HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOL OF INFORMATION TECHNOLOGY AND COMMUNICATION

OBJECT DETECTION
USING SLIDING WIDOWS REPORT

Project name: Object detection with sliding windows

Supervisor:
Student names: Group

Trần Trung Hiếu	**20194764**
Tô Xuân Hùng	**20194772**
Ngô Quốc Thắng	**20194839**
Trần Đức Thắng	**20194842**
Phan Nguyên Anh	**20194727**

Computer Vision project name:

Object detection using sliding windows

Student names: Tran Trung Hieu, To Xuan Hung, Ngo Quoc Thang,

Tran Duc Thang, and Phan Nguyen Anh

Class ICT Global K64, Hanoi University of Science and Technology, No1. Dai Co Viet st., Hanoi, Vietnam

Abstract. Much of the focus in the object detection literature has been on the problem of identifying the bounding box of a particular class of object in an image. Yet, in contexts such as robotics and augmented reality, it is often necessary to find a specific object instance—a unique toy or a custom industrial part for example—rather than a generic object class. Here, applications can require a rapid shift from one object instance to another, thus requiring fast turnaround which affords little-to-no training time. Moreover, gathering a dataset and training a model for every new object instance to be detected can be expensive and time-consuming. In this context, we propose a generic 2D object instance detection approach that uses example viewpoints of the target object at test time to retrieve its 2D location in RGB images, without requiring any additional training (i.e. fine-tuning) step. To this end, we present an end-to-end architecture that detects the specific object from its viewpoint. The sliding windows technique is used to sequentially scan the sub-areas of the image and the image-pyramid technique resizes the image solution to scan which will cover the object even if its size is larger than the sliding window. For the training model, the project uses yolov5 library.

Keywords: object detection, sliding windows, yolov5, train model, image pyramid

1 Introduction

The goal of our project was to design and implement an object detection application using sliding windows algorithm. This is one of the earliest solutions for computer vision and object identification problems. Since the advent of computers, people have always what to enhance the ability of machines on helping and doing more abstract and complicated tasks.

Machines only understand 0 and 1 so how can we make them do more abstract tasks such as identifying objects? This is the problem that we have been solving for a long time. People have been thinking of different algorithms for identifying objects. The algorithm improvement is from using sliding windows algorithm to RCNN to fast-CNN to faster-CNN and to this day Yolo

Our goal was to create a program that implements the sliding windows algorithm with some improvement using the image-pyramid algorithm and for the training model, we use yolov5 library.

2 Problem Definition

The goal was to create a simple application that can identify objects, in this case, we use the application for detecting motorcycles using the sliding windows algorithm. The accuracy of the application should be in the acceptance range. Before running the application, we should train a model based on a data set. After training a model for the application, the input to the core of the program is an image, and the output is a set of cropped images that contain the wanted object.

1. The model should be trained using yolov5 library with an appropriate dataset that is divided into 3 sets: train set, valid set, and test set.

2. When using the application with an input image, the output should be a window that shows the image that is being identified with a window that slides through the image from left to right, from top to bottom. When the windows slide through an area that has the object class (motorcycle) then the sliding window will turn blue and save the cropped image of that window into a folder “runs”.

3. The algorithm will have a supported algorithm for enhancing the accuracy of the application. Which is the image-pyramid algorithm. Basically, the algorithm will resize the image resolution (reduce the image resolution by a factor such as 1.5 after each step). After each time the input image is scanned then the image will be resized and scanned again until the image is resized to a minimum thresh-hold. This algorithm will help the sliding window algorithm to detect objects that is larger than the sliding window itself.

3 Algorithm

3.1 Sliding windows algorithm

In the context of computer vision (and as the name suggests), a sliding window is a rectangular region of fixed width and height that “slides” across an image, such as in the following figure:

