WIRELESS SENSORS IN AUTOMOBILES– AN EVOLUTION THAT TURNED TO A REVOLUTION

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Abstract: A revolution has occurred in the area of measurement using remote wireless sensors due to technological innovations in the area of wireless communications, digital electronics, and personal micro electromechanical systems. Wireless Sensor network (WSN) offers great potential to be employed in critical situations. The growth of wireless sensor networks was originally provoked by military applications like battlefield surveillance. However, Wireless Sensor Networks are also used in many other areas such as Industrial, Civilian, Health, Automobiles, Military, Home and Office application areas. Most important application for sensor networks is detection and tracking of targets as it moves. The key advantage of WSN is that the network can be deployed on the fly and can operate without attending and without the need for any pre-existing infrastructure with bit of maintenance. There may be from a few hundreds to thousands of sensor nodes in WSN. The sensor node equipment includes a radio transceiver along with an antenna, a microcontroller, an interfacing electronic circuit, and an energy source, usually a battery. The size of the sensor nodes can also range from the size of a grain of dust to size of a shoe box. As such, their cost also varies from a few pennies to hundreds of dollars depending on the functionality parameters of a sensor like energy consumption, computational speed rate, bandwidth, and memory. This research paper inspects the use of sensors in hi-tech cars, available and upcoming in the market ensuring human life safety to a greater extent.

Keywords: ABS, BSD, SRIS, VICS

Introduction: Sensors are complicated devices that are frequently used to detect and respond to electrical or optical signals. A Sensor converts the physical parameter (for example: temperature, blood pressure, speed, etc.) into a signal which can be measured electrically. Consider the example of temperature. The mercury in the glass thermometer expands and contracts the liquid to convert the measured temperature, which can be read by a viewer on the calibrated glass tube.

Criteria to choose a Sensor

There are certain features which have to be considered when we choose a sensor. These are:

- Accuracy
- Environmental condition - usually has limits for temperature/ humidity
- Range - Measurement limit of sensor
- Calibration - Essential for most of the measuring devices as the readings changes with time
- Resolution - Smallest increment detected by the sensor
- Cost
- Repeatability - The reading that varies is repeatedly measured under the same environment

Sensors In Hybrid Cars: In recent years, worsening environmental problems such as global warming and air pollution have come under close scrutiny. Therein, in the automobile industry, there are great hopes that low-emission vehicles can be globally popularized, and this trend is now becoming a reality.

Hybrid cars, which seek to reduce environmental burdens by combining conventionally fueled engines with electric motors and restricting gas emission through low fuel consumption, have entered the phase of serious market penetration in advanced nations. With efforts to decrease production costs, the global popularization of hybrid cars is promising. Moreover, the attempts to develop and popularize electric and fuel-cell vehicles with zero emission have also been accelerated.

Technical requirements of in-car current sensors

- Capability of measuring both alternating and direct current - Batteries is basically direct current, but there is also alternating current. The capability to measure both alternating and direct current is necessary. Therefore, current transformers which cannot measure direct current are inappropriate.
- High accuracy - To monitor the inverter/motor current of hybrid cars, especially the charge/discharge current of batteries, an integrated value is calculated from multiple monitor values, which means every detection error is accumulated. Therefore, as a basic performance of current sensors, high detection accuracy is required. Moreover, a small margin of error throughout a wide temperature range is also an essential requirement for use in harsh environments. We can say that current transformer and shunt resistor methods are inadequate for these requirements.
- High durability - A high level of durability which satisfies the rigorous in-car standards such as static electricity, surge noise, thermal shock,

vibration, and drop impact is required.

Sensors and Safety – Anti Lock Brake System: Vehicle safety is another area where sensor use is expanding rapidly and Anti Lock Brakes (ABS) [1, 2] is one such system where they are a vital component. ABS is utilized to stop a car from skidding when heavy braking is required or when road conditions are slick from rain, ice or gravel. Basically, the system replaces the need for the driver to pump the brake pedal in order to help maintain control of the car. Basic physics determines that when a car tire is skidding the coefficient of friction is reduced. The greatest amount of friction occurs just prior to skidding. Also, when a tire is skidding, let's say both front tires, steering the vehicle is virtually impossible. Pumping the brake pedal is how an operator can avoid this problem. However, it is next to impossible for an operator to determine exactly when to pump the pedal. This is where the ABS system can be extremely effective.

