# Collision Avoidance Using Inter-Vehicle Ad-hoc Communication

[1] **Mahesh Panjwani,** [2] **Humera Syed,** [3] **Sumera Qazi**

[1, 2] **Computer Technology Department, Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur, P. C. E. Nagpur, Maharashtra 440019, India**

[3] **Computer Science Department, Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur, A. C. E. T. Nagpur, Maharashtra 440001, India**

**Abstract**

The automobile industry is experiencing an exponential rise in demand, but its sustainability is an issue due to the dynamic nature of the market and environmental conditions. This paper deals with the development of a system dynamic model to simulate Indian automobile market dynamics. The focus of the paper is to study the influence of three major dynamic factors viz., accidents, ease of use, durability. The model has been used to simulate the influence of these dynamic factors for a quarter of a century. As sustainability of the automobile industry is dependent to a great extent on these factors, the study result projects the future scenario. The result obtained would provide significant leads to the manufacturers of automobile and infrastructure providers, as it studies the cumulative effect of the critical factors. Even though the result is at the project level, the concept can be extended further, to provide efficient way for automotive control.

Automotive engine control systems must satisfy diverse and often conflicting requirements. These include regulating to meet increasingly stringent standards without sacrificing good drivability to satisfy customer desires and to comply with regulations and delivering these performance objectives at low cost with the minimum set of sensors and actuators. The dramatic evolution in vehicle electronic control systems over the past two decades is substantially in response to these requirements. It is the capacity and flexibility of microprocessor based digital control systems, introduced in 1970's to address the problem of automotive control which have resulted in the improved function and added convenience, safety and performance features that distinguish the modern automobile.

***Keywords:*** *Embedded Automobile, Wireless, Sensors communication.*

## 1. Introduction

Driver assistance systems have become more popular with the introduction of 24GHz radar systems for passenger cars. In addition to lane change assist and blind spot sensors, applications like ACC (adaptive cruise control) and as an extension of that, ACC Stop-Go are being addressed by OEMs and sensor manufacturers. The car manufactures are now focusing their interest on fusion-based multi-sensor systems, enabling the car to monitor the whole environment. One of the requirements resulting from this system set-up is a new distribution of signal processing blocks between sensor(s) and a central ECU.

As this fusion-ECU becomes responsible for data validation, object recognition, object tracing and communication with the car network, the sensor itself becomes a simple data acquisition unit. Ideally it would transfer all data to the central ECU for processing. Assuming a typical cycle time of 30-40ms this could result in data rates up to 2.9Mbit/s per sensor.

This bandwidth isn't available with today's car networks; therefore some data pre-processing and data reduction has to be performed in the sensor. One approach is to implement the required signal processing in an FPGA. Wireless sensor networks (WSN) are becoming more and more popular due to the growing area of their application. However, finding a single approach to different tasks is rather difficult, as each task has its own peculiarities. In this paper we propose a universal hardware platform as the first step to a quicker development of finished solutions based on WSN. We demonstrate the use of our platform in different types of applications.

## 2. Architecture

### 2.1 First Process

Auto speed trap camera will capture image of the vehicle that breaks of the Malaysian traffic law. Then the picture is saved in the computer that connected to the GSM modem.

### 2.2 Second Process

Any picture that appears at the image stored folder in the computer will be immediately sent to the central database through GSM network.

### 2.3 Third Process

At this stage the data received from the GSM network will be processed and analyzed using image processing software before link to the database to trace the owner's profile of the vehicles.

### 2.4 Forth Process

This is the last stage of the system which is used to trace the owner profile of the vehicles at the central database for appropriate action.

Even tasks like threshold calculation and spectral peak detection can be performed within the FPGA. On the other side, with the flexibility of an FPGA, the system can be adopted to any available bus like CAN, FlexRay or a proprietary bus without changing the system architecture and adding additional external components. A soft processor core optimized for FPGA can be used as system controller and also as host controller for CAN or FlexRay. Using FPGA, cost of the new multi-sensor systems can be kept low, making the new 24GHz radar systems affordable for customers and thus improving road safety.

Wireless sensor networks (WSNs) play a crucial role in visual surveillance for automatic object detection, such as real-time traffic monitoring, vehicle parking control, intrusion detection, and so on. These online surveillance applications require efficient computation and distribution of complex image data over the wireless camera network with high reliability and detection rate in real time. Traditionally, such applications make use of camera modules capturing a flow of two dimensional images through time. The resulting huge amount of image data impose severe requirements on the resource constrained WSN nodes which need to store, process and deliver the image data or results within a certain deadline. In this paper we present a WSN framework based on line sensor architecture capable of capturing a continuous stream of temporal one dimensional image (line image). The associated one dimensional image processing algorithms are able to achieve significantly faster processing results with much less storage and bandwidth requirement while conserving the node energy. Moreover, the different operating modes offered by the proposed WSN framework provide the end user with different tradeoff in terms of node computation versus communication bandwidth efficiency. Our framework is illustrated through a test-bed using IEEE 802.15.4 communication stack and a real-time operating system along with one dimensional image processing. The proposed line sensor based WSN architecture can also be a desirable solution to broader multimedia based WSN systems.

