# Design & Development of a Smart Autonomous Vehicle

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*Abstract*— The smart vehicle system is a new information system for automobile drivers to solve problems caused by automobiles and road traffic. It deals with four fields: information systems for a single vehicle, for inter-vehicles and for vehicle-to-road relations, and studies on vehicle-to-driver relations. The system candidates include: a cooperative driving system, a control configured vehicle system, an active driver assistance system, an intelligent infrastructure, intelligent logistics, and machine vision. This uses LPC2148 of ARM as the core controller in the smart vehicle so as to achieve a real-time operation system (OS) μC/OS-II. This controller works as the control system to operate the entire vehicle. The real-time μC. OS-II enhances the performance of control and simplifies the design and management of software. In addition, this system uses voice-driven principle, improving the human interaction between machines and operators. The utilization of high-precision of ultrasonic sensors on obstacle avoidance robot provides a guarantee for safety. And the usage of LCD as the machine interface facilitates the debugging and control of robot. The work undertaken in this paper explains the impact of autonomous vehicles on society. The work includes a background section which gives information about the history and technology of autonomous vehicles. To evaluate the socio-economic effect of the autonomous vehicles, we review the benefits and economic savings that will emerge as a result of the introduction of autonomous cars in the economy. Impacts on safety, traffic flow, fuel economy, professional driving and culture are some of the important issues mentioned in this paper.

***Key words:*** Vehicle, Robot, Smartness

## I. INTRODUCTION

People drive their cars to work, to go shopping, to visit friends and to many other places. Children take the bus to school. The economy depends largely on the goods that are delivered by trucks. This mobility is usually taken for granted by most people and they hardly realize that transportation forms the basis of our civilization. As the cities grow and the population increases, more traffic is generated which has many adverse effects. Not having a proper transportation system costs people their safety, time and money. The need for a more efficient, balanced and safer transportation system is obvious. This need can be best met by the implementation of autonomous transportation systems. In the future, automated systems will help to avoid accidents and reduce congestion. The future vehicles will be capable of determining the best route and warn each other about the conditions ahead. Many companies and institutions are working together in countless projects in order to implement the intelligent vehicles and transportation networks of the future. The objective of this work is to avoid vehicle theft and control & to avoid the collision between two vehicles and to take some safety measurements and this project is to design an efficient driving guidance system based on sensor networks.

## II. INTRODUCTION

The first known worthy attempt to build an autonomous vehicle was in 1977. The project research was carried out by Tsukuba Mechanical Engineering Laboratory in Japan. The car functioned by following white street markers and was able to reach speeds of up to 20 mph on a dedicated test course. The breakthrough in the development autonomous vehicles came in the 1980's with the work of Ernst Dickmanns and his team at Bundeswehr University München. Their prototype was able to achieve 60 miles per hour on the roads without traffic. Another important milestone in the history of autonomous vehicles was AHS's revolutionary demonstration made in 1997 that included more than 20 fully automated cars.

The demonstration was carried out on a California highway and completed without a glitch. This event stands as gaining the most media coverage of any Intelligent Transportation System activity in US until the 2005 DARPA Challenge. Nowadays we are looking forward to see the next DARPA Challenge that will take place in an urban environment in November 2007.During the 1990s, the basic capability for car automation systems was demonstrated in Europe, Japan and the United States respectively by the PROMETHEUS program, AHSRA (Advanced Cruise-Assist Highway System Research Association) and AHS (Automated Highway System) program. The European projects were completely based on vehicle intelligence, while the Japanese developed systems that were highly vehicle-highway cooperative. The U.S. projects made use of both techniques in their autonomous vehicle systems.

The 1990's projects were very immense and unique. The ASH program of US resulted in the mighty Demo'97. The project was abandoned after this demonstration because of being too long in scope of time. Around 2000 smaller and more private attempts emerged. These smaller projects are mostly shortscoped and more safety based. Currently there are many small and mid-sized projects in progress which are no mach for programs like PROMETHEUS in size, but they show great potential for future development of autonomous transport.