ABS employs sensors located at each wheel that monitor the rate at which the wheel is turning compared to the speed of the car. Most systems are not activated until the vehicle exceeds 8 miles per hour. One such ABS system utilizes a magneto resistive gear tooth sensor which can accurately sense the movement of a ferrous type material. The ferrous material is a wheel that has notches milled into it and rotates along with the vehicles tire. The notched wheel is mounted directly behind the brake rotor or brake drum. The sensor detects the notches as the wheel rotates and develops a signal that is fed to the systems electronic control computer. The computer then calculates the vehicles acceleration, deceleration and skid factors. These factors are used to send control signals to a hydraulic valve which can control the amount of brake pressure at each wheel independently. When the system detects wheel lockup it can rapidly pulse the brake pressure up to 18 times per second. This will prevent skidding and allow the operator to steer the vehicle when rapid stopping conditions are encountered.

Sensors are being used to improve automobile drivability through suspension control. Cadillac is currently designing a system that will utilize electro-mechanical sensors to monitor and adjust shock stiffness levels. One sensor mounted to each corner of the vehicle between the control arm and body will determine suspension height and speed of movement. The information will be fed to a control system that directs signals to the shocks at each wheel. Even more advanced systems are on the drawing board that will use radar to look ahead of the car for irregularities in the road. The system will know ahead of time when to expect a bump and can then adjust the shocks stiffness to compensate for it.

Automatic Braking System: The first in-car system is being tested by Volvo Car Corp. that can sense an imminent collision with pedestrians and brake automatically if the driver doesn't. Automatic braking system [3, 4] is the latest in a line of developments made possible by sophisticated sensors based on cameras, radar and lasers. These sensors already provide drivers with adaptive cruise control, which alters a car's speed to maintain a safe distance from the vehicle in front, as well as technology such as semi-autonomous parking systems. Now we are entering an era in which vehicles will also gather real-time information about the weather and highway hazards, using this to improve fuel efficiency and make life less stressful for the driver and safer for all road users. Ultimately, that means bypassing the imperfect humans behind the wheel -- by building cars that drive themselves. Semi-autonomous vehicles are expected on road by 2015. They will need a driver to handle busy city streets and negotiate complex intersections, but once on the highway they will be able to steer, accelerate and avoid collisions unaided. A few years later drivers will be able to take their hands off the wheel completely: There is a potential for launching fully autonomous vehicles by 2020.

Upcoming Technologies In Near Future

Sris And Vics: A glimpse of a safer future has come from a trial in the form of new system named Slippery Road Information System (SRIS) [5]. The system used sensors and computers installed in 100 cars to gather information on the use of brakes, fog lights, windshield wipers and electronic stability systems, as well as weather conditions. The cars in the SRIS trial beamed the data they gathered to a central database every five minutes.

A more sophisticated system involving shared data is being deployed in Japan this year. The country has become a world leader in the field with the government's decision to fund a network of infrared, microwave and radio transmitters at the roadside. About 2 million vehicles on Japanese roads can already pick up news on congestion, roadwork, accidents, weather, speed limits and parking availability from these transmitters, broadcasting as part of the Vehicle Information and Communication System (VICS) [6].

By that time, a similar system designed to operate on major Japanese highways should also be in place to warn when the driver gets too close to the vehicle in front, when vehicles are converging from the side and when there is congestion ahead.

Alcohol Odor Sensors: A hi-sensitivity alcohol sensor [7] is built into the transmission shift knob "Fig. 1", which is able to detect the presence of alcohol in the perspiration of the driver's palm as he or she attempts to start driving. When the alcohol-level detected is above the pre-determined threshold, the system automatically locks the transmission, immobilizing the car. A "drunk-driving" voice alert is also issued via the car navigation system.