Advances in wireless networking, micro-fabrication and integration (for example, sensors and actuators manufactured using micro-electro mechanical system technology, or MEMS), and embedded microprocessors have enabled a new generation of massive-scale sensor networks suitable for a range of commercial and military applications. The technology promises to revolutionize the way we live, work, and interact with the physical environment.

- Conformity with ETSI and FCC frequency regulations.
- One-Box-Design with integrated detection, tracking and communication software.
- Stand alone or network (sensor fusion) operation

The radar is able to resolve (separate), handle and track multiple targets (i.e. radar reflectors), in the following list, an overview is given of the tasks and signal processing blocks which need to be executed in the radar.

1) Generation of the transmit signal and sampling of the input data.
2) Offset Correction.
3) FFT.
4) Threshold calculation.
5) Frequency and phase value extraction
6) Calculation of targets parameters.
7) Ambiguities resolution.
8) Target tracking.
9) CAN data link to superior control unit.

The simple cost-effective solution is proposed, by which devices used in this project can be controlled remotely while the user is anywhere across the globe. Short Message Service (SMS) and Multimedia Messaging Service (MMS) is a mechanism of delivery of short messages and also image over the mobile networks that are widely spread across the globe.

The main objective is to create a command or programming language that will control the devices such as GSM modem connected to computer sending an image to the centre database through the GSM network provided. In order to operate this project automatically, Visual Basic 6.0 was chosen in the writing of the program as it is the easiest programming language compared to other programming language. It is also reliable to all devices used in this project. After receiving the MMS, the received data will be stored in the database before analyzing the image.

To extend the function, in addition to the 77GHz ACC sensor two 24GHz UMRR sensors are placed behind the front bumper fascia, close to the corners. The combined field of view is selected to cover the full width of the car, beginning directly at the car's front bumper fascia. It covers 3 lanes; the outer limits of the field of view are +45° and -45° from the left and right front corner of the car respectively, given that the mounting position and pointing.

In the actual sensor generation, designed for stand-alone operation, a fixed point DSP is applied. The chip already has A/D converters, a CAN module, Flash and some RAM memory on board and requires just a small number of additional components. The radar makes use of the CAN link and is thus able to deliver data to a superior control unit.

An off-the shelf ACC sensor typically has a narrow field of view. Operating at 77GHz, this type of sensor is today in volume production and fitted to a number of high-class models.

The limitations are: operation typically only above 40km/h, narrow field of view, late detection of cut-in situations, no full coverage of the driving lane close to the vehicle, poor measurement performance at short range. direction are appropriately selected. Excellent short and medium range measurement performance is provided. Three driving lanes can then be covered; this can lead to a significant improvement of the function of long range 77GHz ACC sensors, when the detection results of all three radars are subject to a sensor fusion. Enhanced features like follow-to-stop or stop-and-go become possible.

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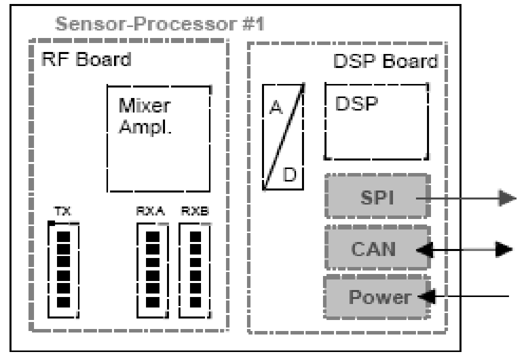


Fig.1 Block dig. of UMRR.

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Fig.2 View of detected targets.

The technology promises to revolutionize the way we live, work, and interact with the physical environment.

## 2.1 Networked Embedded Systems

(1) Some embedded systems already talk to each other (eg)Wireless car keys, TV remote, mobile phones.

(2) The vision: wireless sensor networks eg.Sensing, processing, radio on a single device.Enable new applications.

