School of Transportation Sciences

Master of Transportation Sciences

Master's thesis

Deep Learning- Based Intelligent Driver Model for a Mixed Traffic Scenario

Haseena Bibi Zulfiqar

Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization Traffic Safety

SUPERVISOR :

Prof. dr. ir. Ansar-Ul-Haque YASAR

CO-SUPERVISOR :

Associate Prof. Nafaa JABEUR

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DEEP LEARNING-BASED INTELLIGENT DRIVING MODEL FOR A MIXED TRAFFIC SCENARIO

by
Haseena Bibi Zulfiqar - 2056694

A thesis submitted in partial fulfilment
of the requirements for the degree of

MASTER OF TRANSPORTATION SCIENCES

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Prof.Dr. Ansar Yasar
and
Prof.Dr. Nafaa Jabeur

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ABSTRACT

The search included specific terms, "autonomous driving", "self-driving car" and "driverless car" in either the title, keyword, or summary, and only educational journals listed in the database. Therefore, the purpose of this research was not to find all the literature related to autonomous driving because of its size other fields (robotics, underwater vehicles, military, aeronautics, space vehicles, etc.), but the current in the body of scientific literature Get an overview and overall rating to identify flaws. Therefore, studies on roads, traffic, corridors, and travel, transportation, or production, as well as all related publications related to the automotive industry, as well as papers on other recognized topics, should be considered only for literary publications. Keep in mind this application may be suitable for self-driving cars.

Autonomous cars are not so far away, for example, Audi and Mercedes (Bartlett, 2013) have announced that they are almost ready for production in highly automated features. As a reflection, in the daily news, we can constantly see how this technology comes closer and closer to our daily lives, with the example of the blind man driving cars for taxes in 2012 (Google, 2012), a coast-to-coast tour (CNN, 2015), a trip from Italy to China (Brugge, et al., 2013), and Google (Armson, 2014) have already traveled 700,000 miles. But major carmakers involved in the race, such as Audi, BMW, Cadillac, Ford, General Motors, Jaguar, Land Rover, Lincoln, Mercedes-Benz, Nissan, Tesla, and Volvo, are slowly integrating it into their models despite considerable preparation. Trying of technology. This can be interpreted as a futile attempt to control completely disruptive technology and slow down the aggregate of users, but this old model will not be so good because of the scope and impact of this technology. (Bartle, 2015). According to the IEEE (201), a survey of more than 200 experts by the IEEE, the world's largest professional association, three major barriers to the widespread adoption of driverless cars are legal. Responsibility, policymaker, and consumer. Acceptance, while the following three; Cost, infrastructure, and technology are seen as less of an issue. In the next section, we can see through a literature review how the development of research has focused primarily on the development of technology and has begun to focus only on legal responsibility and policymakers while consumers research on acceptance has been more limited.

1 INTRODUCTION

As transportation becomes more automated and digitally faster, so do the real equipment makers and the big IT Companies are competing at the highest levels to take the lead in autonomous vehicles (AVs). Technical capabilities of AV can lead to better behavioral performance (e.g., shorter reaction time and less desired time progression),

Which is better than traditional human-driven vehicles (HDV). Accordingly, the basic technical settings of the AV can be improve traffic efficiency. However, HDVs that follow AV may not be able to react appropriately to such basic behaviors. From a security standpoint, conservative technology AV settings should also be considered.

This article aims to assess the effects of AV-HDV mixed traffic on single-lane flow dynamics. Using the incoming car model on the motorway and offer a realistic range of AV to AV-HL settings. Safety, comfort, and performance theory for AV and HDV mixed traffic scenarios.

Since adaptive cruise control (ACC) was first introduced in the 1990s, researchers have conducted research. Effect of an automated system that detects spacing with leading vehicle and controls acceleration / slow on the longitudinal motion on motorways.

The AV configuration should be chosen carefully, considering the stability of the vehicle's behavior. Yang At (2015) Investigated car follow-up instability using commercial ACC vehicle estimation parameters with Compounds of HDV, although they have not comprehensively analyzed the acceptable range of parameter combinations. Therefore, the conservative configuration of AV as a stability analysis of ACC vehicles is not appropriate.

Evaluate the correlation between ACC performance and driver expectations using the value of (2004) Clash with time. Casting (2006) investigated the tendency to avoid ACC jams and found that over time Advances for ACC, performance have improved. (Clonder, 2009) concluded that when all vehicles. The lane is equipped with an ACC system, performance and safety are improved.

Analysis of AV's Different Percentage Traffic Flow with Monte Carlo Simulation and Concluding that AV is Capacity enhancement, maximum service flow rate, and service level can also be improved with AV in possession High percentage in traffic. The results of all the papers conclude that performance has improved safety Increasing the percentage of ACC or AV. Tilabpur and Mahasin (2016) considered mixed traffic conditions.

Vehicles without communication capabilities, vehicles ready for communication, and autonomous vehicles using different acceleration models. He concluded that an attached and automatic vehicle could improve stability and they can get high throughput. However, the basic AV settings assumed in these papers can cause this gap.

Between HDV behavior and AV behavior. This type of difference can reduce efficiency and safety. Previous investigations into the effect of AVs on traffic flow have largely predicted a more optimistic approach, claiming that AVs will Improve road performance, safety, and comfort. However, many challenges and worries exist even one-dimensional flow was ignored. For example, AV's behavior setting could be very radical in the future.

Conservatives are also at the implementation stage, which could initially harm traffic flow. This paper with a realistic approach, rather than validating the effect of AV on traffic flow, through microscope analysis for minimal collision, maximum jerk, and shock wave speed variation Percentage of AV with different combination of response time and required minimum forward time settings.

Figure 1 Traffic Death Ratio (sciencedirect, 2018)

Figure 2 Traffic Injuries (sciencedirect, 2018)

1.1 PROBLEM STATEMENT

The autonomous vehicle (AV) is the ultimate solution to the automotive engineering of the future. However, safety remains a key challenge for AV development and commercialization. Therefore, a comprehensive understanding of the development status of AV and advanced accidents is becoming urgent. In addition, the statistics of road AV accident reports are generally analyzed. The results show that from 2014 to 2018, various manufacturers have tested more than 3.7 million miles for AV. The AV is often captured by drivers if deemed necessary, and the frequency of deviation varies from 2 × 10−4 to 3 discounts per mile for different manufacturers. In addition, 128 accidents in 2014–2018 are studied, and approximately 63% of total accidents occur independently. A small proportion (~6%) of total accidents are directly connected to AV, while % of accidents pass. A percentage is initiated passively by other parties, including pedestrians, cyclists, motorcyclists, and conventional vehicles. Road testing identified safety hazards, represented by hazards and actual accidents, indicating that most inactive accidents are caused by other road users. AV's ability to be aware of the safety hazards posed by other parties and to make safe decisions to prevent and prevent potentially fatal accidents will significantly improve AV safety. Practical applications. This literature review summarizes safety issues for the AV through theoretical analysis of the AV system and the investigation of accident report statistics for road testing, and future research for AV progress from these findings. It will help to inform the efforts.

The network design problem (NDP) is a refinement issue in transport planning literature, aimed at finding the maximum value for specific purposes (e.g., travel time) within limited resources. The goal of the NDP is to determine the maximum number of alternative projects, considering the route selection practices of the road users. The NDP can be thought of as a two-stage leader-follower Stalkerberg game that is commonly formulated as a bile problem. At the top level, the network manager (leader) aims to improve network performance under resource constraints, and at the lower level, network users (followers) choose a route with minimal travel costs.

There is a long history in the transportation of research on the issue of network design for different modes of transport with different purpose functions, decision variables, and a wide range of solutions. However, some network design difficulties have been considered in the context of AV.

1.2 BACKGROUND

The dream of autonomous vehicle (AV) goes far back in the mid ages, centuries earlier to the innovation of the car. The draft of a self-propelled car is a basic illustration that has been sketched by Leonardo De Vinci. In the present industrial revolutionized world that has made several best innovative mechanisms or technologies and provided the best navigational system it becomes uncertain to link the unsophisticated ideas during the period of Leonardo De Vinci.

It was in the year 1925 that the first step towards shaping a driverless car took place with Houdina Radio Control Company coming into the lime light of public, it was not an easy task to pitch in this idea during 20th century and there was intensive effort put by the company. A radio-controlled car in 1926. It was an easy to for the business owner to move his car after receiving signals from the car at this tailback on the Broadway and Fifth Avenue route.

From then the radio-controlled car started developing and furthermore research was made on autonomous vehicle (AV).

Transportation sector started get the taste of artificial intelligence from 1980's by the effort of a German aerospace engineer named Ernst Dickmanns (Kevin Mcfall,2105). His experimentation was first implemented on Mercedes-Benz that was capable of driving autonomously at higher speeds. This innovative experiment was carried out by installing camera and sensors in a Mercedes-Benz car and all the data that was received through a computer programming that had been implemented for controlling the essential components of a car i.e. steering wheel, brake and throttle.

The recent work was done by Apple electric car (iCar) project with autonomous driving called as "Project Titan" in 2015(Tuan C. N, 2019). Additional to advance autonomous vehicle designers need driving models today that work in mix traffic situations. Driving models are needed by scientists, to develop behavioral goals for the vehicle.

1.3 OBJECTIVES

Adaptation develops various automated driving functions for daily traffic by activating the level of automation as a situation and as a driver. In addition, the project addresses legal issues that could affect the successful introduction of the market.

Equity is another important consideration. Self-driving technology can help mobilize people who are unable to drive themselves, such as the elderly or the disabled. But the widespread adoption of autonomous vehicles could displace millions of people employed as drivers, negatively affect public transport financing, and perpetuate injustices in the existing transport system.

Environmental impact is a serious concern and major uncertainty. Accessible, affordable, and easy-to-drive cars can increase the total number of miles traveled each year. If those vehicles run on gasoline, then transportation-related air emissions may increase. If vehicles become electric and connected to a clean power grid, transportation costs may be significantly reduced.

