Ai approach for road Safety

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Abstract

Abstract goes here

Dedication

To mum and dad

Acknowledgements

I want to thank...

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Nomenclature

ADAS Advanced Driving assistance Systems

BSM Blind-Spot Monitoring

DAA Driver Attention Alert

DAS Driving assistance Systems

LAS lane keep assist system

LIDAR Light Detection and Ranging

NHTSA National Highway Traffic Safety Administration

RADAR Radio Detection and Ranging

Chapter 1

Introduction

Recently, the development of advanced driver assistance systems (ADAS) has facilitated people's daily life from comfort to safety. However, these systems are complex [5], utilizing vehicle parameters, environmental observations, and traffic patterns to assist the driver. These systems are added cost-to-ownership due to the added expense of sensors and computing hardware needed to perceive the environment, especially in real-time monitoring. Thus, further development in this area is needed to improve reliability, performance, and decrease costs.
This work describes a driver assistance system based on computer-vision techniques.

1.1 Background and Problems

According to the World Health Organization (WHO) [3] around 1.3 million people die each year as a result of road traffic accidents, in addition to 50 million serious injuries. This cost most countries 3% of their gross domestic product.In 2016

The report also highlights More than 90% of road traffic deaths occur in low- and middle-income countries. Road traffic injury death rates are highest in the African region. Even within high-income countries, people from lower socioeconomic backgrounds are more likely to be involved in road traffic crashes.

Although current "*passive*"[1] and "*active*"[2] safety systems [15] can reduce the impact of traffic accidents, only a few car accidents are caused by bad weather and unsafe road infrastructure while most by human fault [1], such as: [3]
-Speeding

[1]Passive systems such as air-bags, seat belts, padded dashboards, or physical structure of a vehicle, normally help to reduce the severity or the consequences of an accident.

[2]Active systems like adaptive cruise control (ACC), automatic braking systems (ABS), or lane departure warning systems (LDWS) are designed to prevent or decrease the chance of crash occurrence.

-Driving under the influence of alcohol and other psychoactive substances
-Nonuse of motorcycle helmets, seat-belts, and child restraints
-Inadequate law enforcement of traffic laws

According to [4] the most likely causes of car accidents are: the driver may lose concentration on the road when driving, drivers falling asleep at the wheel, driver fatigue, or driver distraction, no matter the driver is experienced or not. A study in the United States by the National Highway Traffic Safety Administration (NHTSA) [2], confirms that almost 80% of all types of vehicle accidents involve driver fatigue, driver drowsiness, or driver distraction (in general, distracted driving), with the high speed, may cause the driver to have no time to realize the road status, which leads to car accidents.

These shocking statistics highlight the importance of research and development of advanced driver assistance systems (ADAS) focusing on *"Driver Monitoring"* by driver behavior analysis as well as *"Road Monitoring"* by road hazards detection.

1.2 Motivation

Various driving assistant systems have been developed in automotive engineering, the U.S. National Highway Traffic Safety Administration (NHTSA) defined six levels of automation from level 0 to level 5, which describes the relationship from no autonomous driving to fully autonomous driving in automotive engineering, see 1.1 .

