CSE 424 Project Presentation

Obstacle Pattern Recognition From Vehicle Perspective

Section: 01

Group Number: 23

Group Members:

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Goals

Object detection in a way which is more efficient and reliable for autonomous vehicle or mobile robots.

The detection of objects are -

- Pedestrians
- Cars
- Cyclists
- Animals
- Electric pole

Object detection procedures -

- Localization
- Classification

Literature Review

Paper: You Only Look Once : Unfield, Real-Time Object Detection

- The paper presents a unifield , real-time object detection system that achieves fast processing speeds and high generalization
- YOLO enables end-to-end training and achieves real-time speeds, processing up to 155 frames per second.
- It generalize top detection methods like DPM and R-CNN when tested on different domains, such as artwork.
- The model have difficulties localizing small objects and can produce localization errors.

Literature Review

Paper: Object Detection Using Convolutional Neural Networks

- To implement the object detection using CNN, TensorFlow Object detection API was used which is an open source framework for object detection models.
- Two state of the art models are compared for object detection
- SSD with MobileNetV1 has high speed detection but low accuracy
- Faster-RCNN with InceptionV2 has low speed but more accurate detection

Literature Review

Paper: Faster R-CNN: an Approach to Real-Time Object Detection

- This model merges RPN and Fast R-CNN thus it offers improved speed and accuracy

- Four classes, allocating 80% for training and 20% for testing

- The paper have showed good potential on identifying traffic signal on real time using cheap dashboard camera.

- The model does not work well when the images are not stable enough, when there are bumps on the road the accuracy decreases.

Literature Review

Paper: Object Detection and Recognition using one stage improved YOLOv3

- The primary concern for using this detector is speed more than the accuracy
- The running speed is significantly increased which is approximately 442% faster
- This paper does not extend object localization and recognition from static pictures to a video containing the dynamic sequence of images
- Provided the comparisons of different models

Dataset Description

- **nuScenes dataset**
  - Developed by the nuTonomy team at MIT
  - 3D annotations of 23 classes
  - 1600 x 900 resulations
  - More than 50,000 images
  - Data collected from Boston and Singapore