Block Diagram

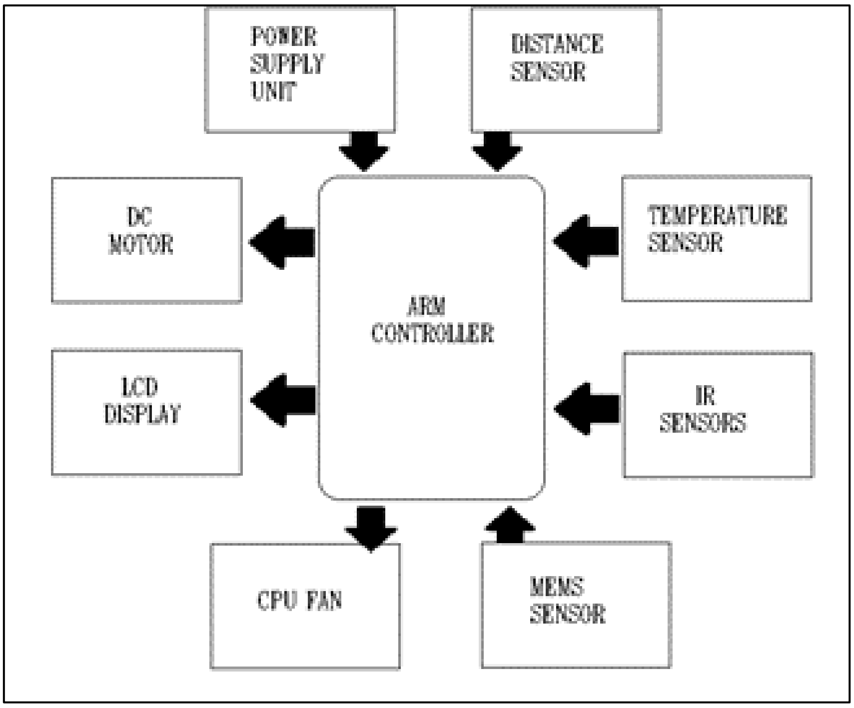


Fig. 1: Block diagram

Although the task of developing vehicle systems capable of driving themselves in current highway and urban contexts is exceedingly complex, scientists and engineers are pushing the envelope to bring the idea of truly smart cars into mainstream reality. For a vehicle to be able to drive by itself, it needs its own senses, brain, control and guidance to perceive and react to its environment. Pre-collision systems are active safety systems designed for automobiles to avoid or minimize the extent of damage in the event of a crash. These systems evaluate the position of the driver and his environment constantly to predict likely accident and take steps in advance to minimize injury. They may either brief up the active safety systems in the car or even brake automatically to bring the car to a halt.

The distance sensor measures the distance of the front vehicle than transmits the signal to controller which calculates the distances between the vehicles based on the time, if the distance is less the vehicle speed is reduced with the help of motor driver. Early pre-collision systems used infrared rays to detect the traffic movement. Infrared had limited visibility, which reduced the effectiveness of such systems. Modern systems are radar based, using ultrasound, radio waves or laser and moisture sensor, temperature sensor, eye blink sensor etc...So as to monitor the car's environment constantly. These systems can detect the position, distance and relative velocity of more than one vehicle in front of the car at any time.

Some systems produce an alarm to alert the driver if the radar finds out a potentially hazardous circumstance. Others take over the control of some aspects of the car like braking. They prepare the car for a collision by tightening the seat belts and arranging the seats of the car so that the passengers are aligned to be perfectly protected by the airbags. Some of these systems pre-charge the cars brake so as to improve the response time or even provide additional-braking pressure to bring the car to a halt. Advanced system will automatically brake the car, bringing it to a pause before crashing on to another car. The setup is fixed on the road vehicles and during normal movement (X-axis), the accelerometer output is nearly constant. When any accident occurs the MEMS sensor gives unbalanced or high axis output value (depends on vehicle position), and then the microcontroller reads the value and expects for the normal movement output value again on same axis (X-axis). Temperature sensor measures the temperature inside the vehicle if it is high than fan is turned ON.

