NEAR EAST UNIVERSITY

INSTITUTE OF GRADUATE STUDIES

DEPARTMENT OF COMPUTER ENGINEERING

Navigation of Autonomous car using Image Processing

M.Sc. THESIS

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September, 2021

Approval

We certify that we have read the thesis submitted by Ahmed Abdulbaset Elgammudi titled "**Navigation of Autonomous car using Image Processing**" and that in our combined opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Educational Sciences.

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Ahmed Elgammudi

17/12/2021

ACKNOWLEDGEMENTS

I'd want to convey our heartfelt gratitude to Dr. ELBRUS IMANOV, my project guide, for his unwavering support and encouragement during this endeavor. I am grateful to him for being present at every stage of the project, sharing his technical skills and providing crucial input and suggestions that helped make it a success. I'd also like to express My gratitude to the officials and employees of the Computer Engineering department who assisted me during that time. Last but not least, I want to express my gratitude to my family for their unwavering support and confidence in me throughout our master's degree journey.

Ahmed Elgammudi

I certify that this research work entitled "**Navigation of Autonomous car using Image Processing**", is my own work. No portion of the work presented in this research report has been submitted in support of another award or qualification either at this institution or elsewhere. Where material has been used from other sources it has been properly acknowledged / referred. If any part of this project is proved to be copied or found to be a report of some other, I will stand by the consequences.

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For the thesis project entitled as “Navigation of Autonomous car using Image Processing”, the researchers declare that they did not collect any data from human/animal or any other subjects. Therefore, this project does not need to go through the ethics committee evaluation.

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Abstract

Navigation of Autonomous car using Image Processing

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MA, Department of Computer Engineering
December, 2021, 59 pages

Autonomous driving has become a hot topic with tremendous technological advancements in the recent decade, the thesis's goals were to look into self-governing technology also how it works as well as how it may be Furnished in the freighting sector, along with what perquisite it could provide and what constraints and obstacles it would have to overcome in order to become a viable solution. Beneficial data was gathered from feasible items, syllabus and inquiry journals, and then argued to accomplish the target.

According to the findings of the studies, separate propulsive has the possibility to progress the trucking/transportation trade and business in a number of ways if it is successfully deployed. mass production and even cost savings are among the improvements. However, before the technique can be commercialized, it must overcome a number of obstacles.

The research can be used as a systematic literature review to familiarize readers for the technology develop and for impending of driving without a personal and comprehend what can and cannot technology bring to the transportation field and trade.

Key Words: GAN, image processing, ml, AI, robot-car, deep learning

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CHAPTER I

INTRODUCTION

Autonomous Driving are vehicles\cars that are designed to function which It works without the need for the driver to directly intervene to control. So the driver does not have to constantly monitor the road while in autonomous mode, according to the EU Department of Transportation. Since the 1926s, the technology has been advertised and tested (The Milwaakee Sentinel 1929). Autonomous vehicles, on the other hand, were not officially introduced to the market until the 2012s. Several major automakers have been testing Self Driving car vehicle systems since then.

Otto, a start-up started by former alphabet workers Anthony and Laor Ran and later bought by Tesla to form Uber Group, released a video in 2018 showing their vehicle/cars finishing the "1" commercial Self Driving freight hauler in the world. it traveled 123 miles (199 kilometers) on G-26 without a driver from Fort Collins to Colorado Falls, carrying a trailer full of Budweiser beer.

Tesla had commercialized autonomous trucks in New York, USA, by the beginning of 2017, although they it only works on highways/ freeway, and for the safe driver it must remain in the cabin throughout the journey.

While fully autonomous driverless trucks are still a way off, the transportation industry's future with Self Driving Cars/Truks is swiftly coming.

1.2 The thesis objectives and goals

The thesis's overall goal was to determine how autonomous vehicle/car technology could help the field of logistics, particularly in the transfer of products on roadways. The thesis was restricted to the transportation industry.

And for that there are only three places with Adequate infrastructure and many actual tests of self-driving vehicles have been conducted in the past years, with corresponding data available in numerous sources, the industry in southern Europe and the USA is well suited.

Some of the samples were from real life industrial zones in USA, where Self Driving cars are already in use.

The thesis tried to answer Four primary research questions: - How are autonomous cars/vehicles Is it more efficient than normal vehicles / cars in moving material?

- How might autonomous vehicle technology increase the safety of both drivers and cars/vehicles?

- What are the potential financial costs and returns of implementing autonomous vehicle technology in the nature, And also the implications for the transportation?

1.3 Research methods

The thesis used a qualitative research approach for the majority of its research. Academic texts were used to investigate the technical aspects of autonomous vehicles, while in-depth assessments based on real-world data were used to clarify hypotheses regarding the benefits of autonomous vehicles. The thesis presented and analyzed theoretical theories as well as genuine situations in order to reach conclusions and future debates.

The information was gathered primarily through observation, which included reading prior publications on the subject, watching movies produced by car firms, and analyzing for lawful - regulatory papers. As a result, The research process has been classified as a methodical revision, It is the evaluation and synthesis of simple research papers based on a brutal and more reliable- process, It also reveals and evaluates studies in order to answer the research inquiry.

CHAPTER II

2 Image processing:

The use of a digital computer to process digital photographs using an algorithm is known as image processing. Digital image processing, as a subsection or discipline of digital signal processing, has a number of advantages over analog image processing. It enables a considerably broader choice of algorithms to be applied to the input data, as well as avoiding issues like noise and distortion during processing. Digital image processing may be described as multidimensional systems since images are defined in two dimensions. Three elements influence the formation and growth of digital image processing: The first is the advancement of computers ; the second is the advancement of mathematics. Third, there has been a surge in demand for a wide range of applications in the environment, agricultural, military, and medical science.

2.1 Anisotropic diffusion:

Anisotropic diffusion is a technique used in image processing and computer vision to reduce image noise without deleting substantial portions of the image content, such as edges, lines, or other characteristics that are critical for the image's interpretation. Anisotropic diffusion is similar to the process of generating a scale space, in which an image generates a parameterized family of increasingly blurred images based on a diffusion process. Each of the images in this family is a convolution of the image with a 2D isotropic Gaussian filter, with the filter's width increasing as the parameter is increased.

