Object Detection and Image Classification for Mobile Robotics Applications

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***Abstract*—This paper presents an improved object detection method based on a combination of one-stage detector followed by an additional classification stage. The research was conducted using computational experiments and modeling techniques. The results were discussed and interpreted.**

***Keywords*—computer vision, object detection, image classification, machine learning, mobile robotics, software tools.**

I. INTRODUCTION

Today it is difficult to imagine our lives without scientific and technical achievements that make our lives easier by taking control of some of the tasks that have become routine, constantly taking away precious time that can be spent on more important things. The use of Artificial Intelligence (AI) is a great example of these advances, which helps to detect various objects more accurately, which in some cases is important, for example, to identify objects on the road. The Object Detection (OD) is a computer technology whose main purpose is to recognize objects by processing images and highlight them with bounding boxes according to a certain classification. Unusual photos (image size, different viewpoints, mixing the object with the background), real-time detection rate, limited data, and class imbalance can cause significant problems for OD. Our research was triggered by the impressions of the use cases of artificial intelligence in various applications, presented at scientific conferences and challenges. That is why we set ourselves the goal of creating a simple but efficient neural network.

II. METHODOLOGY

Today, many classical OD algorithms are used in various fields of human activity. Algorithms such as YOLO [1], Fast R-CNN [2], HOG, and Mask R-CNN [3] are considered among the best. Everyone has their own advantages, for example YOLO is considered one of the best OD algorithms due to its speed. The processing speed of the image in real time allows processing of many frames per second and newer modifications of the algorithm can process more than hundred frames per second.

Participating in the special scientific competition "Roborace" is a great way to test the efficiency and accuracy of the neural network, because due to constant movement we get a blurred image, which can cause problems with recognition and classification of the object. The technical challenge of the competition is to build an autonomous robot [4]-[7]. This includes the solution of such problems: In the shortest period of time the autonomous robot must pass the set number of laps from the starting position to the finish, avoiding other robots and without going outside the track. The main data input device is the camera. Therefore, we proposed to use the additional classification stage after the OD stage. Because by selecting objects in the constraint frame, we can filter out erroneous results by selecting a confidence threshold.

III. Results

The result of our work is the detection and identification of objects with an IoU metric increased by 8%. We achieved this result by using a classifier head after OD, which helped reduce the number of false positives.

IV. Discussion

It should be noted that our neural network does not always accurately recognize the selected objects; the reason for this is that at the stage of recognition the network may receive a very indistinct image and the system may not correctly identify the object in the image. Also, the use of our method is limited by the hardware of mobile robots.

V. Future research

In the future, the direction of research will be aimed at improving the detection quality of and reducing the learning time and computational complexity of the model.

VI. Conclusion

In this paper we proposed the enhanced method for OD for mobile robotics. It is based on the stack of OD and classification heads implemented using an artificial neural network with the open-source library TensorFlow 2. This framework is designed specifically for deep machine learning. A feature of this network is a simple but effective concept that demonstrates the accuracy of object identification with a high level of performance.

VII. Acknowledgment

We are grateful to the Department of Information Technology of the Vasyl Stefanyk Precarpathian National University for the professional advice provided to us in the research process.

VIII. Disclosures

The authors declare that there are no conflicts of interest related to this paper.

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