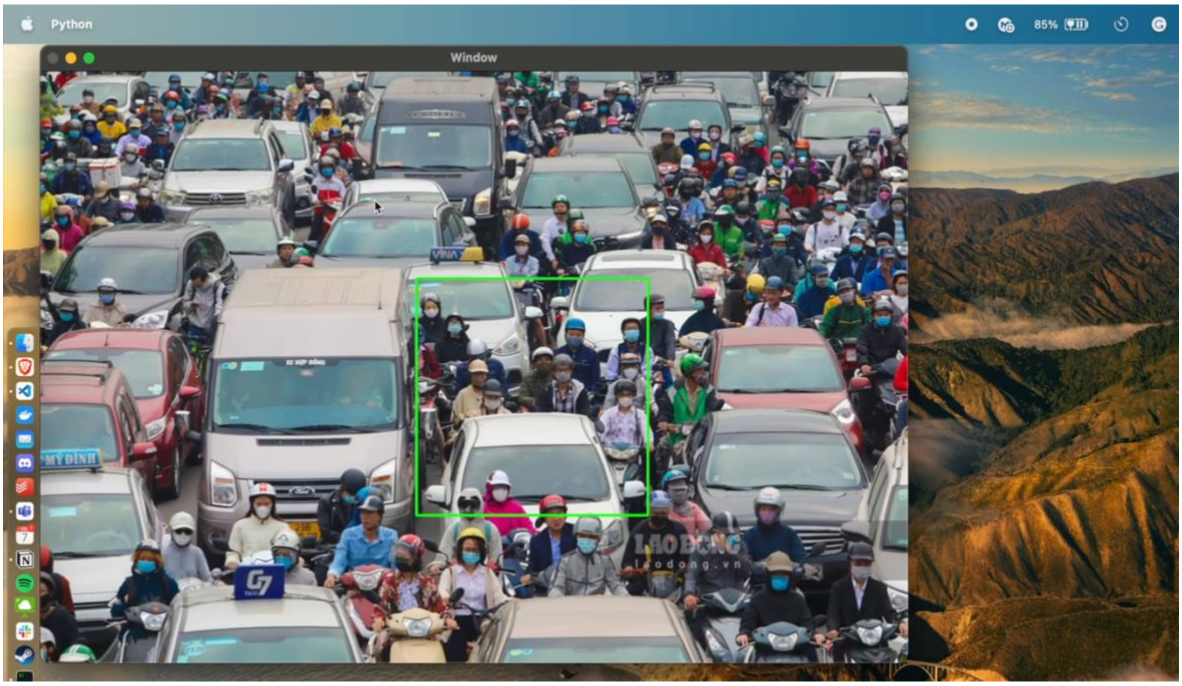


*Figure 1: **Click the image to run video***

There are 3 main attributes of sliding windows:

- Windows height and width
- Windows step size (How many pixels each time the window slides)
- Windows moving speed (How long is the delay between each slide)