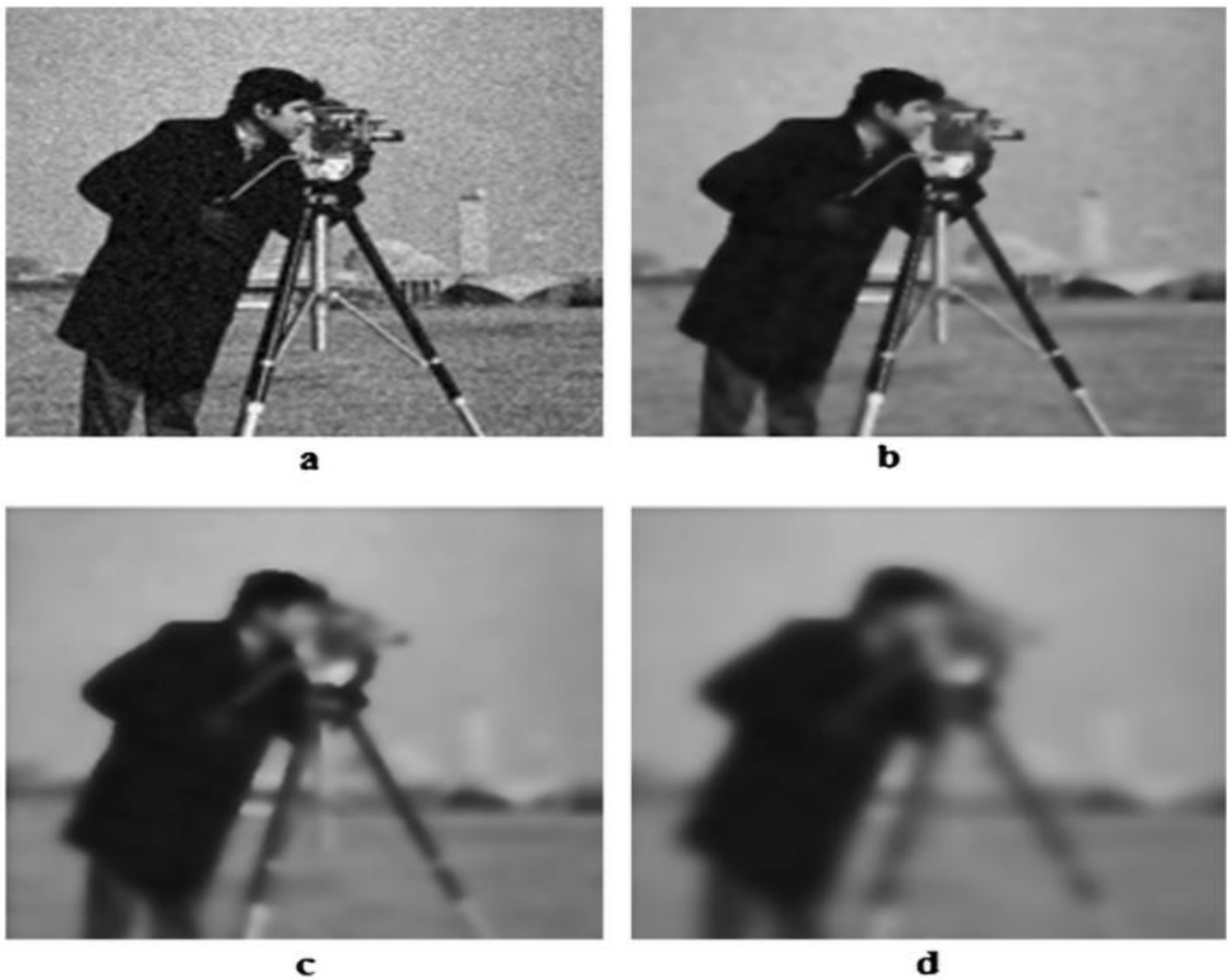

Figure 1: Anisotropic diffusion results: (a) noisy image , (b) denoised image after 10 iterations , (c) denoised image after 30 iterations [18], (d) denoised image after 60 iterations .

2.2 Hidden Markov models:

A hidden Markov model (HMM) is a statistical method that is extensively used in Computational Biology [46] to simulate biological sequences. A sequence is modelled as an output of a discrete stochastic process that proceeds through a number of 'hidden' stages from the observer when using it .

2.3 Image editing:

Picture editing is divided into two categories in digital image processing: pixel editing and parametric image editing. Pixel editing is concerned with modifying an image at the pixel level. Parametric image editing, on the other hand, focuses on adjusting the image's appearance without changing the source image.

2.4 Image restoration:

Image restoration is the process of estimating the clean, original image from a corrupted/noisy image. Motion blur, noise, and camera mis-focus are all examples of corruption. Image restoration is accomplished by reversing the blurring process, which is accomplished by imaging a point source and using the point source picture, also known as the Point Spread Function (PSF) , to recover the image information lost during the blurring process

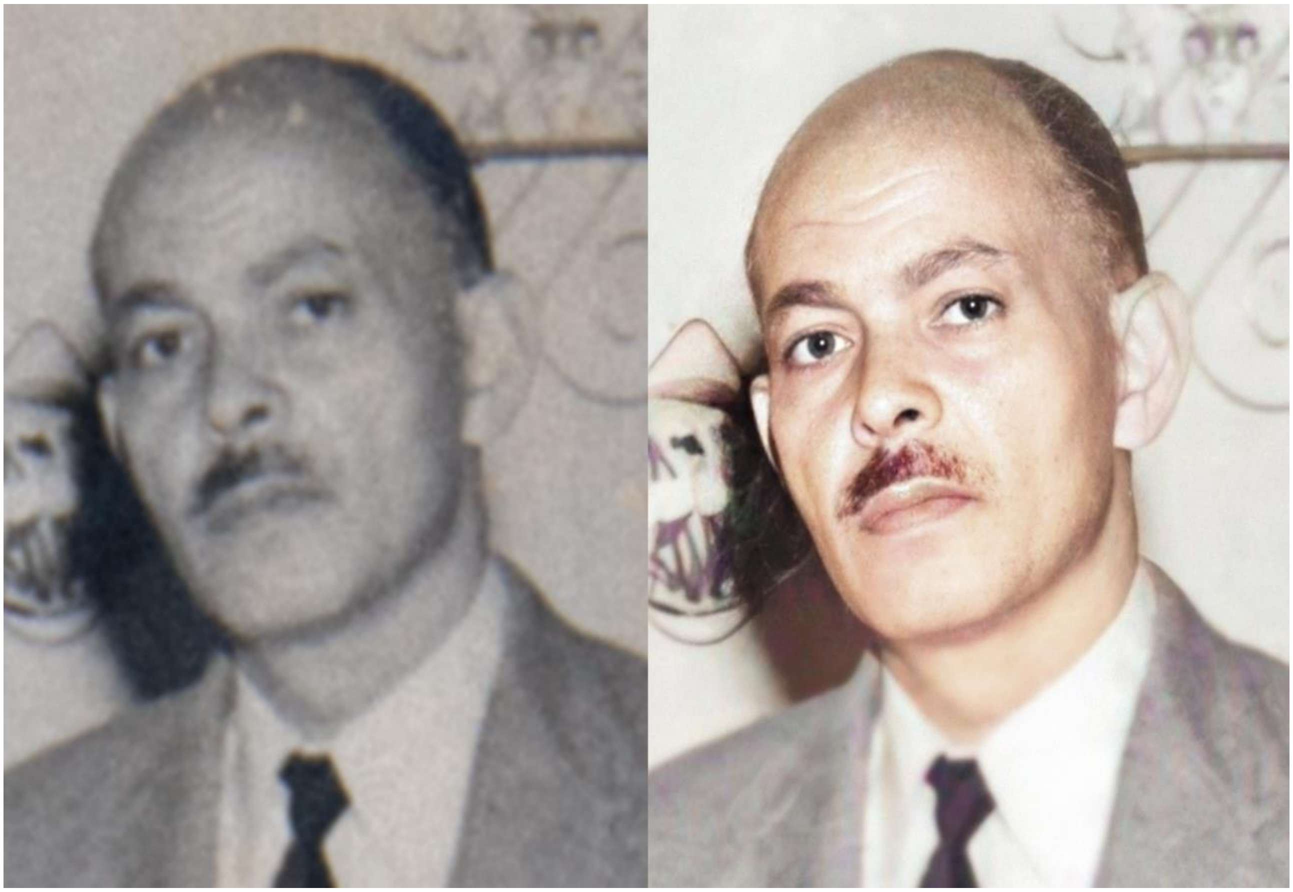

Figure 2: Image restoration using artificial intelligence

2.5 Independent component analysis:

Independent component analysis (ICA) is a computational approach for separating multivariate signals into additive subcomponents in signal processing. This is accomplished by assuming that the subcomponents are non-Gaussian signals and statistically independent of one another .

2.6 Linear filtering

Linear filters convert time-varying input data into output signals while adhering to the linearity condition. Frequency filters [49] are commonly referred to as linear time-invariant filters since their response to sinusoids of various frequencies (frequency response) can be completely described .

