Object Detection in Security Surveillance System

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1. Abstract:

Object Detection is the most basic and crucial part of computer vision field. Object Detection is applied in various fields like agriculture, medical, engineering, surveillance and many other fields. Object detection using TensorFlow is a computer vision technique. As the name suggests it helps us in detecting, locating, tracking an object from an image or video. In security purpose object detection plays a great role. By using Object detection in CCTV, it not only captures the things it but also recognize the threats and take the action accordingly.

2. Problem Statement:

Now a days terrorism, assault, theft is common threat for the public places, stores etc. Closed Circuit Televisions (CCTV) has been used for a long time for monitoring and vigilance. It is difficult for human to recognize a weapon on small or low-resolution feeds and monitoring security cameras also overlooked when a weapon is present. Public places can be major target for terrorism and needs protection very much. CCTV cameras without AI could not detect explosive or other dangerous materials. But here AI comes in the field. AI based Security Surveillance can immediately locate guns or a knife or any kind of explosive devices. That's why TensorFlow object detection technique is being used nowadays in security surveillance.

3. Market/Customer/Business Need Assessment:

Object detection in surveillance is creating a major impact for security purpose. Most of the shops, houses, public places and even security areas don't have object detection technique in their CCTV cameras. That's why guns, assault rifles or other weapons are overlooked and explosive devices can't be detected by normal CCTV cameras while monitoring. Our aim is to bring awareness and upgrading the security surveillance system by using object detection technique.

4. Target Specification and Characterization:

- Our main objective is to provide advanced deep learning technology to security surveillance system.

- Most of the startup companies stated building AI based security camera.

- AI based security camera will not only help to detect guns, rifles and explosive devices it would help to reduce crime rates and emphasize the security forces to take steps before something bad happened.

5. External Search:

Applications of Object Detection in Various Security purposes:

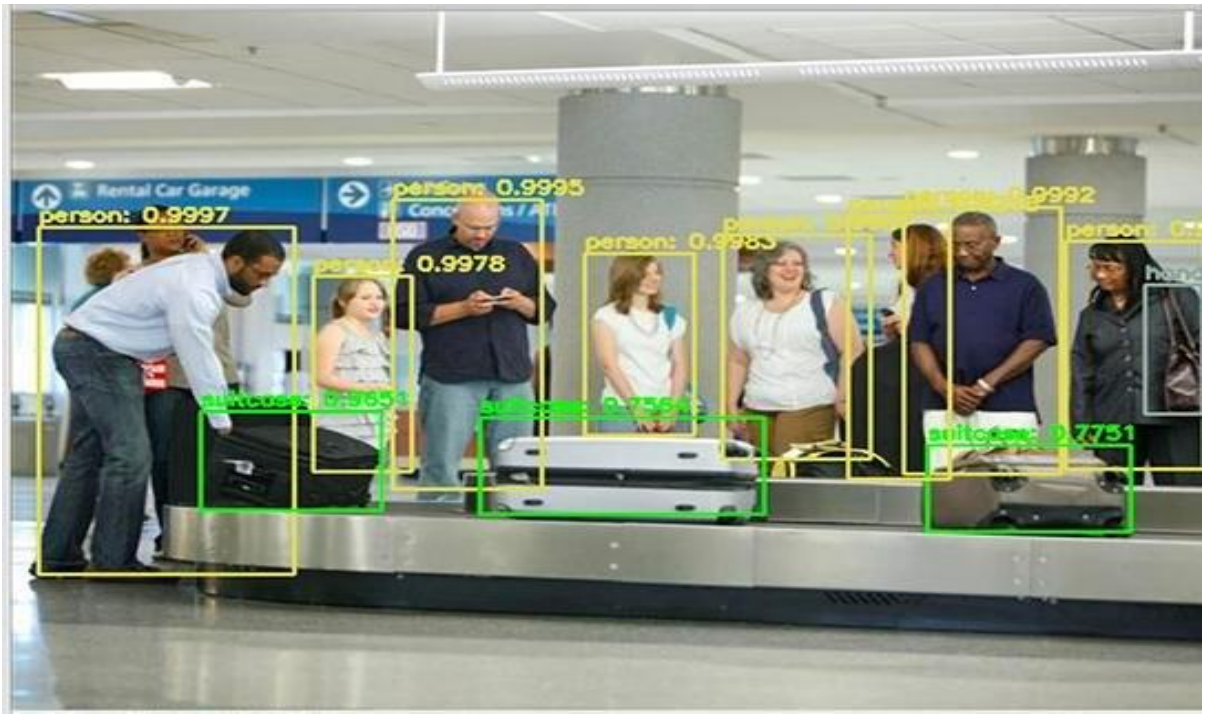
Object detection and recognition includes all the computer vision related task to identify physical objects in images and videos. Computer vision models are able to identify objects from digital images and create alerts based on the information.