## III. MICROCONTROLLER

Fig. 2: Microcontroller LPC2148

ARM is a family of instruction set architectures for computer processors based on a reduced instruction set computing (RISC) architecture developed by British company ARM Holdings. A RISC-based computer design approach means ARM processors require significantly fewer transistors than typical processors in average computers. This approach reduces costs, heat and power use. These are desirable traits for light, portable, battery-powered devices—including smart phones, laptops, tablet and notepad computers), and other embedded systems. A simpler design facilitates more efficient multi-core CPUs and higher core counts at lower cost, providing higher processing power and improved energy efficiency for servers and supercomputers.

## IV. TECHNICAL SPECIFICATIONS

- Microcontroller: LPC2148 with 512K on chip memory
- Crystal for LPC2148: 12Mhz
- Crystal for RTC: 32.768KHz
- 50 pin Berg header for external interfacing
- Wireless module adapter for 2.4GHz ZigBee (Xbee) / Bluetooth / Wi-Fi connectivity
- On board 512 bytes of I2C external EEPROM
- USB Type B Connector
- SD / MMC card holder with SPI interface
- No separate programmer required (Program with Flash Magic using on-chip boot loader)
- No Separate power adapter required (USB port as power source)
- 10pin(2X5) FRC JTAG connector for Programming and debugging
- 50 Pin Expansion header for easy access to I/O pins
- On board Two Line LCD Display (2x16) (with jumper select option to disable LCD)
- L293D 600mA Dual DC motor Driver
- ULN2003 500mA driver
- Two RS-232 Interfaces (For direct connection to PC's Serial port)
- Real-Time Clock with Battery Holder
- 2 Analog Potentiometers connected to ADC
- TSOP1738 IR receiver
- 4 USER Switches
- 4 USER LEDs
- Reset and Boot loader switches
- 3V button cell for on chip RTC

## V. DISTANCE SENSOR-HCSR04

This is shown in the Fig. 3

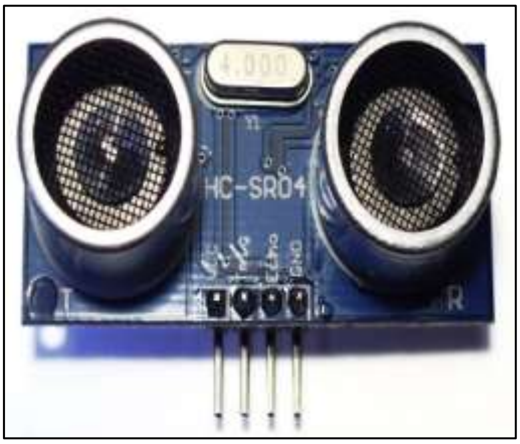


Fig. 3: Distance sensor Ultrasonic Ranging Module HC - SR04

## VI. PRODUCT FEATURES

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

1) Using IO trigger for at least 10us high level signal,
2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.
3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.
4) Test distance = (high level time × velocity of sound (340M/S) / 2,

## VII. WIRE CONNECTING DIRECT AS FOLLOWING

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

LM35 is a precision IC temperature sensor with its output proportional to the temperature (in ºC). The sensor circuitry is sealed and therefore it is not subjected to oxidation and other processes. With **LM35**, temperature can be measured more accurately than with a thermistor. It also possess low self heating and does not cause more than 0.1ºC temperature rise in still air.  The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ºC rise/fall in ambient temperature, i.e., its scale factor is 0.01V/ºC.

