.; Lin, J.; Zhao, L.; Li, J.; Yang, Z. Fast presented a Deep Learning approach for detecting banana in natural environment with the help of monocular camera [11]. First they analyzed traditional machine learning algorithm also another neural network algorithm and checked performance on banana detection with different banana sizes. For this method they have used YOLOv4 detection algorithm. First step for detection process image of the banana fed into the network after that CSPDarknet53 module was used as a backbone, in order to extracts the data from the image Mish activation function was applied. For neck part composition of SPP module and FPN + PAN module that extracted by the backbone. The earlier extracted features were used by head part and gives the result as an output. They compared HOG+LBP+SVM, YOLOv3, and YOLOv4 algorithm that gives the average detection time was 1.325s, 0.038s and 0.171s respectively. By observing results, it can be seen that, the detection rate of banana for HOG+LBP+SVM was 89.63% also for YOLOv3 was 90.78%, and YOLOv4 was 99.29% which is highest among them.

3. CONCLUSION

We have discussed various object classification algorithms for classifying different types of images; image processing systems are helpful for object counting and decreasing time effectively. The accuracy of the algorithm depends upon different factors like the camera used, the size of objects, clarity of the image, whether objects are touching or not, and illumination conditions. We have also discussed different image classification techniques. Our study evaluates different scenarios for image classification as well as their advantages and disadvantages. So, this paper will help us in selecting an appropriate algorithm and technique among all the available techniques.

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