FUTURE OF INTELLIGENT TRANSPORTATION SYSTEMS: COMMUNICATION

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Abstract- Thanks to developments in communication technologies are being developed intelligent vehicle systems to the safety of passengers more than. Especially, recent intelligent transformation Systems (ITS) are focused of subjects such as safe driving, traffic situation, collision avoidance alert, and emergency rescue. In many different countries, ITS are being developed to improve the road traffic effectiveness and safety. In general, in three different groups of ITS applications are being developed. Active road safety applications, Traffic efficiency and management applications and infotainment applications. In almost all of these applications are taking advantage of the communication system. Therefore, communication of the vehicles are vital importance. In this study were given information about ITS and communication technologies.

Keywords- Intelligent transformation systems, ITS, Communication, Vehicular networks.

I. INTRODUCTION

Intelligent Transportation Systems (ITS) that aim to streamline the operation of vehicles, manage vehicle traffic, assist drivers with safety and other information, along with provisioning of convenience applications for passengers are no longer confined to laboratories and test facilities of companies [1].
Development and deployment of Intelligent Transportation Systems (ITS) is one of the activities, which has gained interest and momentum especially in the United States. It has gained interest, as it will have direct impact on the homeland security. The fruits of adopting ITS will not be just limited to roadways but in many areas for example if ITS is deployed then it can help in mass evacuation of people in an event of natural calamity or probably it can save many lives if there is an outbreak of fire or any other activity which can cost lives [2].
The next generation of ADAS (Advanced Driver Assistance Systems) will beyond doubt accommodate the room for communication technologies between the vehicles. The required vehicular technology addresses the safety features, which are required to avert accidents due to collisions, alerts driver to the prospective problems, avoiding collisions by incorporating provisions, which can lead to full control of vehicles. Many different ADAS are available out of which some are in built in the vehicle itself and many are available as an add on package. This system is shown in Figure 1.
Leading-edge technologies are already in use and are being developed to improve transportation around the world. Computer and communication systems are integrated to provide an intelligent link between travelers, vehicles, and the infrastructure to address the challenges that modern society faces, such as an increasing number of vehicles on surface routes. Traffic collisions and congestion take a heavy toll in lives, lost productivity and wasted energy. Fulfilling the need for transportation systems which are economically feasible and environmentally efficient requires new ways of solving transportation challenges.

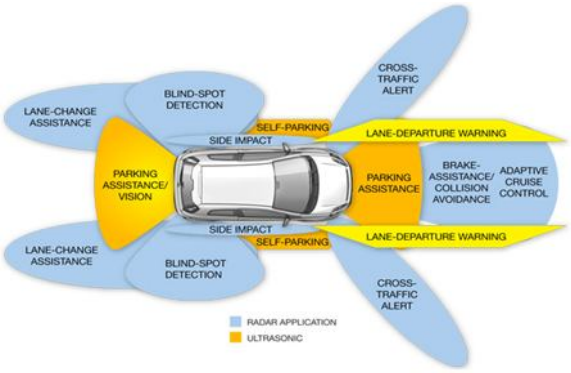


Fig.1. ADAS systems surround next-gen cars. Embedded vision may use cameras along with, or in lieu of, these systems for lower cost implementations [3].

Goals of ITS include moving towards a fully integrated transportation management system, improving efficiency, safety, productivity and general mobility, while reducing threats to travel safety and security as well as the negative effects to the environment such as pollution. Continuing development and integration of new technologies is necessary because of today's constrained transportation agency budgets [4].
The protocols that are needed for the interoperability, constant and faultless flow of information and the related exchange among the information system and devices are provided by the connected vehicle standards. Connected Vehicle Standards provide the software programming codes, definitions, and formats needed to create interoperable, consistent, and seamless communications exchange among shared information systems and devices. USDOT acronym for United States Department of Telecommunication is working hard to strengthen the adoption as well as escalate the deployment of

connected vehicle systems meanwhile taking into account various parameters such as reducing the complexity and the expenses that are involved in the process. To achieve above targeted objectives and costs it is imperative to take into account the interests of the involved stakeholders which by itself defines government policies, the manufactures' interests across various territories and it can only be achieved by harmonizing the ITS standards [1].

II. DESCRIPTION

2.1. Intelligent Transformation Systems (ITS)

The application of advanced and emerging technologies (computers, sensors, control, communications, and electronic devices) in transportation to save lives, time, money, energy and the environment.

