Autonomous Vehicle: A Future Technology

[1]Yogesh Mahendra Borole
[1]UG Student
[1]Department of Mechanical Engineering.

***Abstract*:** The concept of "The autonomous vehicle" or self- driven vehicle is useful to upgrade in the upcoming technology in traditional human driven vehicles. This technology enables to auto-drive in high way roads without the control of the humans. This process will be achieved by the use of LIDAR's, RADAR's, Sensors and Advanced GPS maps. First a compact path of the place where user wants to go is selected on the GPS map. When the engine is started, all the components of the system will start to work. The inputs are obtained from the radar every second. Issue of pre-saved digital maps that are not frequently updated and do not contain all roads and shortcuts. This system introduced paths and roads to traditional digital maps. Radar senses the objects at the limit of 180'and 90' angle and continuously send the input to control system. This control unit is built with a system that makes the vehicle to move in the possible safe directions. And hence 50% of the job is done by the RADAR's components and the remaining job is done by the advanced GPS mapping system to make a safe journey. The separate input signals are obtained from the ground level to detect the speed breakers and some other conditions of the road. Same set of equipment's is fixed on the rear side of the vehicle to avoid other vehicles hit on rear side of the user's vehicle.

***Keywords* -** Autonomous Vehicle, LIDAR, RADAR, Video Camera, Advanced GPS Mapping System.

I. INTRODUCTION

The self-driving car is a research project. This technology corresponds to develop self-drive mode in the vehicle. With the help of this, we can drive the vehicle on highway roads without the control of the humans. This technology will create a new revolution in Automotive Industry and human life. It will save the driving time and it is not mandatory to the drivers to be always there on the driver seat except the signal and road breakers. Carelessness of drivers causes many major accidents. This can be minimized with the help of Auto-drive mode technology. In this technology, many devices and equipment's will be integrated to make a safe Automobile vehicle. This auto driven mode technology is created with the help of different departments of Engineering. But from these departments of Engineering, four departments will play an important role. [1,2]

These departments are Mechanical, Electronics, Information Technology and Computer science. Mechanical department is an important department that will take care of all the physical, dynamic and mechanical movements of the vehicle. Electronics department takes care of the programs made for the functioning of the ECU (Electronic Control Unit) and for its proper working. Information technology and computer science departments are going to be the back bone of this technology. Programs are made which is going to be responsible for the working conditions of the ECU. The brief description of the components and working process of the components is given in following paragraphs. A discussion is already made by HONDA UK in 2006 but there were many drawbacks and they are unable to clearly explain about the working of this technology. [3]

II. HISTORY

The first attempt to build an autonomous car was in 1978. The project had carried out by Mechanical Engineering Laboratory in Japan country. The car functioned by black street markers and was able to reach speeds of up to 35 mph on a testing of the vehicle.[4]

Afterwards in the development, autonomous vehicles came in the 1985's with the work of Ernesto Dickmannos and his team at Bundeswehr Universität München. Their rough idea was able to achieve 65 miles per hour on the roads without traffic. Other important role in the history of automatic vehicles was revolutionary demonstration made in 1998 that included more than 30 fully automated cars. The demonstration was carried out in United States and completed without any error. This event stands as gaining the most media coverage of any Intelligent Transportation System activity in US until the 2006 DAPPR Challenge. And here we are looking forward to see the next DAPPR Challenge that will take place in an environment in November 2008.

During the 1991, the basic car automation systems was developed in Russia, Europe, Japan and the United States respectively by the AHSRA (Advanced Cruise-Assist Highway System Research Association) and AHS (Automated Highway System). The projects in USA were completely based on vehicle intelligence, while the Russian developed systems that were highly vehicle-highway cooperative. The Japanese projects made use of all the techniques in their autonomous vehicle systems. The 1990's projects were very revolutionary and unique. The ASH program of US resulted in the mighty Demo'98.This demonstration was cancelled due to long scope of time. Around 2500 smaller and more private attempts are emerging. These smaller projects are mostly expensive and more safety based. There are many small and medium sized projects in progress which are no much for programs like PROMETHEUS in size. These programs show great potential for future development of autonomous vehicles.[4,5,6]