To the extent that electric self-propelled cars enable more shared rides (for example, through services such as left or upper), emissions may be further reduced.

The Union of Relevant Scientists has been working on transportation policy issues for decades and has supported equitable, low-pollution vehicles, fuel, and infrastructure. In February 2017 we released a policy brief outlining the challenges and benefits of self-driving technology, including seven principles for using policymakers, companies, and other stakeholders as guides.

The objective of the thesis is to achieve the following goals:

- How can we address mixed traffic system problems in real time traffic scenarios (such as traffic with weak lane discipline, and vehicle movement at various levels of traffic density, etc.)?
- How can we enhance AV with Deep Learning capabilities toward mixed traffic conditions?
- How can we assess the performance of the proposed AV?

2 LITERATURE REVIEW

2.1 DRIVER MODEL

Mathematical model which replicates the functionality of the driver during various maneuvers is called driver model.

In case of certain driving tasks, the driver model structure can be determined, like car following. Rest all driving models are models are uncertain and nonlinear. In these models there are 3 types of identification methods in terms of Pattern identification. They are Parameter identification, non-parameter identification and semi- parameter identification.

Car following another car in a highway is a very common during driving the driver want to reach early by adjusting the time of journey. Time varies with velocity of the vehicle. To enhance safety regulations a car following model has to develop and implement. And for further improvements Collision avoidance model is also to be considered. From the perspective of system identification, the challenge will be to identify parameters of the models.

After one model structure has been prescribed, that is, identification of fixed and finite the technique can be used to identify the structure of other models which are used for simulation data analysis.

Admissibility or permissibility: this is referring to driver behavior aspects. Example if the required steering angle of change is small then the driver keeps the steering command constant.

The characteristic is shown in the following figures.

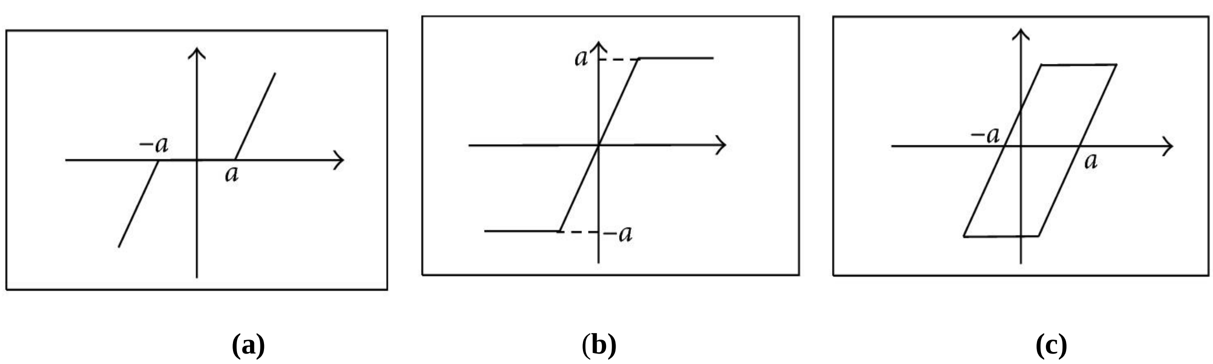
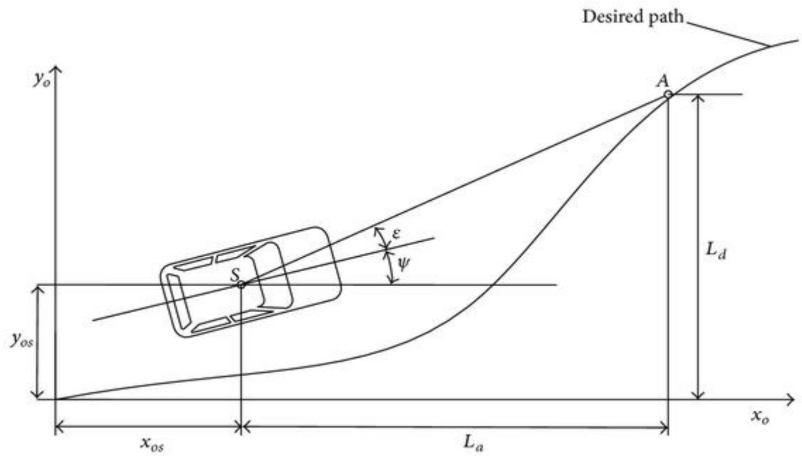


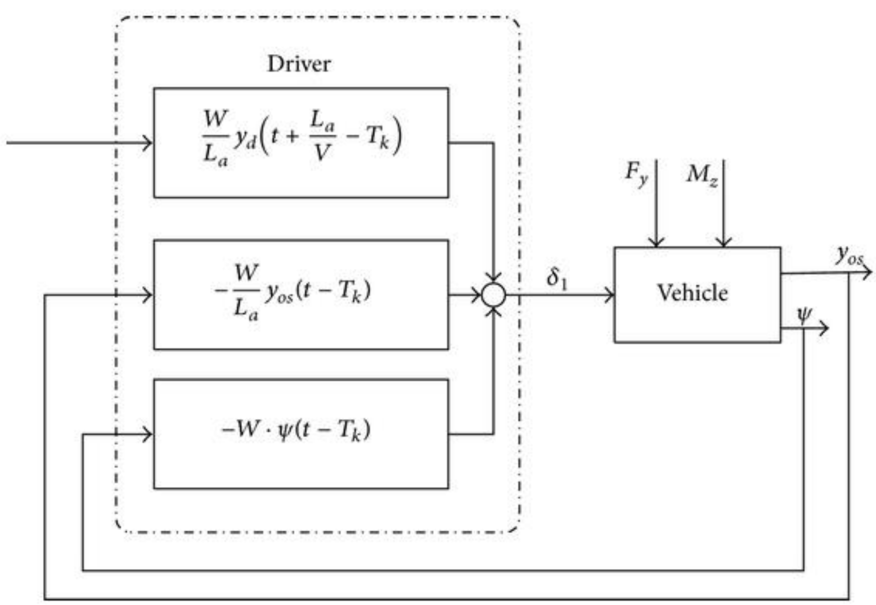
Figure 3 Structuration elements of driver characteristics (a) permissibility, (b) limitations (c) transport time delay (wang. w, 2014)

Physical Limitations: Driver perception, vision and vestibular are important information collected. Driver insensitive to some information or changes. If the vehicle acceleration is lower than 0.005g the driver may not be able to find out the change in speed.

Transport time delay: In some of the cases the driver response time will vary. Response of a young and an old person will different. The driver model is presented using state space diagram using some equations.



(a)



(b)

Figure 4 represents driver vehicle steering control (a) control law of driver's control law (b) driver model of vehicle (wang. w, 2014)

Black box concept is used to define unstructured model and more importantly Uncertain parts of the driver model which cannot be replaced by elements mentioned but by selecting using Non-parametric identification methods. The non-parametric techniques are frequency response analysis (FRS), estimating the disturbance spectrum and spectral analysis. To recognize driving skill and driver behavior in case of non-parameter identification Fourier coefficient method (FCM) is used.

Multiloop car following model structure is shown in figure. Frequency domain identification (FDI)is used to identify the driver transfer function.

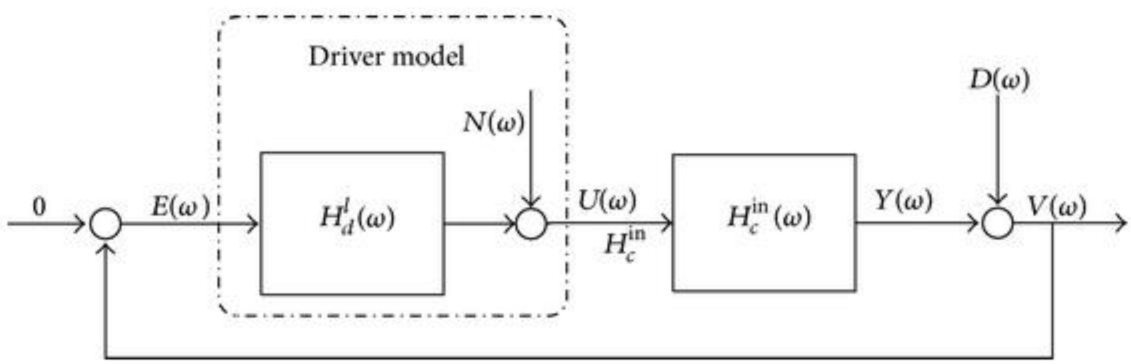


Figure 5 single force modified FDI driver model (wang. w, 2014)

Semiparameter identification

Parameter and non-parameter identification methods have their own operation range and have their own merits. The first one has less stringent output and input requirements. This requires a selection of a set of candidate driver models, and which requires a known forcing function. The input and output relation is considered in case of both non-parameter model and the black box model. This will not consider the inner state variables to overcome all these.

A new concept called semi parameter identification is proposed. The figure 6 shows the flow diagram of driver's model identification.