Additional alcohol odor sensors are also incorporated into the driver's and passenger seats to detect the presence of alcohol in the air inside the vehicle cabin. When alcohol is detected, the system issues both a voice alert and a message alert on the navigation system monitor.

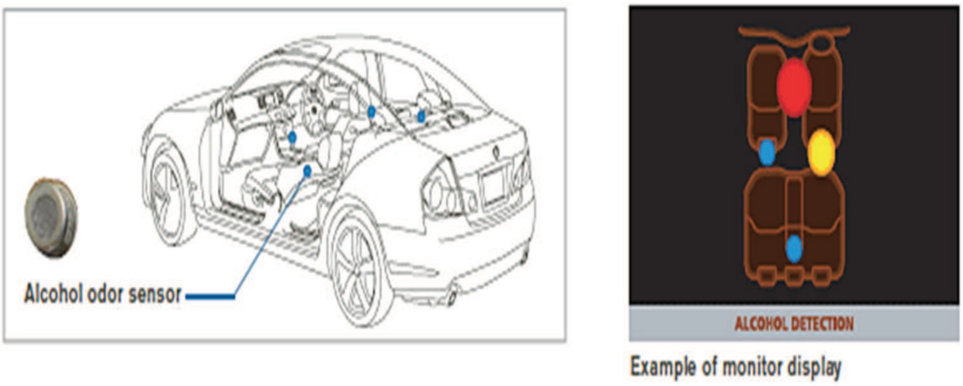

Fig 1. Location of Alcohol Detector Sensors

Detection using facial monitoring system:

Fig. 2 Facial Monitoring Scheme

A camera is mounted on the instrument cluster facing the driver to monitor the driver's face. The facial monitoring system [7] is calibrated to monitor the driver's state of consciousness through the blinking of the eyes “Fig. 2”. When the system detects signs of drowsiness, a voice and message alert is triggered via the navigation system. Additionally, a seat-belt mechanism is activated which tightens around the driver to gain his or her immediate attention.

Detection of the driver's state from the Driving behavior

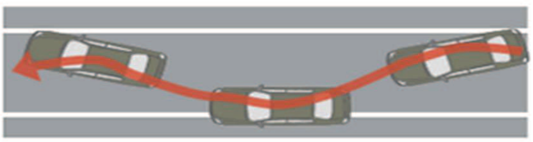

Fig. 3 Distraction while driving

By constantly monitoring the operational behavior of the vehicle (e.g. sensing if the vehicle is drifting out of its driving lane), the system can identify signs of inattentiveness or distraction in the driver. When the system detects such behavior, voice and message alerts are issued via the navigation system. The seatbelt alert mechanism is also activated, tightening around the driver to gain immediate attention.

Safety Shield

Continuing advances in car safety equipment have helped reach that goal. Most of us know about seat belts and airbags, and advances in other areas, such as crash-absorbing body structures, which further help protect us in the event of an accident. But there are other advances in safety technology that not only help protect us should an accident occur, but actually help prevent an accident from happening in the first place.

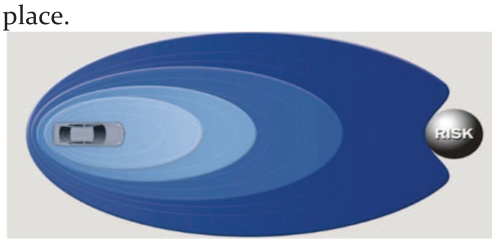

Fig. 4 Safety Shield

Starting in 2005, the concept of "Safety Shield" was introduced in an effort to proactively achieve active safety. The idea behind the Safety Shield Concept is that potential approaching risks are categorized into different phases of driving, and the vehicle activates various "barriers" to help provide multiple layers of protection depending on the type of approaching risk. The car is able to help provide prompts to the driver for safe driving depending on the situation.