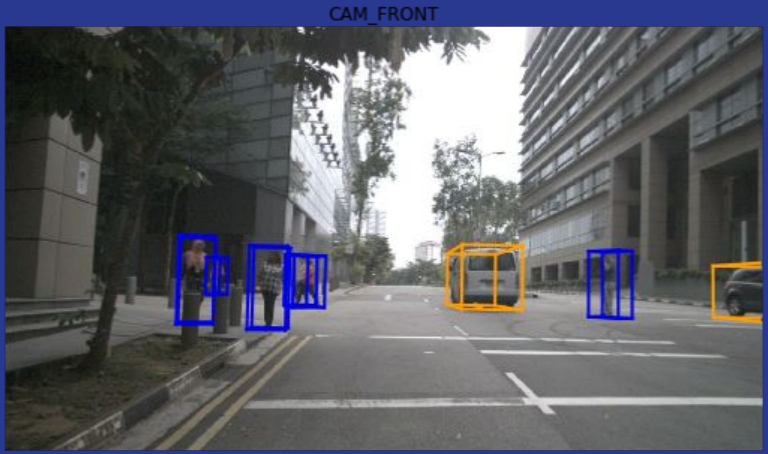
Classes of nuScenes Dataset

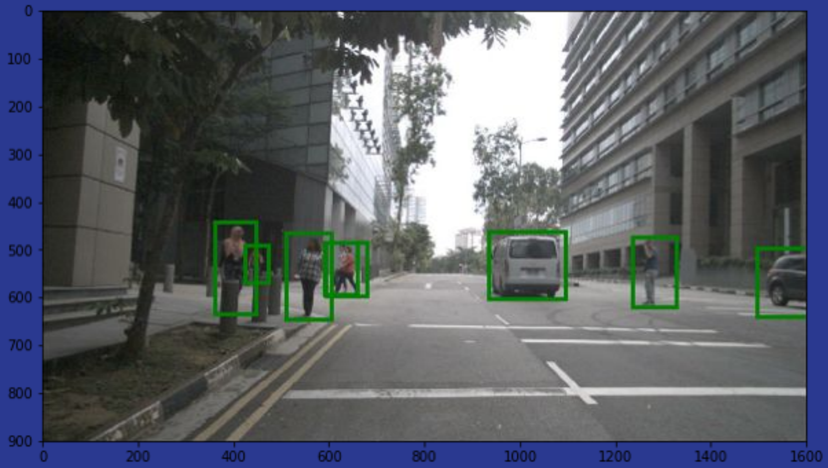
```
human.pedestrian.adult
human.pedestrian.child
human.pedestrian.wheelchair
human.pedestrian.stroller
human.pedestrian.personal_mobility
human.pedestrian.police_officer
human.pedestrian.construction_worker
animal
vehicle.car
vehicle.motorcycle
vehicle.bicycle
vehicle.bus.bendy
vehicle.bus.rigid
vehicle.truck
vehicle.construction
vehicle.emergency.ambulance
vehicle.emergency.police
vehicle.trailer
movable_object.barrier
movable_object.trafficcone
movable_object.pushable_pullable
movable_object.debris
static_object.bicycle_rack
```

Data Preprocessing

- Extracting 2D bounding boxes from corresponding 3D bounding boxes
- Splitting the dataset into 70% for training, 15% for validation and 15% for testing
- Default confidence score threshold is 25%
- Resolution and subdivision of the base model are 416 x 416 and 8 respectively

3D to 2D Bounding Boxes





3D to 2D Bounding Boxes

```python
def threeD_2_twoD(boxsy,intrinsic): #input is a single annotation box
    '''
    given annotation boxes and intrinsic camera matrix
    outputs the 2d bounding box coordinates as a list (all annotations for a particular sample image)
    '''
    corners = boxsy.corners()
    x = corners[0,:]
    y = corners[1,:]
    z = corners[2,:]
    x_y_z = np.array((x,y,z))
    orthographic = np.dot(intrinsic,x_y_z)
    perspective_x = orthographic[0]/orthographic[2]
    perspective_y = orthographic[1]/orthographic[2]
    perspective_z = orthographic[2]/orthographic[2]

    min_x = np.min(perspective_x)
    max_x = np.max(perspective_x)
    min_y = np.min(perspective_y)
    max_y = np.max(perspective_y)



    return min_x,max_x,min_y,max_y
```

Extracting Bounding Boxes

```
def extract_bounding_box(i,camera_name): #give a single sample number and camera name

    '''
    input sample number i, camera name
    outputs min x, max x, min y max y, width and height of bounding box in image coordinates
    2d bounding box
    options for camera name : CAM_FRONT, CAM_FRONT_RIGHT, CAM_FRONT_LEFT, CAM_BACK, CAM_BACK_RIGHT,CAM_BACK_LEFT
    '''

    nusc.sample[i] #one image

    camera_token = nusc.sample[i]['data']['%s' %camera_name] #one camera, get the camera token

    path, boxes, anns, intrinsic_matrix = get_sample_data(nusc,'%s' %camera_token) #gets data for one image

    x_min, x_max,y_min,y_max,width,height, objects_detected,orig_objects_detected = all_3d_to_2d(boxes,anns, intrinsic_matrix)

    return x_min, x_max, y_min, y_max, width, height, path, boxes,intrinsic_matrix, objects_detected,orig_objects_detected
```

Dataset Description

- **Roboflow dataset**
  - Annotations of 10 classes
  - Various resulations
  - More than 9,000 images