5.1 Identifying weapons:

It's difficult for humans to identify weapons like guns, assault rifles, knives on small or low-resolution feeds. Also weapons in video recording are often difficult to detect. Object detection AI camera can easily detect those guns and informs to security who can take action immediately.

5.2 Airport Security:

Object detection also plays a major role in airport security. This capability will allow automated system to identify bags on security purpose and also in the terminals. Objects that are easily overlooked by conventional human video surveillance hardly escape a camera system that is trained to recognize them. Even if objects are located in dense crowd on a platform or in an airport building. Once trained almost any security camera equipped with deep learning vision is able to detect any object.



5.3 Loss Prevention:

Object detection can also be used to prevent theft. By locating objects, such as bags or valuable products, in images security camera can also give alerts when they are taken and also can easily be tracked.

5.4 Locating suspicious objects:

Public spaces can be targets for crimes and terrorism. Human can miss explosives or other dangerous materials. Computer vision-based security camera can constantly scan spaces and identify unusual objects that might be worthy of further investigations.

6. Benchmarking:

Most of the startup companies in USA like Scylla AI, Umbo, Deep sentinel etc. have started building AI based CCTV cameras. But it would be more beneficial when tech giants like amazon, Facebook's AI teams will take a step-in building AI based Security surveillance.

7. Applicable Patents:

US 2017/0032192 AI- This method includes obtaining a 2D representation of a 3D environment. The current patent improves by classifying the foreground object and taking action based on the classification of the foreground object.

8. Applicable Regulations (government and environmental):

8.1 Legality- any limitation to the right to privacy must be prescribed by the law.

8.2 Legitimate Aim: Laws should only permit communications surveillance by specified state authority to achieve a legitimate aim that corresponds to a predominantly important legal interest that is necessary in democratic society.

8.3 Necessity: Laws permitting communication surveillance by the state must limit surveillance to that which is strictly demonstrably necessary to achieve a legitimate aim.

8.4 Transparency: State should transparent about the use and the scope of communications surveillance technique and powers.

9. Applicable Constraints-

Expertise:

A. Annotation of video is the basic step in object detection. Object interpolation tools and task sharing options ensure that video annotation projects are completed on time.

B. Training data for security AI applications is the main step hence it needs to get a huge dataset to train the images.

C. SSD mobile Net, faster RCNN, YOLO etc. algorithms are the best algorithms used to train for object detection.

10. Business Opportunity:

Object detection and recognition is not only applied for the field of security surveillance but also are being applied in agriculture, medical, engineering, vehicle tracking and also other industries. It is already being used in public safety, video analytics, self-driving cars and in healthcare.

11. Concept Generation:

TensorFlow Object Detection API is the mostly used API in computer vision for object detection. There are few steps for object detection.