Distance Control Assist:

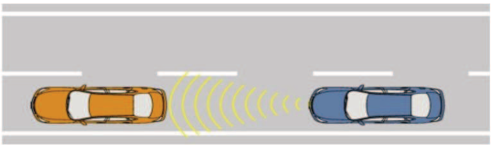

Fig. 5 Distance Control Assist

Safety Shield Concept is the "Intelligent Cruise Control" system, a feature that helps facilitate driving in normal "no-threat" conditions. This technology monitors the car's speed and distance from the vehicle directly in front of it and accelerates or brakes the car accordingly, providing automatic cruise control at a speed set by the driver. It automatically maintains space between the car and the other vehicle according to this set speed, making the car cruise at the same pace as the vehicle in front of it."Distance Control Assist" [8], like the Intelligent Cruise Control system, is a system located on the very exterior of the Safety Shield Concept. This system helps maintain an appropriate distance to a vehicle directly in front of you by prompting the driver to release the throttle when the driver gets too close to the vehicle ahead.

If the car draws near to a vehicle ahead while the driver is pressing on the accelerator, the system adds resistance to the pedal and the pedal "pushes back. If the driver then takes his or her foot off the gas, the system applies the brakes.

Blind Spot Detection Technology:

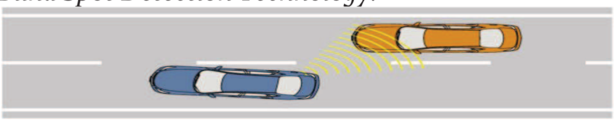

Fig.6 Blind Spot Detection

Blind Spot Intervention [9] is a system that helps alert the driver when vehicles are in the vehicle's blind spot areas and issues a warning if the driver attempts to change lanes in such a situation. Two millimeter wave radar units installed on either side of the rear bumper scan for vehicles entering the detection zones on either side of the car, alerting the driver to their presence by illuminating a light on the windshield pillar. If the driver starts to change lanes, the system sounds an alarm. In addition, the brakes are activated to try to help keep the driver from changing lanes.

Conclusion: Here's a surprising fact: every year, the number of fatalities in Japan, the United Kingdom, and the United States resulting from automobile accidents goes down.

There is an actual reduction in the number of people who die in automobile accidents every year.

Unfortunately, car crashes do cause injuries and fatalities, so considering both how widely the use of cars as spread, and the large number of new cars that appear on the market every year, a reduction in fatalities might be somewhat unexpected. But, the graphs below tell the story Fatal and serious injuries continue to decrease.

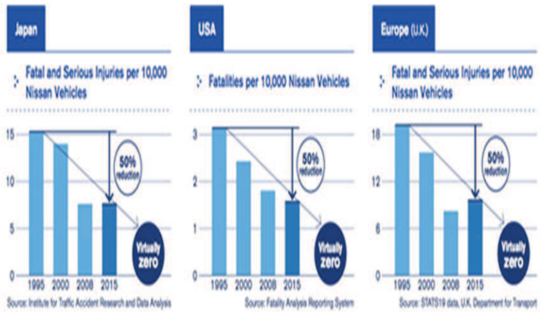

Fig7. Graphs showing decrease in number of accidents from 1995 to 2013 in Japan, USA and Europe

References:

1. auto.howstuffworks.com/auto-parts/brakes/
2. brake.../anti-lock-brake.htm
3. www.drivingfast.net/technology/abs.htm
4. http://auto.howstuffworks.com/under-the-hood/trends-innovations/automatic-braking-systems.htm
5. http://cartech.about.com/od/Safety/a/What-Is-An-Automatic-Braking-System.htm
6. http://www.sris.nu/docs/ Broschure%20 english% 20technical.pdf http://www.vics.or.jp/english/vics
7. http://jalopnik.com/285674/nissan-concept- car-shows-anti-drunk+driving-tech
8. http://www.nissan- global.com/EN/NEWS/
9. 2006/_STORY/060315-01-e.html
10. http://cartech.about.com/od/Safety/a/Blind-Spot-Detection-And-Warning-Systems.htm

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