IOSR Journal of Mobile Computing & Application (IOSR-JMCA)
e- ISSN: 2394-0050, P-ISSN: 2394-0042.Volume 9, Issue 2 (Mar. – Apr. 2022), PP 28-33
www.iosrjournals.org

Use of CNN(YOLO) in Self Driving vehicles

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Abstract: *The field of autonomous automation is of interest to researchers, and much has been accomplished in this area, of which this paper presents a detailed chronology. This paper can help one understand the trends in autonomous vehicle technology for the past, present, and future. We see a drastic change in autonomous vehicle technology since 1920s, when the first radio controlled vehicles were designed. In the subsequent decades, we see fairly autonomous electric cars powered by embedded circuits in the roads. By 1960s, autonomous cars having similar electronic guide systems came into picture. 1980s saw vision guided autonomous vehicles, which was a major milestone in technology and till date we use similar or modified forms of vision and radio guided technologies. Various semi-autonomous features introduced in modern cars such as lane keeping, automatic braking and adaptive cruise control are based on such systems. Extensive network guided systems in conjunction with vision guided features is the future of autonomous vehicles. It is predicted that most companies will launch fully autonomous vehicles by the advent of next decade. The future of autonomous vehicles is an ambitious era of safe and comfortable transportation.*
Background *An autonomous car is a vehicle capable of sensing its environment and operating without human involvement. A human passenger is not required to take control of the vehicle at any time, nor is a human passenger required to be present in the vehicle at all. An autonomous car can go anywhere a traditional car goes and do everything that an experienced human driver does.The Society of Automotive Engineers (SAE) currently defines 6 levels of driving automation ranging from Level 0 (fully manual) to Level 5 (fully autonomous). These levels have been adopted by the U.S. Department of Transportation.*
Key Word*: Self driving cars, CNN,Image processing , Automation*

I. Introduction

Nowadays, even though vehicle driving assistive technology has been assembled in the premium cars on a large scale, the concept of the self-driving car has constantly appeared in various news and reports. Generally, the self-driving car also termed as the wheeled mobile robot, is a kind of intelligent car, which arrives at a destination based on the information obtained from automotive sensors, including the perception of the path environment, information of the route and car control. The main characteristic of self-driving car is transporting people or objects to a predetermined target without humans driving the car.

II. Types Of Autonomous Cars

2.1.1 Level 0: Autonomous car :

Level 0 autonomy refers to a typical, everyday car. The driver performs all operations, including steering, accelerating, and braking and the vehicle has no autonomous or self-driving controls at all. Practically every road vehicle offers level 0 autonomy.

2.1.2 Level 1: Driver assistance :

At this level, the driver still handles most of the car's functions but with a little autonomous help. For example, a level one vehicle might provide you with a brake boost if you edge too close to another vehicle, or it might have an adaptive cruise control function to control your distance and speed. Likewise, Level 1 autonomous vehicles might have a park assist function, where a beeping sound alerts the driver to an approaching obstacle. Level 1 autonomy is common in most cars today, and a typical example would be the 2018 Nissan Sentra, with its Intelligent Cruise Control feature.

2.1.3 Level 2: Partial automation :

Partial automation enables drivers to disengage from some driving functions. Level 2 vehicles are able to assist with functions like steering, acceleration, braking, and maintaining speed, although drivers still need to have both hands on the wheel and be ready to take control if necessary. With steering, Level 2 vehicles assist by centering the car within the lane, whereas the speed control function ensures that the correct distance is kept from other cars. An example of a car with Level 2 autonomy is the 2019 Volvo S60.