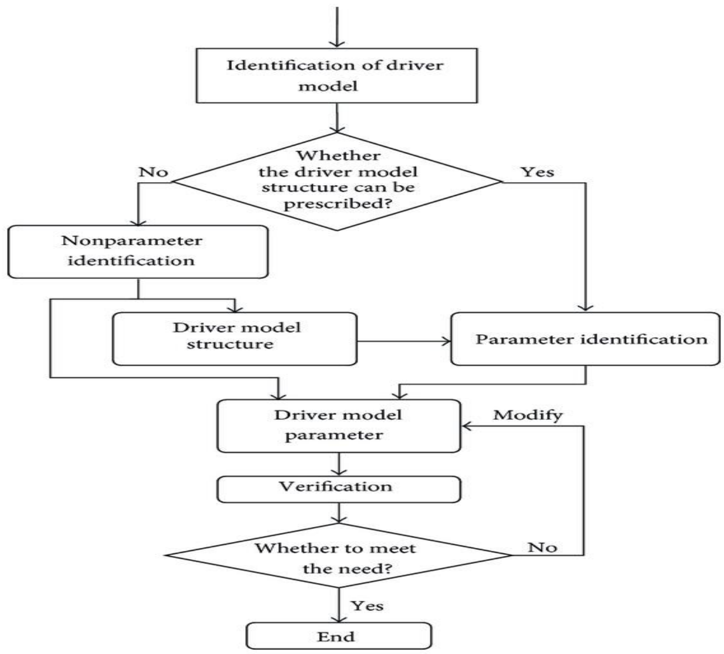


Figure 6 Flow diagram of the drivel model (wang. w, 2014)

Conclusion

From the simulation this can be concluded that output error model is most superior than the ARX model by knowing the identification and validation of the two models. But it is difficult to find the difference in induced driver behavior using this model. The author found two reasons resulting out of this, he found that the second one is very simple to describe the characteristic of the driver behaviour correctly. The uncertainty or unstructured factors can affect the fidelity and accuracy of the driver model. The mathematical methods such as stochastic, nonlinear and fuzzy theories are considered to develop driver model, because these are more advanced and accurate.

Bio-IR-M: A Multi-Paradigm Modelling for Bio-Inspired Multi-Agent Systems

Bio inspired model are widely used nowadays. Bio inspired approaches are getting more internet in computer science. For multidisciplinary research the structural features are favorable fields so, it is agreed that both bio inspired, and natural systems are complex. Decentralization and distribution are inherent features in each system. Bio inspired systems has large emergence and inspired from living organisms and solution for complex problems and becoming new dimensions to design new systems.

Some of them have become paradigms such as Ant colony optimization (ACO) and genetic Algorithms (GA). Some other examples to control and decision system like Artificial Neural Network (ANN).

Artificial immune systems (AIS) for object class detection specially face detection. This also presents the use of AC in intelligence with agent for scheduling and illustrates routing with GA. Other algorithms are particle swarm optimization (PSO), A mobile agent Ant algorithm and it is used in Ant based cyber defense system. Bat algorithm is used in multi objective optimization.

The following are the diagrams for metamodel of general case of multiparadigm bio inspired multiagent system with biomorphic agent and biomorphic group.

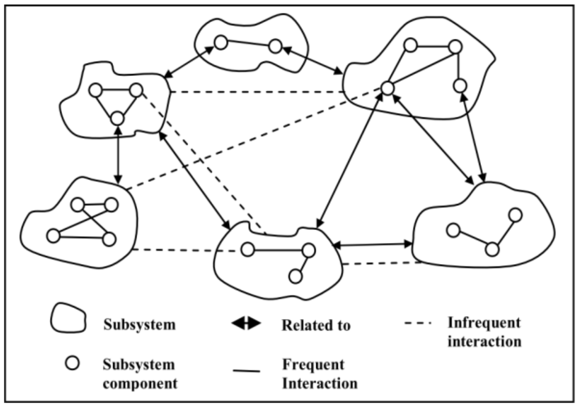


Figure 7 Canonical view of a complex natural system (zeghida, D. 2018)

Paradigms	Metaphor	Inspiration'sNature
ArtificialNeural Network (ANN)	Brain structure& functioning	Structural &Functional.
Genetic Algorithm (GA)	Genetic mechanisms	Functional.
Fuzzy System(FS)	Human reasoning	Functional.
ArtificialImmune System(AIS)	Operating & organisational mechanisms ofimmune cells	Structural &Functional.
Ant Colony Optimization (ACO)	Ant colonybehaviour	Behavioural.
Particle Swarm Optimization (PSO)	Swarm of bird in flightbehaviour	Behavioural.

Table 2-1 Description of some bio-inspired paradigms.

For any given problem, knowing the specific criteria we can choose the bio inspired paradigm to apply possible combinations and can reach the state of real guidance of the user.

2.2 BEHAVIORAL MODELING OF DRIVERS IN MIXED TRAFFIC CONDITIONS

In a developing world the traffic conditions are differentiated in terms of types of vehicles used and lack of traffic discipline. The driving behaviors around the world is dependent on the longitudinal and lateral movements performed over different vehicles. The lane discipline is important because, drivers tend to maneuver the vehicle through a lateral movement while going longitudinally in case of a weak lane. Drivers inculcate negative attitudes like tailgating, multiple leaders following, swerving due to such integrated behavioral changes. Literature falls weak to elaborate regarding these types of behavioral patterns that co-exist with traffic patterns, and the studies that focus upon such things are also not readily available. The model that was looked at for checking on the mixed traffic conditions were the same that was employed for designing and developing homo-geneous traffic models. Every study requires the researcher to analyses the aspherical data by understanding the concepts of a particular system that has been focused to provide right results. The traffic simulation is based upon the driver behavioral models; without which it is difficult to understand this traffic algorithm.

2.2.1 TRAFFIC FLOW MODELS

These are classified into macro, micro and meso-scopic, it depends on the traffic flow levels. When we look into the description of a traffic stream based on macroscopic model, it gives the data by analyzing the vehicles in groups. When we investigate the description of a traffic stream based on microscopic model, it predicts the behavioral pattern by analyzing the longitudinal and lateral movement of each vehicle with regards to speed and acceleration in relation to the vehicles moving around that particular vehicle. When we investigate the description of a traffic stream based on mesoscopic models, it predicts by implementing certain mathematical ideology to predict the set of interactions between cluster of vehicles.

These models can be derived when build a relation between the vehicular flow and the flow of continuous media like fluids or gases. The best thing that complements these models are certain averaged properties of traffic that flow in macroscopic environment, that has a link to speed and density. Such models require small number of equations to make the flow easier to handle.

2.2.2 DRIVER BEHAVIOUR IN MIXED TRAFFIC

The main characteristic feature of mixed traffic is the usage of different type of vehicles and failure to follow a good lane discipline. It is commonly observed behavior pattern among those drivers to drive rash, tailgate etc. since they fail to maneuver their vehicle appropriately in mixed traffic conditions. The safety of the driver and vehicle are at risk in such a condition because the tendency of the driver in a mixed traffic condition is to maintain a short distance in-between the vehicle in the front compared to the lane-based conditions, that have large space between the vehicles. Such a situation arises because the practice of tailgating a leader vehicle is often practiced in missed traffic scenario. There is one more driving problem that arises in such a mixed traffic scenario, when vehicles are tailgating there is a possibility of collision with the leader vehicle and to avoid such a collision the driver of the vehicle swerve it off from the current position, this may or may not save the possibility of collision but also increase the risk of an accident among other vehicles surrounding. Longitudinal and lateral movements occur when the behavioral patter of swerving set to rise among the drivers. So, drivers adapt to a tendency to weave in and out of a mixed traffic situation this channelizes them to form virtual lanes for the movement of their vehicles when they are surrounded by slow moving vehicles. This above said can be modelled by collecting the real time data from the traffic situations.

2.2.3 FACTOR INFLUENCING DRIVER BEHAVIOR

One is to identify the factors that describe the typical driving behaviors and the second is to overcome the difficulties during incorporation in the corresponding behavioral models are the major challenges in driver behavioral models.

Figure 8 Typical driving patterns observed in mixed traffic conditions (sciencedirect, 2018)

Collision Avoidance Models

Here to ensure safe stopping to avoid rear end collisions and to adapt their speeds drivers maintain a safe distance. This is the underlying assumption of this model. This model is developed based on fundamental equations of motion. There will be rear end collision when the preceding vehicle brakes suddenly. Gipps developed a model to overcome these limitations that is by introducing an extra safety reaction time and safety head way margin. The simulation packages for this model are MULTISIM, SIGSIM, SUMO and AIMSUN

Psychophysical Models

Here in this model the control of acceleration is by perceiving relative speed according to the change in visual angle of the preceding vehicle and by setting the thresh old the safety distance is maintained. This is the model used to represent the phenomenon of oscillation, which is shown in many studies. This is model is introduced by Michaels and then later developed by Leutzbach. Some traffic simulation packages like VISSIM and PARAMICS was employed in this model.

Lane Changing

Lateral movement behavior of the drivers is described by lane changing models. Lane selection process and the execution process are the two steps of this behavior. Lane selection process is modeled by lane selection model and execution process is modeled by gap acceptance models.

Lane Selection Models

Stimulus based deterministic rule models, fuzzy logic models and random utility models are the three broad categories of lane selection models according to the technique employed.

Gap Acceptance Models

The gap is defined as the space that exists between the rear end of the leader vehicle and the front end of the following vehicle in the target lane. The lead and the lag gap are the total available gap. The gap acceptance model is the probability of either accepting or rejecting a gap of size under a specific set of prevailing traffic conditions. Critical gap is the minimum gap that a driver is ready to accept.

Integrated Driving Behaviour Models

The two fundamental driving behavioural models are the car following and lane changing which is required for traffic microsimulation. To develop these considerable efforts have been put in this model. The following figure shows the flow chart of the microscopic model.

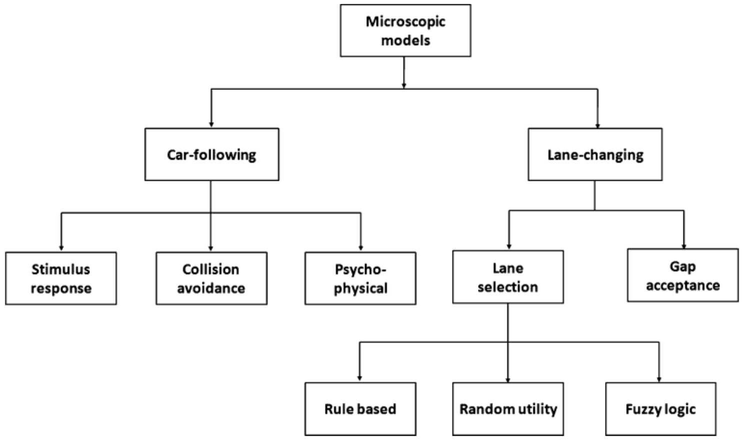


Figure 9 Challenges in mixed traffic driver behavioral modelling (sciencedirect, 2018)

2.3 AUTONOMOUS VEHICLES (AV)

To understand the development of research in autonomous driving in recent years. It is important to review the literature to understand the different areas of application through which autonomous driving has been developed and at the same time, the gap of investigation can be identified.