1. First Prepare the dataset before feeding into machine learning model.

2. Install Image annotation toolkit by running this command in anaconda prompt.

Use below commands to install labelling/annotation tool

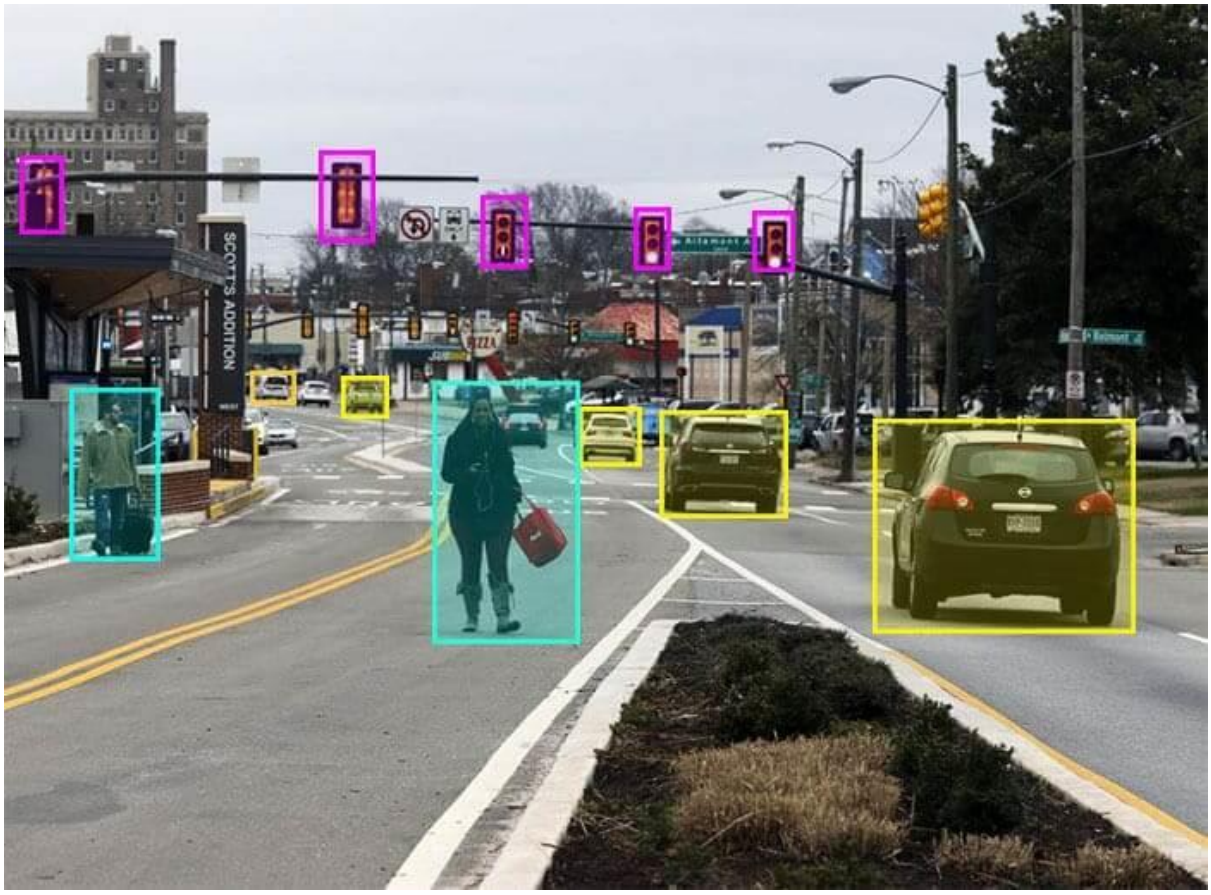
pip install PyQt5

pyrcc5 -o libs/resources.py resources.qrc

python labelImg.py

1. Install Image labelling tool
2. Prepare the image dataset
3. Decide classifier and perform annotation

3. Annotate images and create label images and those annotated images will be saved in xml format.



4. Distribute labelled dataset into training and testing set

4.1 Training set contains 80 percent of images.

4.2 Testing set contains 20 percent of images.

5. Convert labelled images (XML images) into CSV file.

```
set PYTHONPATH=C:\tensorflow\models\research\slim;C:\tensorflow\models\research
```

1. XML to CSV

Python xml_to_csv.py

Use above command twice by changing folder name will result in below two files.