III. WORKING

This technology totally depends on the sensors and components which are discussed in the later part. First the GPS (Global Positioning System) Mapping System will show the desired path where the user wants to go. The path is selected on the GPS system in the display unit. When the user starts the engine, all the components will get into active mode and will receive all the initial parameters and will start working accordingly. The inputs are obtained from the radar every second. RADAR (Radio Detection and Ranging) detects the objects at the limit of 180'and 90' angle and continuously take the input and transfers to the control unit and hence the vehicle will move in safe and proper direction. ECU is an important element which analyses all the parameters and accordingly makes the vehicle to move in the possible safe directions from the readings received from the RADAR, sensors and GPS maps

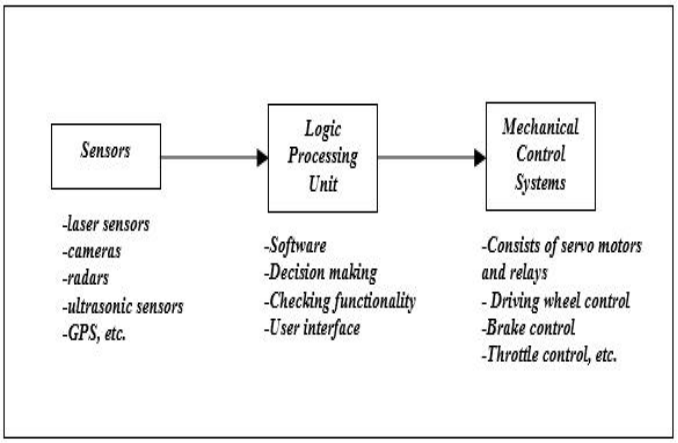

Fig. 1. Basic Block Diagram

Various input parameters are detected by the sensors, RADAR, LIDAR, etc. and these signals are given to Logic Processing Unit. Control Unit analyses the input and processes the input. Then the processed signal output is sent to the Mechanical Control Systems which include Servo Motors, Brake Control, Wheel Control and Throttle Control and accordingly drives the vehicle.

Here 40% of the job is done by the RADAR equipment's and rest of the job is done by the advanced GPS mapping to make a safe journey. Separate signals are obtained from the sensors which are kept at the bottom of the car and given straight to the wheel in order to detect the speed breakers and road damages which will decrease the speed. Advanced GPS mapping technology makes the car as per the Indian rule of "keep left". It synchronizes the vehicle and the road. This only helps the vehicle to turn properly during the roads. Same set of the sensors are fixed on the rear side of the vehicle to avoid other vehicles to hit the user's vehicle during deceleration, curves and overtaking.

IV. COMPONENTS

This technology contains four major components. They are,

1. LIDAR
2. RADAR
3. Sensors
4. Video Camera
5. Advanced GPS Mapping Systems

A. LIDAR

LIDAR (Light Detection and Ranging) is simply called as light detection and ranging. A LIDAR is instrument which consists of a LASER (Light Amplification by Stimulated Emission of Radiation), scanner and specified GPS receiver principally. It is optical remote sensing technology which is used to measure the distance of target with the illumination of light in the form of pulsed laser. It is a laser range finder also known as "heart of system" which is mounted on the roof of spoiler. A detailed map of the environment is generated by the device VELODYNE64 beam laser used for autonomous ground vehicles and marine vessels. A sensor named HDL64E is designed for obstacle detection and navigation. The scanning distance of LIDAR is approximately 60 meters. For 3-Dimensional data collected in mobile and the mapping application this sensor becomes important for most demanded applications due to its durability, high data rates and 360 degree view. One piece design patented the HDE-65E use 65 mounted lasers that are fixed and each of it is mounted to a vertical angle specifically with entire unit to measure the environmental surroundings. Reliability, field of view and point cloud density is dramatically increased by this approach. High resolution maps are combined by the Car laser and hence produces different types of data models that will allow the vehicle to drive on its own avoiding obstacles and respecting traffic laws.