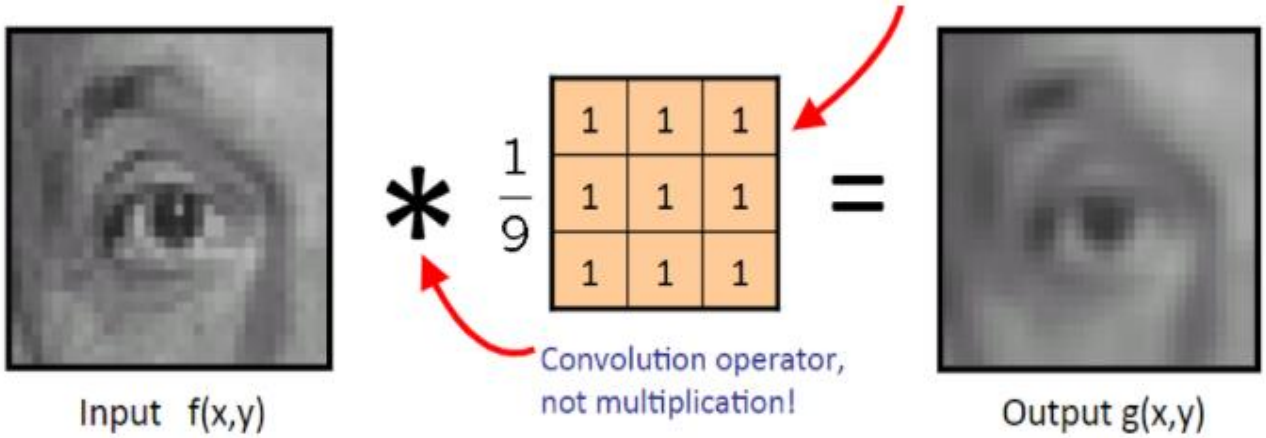

Figure 3: Filters for Noise Reduction and Edge Detection .

2.7 Neural networks:

A neural network is a set of algorithms that attempts to recognize underlying relationships in a batch of data using a method that mimics how the human brain works. Neural networks, in this context, refer to systems of neurons that can be organic or artificial in nature.

CHAPTER III

3 Autonomous vehicles: the answer to the world's transportation woes

The introduction, present implementation, and potential of autonomous vehicle technology in the trucking business are all covered in this chapter of the thesis.

3.1 Briefing on the technologies of self-driving cars

Navigation, scenario analysis, motion planning, and trajectory control are required for a car/vehicle to wheel itself after a driver boarded.

- Navigation: The ability of a vehicle to plan its course, which is now accomplished through the use of satellite navigation systems, most often GPS. In order to find the best route, the vehicle must also acquire information about road kinds, settings, terrains, and weather conditions.

- Situation Analysis: The ability of the vehicle to maintain track of its ambience, along with all relevant items and their motions. This function presupposes the employment of various prospector, for example visual image prospector so on objective is to. The incorporate the possessed data in such a way that the vehicle is constantly aware of its ambience and can select what behavior to take.

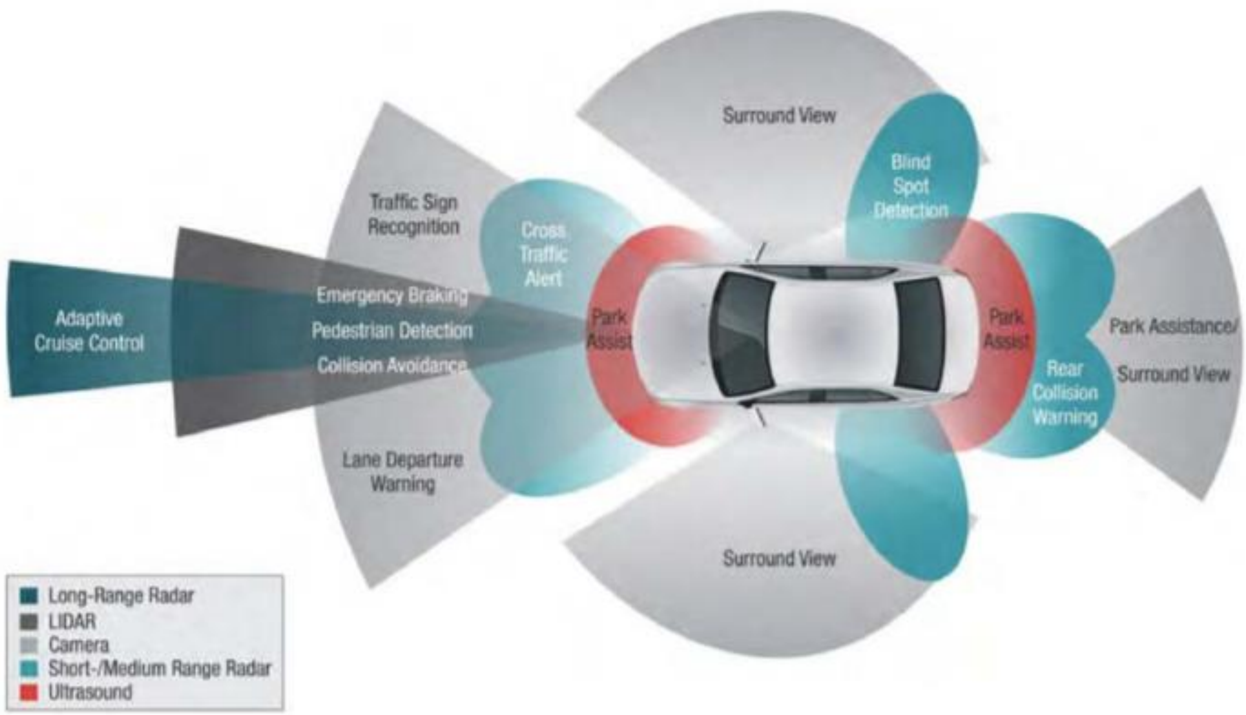

Figure 4: Situation based on Sensors

- Motion Planning: The vehicle's capacity to identify the proper course of motion velocity, direction within a pre-determined time frame, such that the vehicle maintains its lane and pre-set navigational direction without colliding with static and dynamic objects identified by scenario analysis

Programming car/vehicle's passage plan completely bring about coaching the car/vehicle how to consider captured dossier of react in various situations. - Trajectory Control: The car/vehicle's quantity to absorb driving balance in the case of act Planning adjustment in control and acceleration.

To summarize, a self-governing car/vehicle usage an exploration organization to regulate it transmit, there are different types of sensuous to gain alertness of its ambience thanks to a central data processing unit, and the control unit complete what behavior to take established on the data collected all in an almost spontaneous interval.

3.2 Self Driving vehicles are currently being implemented.

3.2.1 Applications in industry

For many years, machinery been used in the sphere of transport.. The autopilot technology, for example, has long been a standard in the aviation sector. Autonomous minesweeping trucks have been deployed in the military to keep soldiers safe from improvised explosive devices Tarantol 2017. Autonomous vehicles can also be used in other industries, such as agriculture and mining, to reduce driver costs and increase productivity for repetitive tasks like going back and forth betwixt a mine and an abstraction plant, or compost, and watering afterwards paddle of plants on a farm.

Figure 5. autonomous haul trucks are being used

3.2 Consumers application**:**

plain computerized dynamic systems, such as bolt damper and adaptive cruise control, has been established to get transport cover, according to DLL.

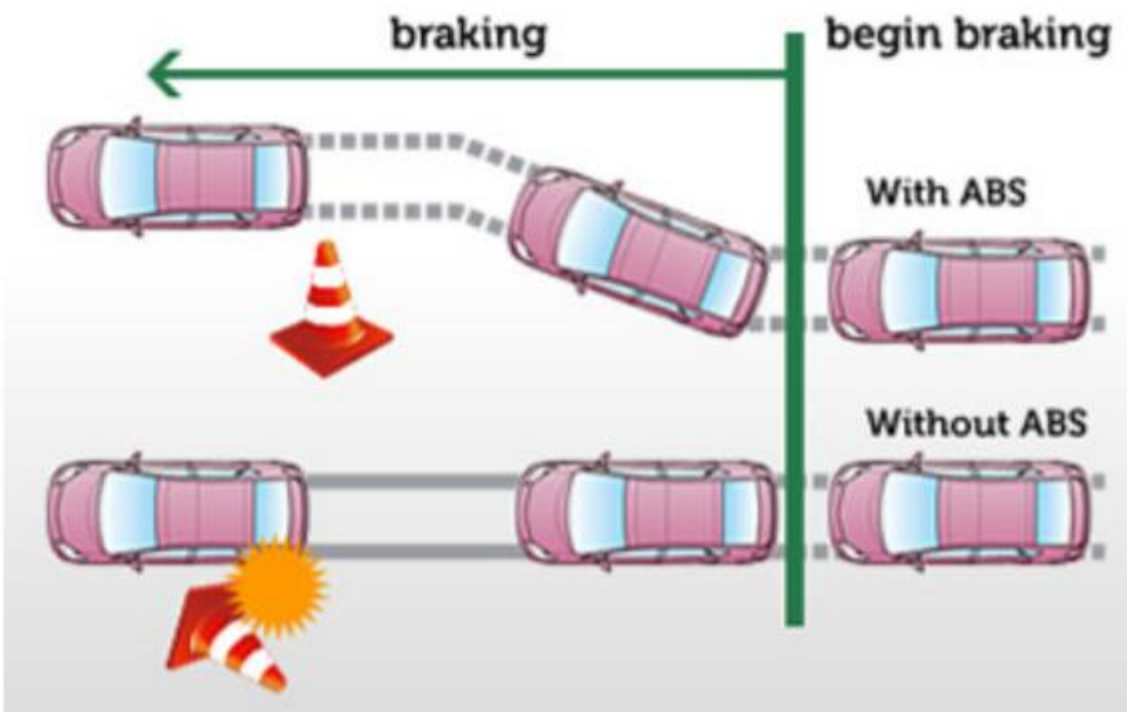

Figure 6. ABC avoid vehicle against sliding whilst brake.