2.1.4 Level 3: Conditional automation :

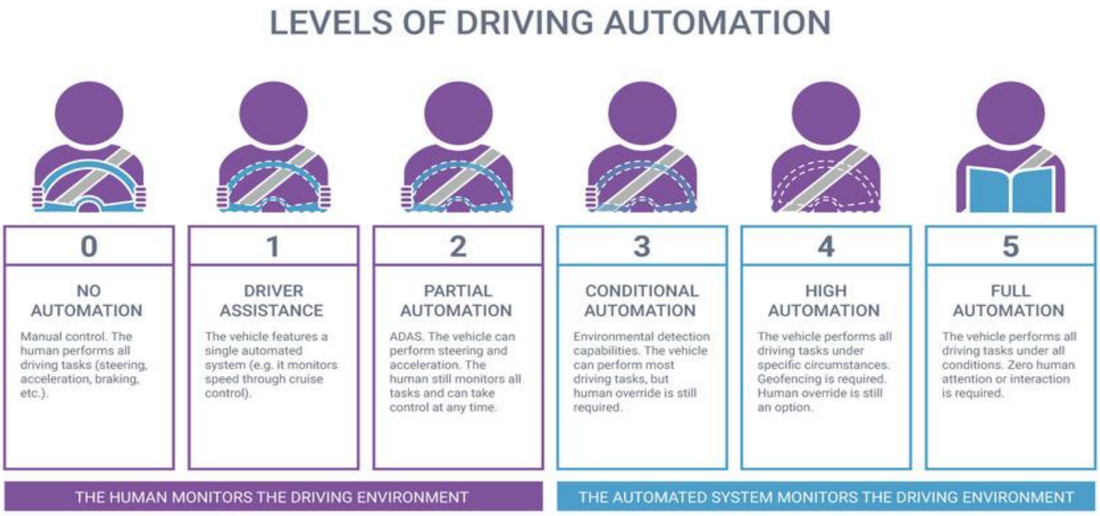
Conditional automation allows drivers to sit back and let the car do all the driving. Also referred to as 'eyes-off' vehicles, drivers are able to focus their attention on other activities like using a mobile phone, for example. Many Level 3 cars don't require any human intervention at all when driven at a speed of less than 60 km/h. At this level, cars can be considered truly autonomous, but only under ideal road conditions. There aren't many (if any) level three vehicles driving on public roads that aren't limited-access highways. However, Honda is reportedly set to introduce a level three car on public freeways soon.

2.1.5 Level 4: High automation :

At Level 4, vehicles are capable of steering, accelerating, and braking on their own. They're also able to monitor road conditions and respond to obstacles, determining when to turn and when to change lanes. Level 4 autonomous driving can only be activated when road conditions are ideal. At this level, vehicles can't negotiate more dynamic conditions like traffic jams or other major obstacles. The best example of a Level 4 autonomous vehicle is Google's Waymo project in the U.S.

2.1.6 Level 5: Full automation :

Level 5 autonomous driving requires no human interaction. Vehicles are able to steer, accelerate, brake and monitor road conditions like traffic jams. Essentially, Level 5 automation enables the driver to sit back and relax without having to pay any attention to the car’s functions whatsoever. Vehicles will be driven using Artificial Intelligence (AI) and will respond to real-world data points, generated from sensors. In a previous article about AI and mobility, we highlighted that a huge amount of data is produced in autonomous vehicles—as much as 4TB per hour. Only a powerful computing system like Artificial Intelligence can process such large volumes of data quick enough to achieve real-time responses.