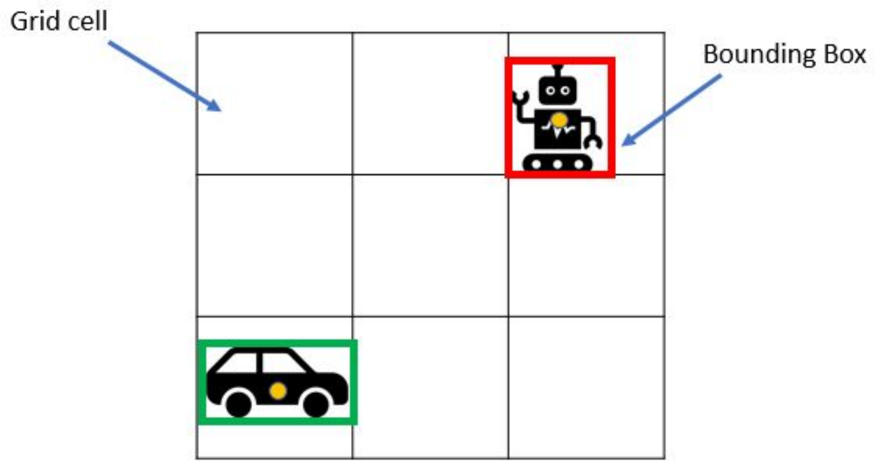
Data Preprocessing

- Adam optimizer
- Blur(p=0.01, blur_limit=(3, 7))
- MedianBlur(p=0.01, blur_limit=(3, 7))
- ToGray(p=0.01)
- CLAHE(p=0.01, clip_limit=(1, 4.0)
- Splitting the dataset into 85% for training, 10% for validation and 5% for testing

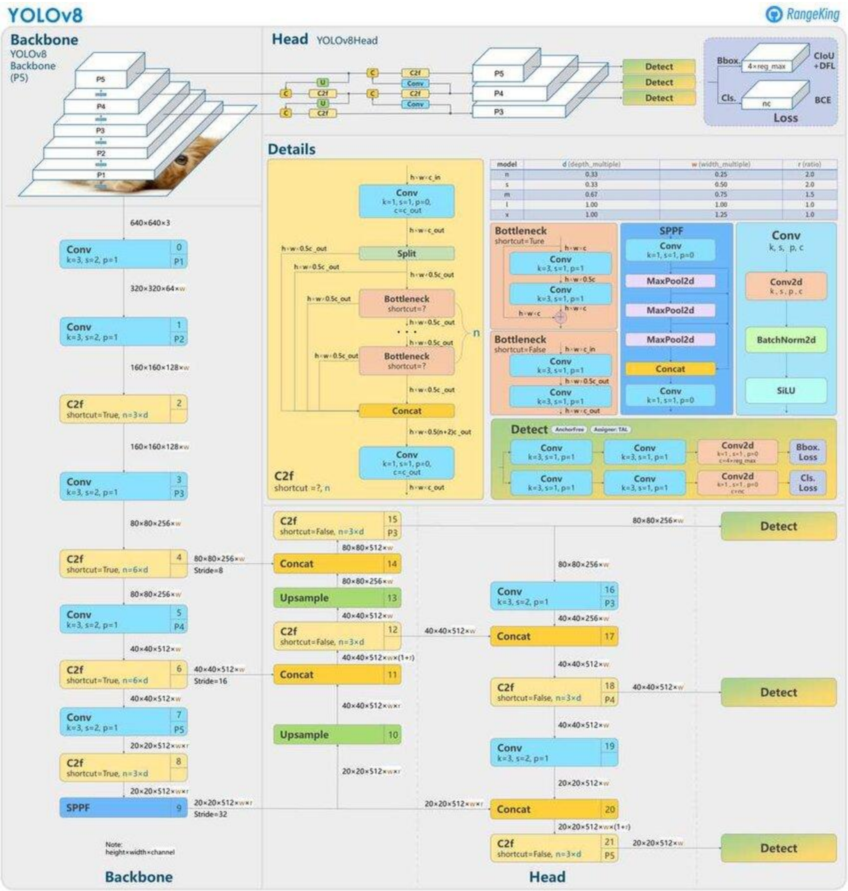
Classes of Roboflow dataset

Model for Project

- **YOLOv8**
  - Faster compared to other versions
  - Less computational requirements
  - Real-time implementation
  - Still developing