Figure 7. ACS adjusts speed automatically to maintain a pre-determined distance from oncoming (Gnntifov 2017)

The technology parking system, in whatever the car parks itself in a tight parking slot at a modest speed and only in parking lots, is a prominent example of fully autonomous vehicle motion. BMW has introduced a remote control parking system, with the caveat that the car must be straight.

Figure 8. Demonstration of parking

It's crucial to note, however, that all of the aforementioned autonomous vehicle applications take place in either a regulated or in areas driven vehicles. At their best fully technology cars/vehicles can travel in a relatively static environment public parking, wherever traffic is light and pieces shift slowly. At this point in time, programmed cars are absolutely capable of traveling safely and effectively on their own, as long as they just follow the intended path. On the open road, however, the situation is different because autonomous vehicles ability to react to the actions of other humans is still being intensively tested.

3.3 Potential implementation in trucking industry

3.3.1 Truck platooning

Scania, a large Swedish truck manufacturer, said in Merch 2018 that it would "create the world's first-full scale autonomous truck platooning operations" in Singapore. Their goal is to create a convoy of four trucks, three of which will follow the leading truck autonomously, to move containers between Singapore's port terminals. The Ministry of Transport and the Port of Singapore Authority (PSL Corporation) are organizing and supporting the project, which is projected to last several years. Toyota is also involved.

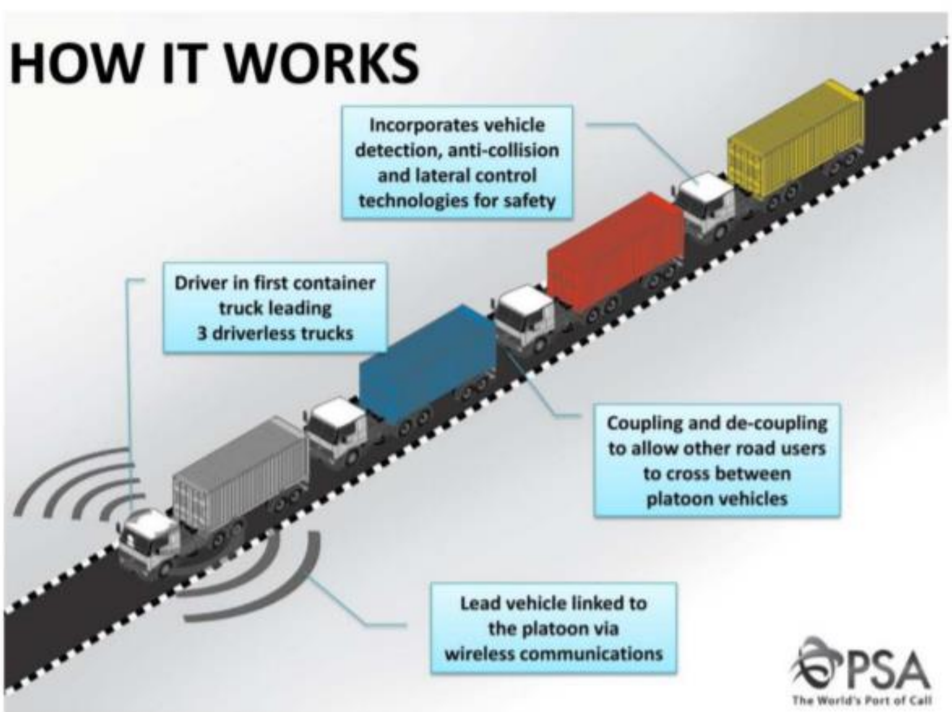

Figure 9. Illustration of Autonomous Truck Platooning Technology

Other automakers are likely to follow suit in the coming years, since the European Automobile Manufacturers Association has already supported the trend. Figure 10 shows a roadmap of measures that must be taken to deploy multi-brand platooning before 2028.

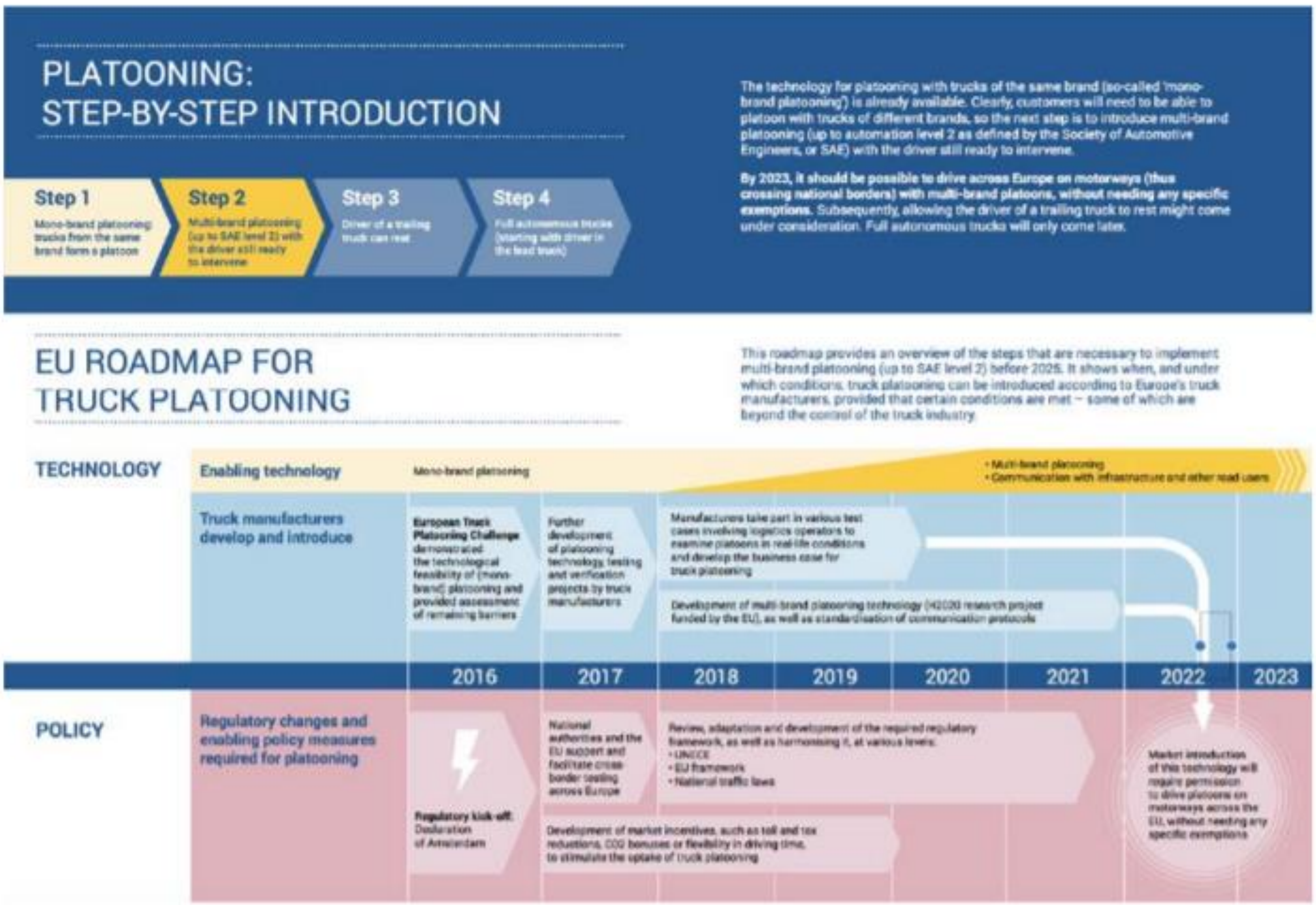

Figure 10. Truck platooning in Europe: A Roadmap

3.3.2 Trucks that drive themselves along a set route

On a broad level, the concept is straightforward and practical: trucks are driven by humans in more complex traffic conditions (urban areas, highway entrances and exits, road joints, and so on), while trucks drive themselves in more predictable and consistent traffic (typically straight highways). Truck drivers can do other things instead of driving during the autonomous driving intervals, such as making phone calls, responding e-mails, or doing other tasks.