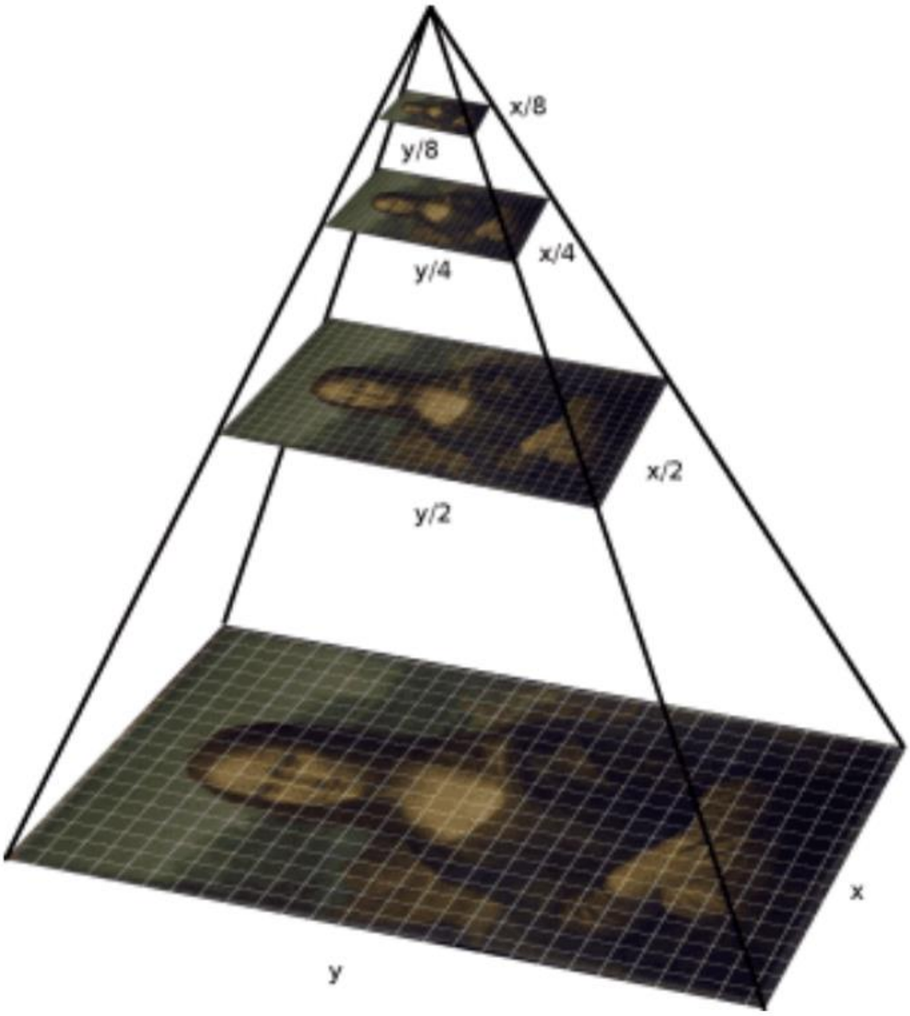
3.2 Image pyramid

An “image pyramid” is a multi-scale representation of an image.

Utilizing an image pyramid allows us to find objects in images at different scales of an image. And when combined with a sliding window we can find objects in images in various locations.

At the bottom of the pyramid, we have the original image at its original size (in terms of width and height). And at each subsequent layer, the image is resized (subsampled) and optionally smoothed (usually via Gaussian blurring).

The image is progressively subsampled until some stopping criterion is met, which is normally a minimum size has been reached and no further subsampling needs to take place.



3.3 YOLOv5 open source for training CV model

YOLO means "You Only Look Once" object detection and image segmentation model developed by Ultralytics. The YOLOv5 model is designed to be fast, accurate, and easy to use, making it an excellent choice for a wide range of object detection and image segmentation tasks. It can be trained on large datasets and is capable of running on a variety of hardware platforms, from CPUs to GPUs.

In this case, the project will use YOLOv5 to train a custom model from a labeled dataset: https://universe.roboflow.com/hva/schoolllll/dataset/1# . The data set contains a train set, a validate set, and a test set.