As more autonomous techniques are used, a variety of errors can occur. If such errors are not handled properly, they can lead to security issues. Systematic analysis of different types of faults or accidents for AV technology will clarify the current state of AV safety. It would be noted that AVK l. Accidents in literature are much less common than conventional vehicles. However, this does not necessarily mean that existing AVs are safer than human-controlled vehicles. Since AV technology is still in the early stages of commercialization and far from fully autonomous driving, more and more road tests should be done, and the accident database should show a different trend.

AV safety is determined by the reliability of the AV architecture and associated hardware and software. However, AV architecture relies so heavily on the level of automation that AV safety can show different patterns at different stages. Even at the same level of automation, the architecture of the AV may vary in different studies. Figure 1 shows the general architecture and fine arts. It consists of a perceptual system based on a common AV sensor, an algorithmic decision-making system, and an actuator-based acceleration system, as well as interconnected systems. Ideally, all AV components should work well to ensure AV safety.

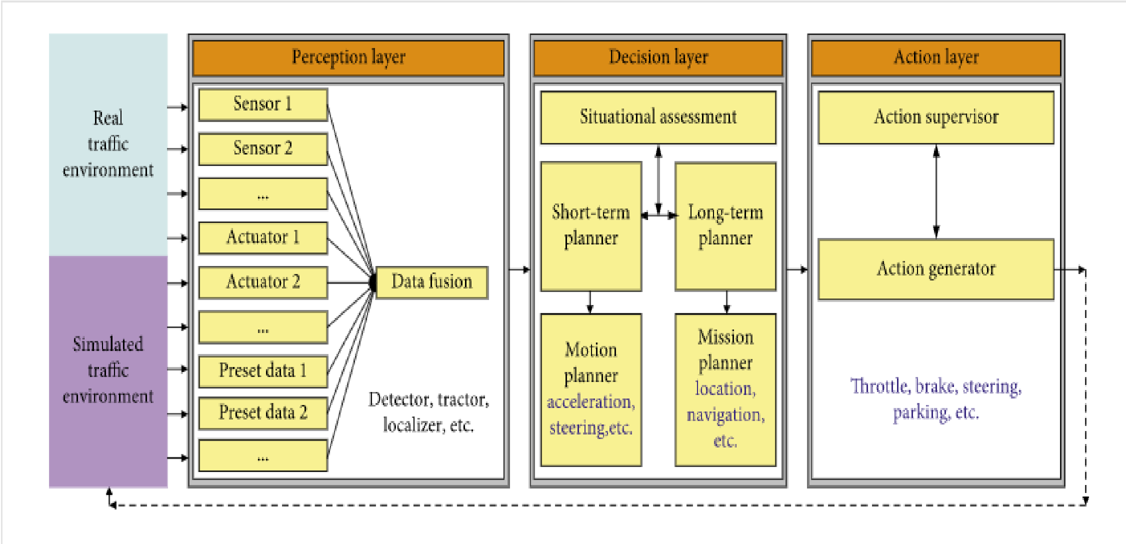


Figure 10 Autonomous Vehicle System Architecture (sciencedirect, 2018)

Occasionally, the perception module is unable to cover enough of the self-driving range, such as B and C with insufficient sensor arrangement due to cost. Thus, an algorithm is proposed in this section to solve this problem by estimating the probability of positions. First, the results of some sensors will be selected to perform as a fusion of the vehicle rotation and transmission (RT) matrix ERT estimates. Note that the type of sensor can be completely arbitrary, and Fusion data includes cloud points, feature points, and search results such as lane markers, road curbs, etc. After obtaining a typical fusion map frame, along with date frames, vehicle ERT can be estimated from algorithms such as Bundle Adjustment (BA). Since then, the matrix has been moved to an ecological context to update the map of fusion data. By combining existing and updated data, local driving maps can be obtained for decision and planning modules. This process is demonstrated in Fig. 5. To illustrate the algorithm, a concept called "probability ellipse (PE)" must first be introduced, in which each point is estimated by the probability value which decreases from the center to edge to zero. Furthermore, different ellipses can overlap with each other, for which the average probability value of the overlapping section is estimated by C (x, y) = ∑i∈LC (xi, yi) / n, where L represents the set of overlapping ellipses and N is the number of elements in L set.

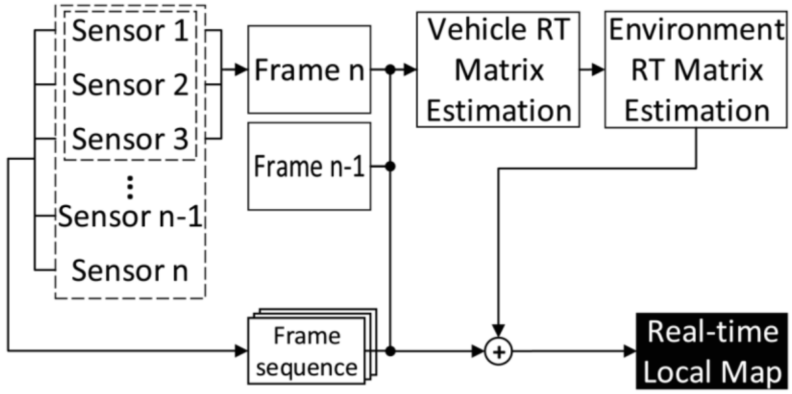


Figure 11 Environment Mapping Diagram (sciencedirect, 2018)

The automotive industry has strict safety barriers imposed by the mandatory ISO 26262 ban. The purpose of active safety is to avoid any injury or malfunction of inputs, hardware, and components in response to climate change. Copies of key error detection and safety components are 26262 mechanisms recommended by ISO. In this proposal, we represent specific functional components for error identification, however, leave out any redundancy or duplicate components.

We also aim to bridge the ISO 26262 standard for autonomous vehicles: safety reasoning. Now, it is not clear how autonomous vehicles will behave in the event of an accident and what the minimum risk is. However, future safety standards are expected to include specific specifications for safety behavior.

Google, Uber, Tesla, Nissan, and other major car companies, researchers, and technology companies have developed several self-driving technologies.

The software then executes the input, plots the route, and sends instructions to the vehicle's "accelerators" that control the acceleration, braking, and steering. Strict code rules, obstacle avoidance algorithms, predictive modeling, and "smart" object distinction (i.e., knowing the difference between a bicycle and a motorcycle) software to enforce traffic rules and navigate obstacles.

Partially autonomous vehicles may require a human driver to intervene if the system faces uncertainty. Fully autonomous vehicles cannot even offer a steering wheel.

Figure 12 Hypothetical view of Autonomous Car (Bohm, 2015)

Self-driving cars can be further identified as being "connected", indicating whether they can interact with other vehicles and/or infrastructure, such as next-generation traffic lights. Most prototypes do not currently have this capability.

Autonomous cars are the future smart cars anticipated to be driverless, efficient, and crash-avoiding ideal urban cars of the future. To reach this goal automakers have started working in this area to realize the potential and solve the challenges currently in this area to reach the expected outcome. In this regard, the first challenge would be to customize and imbibe existing technology in conventional vehicles to translate them into a near-expected autonomous car. This transition of conventional vehicles into autonomous vehicles by adopting and implementing different upcoming technologies is discussed in this paper. This includes the objectives of autonomous vehicles and their implementation difficulties. The paper also touches upon the existing standards for the same and compares the introduction of autonomous vehicles in the Indian market in comparison to other markets. There after the acceptance approach in Indian market scenarios is discussed for autonomous vehicles.

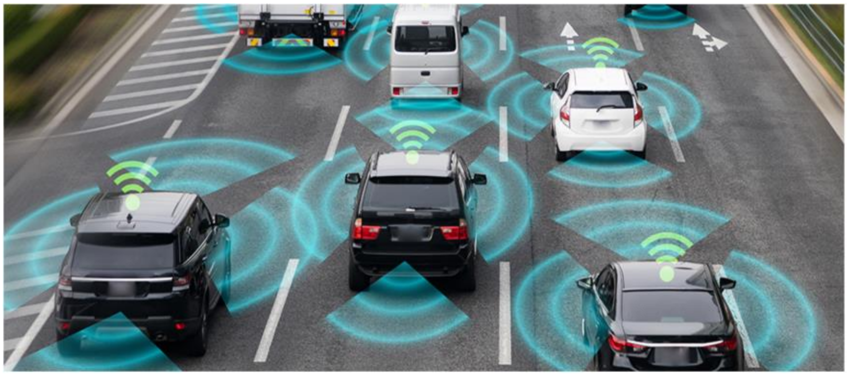


Figure 13 Autonomous Cars in Action (Bohm, 2015)

Machine learning is being deployed for advanced driver assistance, such as perception and understanding of the world around the vehicle, mainly using a camera-based system to detect and classify objects. Included, but progress has also been made in ladder and radar.

2.3.1 DEEP LEARNING IN AUTONOMOUS VEHICLES

The latest advances in the art and science of autonomous driving. Deep learning networks have become indispensable in the design and operation of such systems. We will offer the latest software and hardware tools for the over-computational demand and development of DLNs used in self-driving cars. From the DGX-1 supercomputer for the training of DLNs to the Drive PX2, the AI scale AI car computer platform for estimating, and the recently announced Xavier, an AI supercomputer, tools on the chip of the future autonomous vehicles DLNs are now available for every part of life. We explain how these tools are already being used for autonomous driving, showing some recent results from Nvidia's own, ultimate DLN.