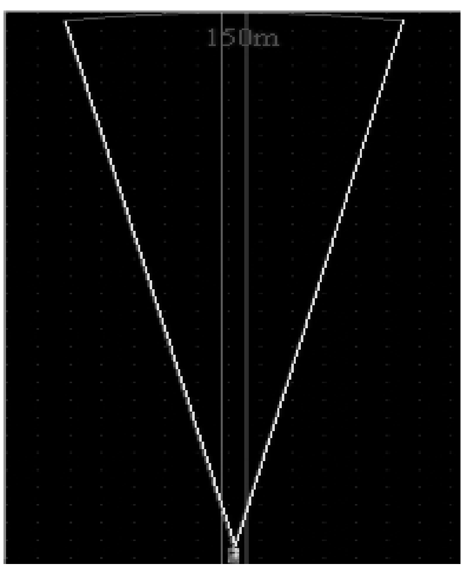


Fig.3.ACC sensor field of view

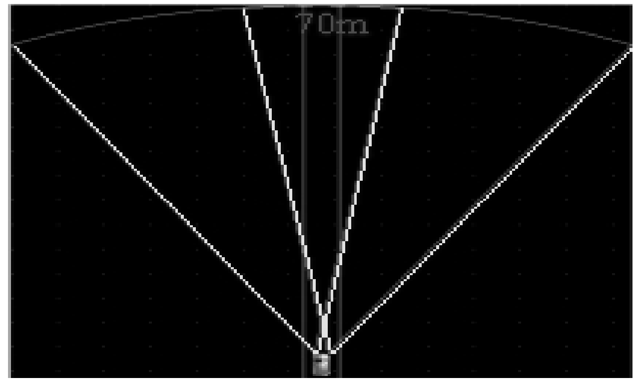


Fig.4 Additional field of view for Stop & Go operation.

In order to develop System-on-a-Chip (SoC) in a short time period, the parallel development of hardware/software is required. For that purpose, the use of an FPGA prototype is effective. However, debugging software on the FPGA prototype is difficult because we can observe signals only on the external pins.

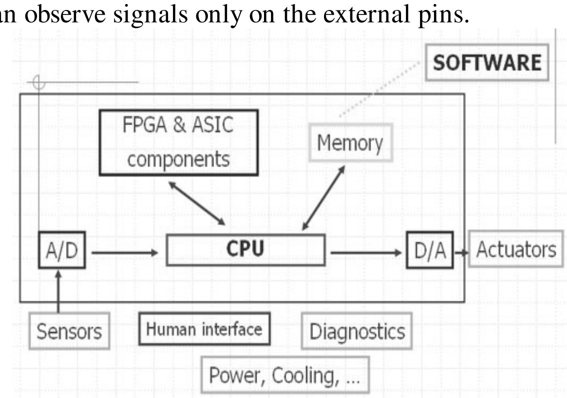


Fig.5. Embedded Configuration

The integration of the whole CPU onto a single VLSI chip therefore greatly reduced the cost of processing capacity. From their humble beginnings, continued increases in microprocessor capacity have rendered other forms of computers almost completely obsolete (see history of computing hardware), with one or more microprocessor as processing element in everything from the smallest embedded systems and handheld devices to the largest mainframes and supercomputers.

GPS" redirects here. For other similar systems, see Global Navigation Satellite System. For other uses of "GPS", see GPS (disambiguation).For a generally accessible and less technical introduction to the topic, see Introduction_to the Global Positioning System. Functionality: For automotive use. Show major roads and landmarks. User interface: At least 400 x 600 pixel screen. Three buttons max. Pop-up menu. Performance: Map should scroll smoothly. No more than 1 sec power-up. Lock onto GPS within 15 seconds. Cost: $500 street price = approx. $100 cost of goods sold.

The GPS uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise

GPS specification

- What is received from GPS;
- map data;
- user interface;
- operations required to satisfy user requests;
- background operations needed to keep the system running.

Microwave signals, that enable GPS receivers to determine their current location, the time, and their velocity (including direction). GPS was developed by the United States Department of Defense. Its official name is NAVSTAR-GPS. Although NAVSTAR-GPS is not an acronym, a few backronyms have been created for it. The GPS satellite constellation is managed by the United States Air Force 50th Space Wing.

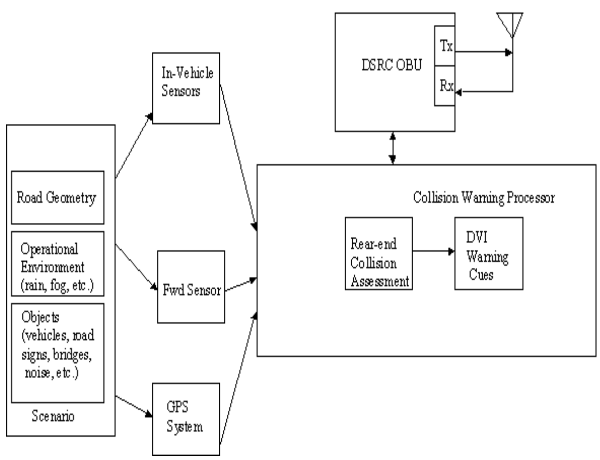


Fig 6 GPS Working

Similar satellite navigation systems include the Russian GLONASS (incomplete as of 2008), the upcoming European Galileo positioning system, the proposed COMPASS navigation system of China, and IRNSS of India. After Korean Air Lines Flight 007 was shot down in 1983 after straying into the USSR's prohibited airspace, President Ronald Reagan issued a directive making GPS freely available for civilian use as a common good. Since then, GPS has become a widely used aid to navigation worldwide, and a useful tool for map-making, land surveying, commerce, scientific uses, and hobbies such as geo caching.