>> test.csv

>>train.csv

Paste above csv files in respective folder

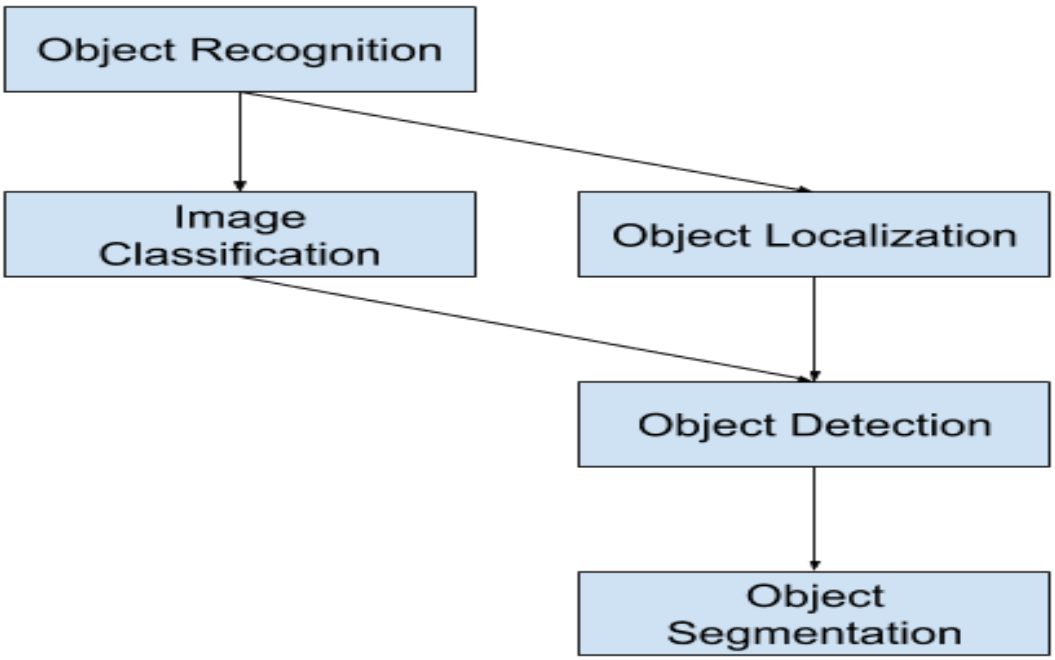
7. Convert CSV files into TfRecord file and after that train.record and test.record files would be created.

8. Create Labelmap.pbtxt file.

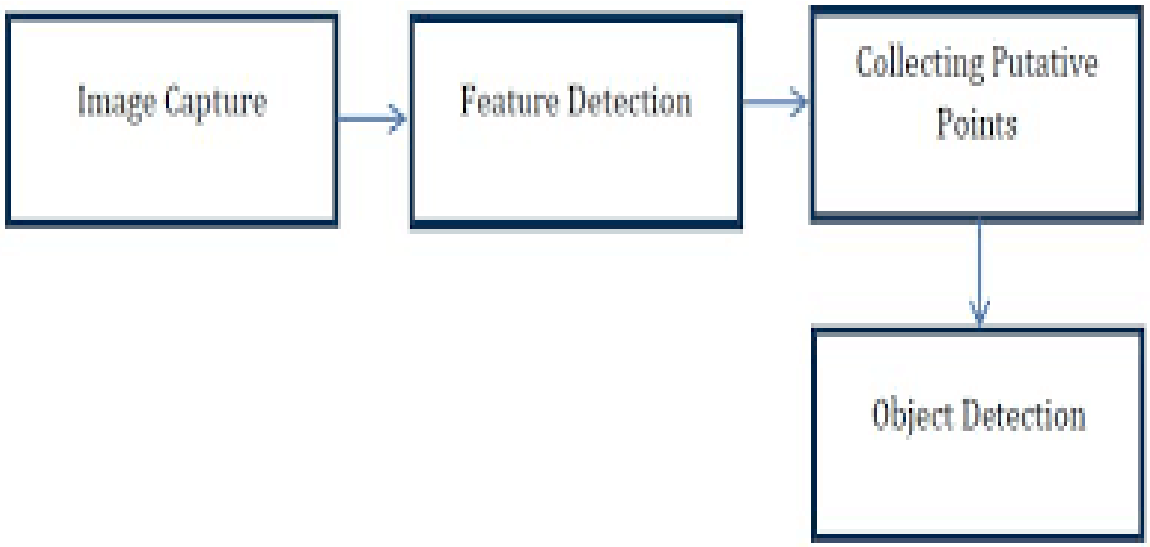
9. Generate model graph using Tensorboard.