Autonomous driving requires reliable and accurate detection and identification of surrounding objects in a conducive environment. Although algorithms for detecting various objects have been proposed, not all are strong enough to detect and identify movable or small objects. In this article, we propose a novel hybrid local multiple systems (LM-CNN-SVM) based on convection neural networks (CNNs) and support vector machines (SVMs), respectively, featuring their ability to extract powerful features. And because of the strong rating feature. In the proposed system, we first divide the whole image into local areas and employ multiple CNNs to find out the properties of the local object.

Second, we select the distinguishing features using the principal component analysis. We then import into multiple SVMs that apply both experimental and structural risk minimization instead of using CNN directly to enhance the generalization capability of the rating system. Finally, we fuse the SVM results. In addition, we use pre-trained AlexNet and a new CNN architecture. We perform object recognition and pedestrian detection experiments on Caltech-101 and Caltech pedestrian datasets. Comparison with the most up-to-date methods shows that the proposed system achieved better results.

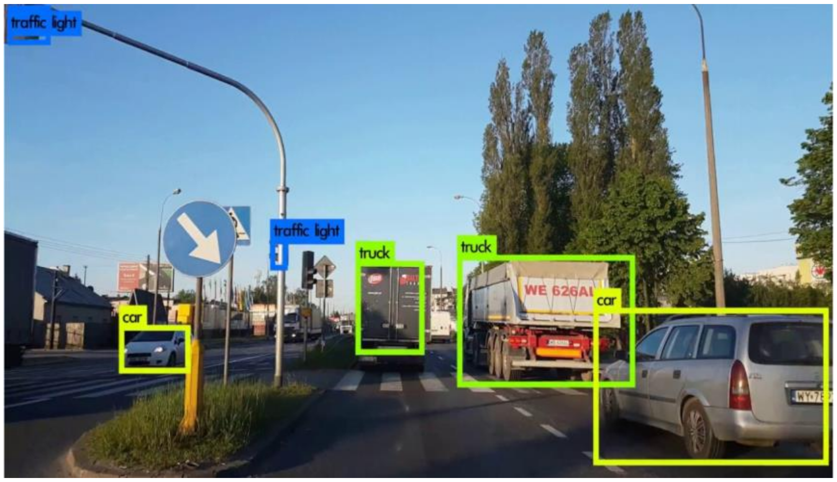


Figure 14 Deep Learning Object Detection (Bohm, 2015)

2.4 IMPACT OF AUTONOMOUS-VEHICLE-ONLY LANES IN MIXED TRAFFIC CONDITIONS

The introduction of autonomous vehicles (AVs) soon will have a significant impact on road traffic. AVs may have the advantages of efficiency and convenience, but safety can be compromised in the mixed operation of manual vehicles and AVs. To deal with mixed traffic issues and to avoid its negative effects, it may be proposed to separate the AV from the manual vehicles in a special purpose lane. In this study, we analyze the impact on AV performance and safety in mixed traffic and in a situation where an AV is the only lane deployed. In the analysis, we investigate average speed, throughput, and reverse time to collision (ITTC). We differentiate manual and AV behavior by reaction time desired speed and car-following models. As a result, we observe an improvement in performance as the AV market penetration rate increases, especially when highway traffic increases by up to 84% in the case of mixed traffic. However, safety is poor when AV's market share is less than 40%. In this case, the average speed can be improved and the frequency of hazardous conditions (ITTC. 0.49) can be significantly reduced in the merging section. Internal Lane AV only. Accordingly, we conclude that AV-only lanes can have a significant positive effect on performance and safety when AVs have a low market share (Hwapyeong, 2018).

- AVs' efficiency and convenience are higher than Manual Vehicles.
- There will be a safety issue of mixed operations of AVs & Manual Vehicles.
- The issue can be overcome by developing a separate lane for AVs.
- AVs & manual vehicles will be differentiated by the Reaction Time & Speed.
- Efficiency improved with the market penetration of AVs.

3 PROPOSED SOLUTION

We are focusing on lane detection and change as well as speeding, to achieve our goals, we have used the detecting algorithm. Object detection is a domain in deep learning. YOLO, SSD, MASK RCNN, and RetinaNet are the algorithms people are using for object detection from past few years.

We will use Python to implement an object detector based on YOLO v3, it is an improvement over previous YOLO detection networks (YOLO v2, Yolo v1).

YOLO can be defined as You Only Look Once. YOLO is an object detecting algorithm used to detect the object and it uses convolutional neural network.

FCN (Fully Convolutional Neural Network)

YOLO is fully convolutional network (FCN) because the use of convolution layer. As FCN is used in YOLO the input images never change. Input images have to be constant due to many problems during implementation of the algorithms because it shows only their heads.

Processing the image is the concern due to processing the image in batches with fixed with dimensions like width and height. By using GPU which increase the speed the images are proceed in parallel, the best method is to multiple images concatenation into a bigger batch.

Using Stride of the network the images are down sampled. If stride of the network is 32 the image size of 416 X 416 input image gives a 13 X 13 size output image. Sitting on any layer the factor is the output will be always smaller than the input.

3.1 PROCEDURE

3.1.1 INTERPRETING THE OUTPUT

The convolution layer is used for object feature detection and this is then processed to classifier, the classifier or repressor will help in detection prediction. like boxes, bounding box coordinates and the class label.

Convolution layer uses 1 X 1 convolution to predict by from this algorithm. The feature map from the output and the prediction map size same which is 1 X 1 convolution. The YOLO v23 interpretation method is used to prediction map where each cell is predicted with a fixed number of bounding boxes.

The feature maps depth wise entry is given by {B X (5 + C) } .Where B is the Predicted number of bounding boxes for each cell, it is proved from research B bounding box is specialized to detect different kind of object.. 5 + C attributes. This describes the center coordinates, dimensions, objectiveness, score and the class confidence. 5 + C attributes are detected from every detected bounding boxes. 3 bounding boxes for each cell is predicted in YOLO v3

The study shows from the feature map; each cell predicts an Object. This prediction is based on bounding boxes position.

This is achieved by dividing Input image dimensions equal to last feature map which forms a grid. As mention earlier the input image size 416 X 416 and also 32 is the network stride. As we noticed earlier, feature map dimension will be 13 x 13, then we divided the input image into 13 x 13 cells.

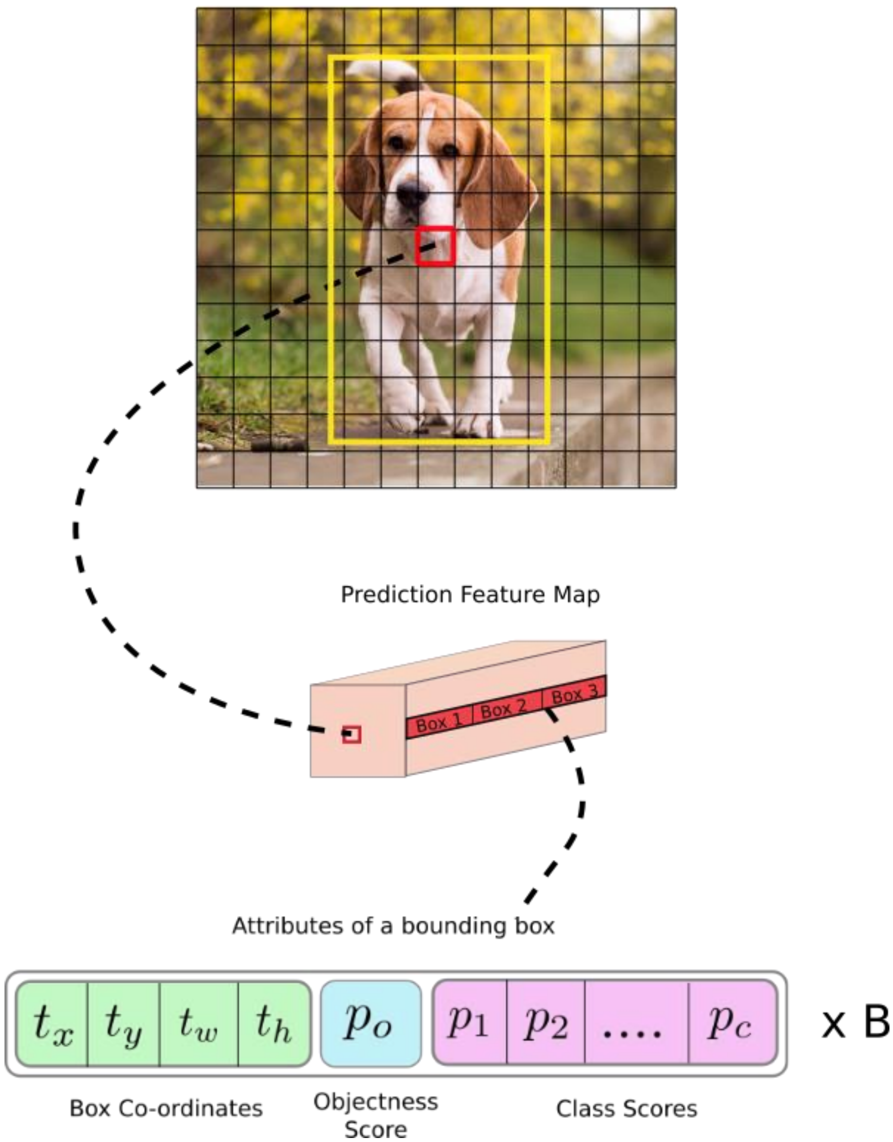


Figure 15 Image Grib- The Red Grid is responsible for detecting the dog

A cell it has the ground truth box center of an object is the one and its work is to predict the object. The red cell in the image contains the Ground truth box center which is the Yellow color.

