Abstract—The equipment that vehicles have nowadays makes driving more and more comfortable, reliable and, over all, safer.

Technology in vehicles does not only include devices based on classical matters such as mechanics, electricity and electronics, but the use of communications and computers is becoming increasingly frequent.

This article describes some of the devices that can be considered representative of the huge technological evolution that vehicles have had recently.

Some of them, like automatic gearboxes, have been well established in the market for a long time, whereas other features, like assisted parking systems, are more recent.

I. INTRODUCTION

The concept of Cybernetics is introduced in modern times in the work [Wiener, 1948], where a theory relates men and machines. In that sense, vehicles have played a key role in the last decades in the development of society and economy, and our most recent history could be hardly understood without this widespread popular mean of transport. During this time, their technical features and performance have been enormously developed in a way that the current technology allows a more and more comfortable and safer driving.

Though the driver’s action is still crucial in many aspects, thanks to the different vehicle devices driving is becoming more and more autonomous and independent from the driver. Mechanics, electricity, electronics, computing and communications are behind all these developments, since they are generally mechatronic devices, as it is shown in the work [Bolton, 2010].

Some examples of these devices are automatic gearboxes, the electronic stability program (ESP), the adaptive cruise control, the lane change warning system, the emergency call system, the assisted parking systems, the multiplexed systems and connectivity. All these systems are explained in the next sections.

II. AUTOMATIC GEARBOXES

The first automatic gearboxes appeared in the market in the United States in the 40’s and 70 % of the vehicles of this country had already automatic gearboxes in the 50’s. Nevertheless their success has varied from country to country. In 2000 ninety per cent of the vehicles in the USA had automatic gearboxes, 70 % in Japan and only 16 % in Europe.

Till the 80’s automatic gearboxes had no electronic central unit to control the gears. The gear shift depended on the accelerator’s position and the control was done by a set of valves that were moved by the oil pressure difference around them. It was a hydraulic control system.

When electronics came into the market, at the end of the 80’s the gear shifts were not done by mechanic references any more, but by a set of rules established by electronics. Several sensors measure the vehicle’s speed, the accelerator’s position and speed, the connected gear, etc. This information is received by the electronic central unit that sets the connected gear at every moment.

The functioning of the different automatic gearboxes is explained in [Brejcha and Tuuri, 2000] and in [Birch and Rockwook, 2006], and can be classified into two main groups: semiautomatic and automatic.

1) Semiautomatic gearboxes: there are the following types:
- Electric automatic gearboxes: they are called robotic automatic gearboxes too. Their internal architecture is very similar to the conventional manual gearboxes one. But there is a difference: in conventional gearboxes the driver pushes in the clutch and shifts the gears, and in these automatic gearboxes the driver shifts the gears when he presses a button or operates a lever. The Selespeed gear shift by Alfa Romeo is an example of this type of automatic gearbox.
- Electrohydraulic automatic gearboxes: similarly to electric ones, they are manual gearboxes that include an automatic system to shift the gears. Instead of using electric motors to shift the gears, they use a hydraulic system that works with variations of oil pressure in the different circuits. As it happens in electric gearboxes, the command system is managed by an electronic unit that modifies the hydraulic system through electro valves.
- Dual clutch transmission gearboxes: they are semiautomatic gearboxes with two different clutches for odd and even gears. They have two oiled multidisc clutches that are hydraulically commanded, but they are electronically managed. The most outstanding system in the market is made by Volkswagen, it is called DSG (Direkt Schaltgetriebe).

2) Automatic gearboxes: they characteristically have epicycloidal gearings commanded by multidisc clutches and braking bands. Till the end of the 80’s
Automatic gearboxes had no electronic components and they were hydraulically commanded. Since then, thanks to electronics, automatic gearboxes have incorporated more and more functions. Generally speaking, you can distinguish three types of authentic automatic gearboxes with electronic management:

- **Automatic gearboxes with simple electronic management**: the intervention of Electronics is small, so the shift management is quite old-fashioned since it provides a poor adjusted functioning to the driver’s needs. Electronics in these gearboxes has the tendency to shift to a shorter gear if you accelerate and the opposite if you release the accelerator.

- **Intelligent or autoadaptive gearboxes**: the aim of these gearboxes is to adapt to the driver’s needs and driving styles at all times, learning the habits of the driver. They have different acting rules and to decide the most suitable one it uses the information provided by several sensors: accelerator’s position and action speed, vehicle’s speed, engine torque, slope, gearbox temperature, etc. Renault and PSA developed together in 1997 an autoadaptive gearbox, which was called “proactive” by Renault and “auto active” by PSA (figure 1).

- **Automatic-sequential gearboxes**: they have a sequence to vary transmissions, so the shift lever does not have a set position for every gear, but it has to be moved touching it up, down or sidewards to shift gears. They have two ways of working, one is completely automatic, when the gearbox shifts the right gear, and another one is manual (sequential), when the driver decides the most suitable gear and shifts it by touching the shift lever. The sequential gearbox came into the market in 1990 in the Porsche 911 and it was called Tiptronic. Afterwards several car-makers like Volkswagen, Volvo and BMW launched their own sequential gearbox versions with different names.

### III. ELECTRONIC STABILITY PROGRAM (ESP)

The electronic stability program (ESP) is a registered trademark by Bosch [Bosch, 2012] and it is one of the most important active safety systems in vehicles and the most revolutionary one of the last years. The aim is to keep control of the vehicle when the driver has lost control of it in any situation, especially when driving on wet or icy roads or in rollovers. To do it, it activates the motor and the brakes in a selective way.

The ESP efficiency is limited by the vehicle speed and the available wheel grip. The ESP is able to detect the risk of skidding and to compensate for it specifically acting together with the ABS and traction control systems.

