Telematic systems in process of ensuring the safety in motor transport

J. MIKULSKI*, A. KALAŠOVÁ

* UNIVERSITY OF ECONOMICS IN KATOWICE, Faculty of Economics, ul. 1 Maja 50, 40-287 Katowice, Poland
b UNIVERSITY OF ŽILINA, Faculty of Operation and Economics of Transport and Communications, Univerzitná 1, 01026 Žilina, Slovakia
EMAIL: mikulski.jurek@gmail.com

ABSTRACT
A particular example that illustrates the application of telematics is modern transport. The transport telematics covers the systems, which allow, due to the transmission of data and their analysis, to influence the behaviour of the traffic participants or the operation of the technical elements in the vehicles, relatively during the travel. The development of the field of intelligent transport (ITS) aims at increase in safety and comfort of travel. The protection against the results of accidents can be aided by the development of technology in a discipline of automotive telematics. The purpose of this work is to introduce the technological novelties regarding the transport safety that are present on the market or about to be introduced.

KEYWORDS: automotive telematics, transport safety

1. Introduction
Presently, in times of huge technological and scientific development there is a lot disciplines in the world that this development can be seen very clearly. One of them is definitely the field of information technology and telecommunication - called telematics.

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2. Intelligent Transport Systems (vehicle)
Nowadays, the modern technologies are the subject of interest of science and automotive industry. The scientists develop and the car manufacturers introduce more and more modern systems that allow to increase the comfort and safety of travel. The Advanced Driver Assistance Systems are designed for the safety of travel and to increase the safety on the road.
2.1. Anti-lock Braking System

The ABS system was first introduced in cars in the 1970s. It prevents the wheels from blocking as a result of automatic change in the braking pressure in a situation when the driver presses the breaking pedal strongly. On the slippery pavement, where the friction between the road surface and the tyre is low the wheels can block easily, which causes to lose control over the vehicle. The system allows the driver to remain control over the vehicle and in most cases manage to stop the car in short distance, by not letting the wheels to block.

Standard ABS system consists of the circuit that controls the rotational speed of each wheel and the circuits that deliberately decrease the pressure in each breaking section, and in more expanded systems, in each wheel. The ABS system detects the sudden decrease in rotational speed of each wheel and lowers the pressure force of the particular break to the point, when it detects the acceleration again.

It is worth mentioning that the ABS system has a significant meaning in the sets composed of many vehicles, e.g. a car with a trailer, or a truck-tractor with a trailer. In case of those vehicles, when the second part loses the grip it usually begins to move crosswise to the travel direction and eventually it may cause the whole vehicle to overturn.

Fig. 1. Principle of operation of the ABS system [3]

2.2. Adaptive Cruise Control

Many drivers intuitively use the adaptive speed regulation on the empty roads, however, in the past years the traffic congestion have increased and a new solutions have been searched for. Adaptive Cruise Control (ACC) helps to maintain not only the same speed, but also the distance between the vehicles. Constant accelerating and breaking in the condition of the lack of road traffic smoothness or while driving in a dense traffic on the road is a tiresome experience, for which the preceding vehicle distance control system is perfect solution. The system monitors the movements of the preceding vehicle by utilising the sensors at the front of the car. Even if the car in front suddenly slows down and then accelerates the ACC system maintains the constant distance between the vehicles. It is beneficiary to the driver, as it lowers their stress level and increases the sense of safety.

The development of the system assumes to prepare it for the traffic jam conditions. The vehicle could be stopped completely and if the road is vacant and the driver wishes it, the speed will be adjusted to the previously selected value. The next step is to integrate the ACC sensor and the short range sensor, which will allow to automate the process of approaching. Thanks to the systematic development of radar technology and the electronic circuits the ACC system will be less expensive and in the future it will be available in middle class vehicles.

Fig. 2. The ACC system graphical presentation [4]

2.3. Forward Collision Warning

The warning system may prevent from hitting the back of the preceding vehicle or minimise the results of that kind of collision. The radar constantly „scans” the area in front of the vehicle. If the car approaches too close to another vehicle, the driver is informed of that fact by audio and visual signals. If the risk of collision increases despite the warnings, the breaks are being initially prepared to effective breaking action by the driver. If the collision is highly probable and the driver still does not react, the car automatically engages the breaks in order to decrease the damage effects. There are differences in the level of breaking assistance depending of different types of vehicles.