Even with this definition, the term ITS is an elastic one, capable of broad or narrow interpretation. It covers all modes, including ground transportation such as private automobiles, commercial vehicles, and public transit, and also rail, marine, and air modes. Because these are dynamic systems, the term 'ITS' is understood to include consideration of the vehicle, the infrastructure, and the driver or user, interacting together dynamically [4].

ITS devices installed in vehicles, roads, bridges and terminals collect information on road and weather conditions, traffic speed, volume and delays, for example. These systems involve vehicles, drivers, passengers, road operators and managers, all interacting with each other and the environment, and linking with infrastructure systems to improve the safety, competitiveness and capacity of our highway network [5].

2.2. ITS Architecture

The National ITS Architecture is comprised of three Layers.

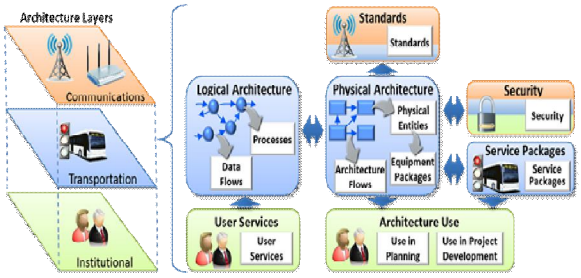


Fig.2. ITS Architecture [6]

The Institutional Layer includes the institutions, policies, funding mechanisms, and processes that are required for effective implementation, operation, and maintenance of an intelligent transportation system. The Institutional Layer is shown as the bottom layer because solid institutional support and effective decisions are prerequisite to an effective ITS program. The Transportation Layer is where the transportation services are defined in terms of the subsystems and interfaces and the underlying functionality and data definitions that are required for each transportation service. This is the heart of the National ITS Architecture. The National ITS Architecture focuses on system integration and system integration requires effective communications. A general description of the communications services and technologies that support ITS is defined in the Communications Layer [6].

2.3. ITS Applications

Below figure shows Subaru's EyeSight system that stereo cameras mounted alongside the rearview mirror. While Mercedes uses a combo camera/radar in its ADAS systems, cameras are by far the cheaper alternative—embedded vision provides added capability with these low cost sensors. Analyst firm Strategy Analytics estimates "100 million cameras will be fitted to light vehicles in 2020" (Roger C. Lanctot; GTC: Merging ADAS and Infotainment for Cloud Enhanced Safety).



Fig.3. Vehicle camera systems [7]

• Adaptive traffic signal control systems which, through the use of various vehicle detection technologies, allow signals to adapt to changing traffic demands while remaining coordinated. Such systems effectively increase the capacity of the road system without expansion.

• Traffic condition data gathered through vehicle detection technologies can be provided to motorists, truckers, transit passengers, fleet managers, dispatchers, etc., to allow them to make informed decisions about critical travel parameters like route/mode choice and travel scheduling. Traveler kiosks in transit stations, changeable message signs on highways, and highway advisory radio systems are good examples.

• Onboard navigation and information systems for motorists are now becoming available in automobiles, allowing drivers to access maps and follow directions to reach their destinations. Manufacturers are also incorporating sensing and control technology for adaptive cruise control and collision warning systems.¨ Transponders, electronic license plates, and

"smart cards" have allowed the implementation of electronic high-speed toll collection, truck weigh-in-motion and pre-clearance programs, and non-stop border crossing.

• Global Positioning Systems (GPS) assist fleet managers in allocating and tracking resources more efficiently. The thermal fatigue test was done in a thermal cyclic furnace. The specimens were tested at 600^0C highest temperature. Heating and cooling time were kept as 10 minutes. When the samples were cooled to the ambient temperature, they were taken out, dried and put into the high temperature furnace again, repeating the same process. More than 90% of the cracked regions of the surface of TBC systems were adapted as the criterion for the failure of the coating. The weight changes of the samples were measured to a precision of 0.5 mg by an analytical balance. Three number of specimens were tested and average was considered for analysis.

2.4. ITS Standards

A network of national standards institutes working in partnership with international organizations, governments, industry, business and consumer representatives to provide a bridge between public and private sectors [3].

ISO TC 204 = "Intelligent Transport Systems" – Transport information and control systems Standardization of information, communication and control systems in the field of urban and rural surface transportation, including inter-modal and multimodal aspects thereof, traveler information, traffic management, public transport, commercial transport, emergency services and commercial services in the transport information and control systems (TICS) field.