## VIII. TEMPERATURE SENSORS

Fig. 4: Temperature sensors


Fig. 5:  Mems sensors

## IX. MEMS SENSORS

The ADXL335 complete, low-power 3-axis accelerometer measures dynamic acceleration (motion, shock, or vibration) and static acceleration (tilt or gravity) over a ±3 *g* range with 0.3% nonlinearity and 0.01%/°C temperature stability. The user selects the bandwidth of the accelerometer using the $C_X$, $C_Y$, and $C_Z$ capacitors at the $X_{OUT}$, $Y_{OUT}$, and $Z_{OUT}$ pins. Measurement bandwidth can be selected to suit the application from 0.5 Hz to 1600 Hz for X- and Y- axes and from 0.5 Hz to 550 Hz for the Z-axis. Operating on a single 1.8V to 3.6V supply, the ADXL335 consumes 350 µA. Available in a 16-lead LFCSP package, it is specified from –40°C to +85°C.

## X. MOTOR DRIVER DESCRIPTION

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge *Motor Driver integrated circuit* (*IC*).

## XI. CONCEPT

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence, H-bridge IC are ideal for driving a DC motor. In a single l293d chip there two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller. There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working. It's like a switch.

## XII. LIQUID-CRYSTAL DISPLAY (LCD)

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.The LCD screen is more energy efficient and can be disposed of more safely than a CRT. Its low electrical power consumption enables it to be used in battery-powered electronic equipment. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of a light source (backlight) or reflector to produce images in color or monochrome. Liquid crystals were first discovered in 1888. By 2008, annual sales of televisions with LCD screens exceeded sales of CRT units worldwide, and the CRT became obsolete for most purposes.

## XIII. INFRARED REFLECTIVE SENSOR

The sensing element used in the PASCO CI-6628 Infrared Sensor is a thermopile. Thermopile detectors are voltage-generating devices that can be thought of as a miniature array of thermocouples. The thermopile is a high output, thin film, silicon based device which has 48 thermopile junctions. The active or 'Hot' junctions are blackened to efficiently absorb radiation. The reference or 'Cold' junctions are maintained at the ambient temperature of the detector the blackening material used on the 'Hot' junctions is capable of absorbing radiant energy from ultra violet to the far infrared. In order to limit the spectral sensitivity, optical filters and windows may be placed in front of the detector.

The window installed in the detector is a ruby-based material which has a spectral response from visible light to the far infrared (about 40,000 nano-meters). The hermetically sealed detector is heat treated and filled with argon gas to improve long term stability. The absorption of radiation by the blackened area causes a rise in temperature in the 'hot' junctions as compared to the 'cold' junctions of the thermopile. This difference in temperature across the thermocouple junction causes the detector to generate a positive voltage. If the active or 'hot' junction were to cool to a temperature less than the reference or 'cold' junction the voltage output would be negative. The output of the thermopile detector is presented to a gain selectable amplifier.

The GAIN switch located on the top of the sensor is used to adjust the output of the sensor to a level appropriate for the experiment being performed. Gain settings of 1X, 10X and 100X are provided. The gain settings on the sensor coupled with the user selectable gain of the PASCO Computer Interface allow a very broad range of measurements to be made with the Infrared Sensor. The TARE switch located on the top of the sensor allows the output of the sensor to be zeroed. This is particularly useful at high gain settings where small voltage offsets may interfere with measurements. The shutter provided with the sensor has two functions. The tab on the front edge is used to give constant spacing between the sensing element and a hot object when performing comparative radiant energy measurements. The spring loaded shutter keeps unwanted radiated energy from heating the sensing element before a measurement is taken.

## XIV. KEIL IDE

The Keil Development Tools are designed for the professional software developer, however programmers of all levels can use them to get the most out of the embedded microcontroller architectures that are supported. Tools developed by Keil endorse the most popular microcontrollers and are distributed in several packages and configurations, dependent on the architecture.

- MDK-ARM: Microcontroller Development Kit, for several ARM7, ARM9, and Cortex-Mx based devices
- PK166: Keil Professional Developer's Kit, for C166, XE166, and XC2000 Devices.
- DK251: Keil 251 Development Tools, for 251 devices
- PK51: Keil 8051 Development Tools, for Classic & Extended 8051 devices

In addition to the software packages, Keil offers a variety of evaluation boards, USB-JTAG adapters, emulators, and third-party tools, which completes the range of products.