Fig. 3. An example of FCW system operation [5]

The fundamental part of the system, which retains the safe distance from the proceeding vehicle is the radar.
2.4. Lane Departure Warning System

Lane Departure Warning System is a mechanism that helps the driver maintain the position on the lane. The warning happens via audio signal or vibration on the steering wheel when the vehicle leaves its lane. It was designed to reduce the cause of accidents such as driver's sleepiness or distraction. Additionally, linked with this system is Lane Keeping System, which slightly operates and by intervening into the steering system corrects the vehicle course. The car with the LDW is equipped with a camera placed in the frame of the rear view mirror. The image from it is sent to the computer, which analyses it constantly and checks if the vehicle is still driving between the lines that define the road lane. If the driver does not use the indicators and the car begins to cross the lane, the system will react.

The system does not work on the city roads, crowded streets (under the allowed speed) in order not to distract the driver with unnecessary warning signals. It recognises most of the lines - both white lines and yellow, continuous and dashed lines. If there are no markings on the road or the system is not able to recognise them correctly (e.g. during the road renovation) it will not operate appropriately. Massive falls of rain, snow or traveling on mud or unpaved roads may also cause the system to malfunction. It was designed mainly for motorways and long straight roads.

2.5. Curve Speed Warning

The technology was developed to help the driver in potentially dangerous situation, when the road curves too rapidly and the decision about the turn must be made quickly. The information on such curves is uploaded from digital road maps. Combining those information with the external factors, such as weather conditions and maximal recommended speed on the curve allows to warn the driver when the approaching the curve with higher speed by preparing the safety systems in the vehicle and successful breaking. The results of the CSW system can be improved by linking it with the rain sensors or the Lane Departure Warning System (LDW), as well as with the system that adjusts the lights at night to the outside conditions.

2.6. Blind Spot Detection System

The Blind Spot Detection System is a system that through the number of sensors monitors the area behind and around the car. It warns the driver who intends to overtake and the car that is traveling behind them is in the so-called „blind spot“. The blind spot detecting systems or lane change assistance constantly monitor the blind spots on both sides of the car, and they are used before the overtaking or lane change maneuverers, when the driver sees in their mirror that the lane is vacant and suddenly there is a car moving from behind present in the field of sight. Such situations occur often in the city traffic, leading to accidents if the car was missed due to the blind spot. When the indicator is turned on to show the intent of changing the lane and in that particular time such maneuverer is dangerous, those systems warn the driver about the danger by signalling visually and by slight steering wheel vibrations.
2.7. Night View Assistant

The Night View system increases the visibility during the night travelling and contributes to major improvement of travelling in the dark. The risk of sustaining serious damages due to car accidents after dark and at night is significantly higher than during the day.

The system image operates with the shades of grey and is extremely real. It spots the “cold” objects such as stones, the cargo elements left on the road and the “warm” objects such as people and animals, which allows for appropriately quick reaction of the driver.

2.8. Intelligent Light System

The optimal visibility is and always will be the most important issue. The innovation in this field turned out to be the adaptive Intelligent Light System. It is a system that automatically adjusts to the current road conditions by controlling the headlights, ensuring the optimal illumination of the road. The system is equipped with a bend lighting and active lighting functions, as well as modern, upgraded fog lamps. The system allows to obtain separate streams of light, adjusting to the road and weather conditions.

Apart from those application the ILS has one more function. It changes the driving beam to dipped beam for the driver. It detects the vehicle approaching from the front or travelling in front and adjusts the lights to not blind other drivers.

2.9. Speed Limit Monitoring

The speed limit system utilises a camera placed in the Lane Departure Warning System and by detecting the speed limit signs it displays them on the dashboard screen.