Anchor Boxes

Anchor boxes are the pre-defined bounding boxes they will help to detect the bounding boxes correctly. Yolov3 network has 9 anchors means 3 set of anchor boxes.

Making Predictions

Using the below formula yolo algorithm will predict the bounding boxes.

$$b_x = \sigma(t_x) + c_x$$

$$b_x = \sigma(t_y) + c_y$$

$$b_w = p_w e^{tw}$$

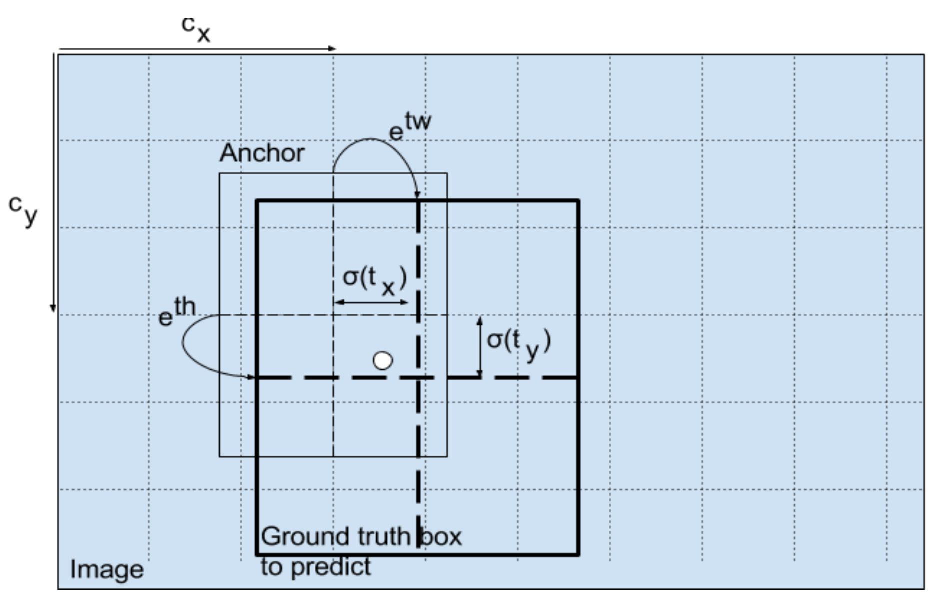
$$b_h = p_h e^{th}$$

x,y Co-ordinates, width, and height of predictions are bx,by,bw and bh.

Yolo network output tx,ty, tw and th .

Top left co-ordinates of the grid cell cx and cy.

Anchor dimensions of the box are pw and ph.



Objectness Score

The probability value of the object contained in the bounding box is the score of the object. It is taken from the research work that the score will be in the range 0 to 1. Where 1 is object is present and 0 is not present. To calculate the probability value Sigmoid is used.

Class Confidences

Class confidence is also coming within the range 0 to 1 and it can decided by using softmax activation function if the classe or more than 2, if classes are 2 then we can use sigmoid activation function.

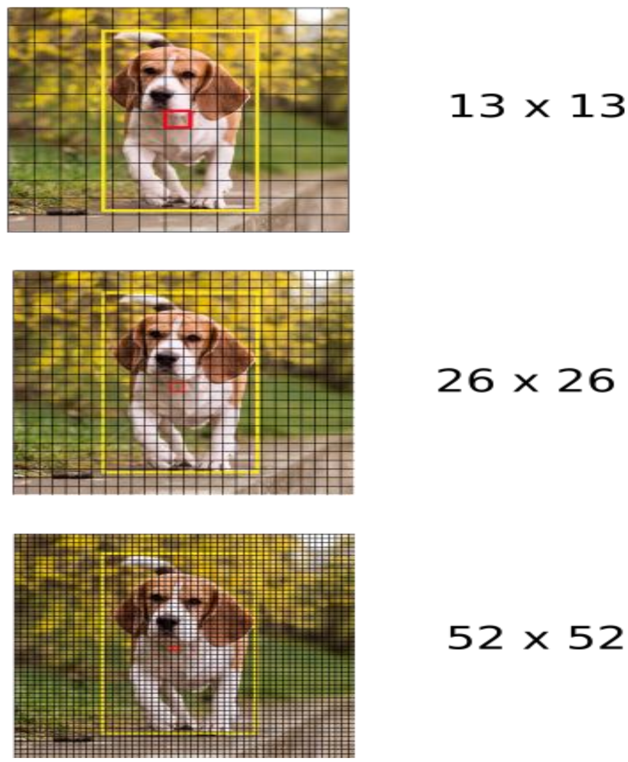


Figure 16 Prediction Feature Maps at different Scales

The author says that yolov3 algorithm will detect the small objects also and using up sampling technique we can easily detect the small objects too.

Output Processing

Input image   size 416 x 416,

Yolov3 predicts   { [(52 x 52) + (26 x 26) + 13 x 13)] x 3} = **10647 Bounding boxes**.

Non-maximum Suppression

NMS will help us to remove multiple bounding boxes of the same object based on the threshold value and its class confidence and objectness.

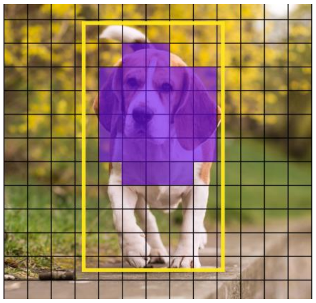
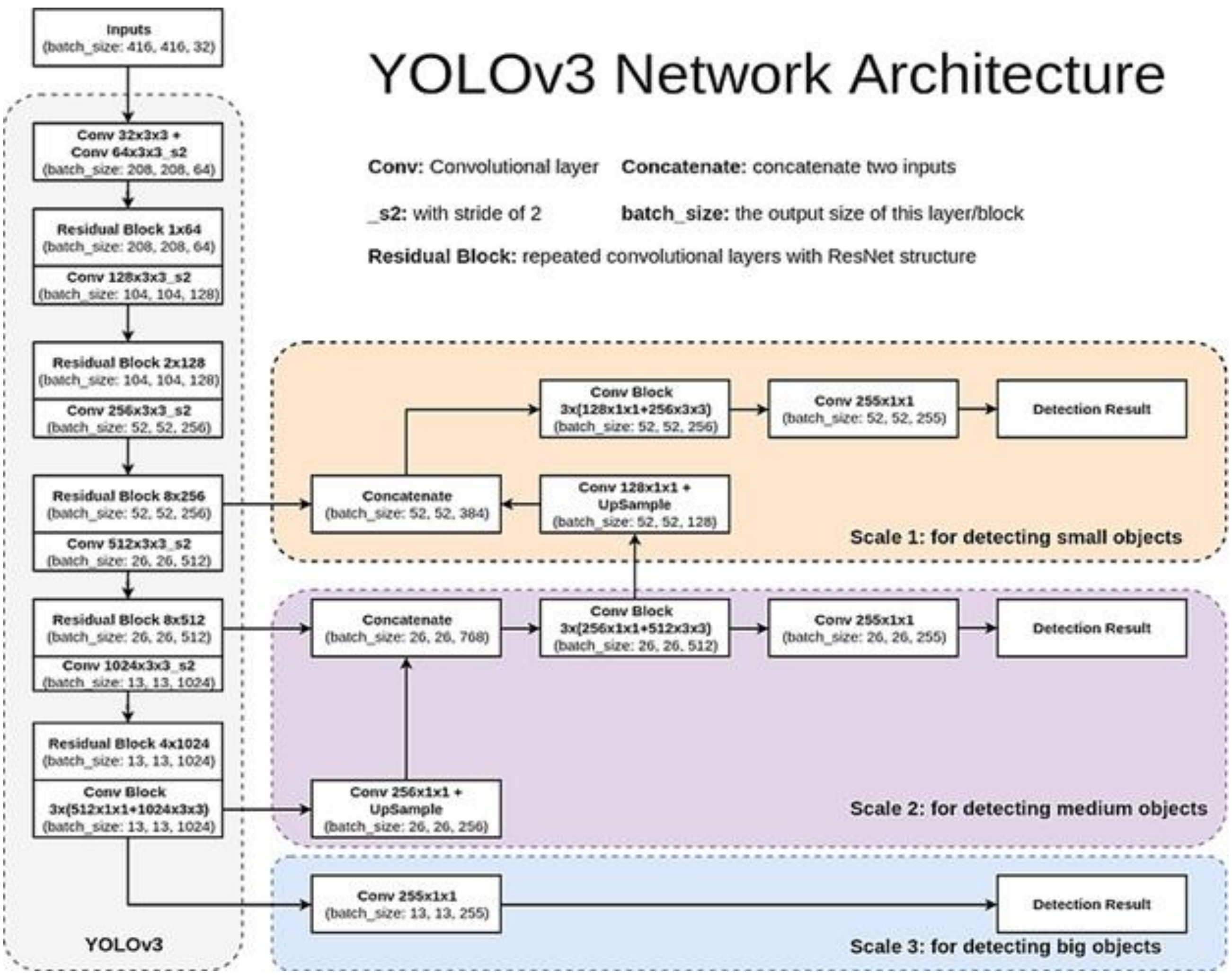


Figure 17 Multiple Grids may detect the same object NMS is used to remove multiple detections

4 IMPLEMENTATION

Yolo model is trained using coco dataset where the dataset contains 80 objects. And for the prediction we need trained model. Using the trained model, we can predict the images using test set.