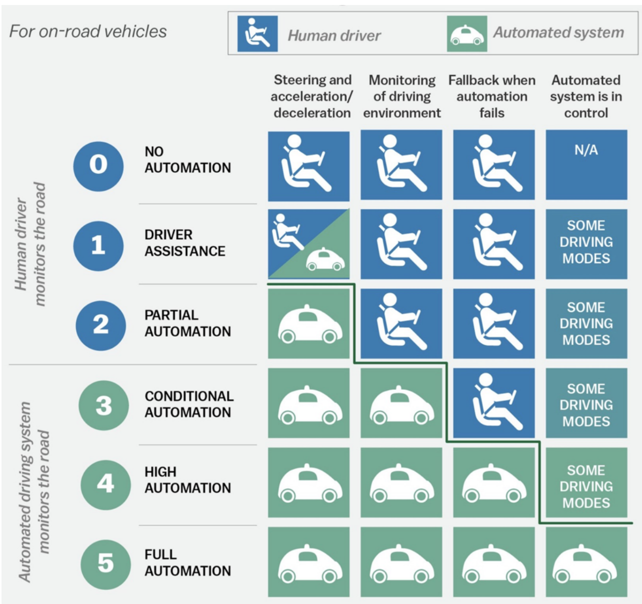

Figure 1.1: The Evolution of Automated Safety Technologies

According to the figure 1.1, in the first level, the driver needs to drive the vehicle and focus on the road to react as soon as possible. In levels 1 and 2, driving automation applies to vehicles with (ADAS) that can take over steering, acceleration, and braking in specific scenarios. But, even though level 1 driver support can control these primary driving tasks. In level 3, the system detects the environment to decide whether the driver needs to drive the vehicle, which is called conditional automation. Level 4 and level 5 indicate high automation and full automation respectively, which means the system will fully control the vehicle.

Among these levels, an (ADAS) is considered to be the basic and important component. Generally, An *ADAS* is an electronic system in a vehicle that uses advanced technologies to assist the driver [9]. It can include many active safety systems, such as [10] lane keep assist system (LAS), blind-spot monitoring (BSM), driver attention alert (DAA), and many other systems that work together to increase the safety of drivers, passengers, pedestrians, and other road users.The objective is to recognize critical driving situations by perception of the vehicle and the divers as *internal parameters*, road as *external parameters*, and the weather and lighting condition as *additional parameters*.

To collect these parameters. ADAS and autonomous driving functions feed off a continuous stream of information about the environment surrounding the vehicle, and it's the sensors' job to provide that [12] see the figure 1.2.

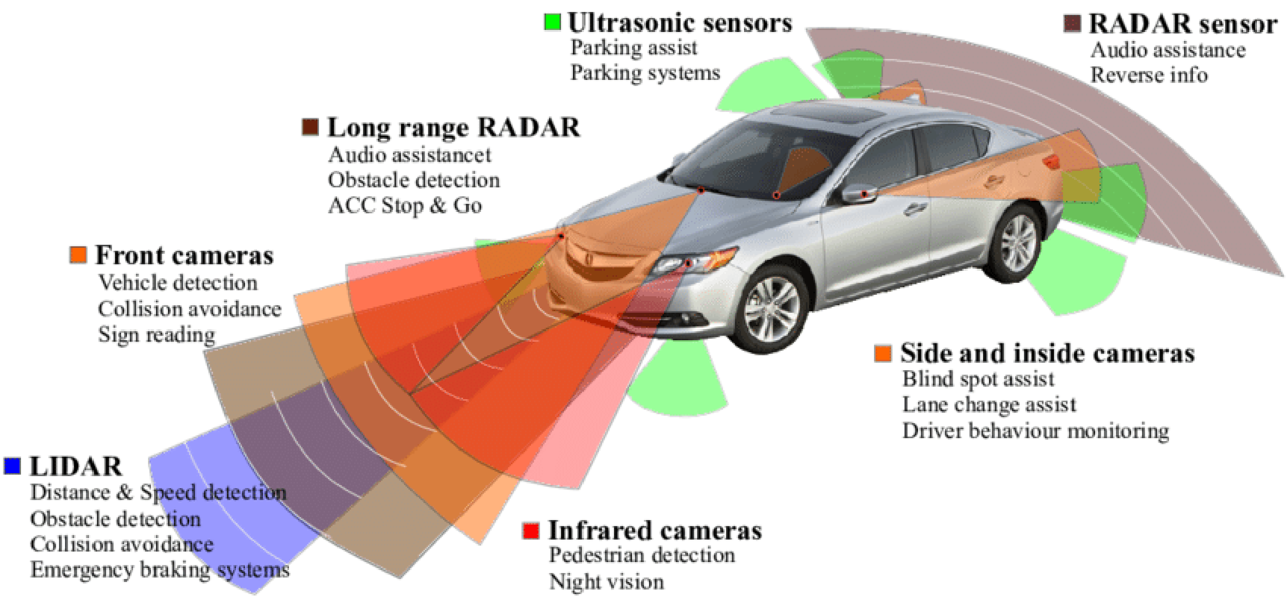

Figure 1.2: Typical types of sensors for ADAS

The three main sensors used by the automotive industry to maintain the perception for autonomous vehicles at various levels of autonomy are [12]:
Ultrasonic sensors [6], (RADAR, LIDAR) [8], Cameras [7].

