"Geospatial Infrastructure and Standards for Autonomous Vehicles"

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Discussion Points

Autonomous Vehicles

Autonomous vehicles (cars, ships, airplanes, etc.) are vehicles that have the capability of sensing the environment and navigating without any human participation. The difference between an autonomous vehicle and a non-autonomous one is data because it is the 'data' that defines whether a vehicle is autonomous or not. Autonomous vehicles or rather self-driving vehicles represent a major innovation for the automotive industry. These kinds of vehicles have become a concrete reality and may pave the way for future systems where computers take over the art of driving. A fully autonomous car is equipped with features of safety and driving and there is no need for human support to drive the car. This overall development of autonomous vehicles is split in four growth stages/zones:

(1) Zone I – Automated driving as safety function but human driver
(2) Zone II – Automated driving in controlled Situation but human driver
(3) Zone III – Full autonomous driver with driver taking over when necessary
(4) Zone IV - Full autonomous driving (Car in complete control – no human contact)

It may be said that autonomous vehicles operate safely within their own context and will therefore have a massive impact on the structure of the society. At present, it is difficult to assess the impact of the autonomous vehicles for it creates a virtuous cycle which blurs the distinction between normal and technology advancement.

I. Technology

Autonomous vehicles may be considered as a major technological development in the field of robotics. The technical requirements are unique for vehicles that are fully autonomous or connected. Communications include aspects like semantics, infrastructure requirements and pay loads. The vehicle needs to be able to drive itself safely by making use of in-car sensor data.

Autonomous vehicles focus on the use of sensors, LiDAR, radar and heavy duty sensors for they are proven technology for scalability. These technical features help in observing the surroundings for the car to drive safely. It is therefore imperative to identify and understand the kind of geo-data that needs to be made available for autonomous cars to function on their own.

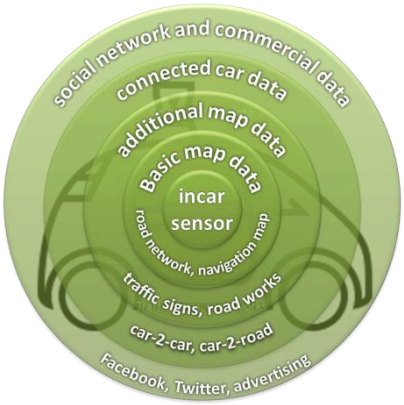
Technical challenges

- Expensive technology: The cost of sensors on board is too high and this needs to be addressed in order for efficient adoption of the technology.
- Tunnel driving: In case of tunnels, the car might lose the connection with the communication network and GPS network. This requires additional techniques for example positioning using the in-car IMU (Inertial Measurement Unit)
- Unpredicted situations – How are autonomous vehicles going to behave in unpredicted situations? Will the driver take over the steering wheel in unpredicted situations? How will the driving behaviour be influenced?
- Reliability of the physical infrastructure
- Real time data updates: Updating dynamic data in milliseconds is a challenge.

II. Geo-Data

Location is the most important aspect of autonomous vehicle technology. Hence, the role of Geo-data and the need for Geo-data infrastructure is crucial to the functioning of an autonomous vehicle. There is a lot of information i.e. Geo Data available about the environment and the more the data more decisions would be automated Geo Data is an area of primary interest as the society moves towards a smarter world. Data operates at various levels which may be listed as below:

- in-car sensor data
- base map data for navigation
- additional map data with traffic signs, road works, etc.
- connected car-to-car or car-to-road data
- social network or commercial data



However, there is lack of clarity regarding the overall quality of data and also in particular the spatial resolution that is available, with regards to suitability for efficient functioning of the autonomous vehicles. Data is huge and extremely important and the analysis of, how much data is going to be generated in interaction within the various components like Geospatial structure inside the car, the other cars ,satellites and sources, is required. It is important to measure the usability & spectrum of the available data as the data is going to be in huge volumes because it is going to be collected every nano second.

Sources of data:

- Automobile industry
- Producer of Sensors
- Government
- Users

It is therefore going to be a mammoth task to accumulate the data. This requires an efficient infrastructure which shall be able to store as well as process such volumes of data.

Data collection methodology: Data may be collected by the car itself or public data sets can be used for the same purpose. Consistency of data is very important and so is the communication element between vehicle to vehicle as well and, between spatial information and vehicle.