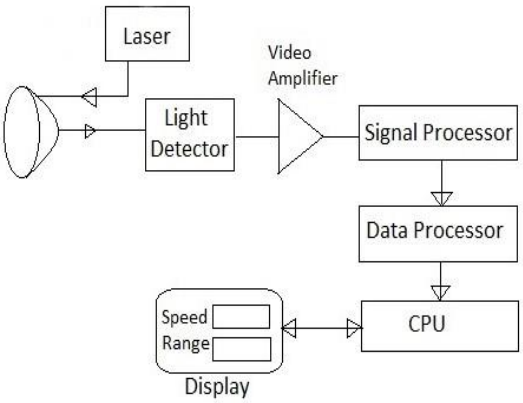

Fig. 2. Block Diagram of LIDAR

B. RADAR

Radar is simply an object detection system. It uses ultra-high frequency waves to determine the position or range of the objects such as aircraft, ships and motor vehicles. The term RADAR is simply defined as radio detection and ranging of the vehicles. A RADAR system has one transmitter that emits radio waves constantly. When these come into contact with an object they are reflected in all directions. The signal is partially reflected back and it has a slight change in wavelength and frequency, if the target is moving. The optimal range of the RADAR can be fixed as 50m length. The receiver is normally in the same location as the transmitter. We know that the signal returned is usually very weak, the signal will be amplified through use of electronic components in the receiver and also in the antenna. This system enables RADAR to detect objects at ranges where other emissions from the target object such as sound or visible light would be too weak to detect.

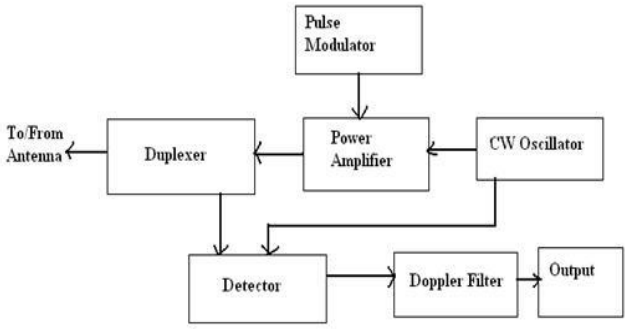

Fig. 3. Block Diagram of RADAR

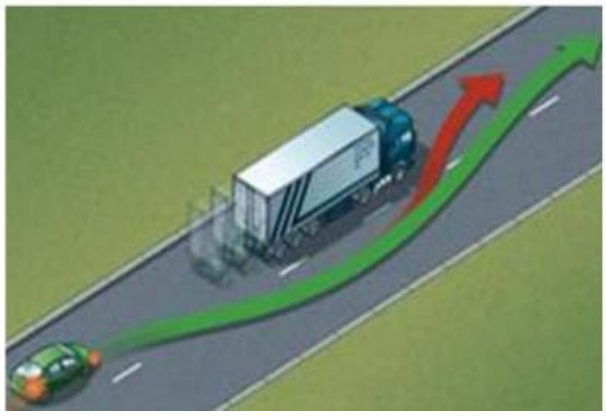

Fig. 4. Start of Overtaking Mode

Figure 4 shows that the radar signals are transmitted and readings of the detected obstacle are received by the reflected signals from it in front of the car. The electronic control unit automatically accelerates and deaccelerates the car according to the readings. In case, the obstacle in front of the car is moving slowly means then the control unit will go for the “overtaking” mode.

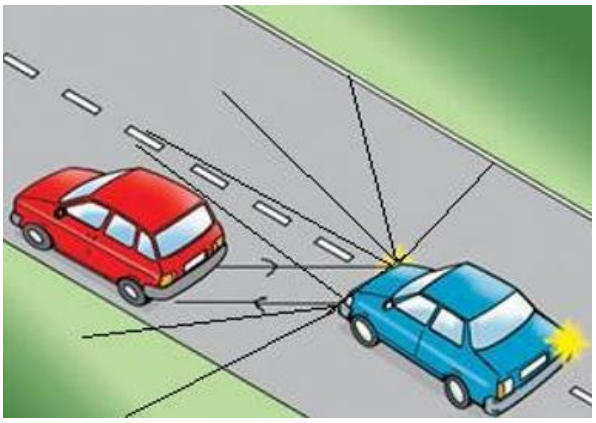

Fig. 5. Front RADAR

It is necessary to analyze what might go wrong while overtaking. This mode will find the every possible direction and will increase the speed to overtake the obstacle in the front to move ahead. Initially the signal from the front radar detects the object that is present in the front of the car. Now the radar will analyse whether it is possible to overtake or not. If it is possible to overtake then the vehicle will try to overtake.