10. Deploy on web camera, and video camera and on Security camera.

12. Concept Development:

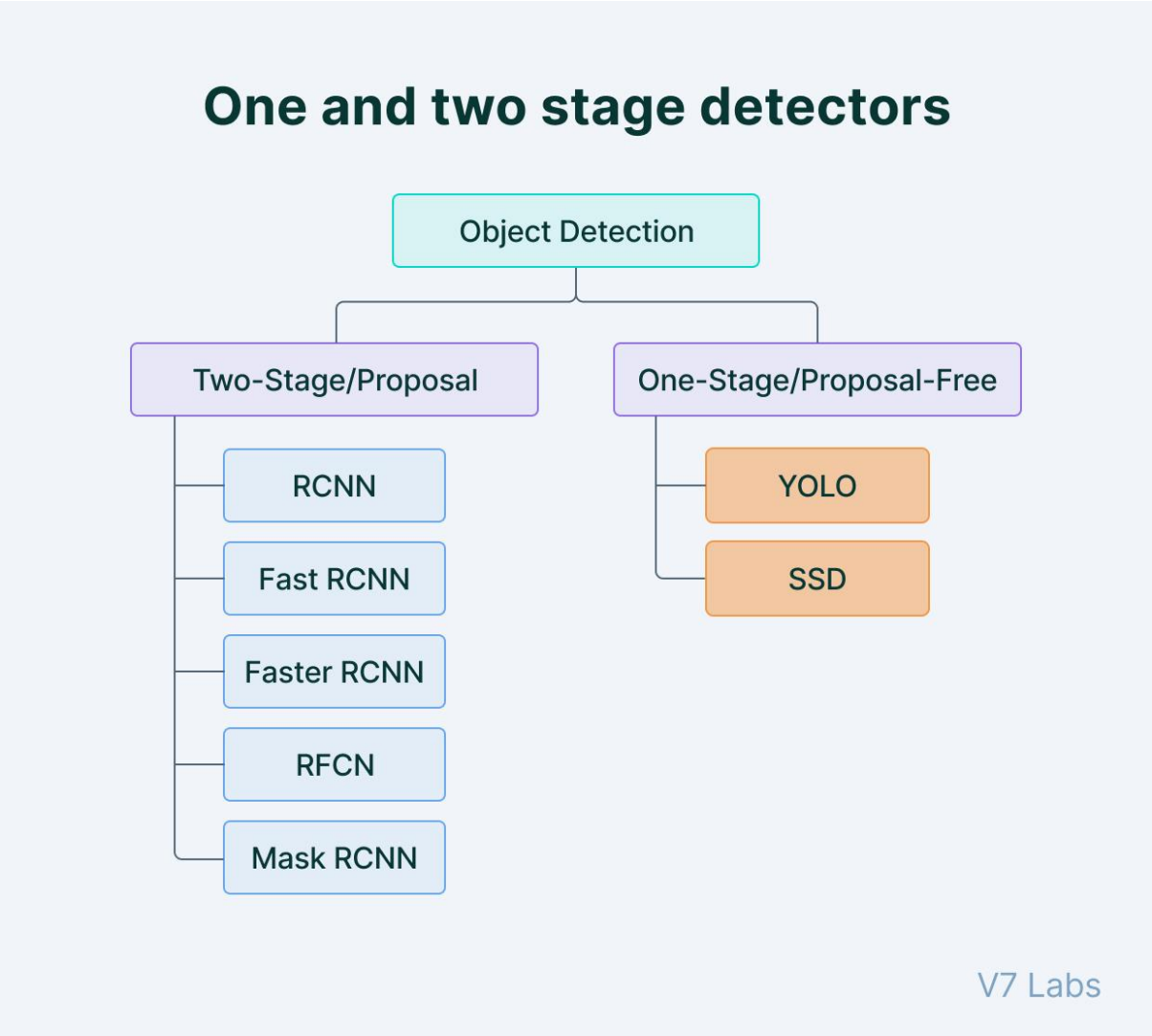


13. Final Product Prototype:



14. Product Details

Some of popular algorithms are used in Object Detection are SSD mobile net, Faster RCNN, YOLO etc.