Also, the precise time reference is used in many applications including scientific study of earthquakes, and synchronization of telecommunications networks. Important branches in this family include Marvell's XScale and the Texas Instruments OMAP series. The ARM design was started in 1983 as a development project at Acorn Computers Ltd to build a compact RISC CPU. Led by Sophie Wilson and Steve Furber, a key design goal was achieving low-latency input/output (interrupt) handling like the MOS Technology 6502 used in Acorn's existing computer designs.

The ARM2 featured a 32-bit data bus, a 32-bit (4 Gbyte) address space and sixteen 32-bit registers. Program code had to lie within the first 64 Mbyte of the memory, as the program counter was limited to 26 bits because the top 6 bits of the 32-bit register served as status flags. The ARM2 was possibly the simplest useful 32-bit microprocessor in the world, with only 30,000 transistors (compare with Motorola's six-year older 68000 model with around 70,000 transistors). Much of this simplicity comes from not having microcode (which represents about one-quarter to one-third of the 68000) and, like most CPUs of the day, not including any cache. This simplicity led to its low power usage, while performing better than the Intel 80286. A successor, ARM3, was produced with a 4KB cache, which further improved performance.

The ARM core has remained largely the same size throughout these changes. ARM2 had 30,000 transistors, while the ARM6 grew to only 35,000. ARM's business has always been to sell IP cores, which licensees use to create microcontrollers and CPUs based on this core. The most successful implementation has been the ARM7TDMI with hundreds of millions sold in almost every kind of microcontroller equipped device. The idea is that the Original Design Manufacturer combines the ARM core with a number of optional parts to produce a complete CPU, one that can be built on old semiconductor fabs and still deliver substantial performance at a low cost. As of January 2008, over 10 billion ARM cores have been built, and iSuppli predicts that 5 billion a year will ship in 2011.

## 3. Collision Avoidance System

Collision Avoidance Systems is a futuristic technology that allows cars to "think." Within this broad field, there are many subdivisions like freeway management, electronic payment for tolls, and road and weather management. One of the biggest of these subdivisions is a technology referred to as Collision Avoidance Systems.

In simple terms, this is a system of sensors that a placed within a car to warn its driver of any dangers that may lie ahead on the road. Some of the dangers that these sensors can pick up on include how close the car is to other cars surrounding it, how much its speed needs to be reduced while going around a curve, and how close the car is to going off the road.

See, how it works is sensors that send and receive signals from things like other cars, obstacles in the road, traffic lights, and even a central database are placed within the car and tell it of any weather or traffic precautions. A situation that provides a good example of how the system works is when a driver is about to change lanes, and there is a car in his blind spot. The sensors will detect that car and inform the driver before he starts turning, preventing him from potentially getting into a serious accident. Collision Avoidance Systems are especially useful in bad weather conditions. Obviously, there are some conditions, such as fog, sleet, snow, and rain that can affect the road and how one drives on it. Basically, the sensors in the car would be capable of detecting the poor conditions and would inform the driver on how to drive in them. For example,

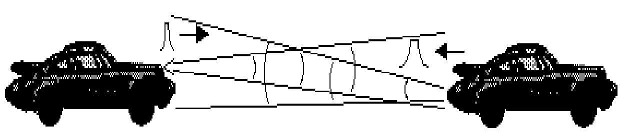

Fig.7 Collision Avoidance

Of any dangers that lie ahead, like a windy turn or another car. Thus, giving the driver enough time to slow down, allowing him to escape from what could have been a bad accident.

Obviously, Collision Avoidance Systems would be very useful in cars and would prevent many accidents from occurring, but the real questions are, “how much does it cost, and is it worth the expenses?” A study done in 1993 on a seventy-seven gigahertz monolithic transmitter and millimeter wave technology gave some hopeful insights. “This module, due to its small size, light weight and low production costs, is a significant advance in millimeter wave technology from traditional waveguide hybrid approaches and it now makes collision avoidance radars affordable.”(Raffaelli) As this study was done in 1993, it shows that collision avoidance systems, although very advanced, are not as expensive as one might perceive.