## XV. PHILIPS FLASH UTILITY

FLASH memory and EEPROM are non-volatile memory solutions that are widely used in embedded systems applications. They are available both on-chip and as external, stand-alone memory. The Keil8051, 251, and C16x/ST10 development tools allow you to write software for all FLASH-based chips and microcontrollers that are available.

## XVI. USES FOR FLASH MEMORY

Program code may be stored in FLASH using any of a number of schemes. Embedded applications that must be updated benefit from FLASH memory. These systems can easily be programmed externally by device programmers and many can be re-programmed in-system. FLASH can also be used for configuration data and mass storage. These systems are typically updated on-the-fly in-system. Since FLASH is non-volatile (unless it's broken) these systems can restore configuration parameters after a power failure or reset.

## XVII. ACCESSING FLASH MEMORY

In either case, your application must include code that allows you to read (or execute) and write the FLASH memory. Reading FLASH memory works just like reading any other type of memory. The only difference with FLASH is that you may have a special format for the data it holds. This can best be represented by a C struct. Executing from FLASH memory also works just like executing from any other type of memory. Your FLASH device (and the code it contains) start at a specific address. When you create a program that is loaded into FLASH for execution you may be required to relocate that code when programming the device (for example, upload to XDATA/RAM then write into FLASH). Writing FLASH memory involves some real work. You must have routines that erase the FLASH and write bytes or blocks. Because of the number of different devices, these routines must be customized for each different device.

## XVIII. EMBEDDED C

Embedded C is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. In 2008, the C Standards Committee extended the C language to address these issues by providing a common standard for all implementations to adhere to. It includes a number of features not available in normal C, such as, fixed-point arithmetic, named address spaces, and basic I/O hardware addressing.Embedded C uses most of the syntax and semantics of standard C, e.g., main() function, variable definition, datatype declaration, conditional statements (if, switch, case), loops (while, for), functions, arrays and strings, structures and union, bit operations, macros, etc

## XIX. EXPERIMENTAL RESULTS

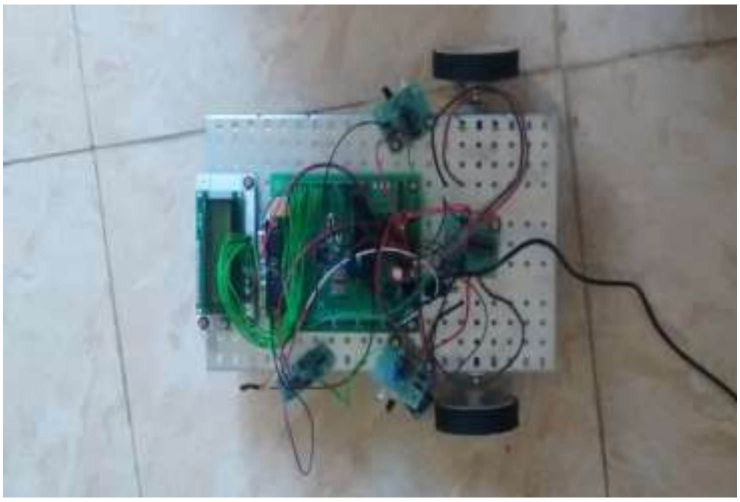

Fig. 6: Project Module

The module which shown above operates in two modes, viz.,

1) Traffic assistance system : In this mode distance sensor measures distance of the front vehicles and calculates the range through the time interval between sending trigger signal and receiving echo signal.
2) Lane assistance system : This system helps in vehicle to move in particular lane.