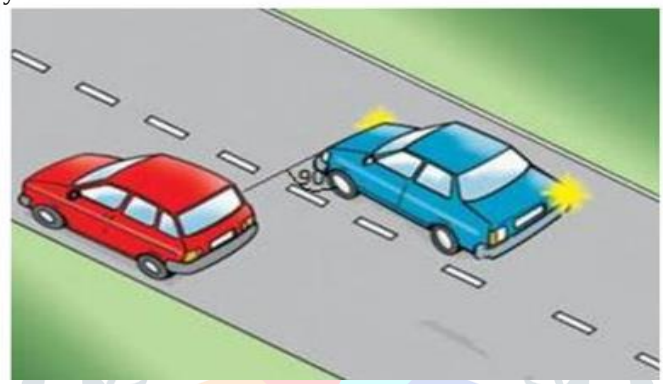

Fig. 6. Front RADAR at 90 degree

While overtaking, there is always a possibility for the vehicle to hit another vehicle or any obstacle while steering left. So, a constant signal at 90 degree is obtained from the radar detect the obstacle in the left.

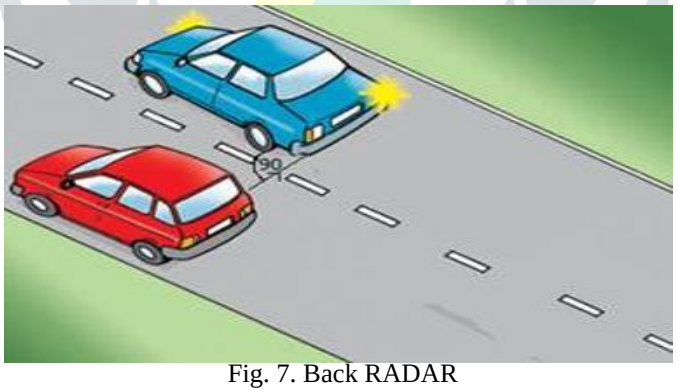

Fig. 7. Back RADAR

After the front radar crosses the vehicle, readings will be detected from the rear radar. This will give the indication of the object that is still present and therefore the vehicle cannot steer left. A constant reading will be taken from the rear radar at 90 degree. This condition will not change until the rear radar crosses the obstacle.

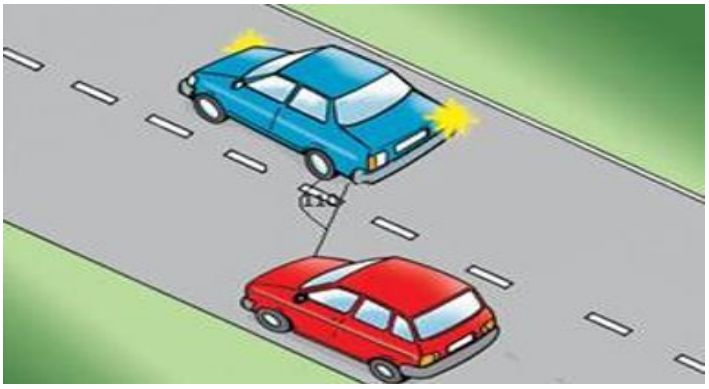

Fig. 8. RADAR at 110 degree

When the back radar crosses the object the angle of 90 degree will start to increase and this will indicate that the car has crossed the object. A particular standard degree angle is already defined in the program. When the vehicle has to steer, generally 110 degree is enough to steer the vehicle safely.

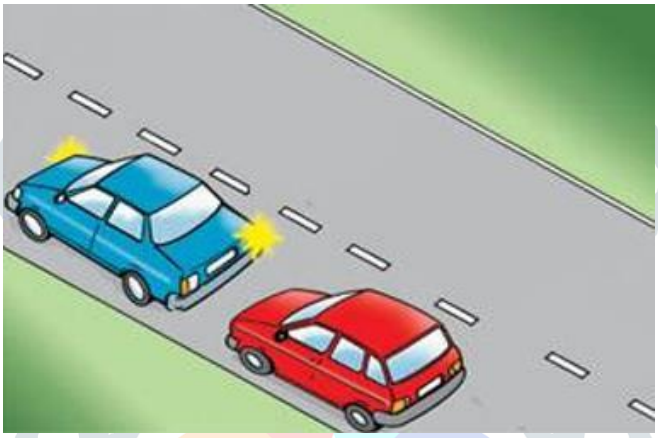

Fig. 9. Overtaking Mode

Thus the overtake mode is achieved successfully and this is how the process works. As RADAR's cannot detect the road condition, so separate sensors are installed near the wheel to detect the road conditions.