A proof-of-principle wideband radar system is currently under development with the eventual goal of developing a low cost collision avoidance radar system. Various components required to complete the entire system are being assembled and/or constructed in order to test and develop the radar. A hybrid sampling circuit has been designed, built and tested. An input pulse waveform has been successfully reconstructed utilizing the circuit with varying delay times to sample different points along the signal. A differential amplifier circuit has been designed and built in order to integrate the output signals from the sampling circuit. A monolithic nonlinear delay line (NDL)

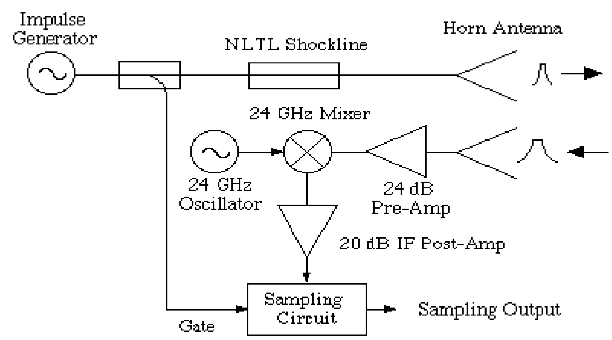


Fig.8 Collision Avoidance Working.

circuit which provides voltage-controlled true time delay is currently being designed. The sampling circuit, NDL and differential amplifier circuitry will eventually be packaged together to form the radar receiver component. Extensive modeling of the pulse driver, NLTL and sampling circuitry is being performed utilizing MDS. Modeling of unbalanced, wideband antenna structures which can readily be coupled to the NLTL driver circuits is also being performed. These antenna structures will eventually be integrated with the radar transmitter/receiver circuitry in order to provide a complete, compact, wideband system.

## 4. Autonomous Cruise Control System

Adaptative cruise control (ACC) is a cruise control system in some modern vehicles. The system also goes under the names of active cruise control (ACC) or intelligent cruise control (ICC). These systems use either a radar or laser setup to allow the vehicle to slow when approaching another vehicle and accelerate again to the preset speed when traffic allows. ACC technology is widely regarded as a key component of any future generations of smart cars, as a form of artificial intelligence that may usefully be employed as a driving aid. Laser-based systems are significantly lower in cost than radar-based systems;

however, laser-based ACC systems do not detect and track vehicles well in adverse weather conditions nor do they track extremely dirty (non-reflective) vehicles very well.

Laser-based sensors must be exposed, the sensor (a fairly-large black box) is typically found in the lower grille offset to one side of the vehicle. Radar-based sensors can be hidden behind plastic fascias; however, the fascias typically looks different from a vehicle without the feature. For example, Mercedes packages the radar behind the upper grille in the center; however, the Mercedes grille on such applications contains a solid plastic panel in front of the radar with painted slats to simulate the slats on the rest of the grille.

Some systems also feature forward collision warning or Collision Mitigation Avoidance System, which warns the driver and/or provides brake support if there is a high risk of a rear-end collision. Toyota's Lexus vehicles was the first to bring laser-based systems to the US market with the 2001 Lexus LS430 "DLCC" (Dynamic Laser Cruise Control). Lexus then offered laser-based systems on its RX and radar-based systems on its IS, ES, GS and LS models. Several Japanese manufacturers first offered ACC systems in the Japanese market in the late 1990s. These early systems did not apply the brakes and only controlled speed through throttle control and downshifting. However, this was changed with the Acura RL. It features Collision Mitigation Braking System, which can alert drivers of objects up to 100 m ahead, if the distance is less, it brakes slightly and tugs at the seatbelts. In case of no driver reaction, the RL retracts, locks the seatbelts and brakes hard. A similar system is offered in the Lexus LS430/460.

## 5. Brake System Assisted With GPS

As part of the efforts to ensure safety driving on the road, Toyota Motor Corporation has just announced the new auto braking system which involves advanced GPS (Global Positioning System) technology for accurate position monitoring for vehicle braking system to work automatically. It will recognize the stop signs at the intersection and then alert users with both audible and visual warning and eventually apply sufficient brake power to avoid any vehicles collision on the road. This is slightly different concept as compared to Pre-crash safety system enveloped by this giant automobile maker before but with same purpose.

The mechanism behind is an intelligent and accurate coordinate sensing using GPS system with the assistance of rear-mounted will start detecting the initial stop sign marking on the road and then alert the driver through soft audible alarm. While the vehicle is approaching, approximately four seconds before the stop sign, the automatic brake system will be activated to continue monitoring if the driver has intention to stop the vehicle and if not, additional force will be applied to further slow down the vehicle automatically. The braking system is linked back to GPS for accurate location calibration with real time monitoring.