The ESP system has an electronic control unit and a hydraulic block at its side that automatically applies the brakes to wheels individually and different sensors that check at every moment the expected reaction of the vehicle and the actual one. If the information that the ESP control unit receives is different, that is, if the direction the driver intends to go is different to that of the vehicle, the control unit can assess that it is a critical situation and that it is necessary to intervene.

The critical situation can be dynamically shown in the vehicle in two ways:

1) **The vehicle tends to understeer**: the ESP System prevents the car from going out of the road and it applies specifically the brake at the inner rear wheel (figure 2) as well as controlling the engine and the gears shift.

![Figure 2 - ESP working if the car understeers](image2)

2) **The vehicle tends to oversteer**: the ESP System prevents the car from skidding and it applies specifically the brake at the outer front wheel (figure 3) as well as controlling the engine and the gears shift.

![Figure 3 - ESP working if the car oversteers](image3)
IV. ADAPTIVE CRUISE CONTROL

The adaptive cruise control (ACC) has an electronic control unit and controls at the steering wheel position with which the driver can adjust manually the vehicle’s speed. The car will go at the set speed with no need to accelerate.

If the car at the front is slower, the system slows down the set speed automatically and there is no need for the driver to touch the vehicle’s controls or to brake so the vehicle is placed at a set distance behind the vehicle at the front. If that vehicle changes lanes, the ACC recovers the set speed again so it accelerates the vehicle engine to get the set cruise speed. In the case that the driver wishes to overtake at a higher speed, the system has the option to accelerate.

The system has a distance sensor which is a microwave radar placed at the front of the vehicle that emits an electromagnetic wave by means of an antenna. This wave is reflected by an object into the radar’s beam and received again. The system measures the propagation time between the signal emission and the echo reception, so it can calculate the front vehicle’s distance and speed.

The control unit processes the information from the distance sensor and decides if there is a vehicle that goes into de set distance and it calculates the vehicle’s theoretical acceleration. This acceleration is transformed into appropriate control signals for the systems attached to the engine and the brakes.

V. LANE CHANGE WARNING SYSTEM

One of the most common causes of traffic accidents is the loss of control of the vehicle due to, in most of the cases, absent-mindedness or somnolence of the driver. These losses of control cause lane changes or driving out of the road and drivers and passengers are in big danger. In the last years, different car-makers have developed systems to warn the driver of a possible unintended change of driving direction.

Nowadays there are different technologies based on infrared, radar or video systems, so sensors are oriented to the ground to detect if the vehicle goes beyond the white lines that delimit the road. One of these systems based on infrared rays is explained in [Citroen, 2012].

When the vehicle goes beyond one of these side lines without switching the indicator, the system central unit warns the driver by a vibration in the driver’s seat at the same side of the line or in the steering wheel. Some of these systems work on the steering wheel and correct automatically the direction of the vehicle. This device, which is active from a set speed of 60 km/h, is designed for drivers in motorways.

E-CALL SYSTEM

The e-call system is an initiative of the European Commission to provide quick help to drivers who have had a car accident. The European Union intends to introduce this system in every new vehicle from 2014 onwards.

The project proposes to use a device installed in vehicles and in case of an accident, an automatic call to the emergency number 112 is made. At the same time some data about the incident is sent to the 112 Center operator: position and direction of the vehicle, time of accident, type of vehicle, etc.

The system can be activated manually by the vehicle passengers or automatically if system sensors detect an impact. At this moment the emergency call device installed in the vehicle calls a PSAP (Public Safety Answering Point) using the 112 voice channel.

The call has two elements: one voice connection using the 112 number and one SMS message which includes Essential Data (MSD) and which is sent through the set voice channel. This can be done thanks to GSM/GPRS/UMTS technology (figure 4).

VI. ASSISTED PARKING SYSTEMS

Car-makers offer some technological devices to help us and make parking easy. These systems are based on sensors installed on bumpers, mainly the rear ones, and give information about obstacles in blind spot areas and the distance to park. Some of the pioneers are equipment makers like Valeo [Valeo, 2012] and Bosch.

They work in a simple way: sensors, which can be ultrasound or microwave ones, are activated when the car is reversing and they detect any kind of obstacles at a distance less than 1.5 meters (figure 5). This information is sent to a control unit that processes all the data and a loudspeaker converts it into an acoustic signal, the frequency of which becomes higher if the vehicle gets closer to the object. This sound becomes a continuous beep if the distance is less than 30 centimeters. It may have an extra visual warning thanks to LED lights or an LCD screen to improve the parking precision.

On the other hand, some car-makers like Volkswagen, Mercedes, BMW and Toyota [Toyota,
2011] go further and include a system to parallel park the vehicle in a very easy way. After detecting a big enough parking space, it steers the car and the driver only has to accelerate and to brake during parking.

Another interesting application for the “connected car” is to know the use of the vehicle at every moment: driving time, average speed, sudden braking, acceleration, etc. This information is gathered from the vehicle and sent to a server. It can be useful for rent-a-car providers, company cars, or insurance companies, which can establish the premium prize depending on the driving.

IX CONCLUSION

Vehicles have a big variety of mechanic, electric and electronic devices to make driving as comfortable and safe as possible. Their technology is being constantly developed and telematics will have a relevant role in it in the near future.

X FUTURE WORK

Safety will be still the most decisive factor in the technological development of vehicles. There are different research areas to work on and some of them are as follows:
- Communication among vehicles as a way to prevent accidents.
- The development of an autonomous driving vehicle, that is, with no human intervention.
- The intelligent traffic management on roads and cities depending on their capacity and the flow of vehicles at every moment.

REFERENCES