(1) Sensors – In-car sensors collect a lot of useful data. This data can be used to update public maps for the purpose like road management. Data collected through sensors provide a wealth of information and this data can fulfil many purposes. As autonomous vehicles become more mass produced, the challenge will be to see what happens when the data is being generated from autonomous vehicles through new sensors. In car sensors give a new meaning to the whole automobile industry. Self-driving cars can now be thought of as a collection device like a mobile mapping device.

An example of this may be cars equipped with cameras and the industry may utilise the data from these cameras to get real time information and photographic imagery to collect data.

(2) Map Data – Cheap and intelligent sensors are now available in the market and these sensors, along with relevant software enable the car to build their own maps. This is considered as a technology breakthrough in map making. The scale at which this happens is very large and unique as there are large numbers of cars on the road. This enables real time map making and updating.

(3) Base Map – The infrastructure for building base maps after getting real time data from large number of sensors is necessary. Here, it has to be understood that base map is not a map but a data model that enables machines to communicate with each other. Base maps need to be derived in collaboration with car makers, map maker and other companies. The base map provides a structure that allows for strict filtering of road information along with complete third party related information to be integrated seamlessly so that autonomous business models can flourish.

III. Role of the government and other legal aspects

The government's role is a point of major concern for the autonomous industry. Automobile manufacturers are already working towards building self-driving cars but are waiting for government laws and regulations so that these cars can be driven everywhere. The questions that arise is will there be a power struggle for the data between car makers, sensor makers, infrastructure companies and the government? What will be the role of the government to develop appropriate laws and regulations regarding competition law and citizen law for autonomous vehicles?

The government's role and legal issues need to be identified for the major problem begins when data commercialisation begins to happen. It therefore becomes imperative for both, the government and private companies to work towards a larger goal. However there is no role for the government in the base map data for autonomous vehicles. However there is a role for the government when it comes to making data available with a more legal or regulatory nature, for example, data without traffic signs. The industry and the government together have to decide the role of the government to provide information networks for cars to operate. The government will have to cooperate with markets to roll out data and will have to work closely with the automobile industry to make the system work.

For instance, countries like Japan provide base layer which accelerates the adoption of this technology. Automobile companies like Lexus and Toyota are frontrunners in using geo-data. Netherlands too had a good base map infrastructure with specifications as per the requirement of the autonomous industry.

Governments will always have the responsibility for safety on the road. In years to come, when cars will be managed through artificial intelligence, road management will change. However, the question remains, whether the governments will adopt this change and give away their responsibility or they will impose strict requirements to the technology (standards and certifications). A level playing field needs to be created where both private players and government players can come together and a business framework can be created.

Liability: Currently, the liability is with the driver and a driver is the worst sensor. OEMs (manufacturers of car and sensors) have to worry about who will be responsible, in case the cars become fully autonomous and there are technology failures

Standards: A number of groups are working on standards for connected and autonomous vehicles, for instance, car-to-road communication (WIFI) and for traffic lights. At OGC, sensor data standards are developed. Technology and data standards have a very important role to play in the functioning of autonomous vehicles.

Used Cases:

The Car for Transportation

- ✓ Taxing of airlines / airplanes
- ✓ Truck Fleets
- ✓ Transportation / Mobility as a service

The car as data collector

- ✓ supervision and enforcement of (semi-) public space
- ✓ road management: road condition / pothole detection

Discussed Questions

- ✓ Is it possible or is there a need only for one single base map?
- ✓ What are the data infrastructure requirements?
- ✓ How to minimize the cost of developing and maintaining the data infrastructure?
- ✓ What will happen if every car has its own 3D Geographic model?
- ✓ What happens if the 3D model is not a standard one and does not fit every car? What problems are foreseen?
- ✓ Where should, data be processed? Is there a need for separate infrastructure or should it be processed on the vehicle itself?
- ✓ How does the data get aggregated/stored and analysed?
- ✓ How are autonomous vehicles going to behave in unpredicted situations?
- ✓ How to deliver these data and the flood of data effectively and efficiently?
- ✓ How does the government reach the pace of the industry and how should the governments decide its vision?
- ✓ When is the switch over from normal cars to autonomous cars going to happen?
- ✓ How soon is it going to be for the world to become fully dependent on autonomous vehicles?
- ✓ Is it important to think about a unique data infrastructure?
- ✓ Do autonomous vehicles need standards?
- ✓ What should be the role and responsibility of the government in defining the role of the base map?

Not Discussed Questions

- ✓ How to get the automotive companies get involved?
- ✓ Privacy issues
- ✓ Laws on how long to keep the data for – important for insurance and liability
- ✓ Cyber security – set up typical scenarios