C. Sensors

A sensor is an important component in the Autonomous Vehicles that first measures a physical quantity and converts it into electrical signal which can be read by an observer or by an instrument. Therefore for this system sensors are kept near the front wheel. And then these sensors focus the road at an angle of 160 degree. The sensor will always focus on the road like a stick from the car. A constant input will be provided from the sensor to the ECU. When the angle changes because of any speed breaker or road damage, the sensor will detect it automatically and eventually the control unit will slow down the car.

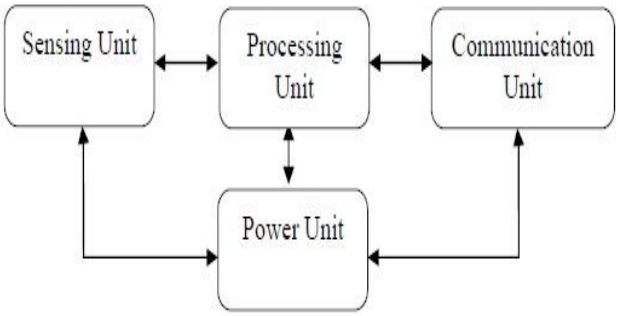

Fig. 10. Block Diagram of Sensor

D. Video Camera

The video camera is one type of sensor positioned near to the rear-view mirror that detects the upcoming traffic light. It performs the same function as the human motorist performs. Basically it reads the signals and keeps an eye out for cyclist, other motorist and pedestrians. This system basically coverts the distance and set to the pulse width modulation. This system also calculates turn direction and set servo motor drive signals. This controls the servo motor and can control the speed of vehicle.

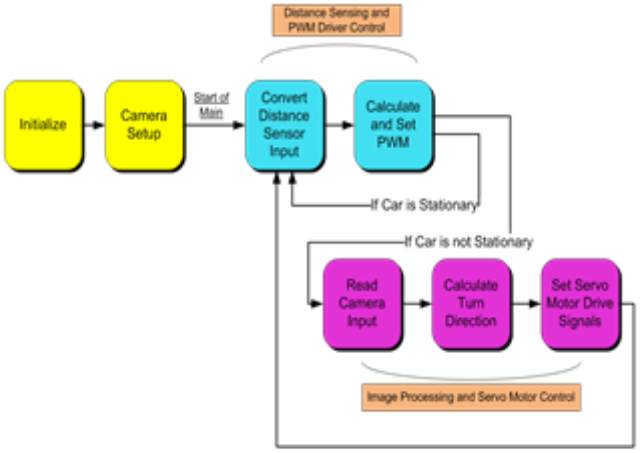

Fig. 11. Block Diagram of Video Camera

E. Advanced GPS Mapping System

This system uses the current position as source and gets the desired route to the destination point from the source. User have to specify the destination in the GPS map. System finds the smallest path to the destination and counts the latitudinal and longitudinal coordinates and sends it to the control unit. Vehicle follows the coordinates using GPS and compass. If GPS signal is not received, initial navigation system is used to obtain the current position. Obstacles around the vehicle are sensed by laser range finder. Simultaneous location of the vehicle is uploaded to the server through GPRS (General Packet Radio Service). At the server, coordinates are obtained and displayed in the Google GPS map for monitoring purpose. So the autonomous vehicle can be monitored from anywhere in the world. Simple Block diagram of the vehicle is shown in the figure below

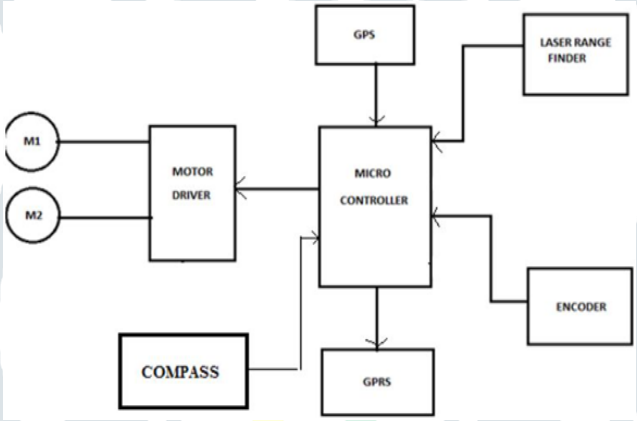

Fig. 12. Block Diagram of GPS Mapping System

V. CHALLENGES

The components and technologies used are costly. The main components used in this technology are RADAR, LIDAR, position sensor, GPS, heterogeneous processor, JAUS interoperable communication systems, high resolution cameras which are very costly.