3.4 Enhancement of efficiency

The first obvious benefit of incorporating autonomous cars into the transportation business rather than driving time, drivers can only drive 62 to 75% of their total working time at their maximum permissible working hours. This chapter examines how much autonomous vehicle technology can benefit the transportation industry in single truck automation.

Table 6. America Two separate trucks

Start	End	Time	Two separate trucks		Two-truck convoy	
			Driver 1	Driver 2	Driver 3	Driver 4
0:00	4:30	4:30	Driving	Driving	Driving	Watching
4:30	5:15	0:45	Break	Break	Break	Break
5:15	9:45	4:30	Driving	Driving	Driving	Watching
9:45	10:30	0:45	Break	Break	Break	Break
10:30	11:30	1:00	Driving	Driving	Driving	Watching
11:30	15:00	3:30	Rest/Working	Rest/Working	Working	Driving
Combined driving time			10 hours		13,5 hours	
Individual driving time			10 hours	10 hours	10 hours	3,5 hours
Total working time			11,5/15* hrs	11,5/15* hrs	15 hours	15 hours

According to the comparison, technology allows three drivers to move the items for four hours longer than a regular three driver crew. This leads in a 38 percent increase in daily transportation hours. Although driver 8 only drives for 12 hours.

Table 7. Theoretical schedule with America platooned

	Drive (hrs)	Break (hrs)	Watch (hrs)	Rest (hrs)	Direct driving (hrs)	Actual driving (hrs)	Working time (hrs)
Mo	9	1,5	4,5	9	56	75	84
Tu	9	1,5	4,5	9			
We	9	1,5	4,5	9			
Th	10	1,5	1,5	11			
Fr	10	1,5	1,5	11			
Sa	9	1,5	2,5	11			
Su	Day off			24			
Mo	10	1,5	3,5	9	34	68,5	76
Tu	10	1,5	3,5	9			
We	9	1,5	4,5	9			
Th	5	1,5	7,5	10			
Fr	0	1,5	12,5	10			
Sa	0	0	3	21			
Su	Day off			24			

Over the course of two weeks, the real driving time for a driver has increased by 62.4%, from 98 to 122,6 hours.

To summarize, the implementation of autonomous trucks authorize help cut the number of driving all hours that drivers should do while maintaining the number of actual hours that fleets are moving on the roads, implying that fleets would be used from drivers in input by hour.

3.4.2 Enhancement of security

The trucking sector has not improved, as evidenced by dropping for the previous 12 years as indicated in Chapter 1. This chapter examines how autonomous driving technology, both conceptually and practically, improves safety when compared to human driving.

Recognition mistakes, judgment errors, and performance errors account for the majority of human errors that cause road accidents. For each of these types of faults, autonomous driving technologies should be able to help prevent or at least mitigate the impact of the errors.

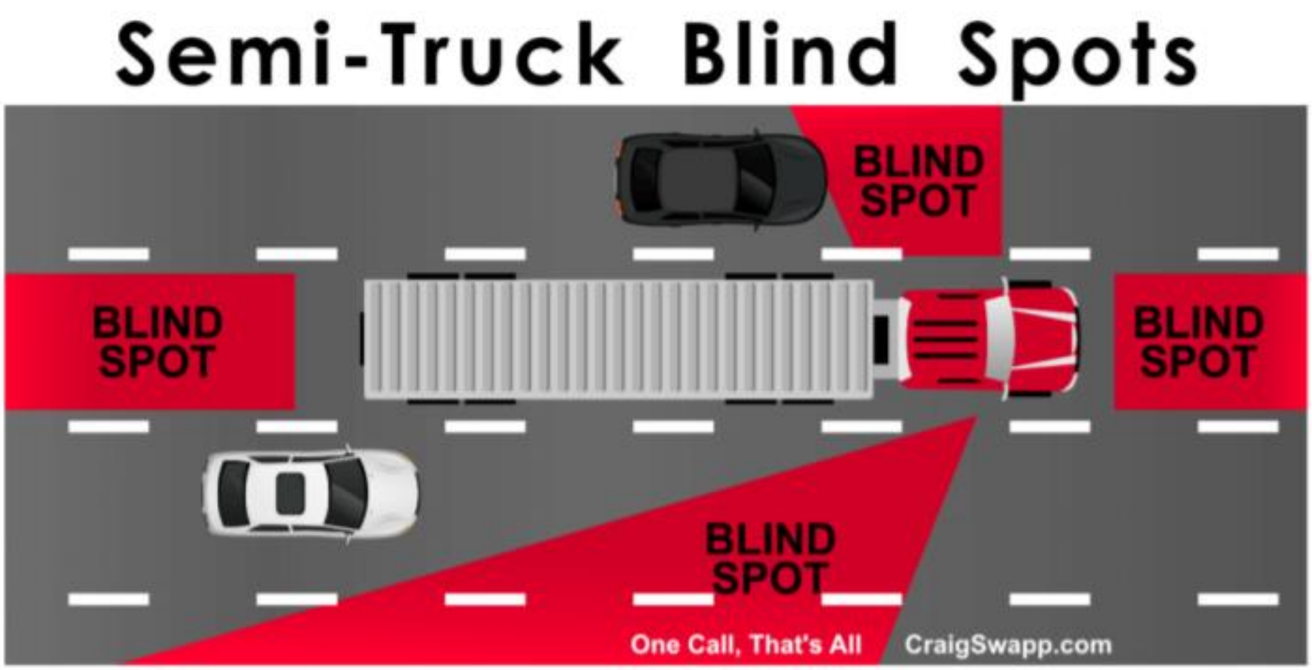

Figure 11. Blind spots on a truck

As the name implies, decision errors refer to a driver's incapacity to make the best decisions under certain circumstances, such as when speeding or steering. In this regard, provided it has been programmed for every possible road circumstance, a computer-controlled vehicle should always make the correct decision, which will be discussed in the next chapter.