Ultrasonic sensors operates by transmitting short bursts of sound waves and measuring the time taken for the sound to travel to a target object, be reflected, and return to the receiver, they are usually used for short-distance applications at low speeds, such as park assist, self-parking, and blind-spot detection.

RADAR (Radio Detection and Ranging) sensors emit radio waves and analyse the bounced wave via a receiver. Because RADAR signals can range 300 meters in front of the vehicle, they are particularly important during highway speed driving. Additionally, RADAR can see through bad weather and other visibility occlusions. Because their wavelengths are just a few millimeters long, they can detect objects of several cm or larger . LiDAR (Light Detection and Ranging) systems are used to detect objects and map their distances in real-time. Essentially, LiDAR is a type of RADAR that uses one or more lasers as the energy source. LIDARs can provide a higher resolution result but in a narrower angular field.

Camera sensors are similar to regular consumer cameras, like those that equip most smartphones. They are cheaper than both RADAR and LIDAR sensors. They can be adapted to any vehicle and any user can use them with no difficulty. For many years the fields of computer vision and image processing have used them to solve their problems. On the other hand, camera's performance drops dramatically under bad lighting conditions and they generally need a more complicated post-processing (image processing, image classification, and object detection) in order to convert the raw perceived images into a meaningful information.

Each of the above mentioned sensors have advantages and disadvantages, so that the ideal system would be a combination of all three.

1.3 Related Work

There is a wide range of research topics under the umbrella of road safety and driver assistance systems (DAS) such as *traffic signs recognition* [x], *lane detection* [x] *pedestrian detection* [x], *vehicle detection* [x], and *driver behaviour monitoring* [x] including driver fatigue, drowsiness and distraction detection. However, at a higher level, the research could be classified into two main categories: the research related to “Road monitoring” and the research works that focus on the “Driver monitoring”.

1.3.1 Driver monitoring

bla bla bla

1.3.2 Road monitoring

bla bla bla

1.4 Thesis Organization

bla bla bla

Chapter 2

Theory and Concepts

In this chapter, we will simply introduce some basic concepts, methods, and mathematical background that we use in this thesis. We also provide symbols, image notations, and the equations that will be consistently used in the following chapters.

2.1 Digital Image Processing Basics

Digital Image Processing means processing digital image by means of a digital computer. We can also say that it is a use of computer algorithms, in order to get enhanced image either to extract some useful information [11].

In Digital Image Processing, signals captured from the physical world need to be translated into digital form by Digitization[1] Process. In order to become suitable for digital processing.

An image is defined as a two-dimensional function,I(x,y), where x and y are spatial coordinates, and the amplitude of I at any pair of coordinates (x,y) is called the intensity of that image at that point.An image must be digitized both spatially and in amplitude [11]. This digitization process involves two main processes *Sampling*, and *Quantization* [14].

2.1.1 Sampling

In digital image processing, Sampling is the reduction of a continuous-time signal to a discrete-time signal.Since an analogue image is continuous not just in its co-ordinates (x axis), but also in its amplitude (y axis), so the part that deals with the digitizing of co-ordinates is known as sampling [13], see Figure 2.1 .

[1]Digitization: is the process of converting information into a digital (i.e. computer-readable) format.

2.1.2 Quantization

Quantization is the process of mapping input values from a large set to output values in a smaller set, often with a finite number of elements. Quantization is the opposite of sampling, It is done on the y-axis [13], see Figure 2.2

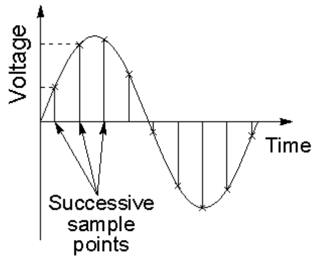

Figure 2.1: Sampling an analogue signal

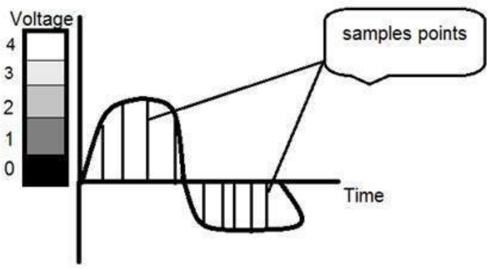

Figure 2.2: Example of Quantization

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