4 Experimental Results and Evaluation

4.1 Experimental Results

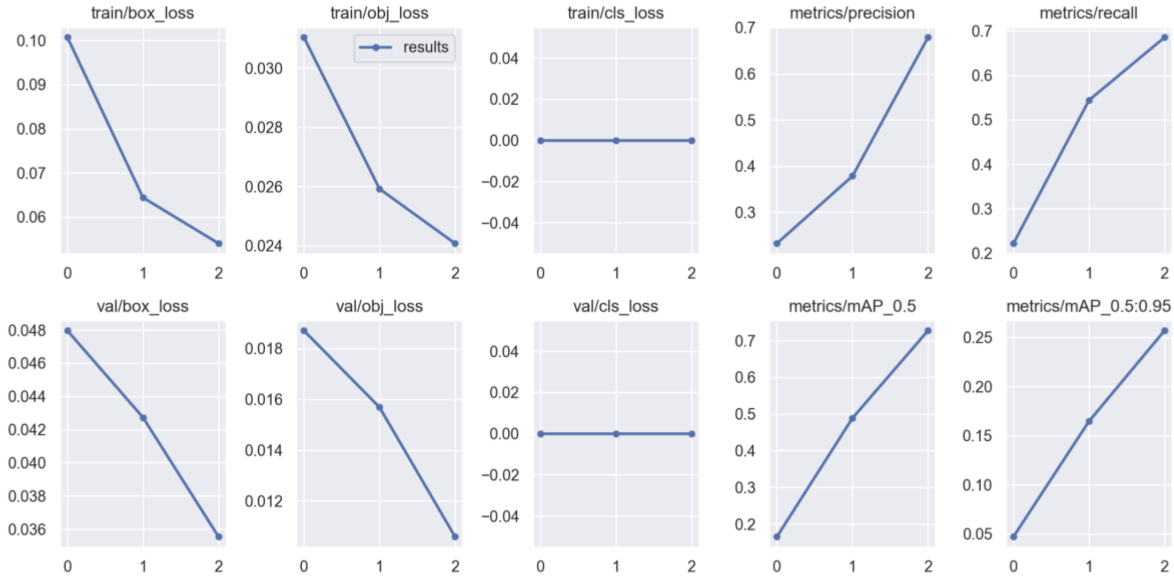


Figure 2: result

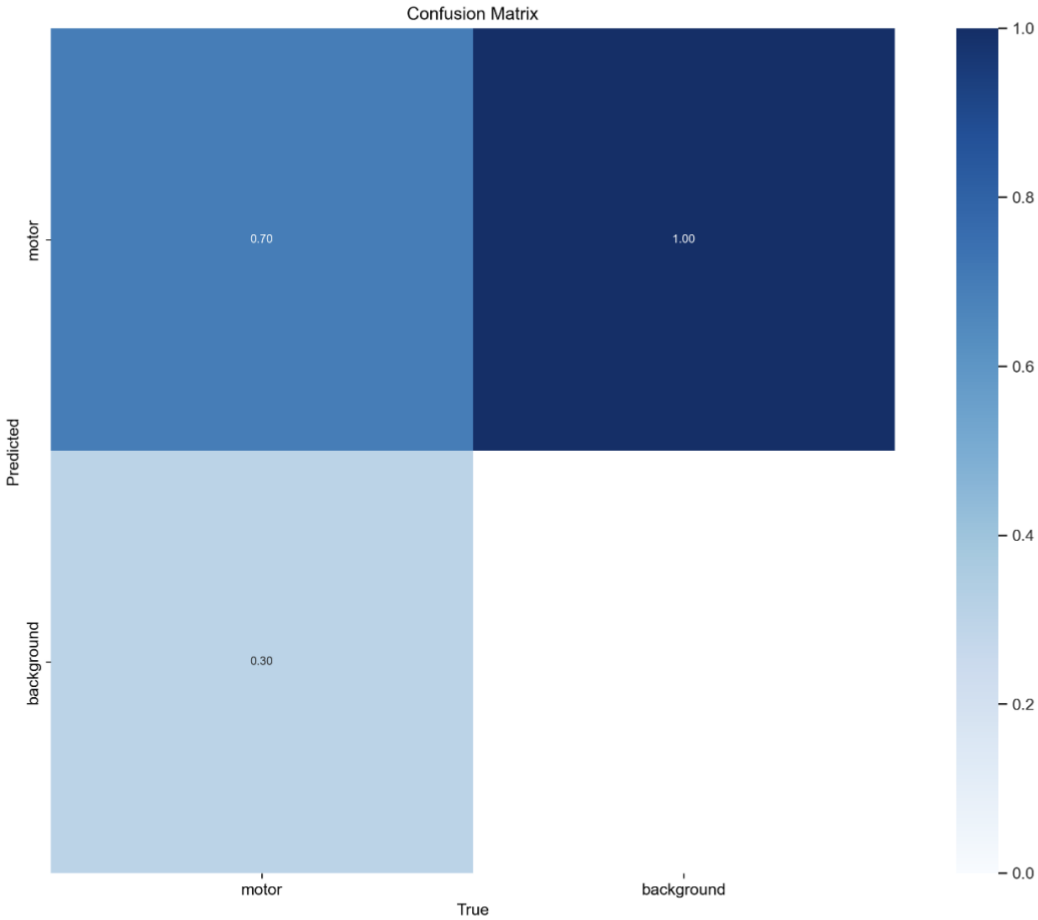


Figure 3: Confusion matric

5 Conclusion

Many improvements could be made to the implementation in its current form. They can come either from using more algorithms or improving the existing model.

The sliding algorithm can be considered as falling behind compared to other algorithms (RCNN, fast and faster RCNN, or YOLO). However, sliding windows is still one of the earliest algorithm for solving Computer Vision problems.

Many improvements could be made to the already implemented algorithms and concepts. The algorithm image-pyramid for example helps the application to avoid ignoring objects that are larger than the sliding windows. Also, even with the current model, the application still can be further optimized and tunning by optimizing the trained model.

References

1. Sliding windows: https://pyimagesearch.com/2015/03/23/sliding-windows-for-object-detection-with-python-and-opencv/
2. Image pyramid: https://pyimagesearch.com/2015/03/16/image-pyramids-with-python-and-opencv/
3. YOLOv5: https://github.com/ultralytics/yolov5