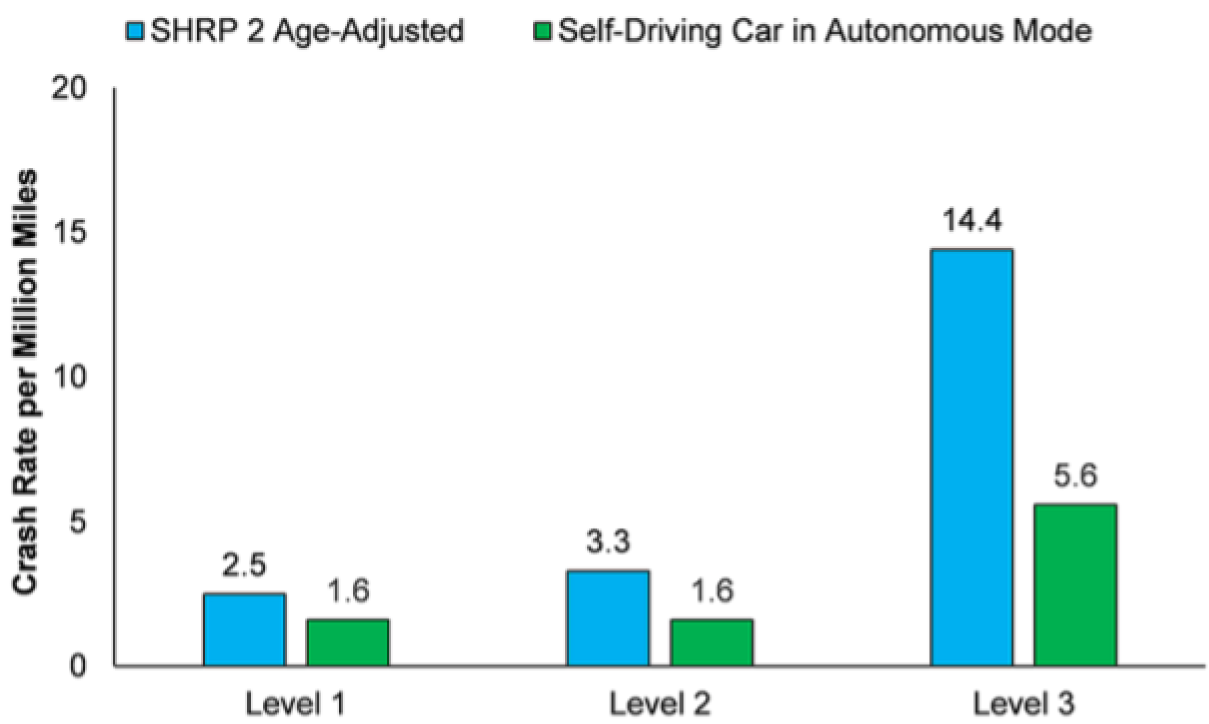

Figure 12. Crash Rates per Million for Self Driving Cars

Tesla's Auto steer was adopted in many Tesla models between 2015 and 2017, according to a report published by the National Highway Traffic Safety Administration in early 2019.

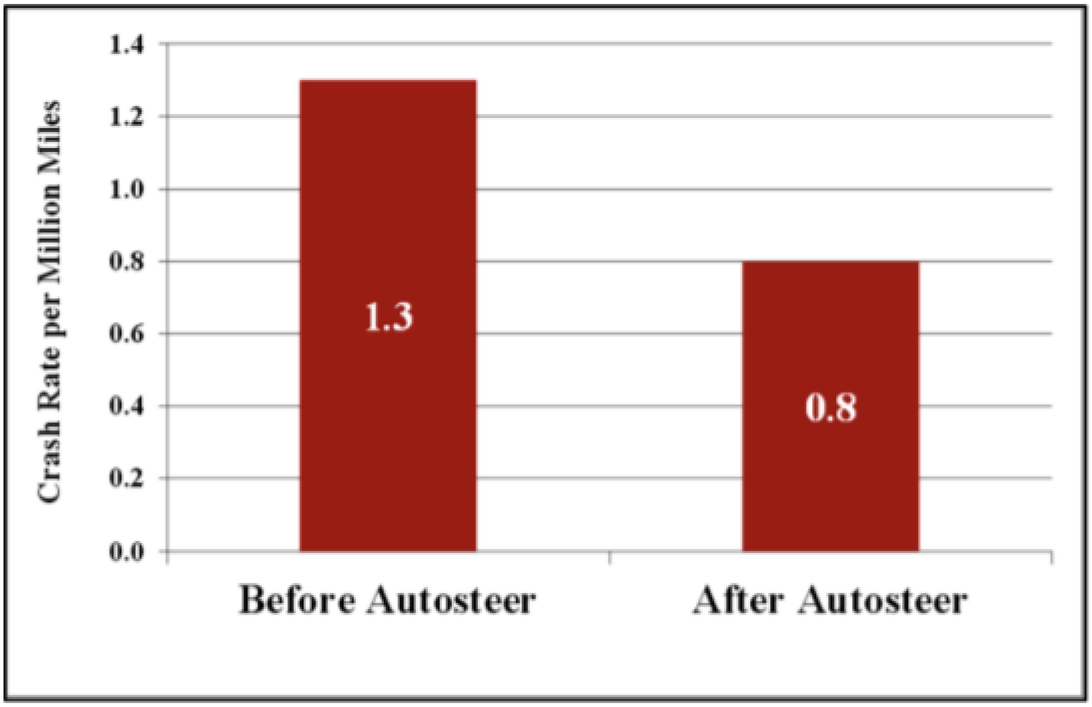

Figure 13. Crash Rates in NY 2015-16 Tesla Model S and 2017 Model X Vehicles

3.4.3 Cost cutting

The Operating a standard cars/ vehicle costs a lot of money as follows, according to Haoper and Marray (2018, 36).

Table 8. The cost structure of trucking

Motor Carrier Costs	Share of Total Cost
Fuel Cost	21%
Truck/Trailer Lease or Purchase Payments	12%
Repair & Maintenance	19%
Insurance	9%
Permits and Licences	2%
Tyres	3%
Tolls	2%
Driver Wages	23%
Driver Benefits	9%
TOTAL	**100%**

automobiles because autonomous vehicles are not yet fully commercialized. However, there are various assumptions that autonomous vehicles will save money in terms of fuel usage and driver labor expenses.

3.5 Autonomous vehicle requirements, restrictions, and challenges

As a new technology, autonomous vehicles must meet a number of requirements before they can function properly. Infrastructure, laws and regulations, and popular opinion are all factors in these circumstances. Furthermore, self-driving cars are not without problems. They must overcome a number of obstacles to become new driving transportation.

CHAPTER IV

4 In the real world, autonomous automobiles

Three accidents involving autonomous driving systems are given in this section to provide a practical perspective on the technology's challenges and limitations. there's no dominant incidents which demanding self-governing commercial vehicles have been occurred until now, the incidents that will be discussed will largely involve the technological aspects of autonomous driving in general.

4.1 trainer has been killed in a car accident during using Autopilot robotics.

Background

First Autopilot has been released in Tesla factory in 2015 Motor S and Autopilot 2015, and later promoted Like the improved autopilot, it is to assist the driver technology supplied by Tesla that, Once activated, it can be directly steer the cars/vehicle to stay in its highway.

4.1.2 The incident

According to Reuters, Tesla car which is Model X was on autopilot Technology dormant with a Mix Trailer Truck near Williston, Florida, driver was driving Tesla car killed during the driving in auto mode nutshelled airtight with the trailer bottom as the slipped covered the trailer of tesla car and continued to proceed. After leaving the road and colliding with multiple barriers, I came to a 110-foot stop. (32.5 meters) away from the road