4.1 DESIGN AND ARCHITECTURE



4.2 INPUT AND OUTPUT

Input parameters list:

model_path: 'model_data/yolo.h5',

anchors_path: 'model_data/yolo_anchors.txt',

classes_path: 'model_data/coco_classes.txt', score : 0.3,

iou : 0.45,

Learning rate = 0.00001

model_image_size: (416, 416),

gpu_num : 1 (“if GPU Available)

Basically, input will be provided to the input layer I.e.

```
yolo_body(Input(shape=(None,None,3)), num_anchors//3, num_classes)
```

The output will have generated by using the output layer of the model I.e.

```
boxes, scores, classes = yolo_eval(yolo_model.output, anchors,
        len(self.class_names), input_image_shape,
        score_threshold=score, iou_threshold=self.iou)
```

There are 3 output layers one layer is for predicting boxes, another one is for predicting class score and one more layer is for predicting class.

Loss Function: Loss function is used to calculate the loss between the ground truth values and the predicted values. We can get the values in the range of 0 to 1. then we can be able to convert those values in percentages.

```
def yolo_loss(args, anchors, num_classes, ignore_thresh=.5, print_loss=False):
    '''Return yolo_loss tensor

    Parameters
    ----------
    yolo_outputs: list of tensor, the output of yolo_body or tiny_yolo_body
    y_true: list of array, the output of preprocess_true_boxes
    anchors: array, shape=(N, 2), wh
    num_classes: integer
    ignore_thresh: float, the iou threshold whether to ignore object confidence loss

     Returns
    -------
    loss: tensor, shape=(1,)
```

Data: PASCAL VOC (PASCAL Visual Object Classes Challenge).

Tools: Pycharm, Tensorflow, Keras, cv2.

DataAnalysis: The PASCAL VOC dataset is devided into three subsets: 1,464 images for training, 1,449 images for validation, and a private testing set.

Output:

Figure 18 Detecting objects and the lane Simulation.

From the above figure we can be able to see the object detection and lane detection so our will detect both objects and lane at a time. The model can detect 80 objects. The green color which is plotted on the road shows the detection part of the lane in the road and bounding boxes are the detected objects from the model.

4.3 DISCUSSION

YOLOv3 is fast, and it is very powerful detector because of detection accuracy of large and small object detection. So, we can use this model in autonomous car, surveillance, and other computer vision fields and, it processes speed also fast, and it is very powerful model we can detect every small object with the threshold value of 0.5

5 CONCLUSION

The process of transitioning from self-driving cars to fully autonomous vehicles with different levels of autonomy remains to be done. However, modern AI technologies and machine learning development are rapidly advancing in this direction, and this is what is driving the industry. Top automotive brands such as General Motors, Ford, and Tesla are in the final stages of testing their driverless vehicles, which means we are on track to see a revolutionary change in the way we travel.

To conclude finally that the well developed technology is ready to manufacture semi-basic and fully autonomous vehicles. Software developers and many automotive companies have made large improvements in navigation, collision avoidance, and street mapping. Governments can control the flow of self-driving vehicles for commercial use. Resolving related issues and ensuring that regulatory laws are clear should be a high priority in all countries that consider autonomous vehicles.

Once the AV has commercialized then social and ethical concerns arises, example AV cannot be a choice if it is hitting a child or a group of 10 people. One can imagine the various ethical issues that come to the fore and software designers must make choices about how to deal with them.

In addition, there are important resources for the workforce. Ober has about 1 million drivers on this road. Possibly phasing out in autonomous vehicles means that at least some of these people will lose their jobs and will need to be retrained to other positions. One of the major challenges facing the world is how to manage this economic and social chaos.

The self-driving has become safe and becoming safer. And only thing is people must believe and try and enjoy the technology. Driverless cars are an important next step in transport technology. They are a new safe and computerized technology for your desire. Autonomous cars continue to evolve, and in-car software updates continue. This reduces the congestion, faster response and also can increase safety with less errors. even without the thought of radio frequencies, cameras, sensors, more semi-autonomous features have emerged. Those who currently reject self-driving cars will not accept modern technology and automated systems.

AV has been an active area of research for decades, but especially in the last five years. Recent joint efforts by universities and manufacturers have brought AV closer. It is believed that the cost of transport in AV is very low. According to one estimate, the impact of social AV 2000 per year may be greater per year in terms of crash savings, reduced travel time, fuel efficiency, and parking benefits, and when the overall cost of a crash is calculated. Can be up to 000 4000. AV is still in its infancy. There is a long way to go before maturity, implementation, and mass-market release can be achieved.

This path is still fraught with difficulties, with many challenges. Understanding the environment for reliable, smooth, and safe driving is the biggest challenge. There is a long list of research questions covering a wide range of topics that need to be addressed and answered, including not limited to customer acceptance, social impact, communication technologies, ethics, planning, standards, and policy. Software challenges such as system security and integrity have also become serious issues. This includes the challenge for policymakers to smooth and manage a wide variety of vehicles with different operating constraints. It is also important for policymakers to make sure drivers understand the capabilities of these vehicles and drive them safely. One of the challenges ahead is to connect multiple intelligent vehicles and to the infrastructure that gives rise to the application of big data, a topic related to the processing and analysis of large datasets. In this article, we highlight transportation-related topics that are directly or indirectly affected by emerging AV technology, both positively and negatively. Examples are land use, safety, kilometers traveled by car, parking, diversification of demand, and fuel consumption. We have also highlighted the vast possibilities of integrating connected vehicles into existing traffic networks resulting in more efficient and smoother traffic circulation. To this end, we introduced the concept of vehicle navigation to solve the routing problems faced by AVs when connected to non-AVs. We then developed a traffic assignment model for a combination of AV and non-AV, which is a harmonization of the best system and user balance requirements.

As expected, and used as an example, moving centrally, a fleet of vehicles (AV in this case) can improve the overall flow of traffic after the best modeling of the system. In theory, the improvement could be 2.15 times more, which is amazing. This fact should not be overlooked in modern traffic planning and management procedures. Therefore, AV and SO Navigation is, of course, a worthwhile thread of research and practice for scholars and practitioners.

Soon, AVs will be an integral part of modern transportation systems. Furthermore, considering such rapid changes in the intelligent transport system, the education system will undoubtedly have to align itself with these emerging technologies. Traffic engineering schools need to improve their curriculum to ensure that it includes a variety of disciplines, including communications technologies, software development, electrical engineering, and environmental and energy sustainability. This paper provides a methodological framework for modeling the first-time AV conventional vehicles (non-AVs) with UE traffic patterns as SO traffic patterns as well as AVA navigation. Numerical applications using methods such as variable inequality, completion, or fixed point are much more scalable. At the same time, developing agent-based microsimulation for the integration of AV and non-AV, following the principles of SO and EU, should be the subject of further studies. Such agent-based modeling can be used in real-time traffic management.

Automated driving technology has evolved. Opportunities for smart city mobility with the rise of the smart city agenda, automated vehicles are now a popular topic. However, legislators, city administrators, policymakers, and planners are unwilling to address the potential bottleneck of autonomous vehicles, which could potentially replace traditional transportation. There is a lack of information about it.

New capabilities will disrupt and what policy strategy is needed to address such disruptions. This approach involves systematic review based on existing evidence to understand the potential, impact, planning, and policy issues associated with autonomous vehicles.

In this review, the pace of technological progress, the disruptive effects of such development, Strategies to bridge barriers, and potential differences in literature.

In the contemporary smart city debate, AV offers a way to create the shape and progress of an ideal city. In autonomous driving, technology has the potential to bring smart mobility into our fast-paced urban world. But for others, AV is a branding deception. Despite a large amount of recent literature on AV, only a limited number of studies have outlined the disruptive effects that AV can have on city planning and society in general. This paper aims to determine the current state of research through a systematic review of the literature. Literature on AV technology, the future direction that this technology is taking towards this technology, how things are changing.

6 LIMITATION AND FUTURE RESEARCH

This approach has been effective in achieving the proposed research objectives, but it is important to acknowledge the limitations of the various approaches, which in themselves present future research opportunities.

First, the use of a single database to compile source literature may result in the discovery of some relevant educational publications on AV. Academically, databases retrieve different sets of publications when the same search query is processed and their coverage levels vary according to the subjects under investigation (Martin Martin et al., 2018). With this limitation in mind, Scopes and Science of the Web, two key sources of bibliometric data currently available (Monjen and Paul-Hus, 2016), experimented with both to establish their coverage of AV research. had gone. The initial keywords were searched in both databases and Scopes was offered a wider coverage of the literature, with 6626 additional titles.

Second, this study focuses only on peer-reviewed publications. Therefore, gray literature on AV was not considered. It will be interesting to see if this type of literature, which is not subject to the formal process of Monday's review, has influenced the academic debate and the formation of the intellectual structure of the AV research field.

Finally, the diagnostic phase of topic modeling output can be further enhanced. This phase of the analytical process has demonstrated success in generating evidence and input to improve the detail of thematic groups. However, due to resource constraints, authentication was detected by a limited number of domain experts, and the reliability of the intruder was measured by considering quality rather than a quality approach, which would provide more robust measures. Therefore, additional research on many data collection tools will be useful for further examination and refinement of topic modeling results.

As more and more software is used in vehicles, you can bet that criminals will find ways to hack and control vehicles. It can be used to steal vehicles or turn them into weapons that are intended to cause an accident in other vehicles or pedestrians. Are used. Manufacturers are working hard to identify and identify potential holes that hackers may expose. Many have even gone so far as to hire their hackers to help them find and fix these security breaches.

For cybersecurity, this level is more important than the maximum height, as attacks on one or more vehicles can cause chaos on the roads and even cause accidents and serious injuries.

Level 4 long-term autonomy provides time for permanent investment in manpower training that can help drivers and other mobile workers move into new careers that move mobility. Supports systems and technologies. Changing from current day driving jobs to these jobs represents possible employment routes if job training resources are available. Since level 4 automatic driving is expected to be a geographical rollout, human workers will be required to operate these systems for the future, in roles that will be both old and new. Will

In some cases, the Level 4 Remote Driving System can transfer driving jobs from vehicles to designated location centers, but it can represent a step down in job standards for many professional drivers. The skills required for these jobs are largely unknown, but they are likely to be a combination of strong language skills call center, dispatcher, technician, and maintenance role. If automated taxi fleets are deployed on a large scale, more advanced engineering roles can also be a source of good jobs, but this will require rigorous technical training that may be beyond the reach of many. The increasing availability of Level 2 and Level 3 systems will change the nature of work for professional drivers but will not necessarily affect the number of jobs to the extent that other systems may be affected because these system drivers Are not removed from vehicles.