III. Literature Survey

As of March 2018, 52 companies possessed permits to test autonomous vehicles on the roads of the State of California alone . Self-driving vehicles represent a fast-paced field of modern technology, as companies compete for dominance in this important field of emerging transportation capacity. Nevertheless, relatively few members of the traveling public have yet experienced trips in an autonomous vehicle. This personal inexperience can make it difficult for the general populace to judge the potential utility, for good or bad, of such vehicles. The advent of the driverless car is usually portrayed as both labor saving and accident reducing. However, the societal impact of these mobile robots will certainly be more extensive than a simple change in the journey between the immediate origin and the destination. For example, in coming years it may not be necessary for individuals to own a car, especially when they can summon one from a circulating fleet using a simple portal such as a smartphone application and being fully confident that it will arrive within minutes or even seconds. This sea change in vehicle usage will have many knock-on effects. Some studies have suggested that up to 30% or more of traffic circling downtown streets is actually searching for parking . The search could become unnecessary when the vehicle is driving itself to pick up its next user, as some projections concerning Uber usage seem to suggest. Such functionality could free up curb space, which is becoming increasingly more important for safe pick-ups and drop-offs in already congested locations . These technological changes may then foreshadow a repurposing of parking structures or parking spaces within buildings to accommodate new housing, offices, or retail uses. Of course, parking concerns are not by any means the only dimension of change.The radical changes promised by AVs will have profound and extended effects on the general public. Some of these are changes we can readily anticipate; others are much less predictable. On what basis will individual members of the public judge the value of such technical innovations ? One prominent issue in such a discussion is what people understand an AV to be. It may well be that the general public views such vehicles as not requiring any driver input whatsoever. However, this perception fails to capture many of the major differences between proposed AVs and the present, semiautomated on-road vehicles. The latter provide various forms of driver assistance to help the driver who remains in ultimate control. Fully autonomous vehicles are designed to drive themselves. These differing forms of advancing vehicles have been categorized in a hierarchy which compares driver control versus vehicle control. The hierarchy is described in the Society of Automotive Engineers (SAE) levels of control . Although we do not specifically discuss each of these levels here, it is vital to note that many public assumptions about advanced vehicle capabilities may be misplaced. Thus, individuals may well assume that such AVs possess much more intelligence and operational capacity than is actually the case. Such assumptions may prove critical, if not fatal.Some of the most evident proximal impacts will be on jobs and associated commuting patterns. The driverless car has the potential to make its human controller as redundant as the horse became for the horseless carriage. Truck and taxi drivers may well have to find new forms of employment, some perhaps supervising these individual vehicles from remote control call centers. However, jobs in the new transportation sector may well diminish, as they have in other sectors radically changed by automation and now emerging machine autonomy . It is true that some jobs will be created, e.g., in maintaining such fleets of autonomous vehicles, and access to employment for those in economically depressed regions could be improved with AV transport services. Studies show that, in general, societal changes resulting from the introduction of these innovations are likely to be extensive. Of course, it is likely that many human-driven vehicles will remain on the roadways for some decades to come. For those who still choose to own their own vehicle, that vehicle need not be parked and taking up space for 22 hours a day. It could be out earning money by giving rides to others. City transit agencies need to consider the arrival of the driverless car now, when plans for future transit projects are in the pipeline. Does a costly subway extension still make sense in light of these emerging transport options? Driverless cars can provide mobility to those who cannot physically drive, such as children, the disabled, or the frail elderly. However, for such populations the problems of ingress into and egress from the vehicle remain, emphasizing that mobility is more than just the car journey alone. Fuller, augmented mobility is a social amenity that can prevent the loneliness, depression, and failing quality of life that attend isolation and immobility. Perhaps such AVs will lure passengers off buses, deleteriously impacting the economics of bus operations in urban areas. These represent only a limited set of the foreseeable changes; more widespread and radical change is promised.

IV. Equipments Used In Autonomous Cars :

4.1.1 CAMERA:

Cameras are very good at detecting and recognizing objects, so the image data they produce can be fed to AI-based algorithms for object classification. Some companies, such as Mobileye, rely on cameras for almost all of their sensing. However, they are not without their drawbacks. Just like your own eyes, visible light cameras have limited capabilities in conditions of low visibility. Additionally, using multiple cameras generates a lot of video data to process, which requires substantial computing hardware.Beyond visible light cameras, there are also infrared cameras, which offer superior performance in darkness and additional sensing capabilities.

4.1.2 LIDAR:

LiDAR (**Light Detection and Ranging**) is one of the most hyped sensor technologies in autonomous vehicles and has been used since the early days of self-driving car development. A hugely versatile technology, it is increasingly being used in a wide range of applications. LiDAR systems emit laser beams at eye-safe levels. The beams hit objects in the environment and bounce back to a photodetector. The beams returned are brought together as a point cloud, creating a three-dimensional image of the environment. This information is highly valuable one as it allows the vehicle to sense everything in its environment, be it vehicles, buildings, pedestrians or animals. Hence why so many development vehicles feature a large 360-degree rotating LiDAR sensor on the roof, providing a complete view of their surroundings. While LiDAR is a powerful sensor, it’s also the most expensive sensor in use. Some of the high-end sensors run into thousands of dollars per unit. However, there are many researchers and startups working on new LiDAR technologies, including solid-state sensors, which are considerably less expensive, such as Ouster and Luminar.