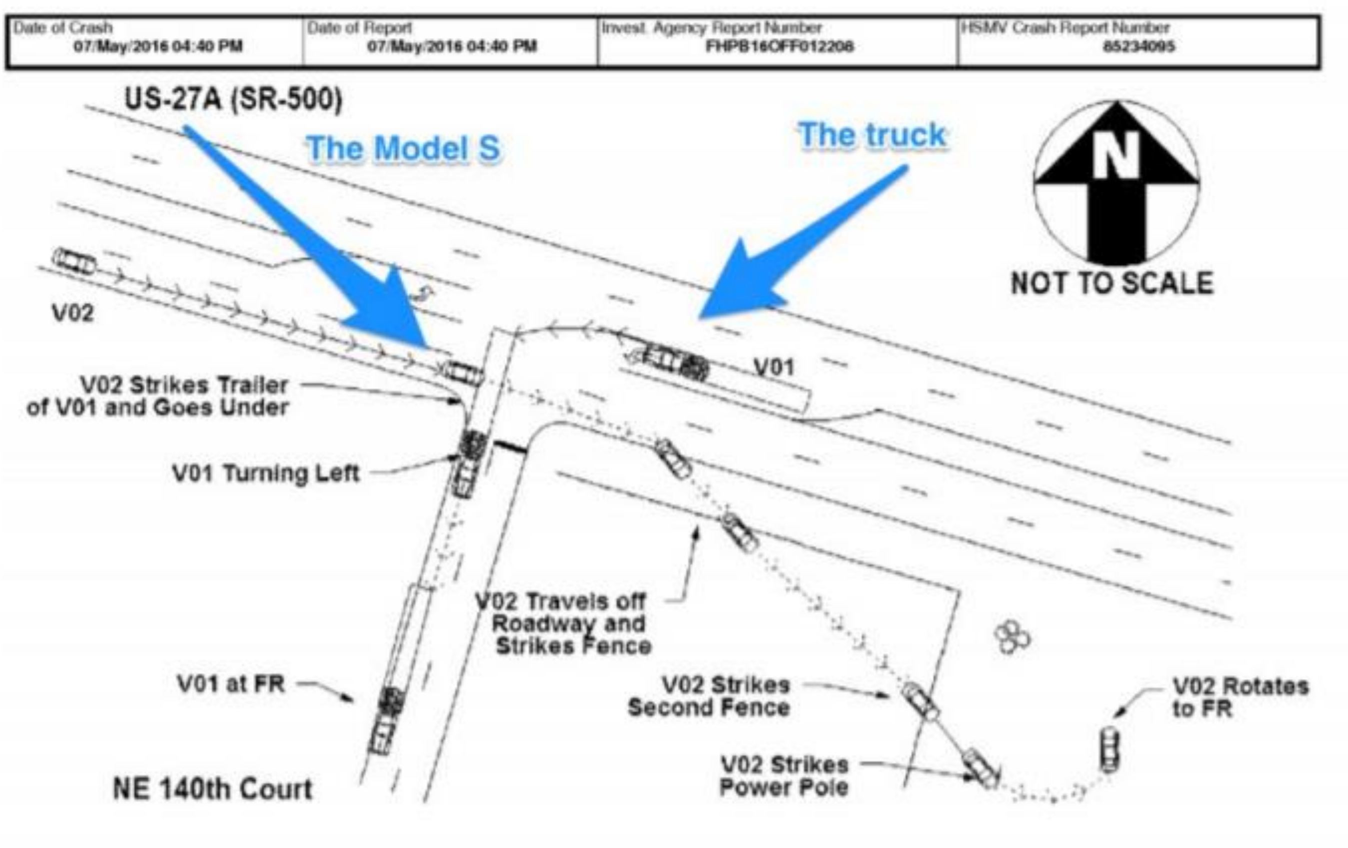

Figure 14. The crash is depicted in this diagram.

The Tesla was travelling straight and without slowing down because it had the right of way over the truck ready to make a left turn. As a result, the Tesla followed the laws, whereas the truck driver was at fault for turning without his right of way.

4.2 Pedestrians were killed by Self Driving cars.

4.2.1 Background

According to the Associated Press, Tesla has Self Driving cars which been tested in America from Merch 2019, With a safe driver in the driver's seat to monitor and act if necessary. Which is famous for its peer-to-peer ride-sharing service, has given customers in Tempe, Arizona the option of taking a self-driving car ride. Gov. Doag Doeey praised the program after riding in one of the cars on Merch 21st 2018

4.2 -2 The incident

in accord with the New York Times a lady ,she was hit by a self-driving car operated by Tesla in Americ on March 18th, 2018. The car has a driver at the wheel and was traveling at roughly 40 miles per hour 69,37 kilometers per hour in autonomous driving auto mode when it collided with the victim, Ms. Hsrzberg, 42, who was walking crossing the street with her bicycle, as shown in Figure 15. Wakcbayashi 2019

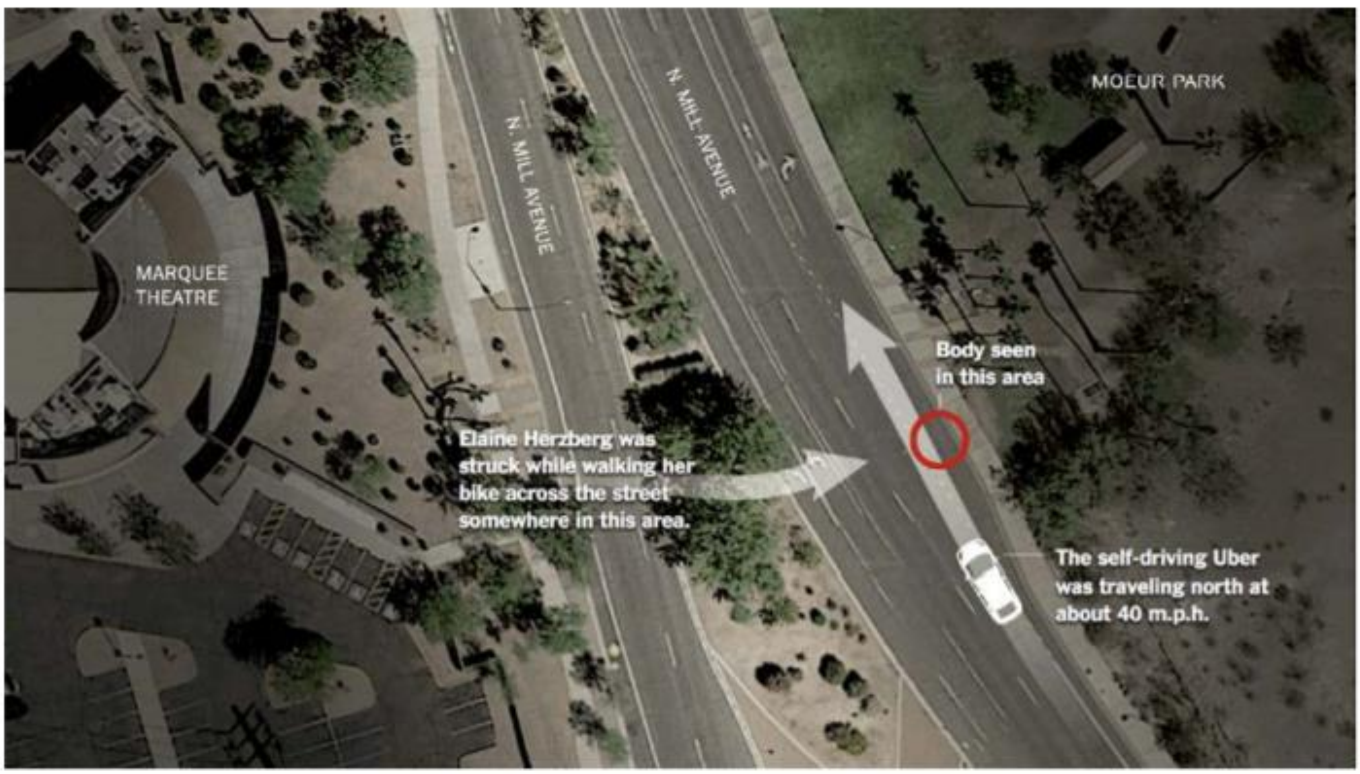

Figure 15. blueprint of the Tempe calamity

According to the Tempe Police Department, the automobile showed no signs of slowing down before the fatal collision (Hewkins 2019b). Tempe authorities has been released footage from a dashboard camera which was recording from the vehicle on May 21st, three days after the event, showing the indoor and dissenter in the vehicle.

Figure 16. image from the outgoing

Meanwhile, she was not giving consideration to the line and her hands were not on the orienting wheel in the second video posted. When the incident occurred, she was visibly distracted and seemed stunned.

4.3 Remarks about the situation

There are a few commonplace elements that show the frequency of mishap in this position

- Self Driving mode autonomous car driver's dismal it. The drivers in same opportunity there are not giving attention to the traffic and there were not prepared to interfere.

- independents cars modes unsuccessful to interact in a human like manner to unanticipated events caused by other human driver actions. In both occasions, he self-governing vehicles did not slow under until the clash released hinting that they were unable to detect the possibility of an mishap.

CHAPTER V

5- Conclusion

5.1 Research results

The proposed research topics in Chapter 2 were satisfactorily addressed by the study. In conclusion, Autonomous driving has What can be imagined to dramatically improve amount carrier ability over time. As discussed in chapter 3, a driver's productivity might theoretically rise by up to 55% if the technology is adopted. Even though the technology is still in its early stages of deployment, it is already improving road safety, as seen by the drained incident collection of cars by up to half after the pursuance of autonomous driving propulsive systems, as indicated in chapter 3.