Fig. 7: Selection of mode

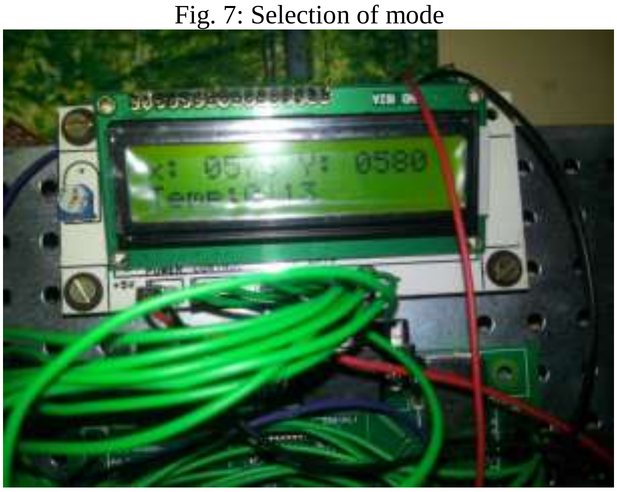

Fig. 8: Temperature sensing operation

The LM35 series precision integrated-circuit temperature sensors is used in our module. this sensor senses the temperature inside the vehicle whenever it reaches maximum fan will turns ON automatically.

## XX. ADVANTAGES & DISADVANTAGES

- To locate the position of the vehicle in Defense.

- Can be used in cars, bus, ship safety system.
- Automotive applications and so on.
- For the safety of the driver.
- In real time it's hard to stop the vehicle immediately

## XXI. CONCLUSION

Currently, there are many different technologies available that can assist in creating autonomous vehicle systems. Items such as GPS, automated cruise control, and lane keeping assistance are available to consumers on some luxury vehicles. The combination of these technologies and other systems such as video based lane analysis, steering and brake actuation systems, and the programs necessary to control all of the components will become a fully autonomous system. The problem is winning the trust of the people to allow a computer to drive a vehicle for them. Because of this, there must be research and testing done over and over again to assure a near fool proof final product. The product will not be accepted instantly, but over time as the systems become more widely used people will realize the benefits of it.

The implementation of autonomous vehicles will bring up the problem of replacing humans with computers that can do the work for them. There will not be an instant change in society, but it will become more apparent over time as they are integrated into society. As more and more vehicles on the road become autonomous, the effects on every day life will be shown. It will result in an increase of the efficiency of many companies as less time is wasted in travel and less money is spent on tasks autonomous vehicles can perform where a human was previously needed. This will also cause the loss of thousands of jobs all over the world. There would have to be a plan in place before society would allow this to happen. This is an important reason behind the lack of interest and slow development of fully autonomous vehicles. If this problem is solved, we could see fully autonomous vehicle systems in the near future.

## XXII. FUTURE SCOPE

The transition to an automated transportation structure will greatly prevent many problems caused by the traffic. Implementation of autonomous cars will allow the vehicles to be able to use the roads more efficiently, thus saving space and time. With having automated cars, narrow lanes will no longer be a problem and most traffic problems will be avoided to a great extent by the help of this new technology. Research indicates that the traffic patterns will be more predictable and less problematic with the integration of autonomous cars.Smooth traffic flow is at the top of the wish list for countless transportation officials. "We believe vehicle-highway automation is an essential tool in addressing mobility for the citizens of California," says Greg Larson, head of the Office of Advanced Highway Systems with the California Department of Transportation, who notes that "The construction of new roads,in general, is simply not feasible due to cost and land constraints".

It is clearly seen that most government officials and scientists see the future of transportation as a fully automated structure which is much more efficient than the current configuration. All developments show that one day the intelligent vehicles will be a part of our daily lives, but it is hard to predict when. The most important factor is whether the public sector will be proactive in taking advantage of this capability or not. The Public Sector will determine if the benefits will come sooner rather than later. Car manufacturers are already using various driver assist systems in their high-end models and this trend is becoming more and more common. Since these assist systems are very similar with the systems that are used in autonomous car prototypes, they are regarded as the transition elements on the way to the implementation fully autonomous vehicles. As a result of this trend, the early co-pilot systems are expected to gradually evolve to auto-pilots. More detailed information on the driver aid systems can be found in the following technology section.

## XXIII. CONCLUSIONS

In this paper, an autonomic moving vehicle is being designed & implemented, the unit is working well even now, thus, highlighting the practical implementation point of view in the field of automation & robotics.

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