## 6. Controller-Area Network

Controller-area network (CAN or CAN-bus) is a computer network protocol and bus standard designed to allow

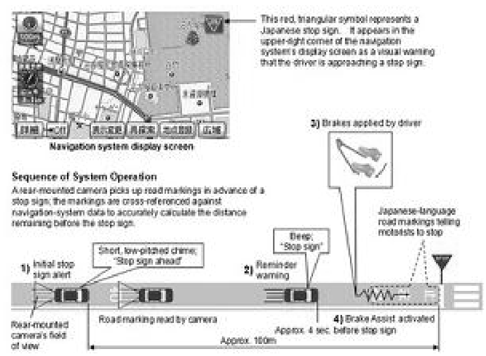


Fig.9 Brake system assisted with GPS

microcontrollers and devices to communicate with each other without a host computer. It was designed specifically for automotive applications but is now also used in other areas.CAN is also supported in the Linux Kernel since version 2.6.25. A modern automobile may have as many as 50 electronic control units (ECU) for various subsystems. Typically the biggest processor is the engine control unit, which is also referred to as "ECU" in the context of automobiles; others are used for transmission, airbags, antilock braking, cruise control, audio systems, windows, mirror adjustment, etc. Some of these form independent subsystems, but communications among others are essential. A subsystem may need to control actuators or receive feedback from sensors. The CAN standard was devised to fill this need.

The CAN bus may be used in vehicles to connect engine control unit and transmission, or (on a different bus) to connect the door locks, climate control, seat control, etc. Today the CAN bus is also used as a field bus in general automation environments; primarily due to the low cost of some CAN Controllers and processors. Bosch holds patents on the technology, and manufacturers of CAN-compatible microprocessors pay license fees to Bosch, which are normally passed on to the customer in the price of the chip. Manufacturers of products with custom ASICs or FPGAs containing CAN-compatible modules, may need to pay a fee for the *CAN Protocol License*. Unforeseen problems incorporated into CAN-based system are often attributed to the design methods used for the system and the individual component implementations. Scheduling methods which take into account the timing related to ECU software and hardware architecture, communication driver performance, and the network arbitration are required for minimizing the effort of testing required prior to manufacturing.

The development of distributed network-based systems often utilizes multiple suppliers for the prototyping of different modules and sub-systems. In order to best control the complexities incorporated from such a distributed developmental process, the Original Equipment Manufacturer usually requires a set of standard tests and procedures to be run on the prototypes prior to delivery. Time constraints require efficient use of test processes, available resources and tools to ensure the highest levels of product quality are delivered at the conclusion of the integration testing phase. Testing teams must possess a means for identification and isolation of faults, along with the experience needed for quickly assessing possible root causes. The time required for actually tracking down and solving the root failure mode can often be extremely difficult and not time effective in widely distributed processes.

Testing tools must be scalable, flexible, and integrate able to provide test coverage for all pertinent levels of the OSI model. The ideal test tools themselves must provide the knowledge and know-how of skilled engineers by identifying questionable conditions, and then using reasoning to guide the test engineer in solving the issue. The tool should also be easily configurable, comprehensive, include predefined test libraries, and provide extremely reliable measurements.

## 7. Technology

CAN is a broadcast, differential serial bus standard for connecting electronic control units (ECUs). Each node is able to send and receive messages, but not simultaneously: a message (consisting primarily of an ID — usually chosen to identify the message-type/sender — and up to eight message bytes) is transmitted serially onto the bus, one bit after another — this signal-pattern codes the message (in NRZ) and is sensed by all nodes. The devices that are connected by a CAN network are typically sensors, actuators and control devices. A CAN message never reaches these devices directly, but instead a host-processor and a CAN Controller is needed between these devices and the bus.

**Each node requires**

- a host-processor
  - The host-processor decides what eceived messages mean, and which messages it wants to transmit itself
  - Sensors, actuators and control devices can be connected to the host-processor (if desired)
- a CAN Controller (hardware with a synchronous clock)
  - *Receiving*: the CAN Controller stores received bits (one by one) from the bus until an entire message is available, that can then be fetched by the host processor (usually after the CAN Controller has triggered an interrupt)
  - *Sending*: the host-processor stores its transmit-messages into a CAN Controller, which transmits the bits serially onto the bus
- a **Transceiver** (possibly integrated into the CAN Controller)
  - *Receiving*: it adapts signal levels from the bus, to levels that the CAN Controller expects and has protective circuitry that protect the CAN Controller
  - *Sending*: it converts the transmit-bit signal received from the CAN Controller into a signal that is sent onto the bus

Bit rates up to 1 Mbit/s are possible at network lengths below 40. Decreasing the bit rate allows longer network distances (e.g. 125 kbit/s at 500 m).The CAN data link layer protocol is standardized in ISO 11898-1 (2003). This standard describes mainly the data link layer — composed of the Logical Link Control (LLC) sub layer and the Media Access Control (MAC) sub layer — and some aspects of the physical layer of the OSI Reference Model. All the other protocol layers are left to the network designer's choice. Certain microcontrollers, like some models of the PIC microcontroller family by Microchip Technology, some models of any Renesas family and Atmel AVR, many Free scale Semiconductor microcontrollers, as well as several ARM based microcontrollers have built-in CAN support.