III. VEHICLE COMMUNICATION

The vehicle communications can be broadly seen as vehicle-to-vehicle (V2V) or vehicle-to-infrastructure (V2I) communications. In the vehicle communications signal distortion and signal corruption are critical issues which needs to be addressed. A dedicated standard is developed for vehicle communications i.e. uses channels of 10MHz bandwidth in the 5.9 GHz band (5.850-5.925 GHz), which addresses the vehicular safety communication. Figure 4 depicts the overall system architecture. The overall system consists of antenna, VMC on-board-equipment (OBE), vehicle terminal and road-side-equipment (RSE). Antennas of the vehicle and the infrastructure are omnidirectional and support 5.83-5.90 GHz frequency range. OBE and RSE have the communication module which is equipped with Modem, MAC and RF module. The vehicle terminal displays the information of my vehicle and adjacent vehicles by using GPS and the communication module [8].



Fig.4. Vehicular ITS Communications [9]

OBD provides both V2V and V2I communications, and multi-hop communication is also supported. RSE is connected to the ITS center which collects, processes and reroutes the traffic information from vehicles or other RSEs.

The dedicated standard reported literature IEEE 802.11p also called as wireless access in vehicular environments (WAVE). The standard IEEE 802.11 p is only good for time independent channels. Table 1 explains in general the IEEE 802.11p PHY standard.

Table 1. IEEE 802.11P Standard (10MHZ Bandwidth).

Parameter	Value
Bandwidth	10 MHz
FFT size	64
# of data subcarriers	48
# of pilot subcarriers	4
# of subcarriers(total)	52 (48+4)
subcarrier frequency spacing	0.15625 MHz
Signal bandwidth	8.28 MHz
IFFT/FFT period	6.4 μs
GI duration	1.6 μs
Symbol interval	8.0 (6.4+1.6) μs

Due to the relative motion of vehicles in vehicular communication, the channel changes rapidly. Hence, it leads to drastic increase in the system's performance. To overcome this issue decision based directed channel method can be used at the expense of increased processing of the data symbol, channel estimation time and complexity [10, 11]. The other approach can be pilot subcarrier for tracking the channel variations [12] but the increase in pilot tones costs on the data rates. Performance evaluation is done for vehicular communications midamble insertion [8].

Even though there are many fruits of vehicle-to-vehicle (V2V) communications, but the communication is highly unreliable. There are many reasons for the bad wireless communication such as packet collisions, channel fading and communication obstacles can add to the severity of the situation. A unique amalgamation of numerical and analytical approaches is studied to investigate the shortcomings of vehicle-to-vehicle communications in terms of latency and reliability requirements [8].

Various forms of wireless communications technologies have been proposed for intelligent transportation systems. Radio modem communication on UHF and VHF frequencies are widely used for short and long range communication within ITS.

1-Short-range communications of 350 m can be accomplished using IEEE 802.11 protocols, specifically WAVE or the Dedicated Short Range Communications standard being promoted by the Intelligent Transportation Society of America and the United States Department of Transportation. Theoretically, the range of these protocols can be extended using Mobile ad hoc networks or Mesh networking.

2-Longer range communications have been proposed using infrastructure networks such as WiMAX (IEEE 802.16), Global System for Mobile Communications (GSM), or 3G. Long-range communications using these methods are well established, but, unlike the short-range protocols, these methods require extensive and very expensive infrastructure deployment. There is lack of consensus as to what business model should support this infrastructure [13].

CONCLUSIONS

Among technical challenges to be overcome, high mobility of vehicles, wide range of relative speeds between nodes, real-time nature of applications, and a multitude of system and application related requirements can be listed. Furthermore, considering ITS applications that require information to be relayed multiple hops between cars, vehicular networks are poised to become the most widely distributed and largest scale ad hoc networks. Such challenges and opportunities serve as the background of the widespread interest in vehicular networking by governmental, industrial, and academic bodies.

In general, in three different groups of ITS applications are being developed. 1. Active road safety applications, 2. Traffic efficiency and management applications and 3. Infotainment applications.

Intelligent Transport Systems (ITS) include telematics and all types of communications in vehicles, between vehicles (e.g. car-to-car), and between vehicles and fixed locations (e.g. car-to-infrastructure). However, ITS are not restricted to Road Transport - they also include the use of information and communication technologies (ICT) for rail, water and air transport, including navigation systems [9].

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