However, as of May 2019, the improvement in cost efficiency is dubious due to a number of unknown aspects involving the expenses of performing self-governing trucks as no driverless trucks have been extensively commercialized. According to certain research, driverless in general trucks, and autonomous cars/vehicles have the likely to save money on gas and employment. However, because of the ambiguity surrounding central and preservation outlay, it hard and difficult for the autonomous trucks would curtail total consignment region structure costs or not all that is definite is of traffic structure will be changed.

5.2 research suggestions for the future

Because the study was undertaken during the early stages of Install and upgrade autonomous driving machinery the chunk and change of data available was defined. As of May 2019, autonomous vehicles North America, Africa, and Australia was the first to be tested in to a narrow amount.

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Appendix

Test.py

```
import argparse
import cv2
import numpy as np
import tensorflow as tf
from glob import glob
from os.path import join
from traffic_light_dataset import TrafficLightDataset
from traffic_light_classifier import TrafficLightClassifier


def parse_arguments():
    """
    Parse command line arguments
    """
    parser = argparse.ArgumentParser(formatter_class=argparse.ArgumentDefaultsHelpFormatter)
    parser.add_argument('checkpoint_path', type=str)
    parser.add_argument('--mode', type=str, choices=['from_npy', 'from_file', 'from_dir'], required=True)
    parser.add_argument('--data_path', type=str, required=True)
    parser.add_argument('--resize_h', type=int, default=64, help='Height to which input is resized')
```

```
    parser.add_argument('--resize_w', type=int, default=64, help='Width to which input is resized')
    return parser.parse_args()


def load_test_data(args):
    """
    Load a data batch to perform inference, according to selected mode.
    """
    dataset = TrafficLightDataset()

    def read_and_resize_image(image_path):
        image = cv2.imread(image_path, cv2.IMREAD_COLOR)
        return cv2.resize(image, (args.resize_h, args.resize_w))

    # Load a random batch of data from a `.npy` dataset
    if args.mode == 'from_npy':
        dataset.init_from_npy(args.data_path)                  # Init traffic light dataset
        x_batch, y_batch = dataset.load_batch(batch_size=16)  # Random batch of examples

    # Load a single image from disk
    elif args.mode == 'from_file':
        image = read_and_resize_image(args.data_path)
        x_batch = np.expand_dims(dataset.preprocess(image), 0)
        y_batch = np.ones(shape=(x_batch.shape[0], 1)) * -1   # -1 means label not available
```

```
    # Load all images in a certain directory
    elif args.mode == 'from_dir':
        x_batch, y_batch = [], []
        image_list = glob(join(args.data_path, '*.jpg'))
        for image_path in image_list:
            image = read_and_resize_image(image_path)
            x_batch.append(dataset.preprocess(image))
            y_batch.append([-1])                    # -1 means label not available
        x_batch = np.array(x_batch)
        y_batch = np.array(y_batch)
    else:
        raise ValueError('Mode: "{}" not supported.'.format(args.mode))

    return x_batch, y_batch



if __name__ == '__main__':

    # Parse command line arguments
    args = parse_arguments()

    # Load data on which prediction will be performed
    x_batch, y_batch = load_test_data(args)
```

```
# Define model
classifier = TrafficLightClassifier(input_shape=[args.resize_h, args.resize_w], learning_rate=1e-4)

# Add a saver to save the model after each epoch
saver = tf.train.Saver()

with tf.Session() as sess:

    # Restore pretrained weights
    saver.restore(sess, args.checkpoint_path)

    # Predict on loaded batch
    prediction = sess.run(fetches=classifier.inference,
                          feed_dict={classifier.x: x_batch, classifier.keep_prob: 1.})
    prediction = np.argmax(prediction, axis=1)  # from onehot vectors to labels

    # Qualitatively show results
    for b in range(x_batch.shape[0]):

        # Revert data normalization
        image = x_batch[b]
        image += np.abs(np.min(image))
        image *= 255
```

```
        image = np.clip(image, 0, 255).astype(np.uint8)


        # Display result

        image = cv2.resize(image, (256, 256))

        cv2.imshow('PRED {} GT {}'.format(prediction[b], y_batch[b]), image)

        cv2.waitKey()

import socket


from keras.models import import load_model




from PIL import ImageGrab

import numpy as np

import cv2

import os


#Load the model.

model = load_model('Directory/To/Load/Your/Model/YourModelName.h5')     # Directory to load
the model




# Socket Tcp Connection.

host = "127.0.0.1"

port = 25001       # Port number
```

```
#data = "1,1,11"        # Data to be send
sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)    # TCP connection
print("starting connection")
try:
    sock.connect((host, port))                  #To connect ot the given port.
    print("Connected")

except:
    print("Might happen socket is closed!")
#######

def send_data(steering_angle, throttle):
    data_01 = str(steering_angle)
    data_02 = str(throttle)
    data = data_01 + ',' + data_02
    sock.sendall(data.encode("utf-8"))          # To send the data

steeringAngleList = []
velocityList = []
throttleList = []

steeringAngle = 0
velocity = 0
throttle = 0
```

```
arr1=[]

arr2=[]

arr3=[]

splitted_data = []

reply=[]

def socketConnection():

    global globalsteeringAngle

    global velocity

    global throttle

    try:

        #data = "1,0"


        reply = sock.recv(2048).decode("utf-8")    # To receive the data

        #######send_data(reply)

        #print("Actual data received is: ", reply)


        splitted_data = reply.split(',')

        #print("after splitting the data: ", splitted_data)

        arr1.append(splitted_data[0])

        arr2.append(splitted_data[1])

        arr3.append(splitted_data[2])


        steeringAngle = float(splitted_data[0])
```

```
        velocity = float(splitted_data[1])

        throttle = float(splitted_data[2])


    except:

        print("Exception")


    steeringAngleList = np.array(arr1)

    velocityList = np.array(arr2)

    throttleList = np.array(arr3)


    return steeringAngleList, velocityList, throttleList, steeringAngle, velocity, throttle




filename = 'Directory/To/Csv/File/YourCSVFile.csv'          #Directory to save your current Data in a
csv file.


def csv_file(steer_Angle, velocity, throttle):


    #print("Writing to csv file!")

    f = open(filename, "w")

    f.write("{},{},{}\n".format("Steerring Angle", "Current Velocity", "Throttle"))


    for x in zip( steer_Angle, velocity, throttle):

        f.write("{},{},{}\n".format(x[0], x[1], x[2]))
```

```
    f.close()


#############################

MAX_SPEED = 25

MIN_SPEED = 10

speed_limit = MAX_SPEED


def preprocess(image):

    return cv2.resize(image, (200, 66), cv2.INTER_AREA)
```

Drive.py

```
def drive(image, steering_angle, velocity, throttle):


    try:

        image = np.asarray(image)       # from PIL image to numpy array

        image = preprocess(image)       # apply the preprocessing
```

```
    image = np.array([image])       # the model expects 4D array



    steering_angle = float(model.predict(image, batch_size=1))

    steering_angle = (steering_angle/10)

    global speed_limit

    if velocity > speed_limit:

        speed_limit = MIN_SPEED  # slow down

    else:

        speed_limit = MAX_SPEED

    throttle = 1.0 - steering_angle**2 - (velocity/speed_limit)**2



    print('{} {} {}'.format(steering_angle, throttle, velocity))

    steering_angle = (steering_angle*10)

    send_data(steering_angle, throttle)



except Exception as e:
```

```
        print("Exception Occured", e)



num = 0

path = 'Directory/To/Save/Your/Current/Image'        # Destination/path to which all the current images
will be saved

while (True):

    num = num + 1

    imageName = 'Wasil'+ str(num) + '.png'      # Name of the images.

    #collecting current data

    strAngl, vlcty, thrttl, steeringAngle, velocity, throttle  = socketConnection()

    image = np.array(ImageGrab.grab(bbox=(0, 120, 750, 540)))         # Taking the screebshot and
adding in the array



    csv_file(strAngl, vlcty, thrttl)
```

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