4.1.3 ULTRASONIC SENSOR :

Ultrasonic sensors have been commonplace in cars since the 1990s for use as reverse parking sensors, and are very inexpensive. Their range can be limited to just a few metres in most applications, but they are ideal for providing additional sensing capabilities to support low-speed use cases. The sensors discussed above aren't the only source of information for a self-driving car to know where it is and where to go. Other source inputs include Inertial Measurement Units (IMUs), GPS, Vehicle-to-Everything (V2X) communication, and high definition maps.

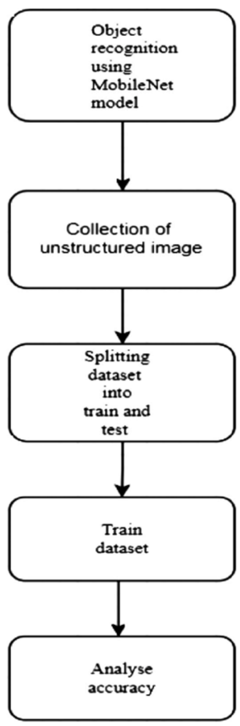
4.1.4 RADAR :

Many ordinary cars already have radar sensors as part of their driver assistance systems – adaptive cruise control, for example. Automotive radar is typically found in two varieties: 77GHz and 24Ghz. 79GHz radar will be offered soon on passenger cars. 24GHz radar is used for short-range applications, while 77GHz sensors are used for long-range sensing. Radar works best at detecting objects made of metal. It has a limited ability to classify objects, but it can accurately tell you the distance to a detected object. However, unexpected metal objects at the side of the road, such as a dented guard rail, can provide unexpected returns for development engineers to deal with.

V. Use Of CNN in Self Driving Vehicles

Convolutional neural network (ConvNets or CNNs) is one of the main categories to do images recognition, images classifications. Objects detections, recognition faces etc., are some of the areas where CNNs are widely used. CNN image classifications takes an input image, process it and classify it under certain categories (Eg., Dog, Cat, Tiger, Lion). Computers sees an input image as array of pixels and it depends on the image resolution. Based on the image resolution, it will see h x w x d(h = Height, w = Width, d = Dimension). YOLO (**You Only Look Once**) is a clever convolutional neural network (CNN) for doing object detection in real-time. The algorithm applies a single neural network to the full image, and then divides the image into regions and predicts bounding boxes and probabilities for each region. These bounding boxes are weighted by the predicted probabilities.With YOLO, a single CNN simultaneously predicts multiple bounding boxes and class probabilities for those boxes. YOLO trains on full images and directly optimizes detection performance.

Proposed Workflow :



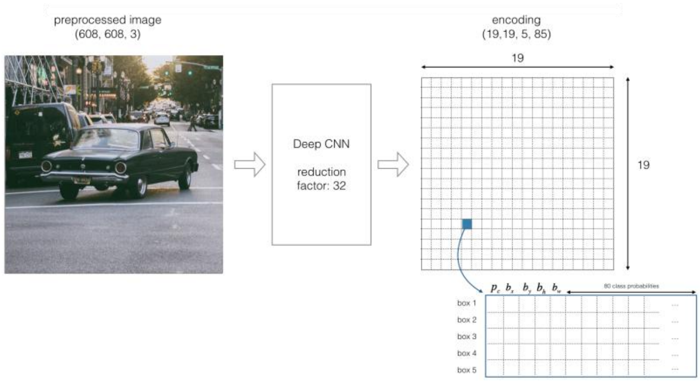
5.1.1 Convolutional layers : They are like filters that scan an image; these smaller matrices are called convolutional kernels. The kernels move around the image. Each matric is responsible for scanning part of the larger matrix.

5.1.2. Preparing dataset:

The camera setup mounted on the test car captures the images of objects on the test bench. Ideally 250–300 test images are to be captured of each object on the test-bench. The collected images were to be split into two sub datasets i.e., train and test. Of the total images captured 10% were used as testing and remaining images were used for training the database