Object detection has two types of detector algorithms –

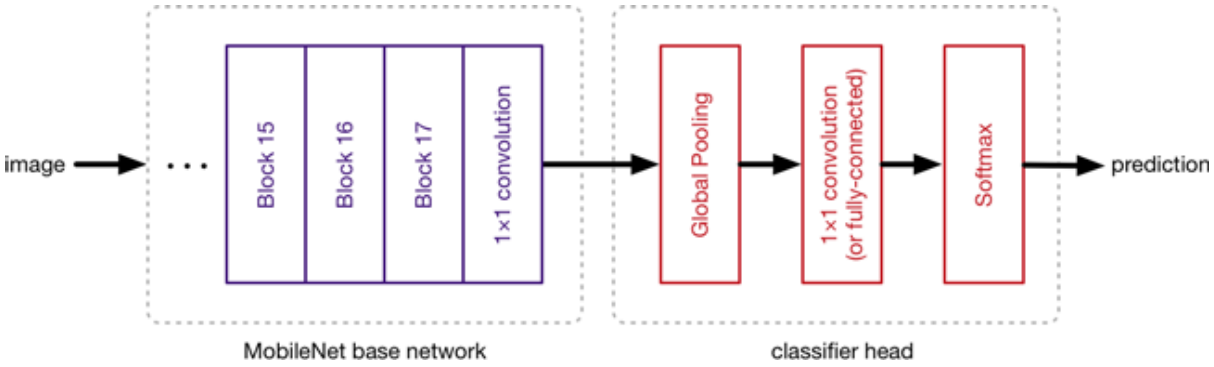
1. Two-stage Detectors

2. One-Stage Detectors

14.1 Mobile Net SSD-

Mobile net SSD (stands for Mobile net Single Shot detector) is an object detection model with 267 layers and 15 million parameters. It provides real time inference under compute constraints in devices like smartphones. Once trained MobilenetSSDV2 can be stored with 63MB, making it an ideal model to use on smaller devices.

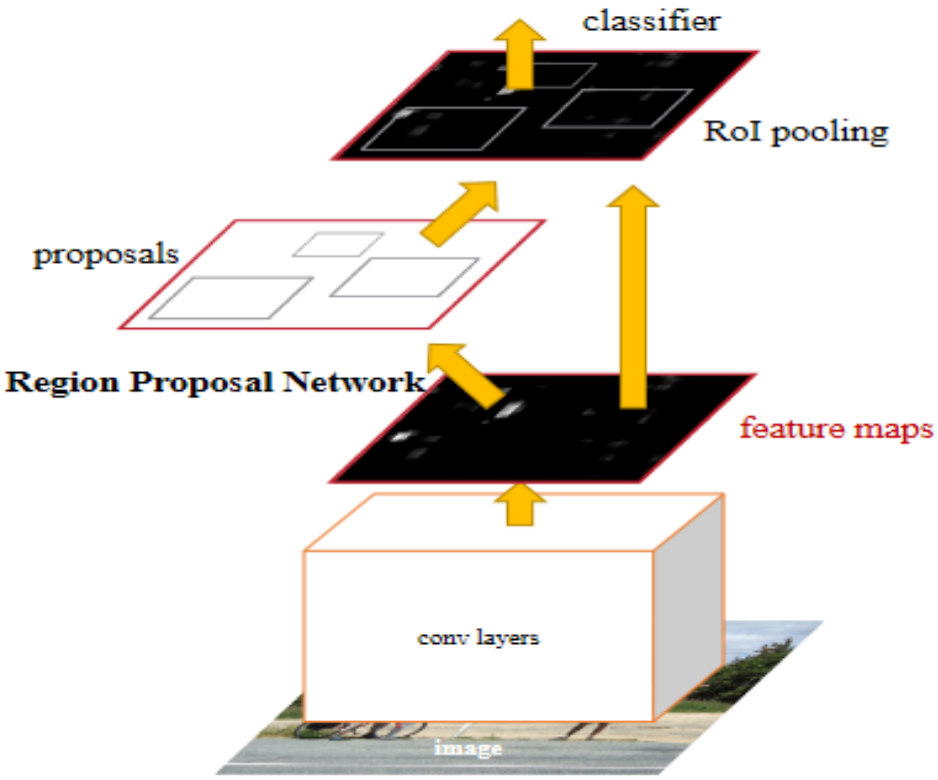
The mobile net SSD is a 2-part model. The first part consists of base MobilenetV2 with SSD layer that classifies the detected images. In essence the mobile net based network acts as a feature extractor for the SSD layer which will then classify the object of interest.



14.2 Faster RCNN-

Faster R-CNN is a state-of-the-art object detection framework. It has been around for a while and has a lot of nice integrations. Despite its name, Faster R-CNN is known as being a slower model than some other choices (like YOLOv3 or Mobile Net) for inference but in return is more accurate. It is one of the many model architectures that the TensorFlow Object Detection API provides by default.