2.10. Potential Collision Detection System

The collision detection system helps the driver during the approach to a junction. There is an option of warning the driver about the pedestrians around the corner (not visible) of the junction by the voice massages or displays on the screen. It is possible because the on-board computer can detect the data transmitted via GPS (Global Positioning System) in the pedestrian smartphone and send them to the navigation system in the car. The system helps the driver to take precaution and to drive safely. Apart from warning the driver the system can also initially prepare the vehicle to “possible” event.
2.11. Electronic Stability Program

ESP is an electronic program that stabilises the ride. The stabilisation system is a system that detects the diversions from the trajectory and changing travel direction. It allows to prevent from an accident that may happen due to inadequate judgement of the road situation, carrying out a sudden maneuver or slippery surface. In such cases the vehicle often loses the grip and begins to skid. The driver is not able to react quickly enough or turns the wheel too rapidly and the vehicle spins around.

The main task of the system is to prevent the vehicle from skidding while passing a curve. The system operates in a manner that on each wheel there is a sensor, which tests the revolution speed of the particular wheel and compares it with the revolution speeds of other wheels. Thanks to that solution the system accurately detects all diversions from the selected trajectory and, if needed, it breaks the individual wheels to stabilise it. The ESP system is a combination of many solutions taken from other systems, including: electronic control of brake force distribution between axles, the torque control system, ABS, traction control system - ASR as well as, in some cases, also the ABS system that supports full use of the brakes in particularly dangerous situations.

2.12. eCall system

The eCall system can automatically alert the appropriate services in case of an accident. Such alert may be done manually or automatically through the sensors, which are being turned on after the accident occurred. The system also directly connects with the 112, sending the most important massages, such as time and place of the accident and the description of the vehicle that participated in it.

The eCall system consists of elements that are visible for the driver and the ones that are installed outside. The visible element is the panel with the alert buttons. One of the elements included in the device is the GPS navigation and the loudspeaker set. However, the most important element, which saves human lives, is the accident sensor that the car will „help” in the situation when the driver and the passengers are not able to call for help on their own.
2.12. Gear Shift Indicator

This system helps the driver to maintain the composed driving style, at the same time allowing to save the fuel and economical driving. The operation of this system is based on the visual indication of the moment in which the gear shift is necessary. All the information needed for the system to function are supplied by the engine control unit. By the GSI system the driver using manual transmission is informed when to change the gear to higher or lower.

2.13. Driver's Fatigue Monitoring System (DFMS)

The older DFMS system is the driver’s attention assistant. This system evaluates the driving style during the travel. The innovative thing is that it does not analyse the driver’s behaviour only in the dangerous moments, but also during normal travel.

The indicator for the generation of the announcement is the time and duration of the travel. The system attempts to analyse a group of factors, from turning the steering wheel that has a special turning angle sensor installed, using pedals to longitudinal and lateral acceleration. If the driver’s reactions derivate from the standards programmed in the system, the information about suggested break to rest is sent to the gages. The key factor when it comes to fatigue is the manner of maintaining the driving trajectory while the driver with signs of fatigue is turning the steering wheel. In connection with the analysis of roadway quality, side wind or the indicator usage the actual physical state of the driver is created.

The newest DFMS systems operate in real time, testing the physical and mental state of the driver based on driver’s face image processing. The system sensors can detect the fatigue or distraction based on the blinking frequency, looking directions, yawning and head movements. The driver’s face monitoring systems can be divided into two categories:

- The first category includes the systems which monitor only the eyes area. Most of the DFMS systems studies is conducted on the eyes area monitoring systems only, due to a believe that the main signs of fatigue and distraction are presented in the eyes area. The “processing” of the eye area instead of the whole face is less complicated. There are also systems that detect the distraction and fatigue on the whole face of driver.
- The second category of Driving Monitoring systems are currently tested systems, where the source of information on the driver’s condition are the physiological signals - EEG (electroencephalogram) or EKG (electrocardiogram). The systems based on the bioelectrical signals are one of the most reliable and accurate systems for detection of fatigue or falling asleep behind the wheel. Those systems are able to supervise the driver constantly in real time, however, in case of the systems based on the vehicle location and the face detection the sensor detects the abnormal signs after they actually occurred, thus, the detection and the reaction of the system are only a few seconds before they might happen.

3. Conclusion

The article discusses the topics connected with the safety on the roads and the technologies allowing for its improvement. It included the technological novelties that are suggested and incorporated in the modern vehicles for the purpose of improvement in convenience of travel, its safety and the facilities connected with participation in the traffic.

Bibliography