## 8. Data Transmission

CAN feature an automatic 'arbitration free' transmission. A CAN message that is transmitted with highest priority will 'win' the arbitration, and the node transmitting the lower priority message will sense this and back off and wait. This is achieved by CAN transmitting data through a binary model of "dominant" bits and "recessive" bits where dominant is a logical 0 and recessive is a logical 1. This means open collector, or 'wired or' physical implementation of the bus (but since dominant is 0 this is sometimes referred to as wired-AND). If one node transmits a dominant bit and another node transmits a recessive bit then the dominant bit "wins" (a logical AND between the two).

So, if you are transmitting a recessive bit, and someone sends a dominant bit, you see a dominant bit, and you know there was a collision. (All other collisions are invisible.) The way this works is that a dominant bit is asserted by creating a voltage across the wires while a recessive bit is simply not asserted on the bus. If anyone sets a voltage difference, everyone sees it, hence, dominant. Thus there is no delay to the higher priority messages, and the node transmitting the lower priority message automatically attempts to re-transmit 6 bit clocks after the end of the dominant message. When used with a differential bus, a Carrier Sense Multiple Access/Bitwise Arbitration (CSMA/BA) scheme is often implemented: if two or more devices start transmitting at the same time, there is a priority based arbitration scheme to decide which one will be granted permission to continue transmitting. The CAN solution to this is prioritized arbitration (and for the dominant message delay free), making CAN very suitable for real time prioritized communications systems.

During arbitration, each transmitting node monitors the bus state and compares the received bit with the transmitted bit. If a dominant bit is received when a recessive bit is transmitted then the node stops transmitting (i.e., it lost arbitration). Arbitration is performed during the transmission of the identifier field. Each node starting to transmit at the same time sends an ID with dominant as binary 0, starting from the high bit. As soon as their ID is a larger number (lower priority) they'll be sending 1 (recessive) and see 0 (dominant), so they back off. At the end of ID transmission, all nodes but one have backed off, and the highest priority message gets through unimpeded.

## 9. Networking with Sensors

Networking is a key part of WSNs. The radio communication is the most expensive operation in terms of energy usage. Therefore, a node must find efficient ways for communication to save energy. The wireless nodes are deployed in an ad hoc manner which creates issues such as node failures, unstable links, and network disconnections. Efficient protocols, routing algorithms, load balancing and energy awareness can counter most of the issues stated above. This section will discuss the issues stated above with a generic sensor network for strain measurements as shown in. Figure has two transceivers for every tire which sends data to a base station which will be located on a car dashboard. The following sections will describe Media Access Control (MAC) schemes, topology.

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants, at different locations. The development of wireless sensor networks was originally motivated by military applications such as battlefield surveillance.

However, wireless sensor networks are now used in many civilian application areas, including environment and habitat monitoring, healthcare applications, home automation, and traffic control. In addition to one or more sensors, each node in a sensor network is typically equipped with a radio transceiver or other wireless communications device, a small microcontroller, and an energy source, usually a battery.

The envisaged size of a single sensor node can vary from shoebox-sized nodes down to devices the size of grain of dust, although functioning 'motes' of genuine microscopic dimensions have yet to be created.

A sensor network normally constitutes a wireless ad-hoc network, meaning that each sensor supports a multi-hop routing algorithm (several nodes may forward data packets to the base station). In computer science and telecommunications, wireless sensor networks are an active research area with numerous workshops and conferences arranged each year

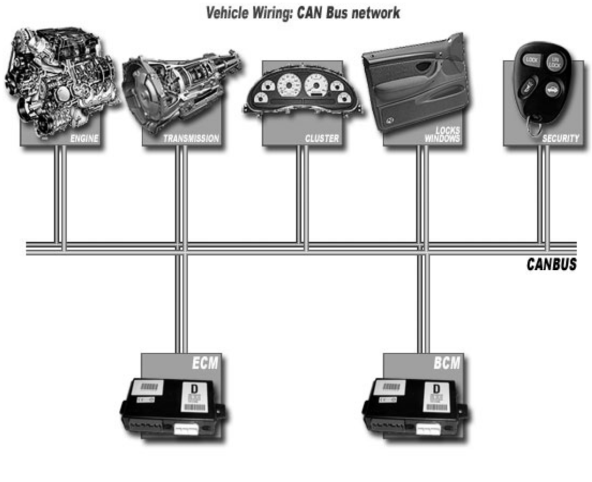


Fig. 10 Use of CAN Bus in Networking

The applications for WSNs are many and varied, but typically involve some kind of monitoring, tracking, and controlling. Specific applications for WSNs include habitat monitoring, object tracking, nuclear reactor control, fire detection, and traffic monitoring. In a typical application, a WSN is scattered in a region where it is meant to collect data through its sensor nodes.