The Faster R-CNN utilizes is a two-stage deep learning object detector: first, it identifies regions of interest and then passes these regions to a convolutional neural network. The outputted feature maps are passed to a support vector machine (SVM) for classification. Regression between predicted bounding boxes and ground truth bounding boxes is computed. Below is the general architecture for the Faster R-CNN.



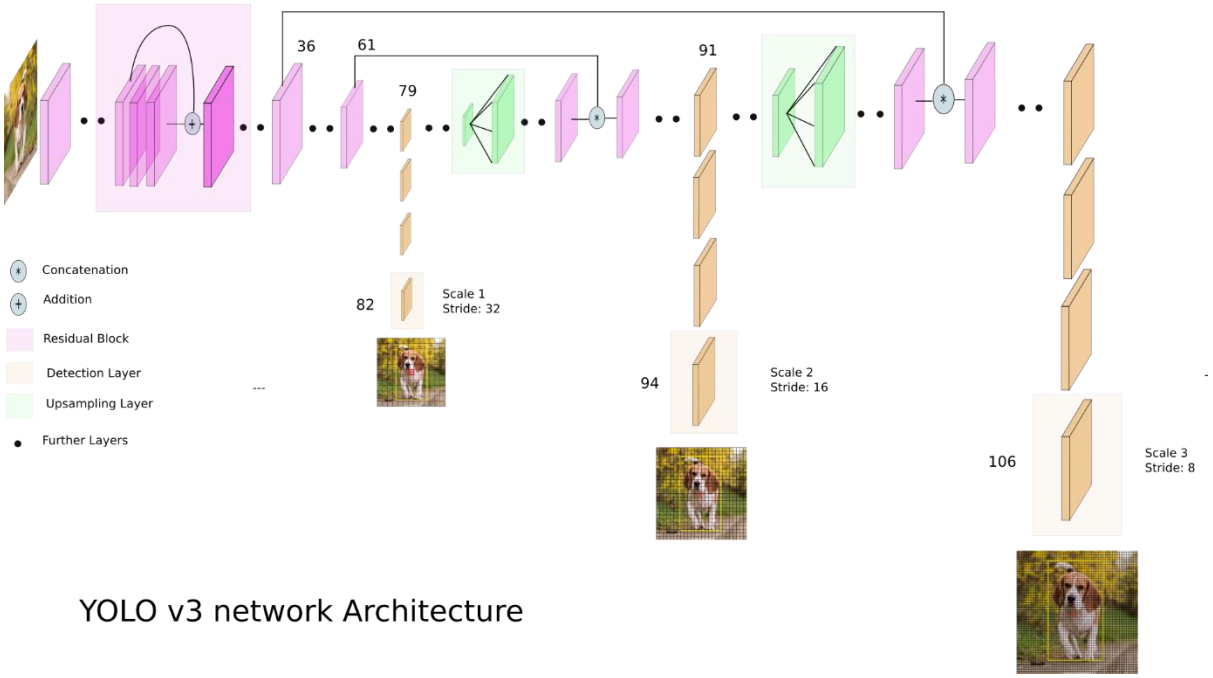
14.3 YOLO (You Only Look Once):

YOLO is an abbreviation of You Only Look Once. This is an algorithm that detects and recognizes various objects in a picture (in real time). Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images.

YOLO algorithm employs convolutional neural networks (CNN) to detect objects in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects.

This means that prediction in the entire image is done in a single algorithm run. The CNN is used to predict various class probabilities and bounding boxes simultaneously.

The YOLO algorithm consists of various variants. Some of the common ones include tiny YOLO and YOLOv3.



YOLO v3 network Architecture

15. Conclusion:

Object detection is a key ability for most of the computer and robot vision system. Although great progress has been observed of object detection used in various fields. In case of autonomous machine, security surveillance the need of object detection is gaining more importance. Object detection in security camera can also be augmented to discover a potential threat and alert the authorities in advance for the incoming threat and also increasing the safety of people.

16. Reference:

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5. Surajit et al., "Object Detection for Crime Scene Evidence Analysis Using Deep Learning", *International Conference on Image Analysis and Processing*, pp 14-24.