5.1.3. Creating bounding box:

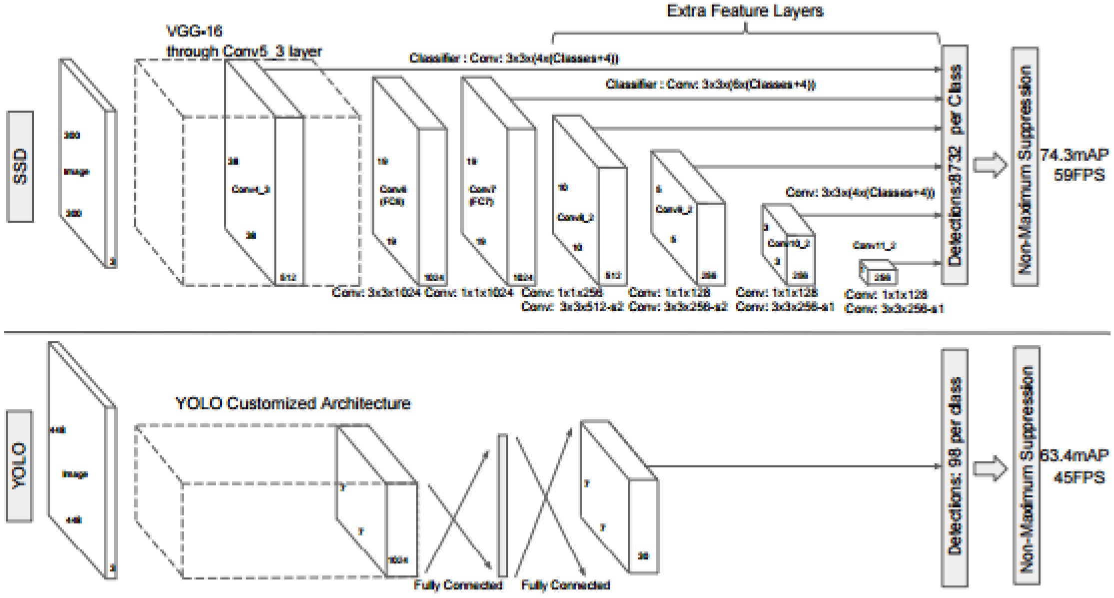
For creating the bounding box around the test images, the image's height, width and each class with parameters like xmin,xmax,ymin,ymax are required. The bounding box captures exactly the class of the object in the image.This follows the task of creating labels for the test images. Labels are created by using 'labelImg'tool. The labels are stored into individual xml label for each image which further need to be converted into csv file for training

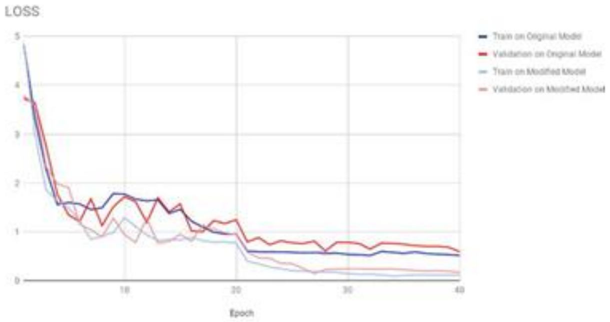


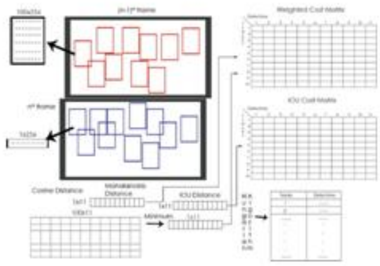
5.1.4 Converting csv file into Tensorflow Record : For each training and testing dataset, a csv file is obtained which is further converted into TFRecord. TheTFRecord is a format for storing the sequential structured data into binary strings(Fig. 4).

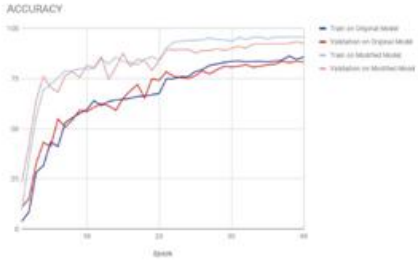
5.1.5. Selecting a model: SSD model along with MobileNet neural network is selected as it provides moderate efficiency and the rate of result production is faster. TheMobileNet is a light weight neural network as it consumes low processing power

YOLO ARCHITECTURE :









(LOSS DURING TESTING AND TRAINING) **(INTERNAL ARCHITECTURE)**

(YOLO ACCURACY)

VI. Conclusion

Self driving cars , though with varying complexity , could be easily implemented with yolo image detection .Moreover , The real time latency in image detection can be very well controlled by a powerful processor .

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