While the implications of large-scale Level 4 automation employment in tracking, like other domains, may be substantial, the rollout is expected to be gradual. Truck drivers do more than just drive, and the presence of a human inside a highly automated truck will be invaluable for other reasons such as loading, unloading, and maintenance. Human Autonomous Truck Platooning, in which multiple Level 4 trucks follow a man-powered lead truck, will soon be more operational than the fully operational Free Level 4 operator.

Most people would agree that driverless cars are the future. With the recent leaps and bounds in the self-driving car industry, few people will be bold enough to dispute the fact that these cars will reduce the number of road accident deaths. Research shows that by 2050, self-driving cars could reduce the number of American road deaths by more than 90%.

However, it will only affect our future of driverless cars. In general, cars and vehicles are a big part of our daily lives and society. Surprisingly, as human beings, we get angry as soon as we are behind the wheel. So now the question is, will driverless cars make us better people?

Such fundamental changes in the automobile industry will have far-reaching effects on every other aspect of our lives.

Tech companies have established themselves in the fast lane of the power, autonomous world and are rushing to retain the original manufacturers (OEMs) of equipment. Consider an important clue: German regulators have given Mobile, Intel's autonomous vehicle (AV) division, which allows cars without its driver to be tested on public roads, in world traffic. Mobile is one of the first non-traditional manufacturers to take the lead in testing, giving the firm a chance to overtake traditional manufacturers despite its initial start-up.

As they race to compete with digital-minded and cash-fueled tech companies, the Covid 19 epidemic also threatens to hamper the progress of some OEMs. Cash protection and cost coverage are now a top priority, requiring careful research and development (R&D) and CAPEX investment. Inevitably, it involves tough choices. Daimler and BMW, for example, have suspended their AV collaboration considering higher prices. At the same time, Daimler has partnered with Nvidia to develop software-based vehicle architecture for autonomous driving. In addition, the carmaker recently announced a partnership with Waymo to build a Level 4 autonomous truck that can run on its own without human interaction in a specific situation. Reducing investment in home development for AV technologies allows OEMs to move limited resources to more timely opportunities, such as their power pressure.

Daimler and BMW will not be alone in their thinking. The global crisis could be a catalyst for the adoption of electric vehicles (EVs). European governments are using economic stimulus to push for a more sustainable world after epidemics. France, Italy, and Germany are increasing EV subsidies as part of their recovery plans. The Chinese government, which had planned to bring back EV subsidies by the end of the first year, has decided to reduce the pain of automakers by 2022, instead of extending some of the revised incentives. In addition, ride-hailing companies such as Left, and Ober have recently pledged to move to a fleet of 100% electric vehicles by 2030.

The decisions that automotive leadership teams make in the coming months will be critical to determining their future competitiveness. And with so many options to choose from, no company can afford to win every battlefield alone. But here are some practical things that OMS can do to re-paint themselves for the reality of the future of EVs and AV-powered now. It starts with evaluating opportunities, determining where to play, and building the right investments to stay competitive in the right place.

Two revolutions are taking place in the automotive industry side by side: the transition from electricity to electricity and the rise of autonomous vehicles. Self-driving cars can use far more energy than people-driven cars to use everything from power-driven cars to sensors and computers for safe navigation. On the other hand, they drive more easily than humans, which will reduce energy consumption.

An overall increase in energy consumption will reduce the driving range, which requires more frequent charging and rapid battery degradation. Because many people fear that electric vehicles are a short distance from gas cars, some believe that electric autonomous vehicles may not exist. This concern prompted the CMU team to investigate the effects of automation on vehicle limitations.

"We want to know if automation will affect us to such an extent that we can't have electric and automatic vehicles together in one vehicle," said Serpa, Ph.D. Candidate in Mechanical Engineering. "We wanted to fix the amount of trade between the two of us."

Using the vehicle's dynamic model, Mohan and Sreepad estimated the energy demand of self-driving cars to determine how much power is needed for safe autonomous driving. They consider any additional drag from automation technology and smooth driving of computer control.

Although they reduced their driving capacity, it was not enough to eliminate the possibility of autonomous automobiles. However, it was more common in cars that used a stretch sensor that increased drag.

Viswanathan, an associate professor of mechanical engineering, said: "We know that the choice of design will depend on the energy efficiency of the computing hardware and the aerodynamic design of the sensors. Next, researchers will examine how low visibility drivers look. While consumers value long-distance driving, they can also value the luxury of not driving. Vishnu, an assistant research professor of engineering and public policy, said, "Future works will have to assess whether the extent of the damage is significant enough to affect consumer preferences."

7 REFERENCES

- M. Everingham, L. Van Gool, C. K. Williams, J. The pascal visual object classes (voc) chal- lenge. *International journal of computer vision*, 88(2):303– 338, 2010.
- C.-Y. Fu, W. Liu, A. Ranga, A. C. Berg. Deconvolutional single shot detector *arXiv preprint arXiv:1701.06659*, 2017.
- D. Gordon, A. Kembhavi, M. Rastegari, J. Redmon, D. Fox, and A. Farhadi. Iqa: Visual question answering in interactive environments. *arXiv preprint arXiv:1712.03316*, 2017. K. He, X. Zhang, S. Ren, and J. Sun. Deep residual learn- ing for image recognition. Proceedings of *IEEE conference on pattern recognition and computer vision ,pages 770-778,2016.*
- J. Huang, V. Rathod, C. Sun, M. Zhu, A. Korattikara, Fathi, I. Fischer, Z. Wojna, Y. Song, S. Guadarrama et al. Speed /accuracy trade –offs for modern convolutional object detectors.
- I. Krasin, T. Duerig, N. Alldrin, V. Ferrari, S. Abu-El-Haija,A. Kuznetsova, H. Rom, J. Uijlings, S. Popov, A. Veit, S. Belongie, V. Gomes, A. Gupta, C. Sun, G. Chechik, D. Cai, Z. Feng, D. Narayanan, and K. Murphy. Open- images: A public dataset for large scale multi class image classification .*Dataset available from https://github.com/openimages*, 2017.
- T.-Y. Lin, P. Dollar, R. Girshick, K. He, B. Belongie. Feature pyramid networks for object detection. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 2117–2125, 2017.
- T.-Y. Lin, P. Goyal, R. Girshick, K. Dollár. Focal loss for dense object detection. *arXiv preprint arXiv:1708.02002*, 2017.
- T.-Y. Lin, M. Maire, S. Belongie, J. Hays, P. Perona, D. Dollár, and C. L. Zitnick. Microsoft coco: com-mon objects in context. In European conference on computer vision, pages 740–755. Springer, 2014.
- W. Liu, D. Anguelov, D. Erhan, C. Szegedy, S. Fu, and A. C. Berg. Ssd: Single shot multibox detector. In *European conference on computer vision*, pages 21–37. Springer, 2016.
- Newton. *Philosophiae naturalis principia mathematica*. William Dawson & Sons Ltd., London, 1687.
- J. Parham, J. Crall, C. Stewart, T. Berger-Wolf, and D. Rubenstein. Animal population censusing at scale with citizen science and photographic identification. 2017.
- J. Redmon. Darknet: open source neutral network in c, http://pjreddie.com/darknet/, 2013-2016.

- J. Redmon and A. Farhadi. Yolo9000: Better,faster,stronger. In *Computer Vision and Pattern Recognition (CVPR), 201 IEEE conference on*, pages 6517-6325. IEEE, 2017.
- J. Redmon and A. Farhadi. Yolov3: An incremental improve-ment. *arXiv*, 2018.
- S. Ren, K. He, R. Girshic, and j. Sun. Faster r -cnn: To wards real time object detection with region proposal net-works. *Arxiv preprint arXiv:1506.01497*, 2015.
- Y. kakimoto, (2018). A Study on the Impact of AV-HDV Mixed Traffic on Flow Dynamics of Single-Lane Motorway . *sciencedirect*.
- R. Munigety, c. (2016). Towards Behavioral Modeling of Drivers in Mixed Traffic Conditions. *springer international publising* .
- Y. Sciencedirect, (2018). A Study on the Impact of AV-HDV Mixed Traffic on Flow Dynamics of Single-Lane Motorway . *science direct*.
- W. Wang, (2014). *Modeling and Recognizing Driver Behavior Based on Driving Data: A Survey*.
- D. Zeghida, (2018). Bio-IR-M: A Multi-Paradigm Modelling for Bio-Inspired Multi-Agent Systems. *researchgate*.
- O. Russakovsky, L.-J. Fei-Fei. Best of both worlds: human-machine collaboration for object annotation. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, pages 2121–2131, 2015.
- M. Scott. Smart camera gimbal bot scanlime:027, Dec 2017.
- A. Shrivastava, R. Sukthankar, a. Be- yond skip connections: Top-down modulation for object detection . *arXiv preprint arXiv:1612.06851*, 2016.
- C. Szegedy, S. Ioffe, V. A. Alemi. Inception –v4, inception-recent and the impact of residual connections on learning 2017.
- Hwapyeong. (2018). *Impact of autonomous vehicle only lanes in mixed traffic.*
- F. Bohm, (2015). *Introduction of autonomous vehicles in swedish traffic.*
- Abdelmohsen, A. (2016). *Optimal trade offs between construction cost and Traffic*.
- N. C. Tuan, (2019), *History of Self-Driving Cars,* https://www.thoughtco.com/history-of-self-driving-cars-4117191?print