## 10. Area Monitoring

Area monitoring is a common application of WSNs. In area monitoring, the WSN is deployed over a region where some phenomenon is to be monitored. As an example, a large quantity of sensor nodes could be deployed over a battlefield to detect enemy intrusion instead of using landmines.

When the sensors detect the event being monitored (heat, pressure, sound, light, electro-magnetic field, vibration, etc), the event needs to be reported to one of the base stations, which can take appropriate action (e.g., send a message on the internet or to a satellite). Depending on the exact application, different objective functions will require different data-propagation strategies, depending on things such as need for real-time response, redundancy of the data (which can be tackled via data aggregation techniques), need for security, etc.

## 11.Conclusion, Scope & Future Developments

In this dissertation I have discussed, the various functionalities which are implemented in Automobiles, using embedded systems. We believe that the challenge of designing embedded systems offers a unique opportunity for reinvigorating Computer Science. The challenge, and thus the opportunity, spans the spectrum from theoretical foundations to engineering practice. We expect that these new capabilities will increase interest in and applicability of CORBA for distributed real-time & embedded systems. Inspires new automation solutions. Design methodologies help us manage the design process.

Many systems have complex embedded hardware and software. Embedded systems pose many design challenges: design time, deadlines, power, etc. Real-time and embedded is now everywhere and everyone's business. Fast design-to-market is essential. Embedded processors are ubiquitous. Demand for systems that use them is increasing. Domain-specific embedded processors are specifically tailored to a particular application domain. Needed to meet stringent power, performance, cost, and real-time processing constraints. Challenging research problems in embedded processor design. Reducing power consumption. Selecting appropriate hardware resources. Performing hardware/software co-design. Ensuring reliability and security.

Conventional digital signal processors. High performance vs. power consumption/cost/volume Excellent at one-dimensional processing Per cycle: 1 16 × 16 MAC & 4 16-bit RISC instructions. High performance vs. cost/volume. Excellent at multidimensional signal processing. Per cycle: 2 16 × 16 MACs & 4 32-bit RISC instructions. Native signal processing.

Embedded Systems open a whole new world of possibilities. They still have the "classic" bugs which are near non-existent in the software realm. I hope I've shown that exploiting hardware isn't just a "gimmick" and that the threat is real. An extreme variety of application areas. Each application area has its "habits". An increasing amount of money is involved. Only few engineers worldwide involved (maximum 200K ?) having influence on our daily lives of all of us. Hardware is important and will produce the money. However – the intelligence in the software is the sales driver: smart – smarter – smartest. In industry most people are hardware educated Martin's statement: "embedded systems = the world of electronic hobbyists". Is it art, technology or science?. Microcontrollers are great little processors for I/O and data manipulation. The CISC-style programming makes assembly programming easier Variable instruction length can be a problem for Word-aligned machines. Super-scalar machines Pipelines .The RISC philosophy is to. Use simple instructions and let the compiler optimize. Use loads and stores to support higher-speed registers. Neither RISC, its

CISC predecessors, nor CISC / RISC has the definitive advantage. Depends on application, architecture, and implementation.

Furthermore, we intend to expand the application of evolutionary functional tests to further vehicle systems such as intelligent speed control or emergency brake systems. We also intend to research the interaction between evolutionary functional tests and structure tests more intensively. This should answer questions such as: Which coverage is achieved with functional tests? Does the seeding of functionally determined test data prove useful for an evolutionary structure test and, on the other hand, does the seeding of structure oriented test data increase the test quality of the evolutionary functional test?

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**First Author** Prof. M G Panjwani, working as Asst. Professor in Computer Technology Department of Priyadarshini College Of Engineering, Digdoh Hills, Hingna, Nagpur. Masters of Engineering in Embedded Systems form G.H. Raisoni College Of Engineering. Bachelor Of Engineering in Computer Science from Anjuman College Of Engineering and Technology. Diploma in Computer Engineering from Anjuman Polytechnic.

**Second Author** Prof. S Humera, working as Asst. Professor in Computer Technology Department of Priyadarshini College Of Engineering, Digdoh Hills, Hingna, Nagpur. Masters of Engineering in Computer Science form G.H. Raisoni College Of Engineering. Bachelor Of Engineering in Computer Science from Anjuman College Of Engineering and Technology.

**Third Author** Prof. S Quazi, working as Asst. Professor in Electronics Department of Anjuman College Of Engineering and Technology. Masters of Engineering in Electronics form G.H. Raisoni College Of Engineering. . Bachelor Of Engineering in Electronics from Anjuman College Of Engineering and Technology.