Ahead of it, Law is the major problem to this technology as Lawmakers have a huge impact on innovation. In the US most federal and state automobile Laws states that it requires a human operator. Before the technology can be commercialized these need to be repealed. To legal the operation of autonomous cars on the roads, Nevada became the first state in 2012. This is an attempt to gain from state support for similar changes in Law, Lobbyists from Google have been travelling around other states and targeting Insurance companies as well. The technology also poses serious issue to in terms of Regulatory and Liability.

VI. FUTURE SCOPE

The transformation to an automated transportation structure will surely prevent many problems caused by the traffic issue. Use of autonomous cars will allow the vehicles to be able to use the roads more efficiently and thus it will save space and time. When we have automated cars, shorter lanes will not be a problem and most of traffic problems will be avoided with the help of this new technology in great extent. Research indicates that the traffic patterns will be more predictable and less problematic with the integration of autonomous cars.

It is seen that most government officers and scientists see the future of transportation as a fully automated structure which is much more efficient than the current situation. All researches shows that one day the autonomous vehicles will be a part of our daily lives but we can't predict when. The most important consideration is whether the public sector will take advantage of this capability or not. The humans will determine if the benefits will come sooner rather than later. The Indian Motor Vehicle ACT,

1988 and the rules that regulate the operation of vehicle in India do not currently allow fully automated Systems. A human driver needs to be in effective control of vehicle at all times.

VII. CONCLUSION

Technology used in autonomous vehicles is going to make a priority for many automobile manufacturers. Development and implementation of systems such as ACC (Adaptive Cruise Control) and LKA (Lane Keep Assist). These systems are currently used to assist the driver with tasks. After that continuing research will eventually lead to the integration of a autonomous car in all types of vehicles. The many systems described the building blocks or block diagram to achieving a fully autonomous system. Eventually, after years there will be few human driven cars on the road and autonomously driven vehicles will be more. Implementation of this Autonomous car technology will surely reduce the occurrences of road accidents by a considerable value. In the future, the wide acceptance of this technology will create an "Accident free world". The Indian law don't permit even testing of Autonomous Vehicles in India but surely this scenario will change after the development of research in the field of Autonomous Vehicle. Autonomous Vehicle is surely a promising technology but there is a need of further research and development for this technology to be introduced on road and to be more effective and safe.

.

REFERENCES

[1] Yassine Zein , Mohamad Darwiche , OssamaMokhiamar 'GPS tracking system for autonomous vehicles', '13 November 2018

[2] *Scott A. Cohena, Debbie Hopkinsb 'Autonomous vehicles and the future of urban tourism' , '28 October 2018.*

[3] Kanwaldeep Kaur, Giselle Rampersad, 'Trust in driverless cars: Investigating key factors influencing the adoption of driverless cars' 30 April 2018.

[4] Maria Laura Delle Monachec, Benedetto Piccolid, Benjamin Seibolde, Jonathan Sprinklef, Daniel B. Work. 'Quantifying air quality benefits resulting from few autonomous vehicles stabilizing traffic.' 14 December 2018.

[5] Nadia Adnana,Shahrina Md Nordina, Mohamad Ariff bin Bahruddinb, Murad Alic., 'How trust can drive forward the user acceptance to the technology? In vehicle technology for autonomous vehicle.' 16 October 2018.

[6] J. Jansson, 'Decision Making for Collision Avoidance System',SAE, Detroit, Michigan, 2002.

[7] Y. Kojima, K. Kidono, A. Takahashi, Y. Ninomiya, 'Precise Ego Localization by Integration of GPS and Sensor-based Odometry, AVEC, Kobe', Japan, 2008.

[8] Alessandrini, A., Campagna, A., Site, P. D., Filippi, F., & Persia, L. 'Automated vehicles and the rethinking of mobility and cities. Transportation Research.',2015.