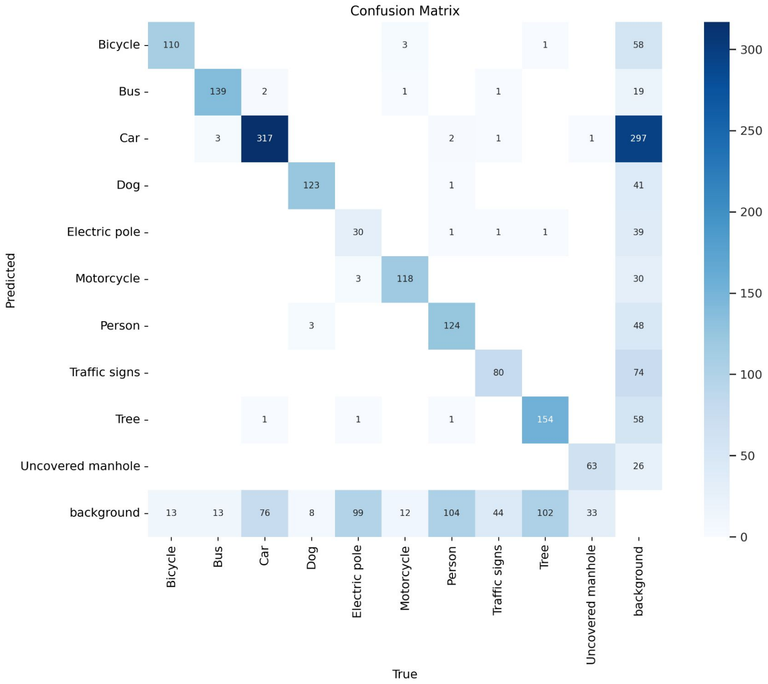


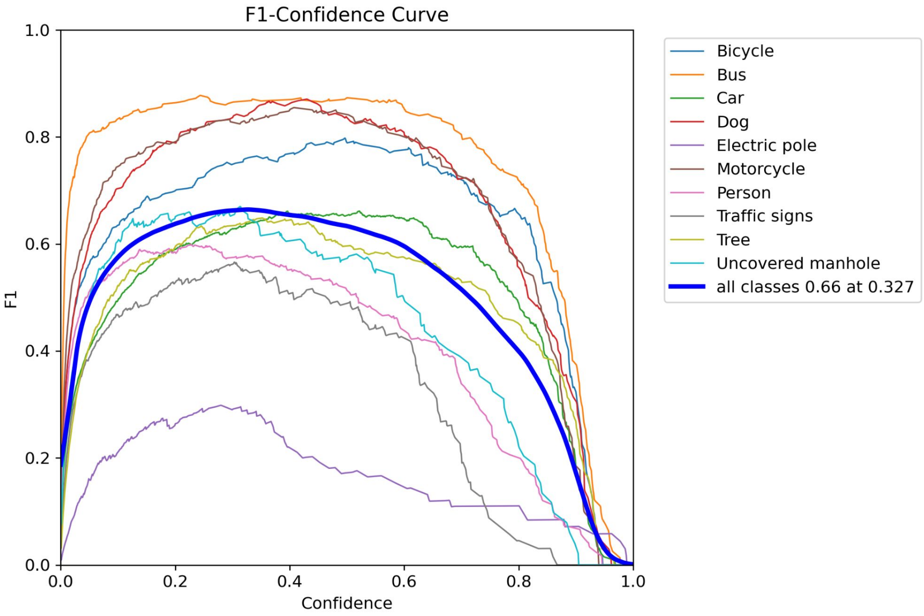
Method of YOLO



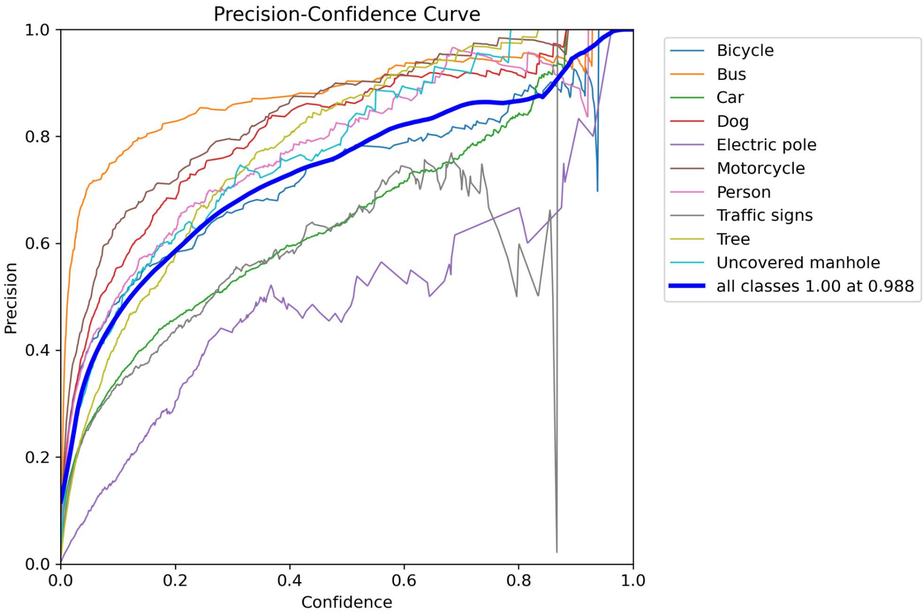
Structure of YOLOv8

Confusion matrix



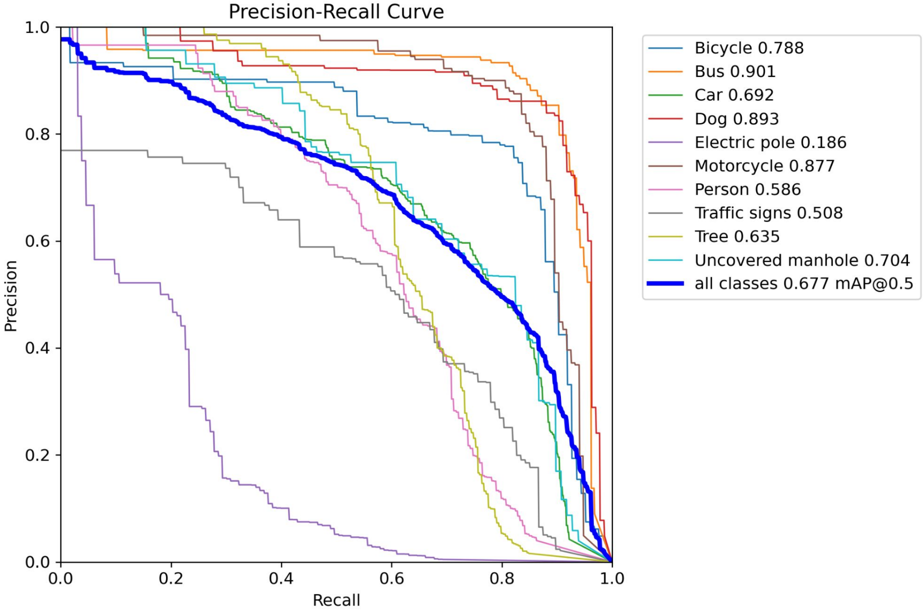

F1-Confidence Curve
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
F1
Confidence
Bicycle
Bus
Car
Dog
Electric pole
Motorcycle
Person
Traffic signs
Tree
Uncovered manhole
all classes 0.66 at 0.327

F1 curve



Precision confidence curve

Precision recall curve



Detection Outcome

Conclusion

The model maintains high accuracy and speed for nuScenes, roboflow dataset. In future we would like to extend our work for different dataset and changing the parameters for more reliability and accuracy.

Thank You