Autonomous Transportation in Logistics

Overview

Autonomous transportation describes systems that provide unmanned, autonomous transfer of equipment, baggage, people, information or resources from point-to-point with minimal intervention.

There is a strong case for suggesting that the logistics industry will adopt self-driving vehicles much faster than most other industries. The reason for this is that different rules apply when a vehicle is moving around in a secure, private zone. Also, liability issues are less pressing when that vehicle is transporting goods instead of people.

Applicable Industries

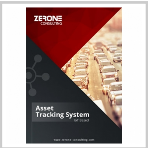
- Automotive
- Logistics
- Telecommunications

Applicable Functions

- Information Technology
- Logistics

Production - Manufacturing

Case Studies



IoT Based Asset Tracking System

The existing system used by the customer could only track a few thousand assets and was able to generate only a few standard set of reports.

As the number of assets tracked grew exponentially, the ...

Market Size

Estimate A	$1.3 billion (2014, Global, Autonomous Robots), $3.6 billion (2019), $13.9 billion (2023) Source: (siemens.com)
Estimate B	In 2016, Mckinsey said the self-driving vehicle market could be worth $1.5tn in 2030. Source: (Mckinsey)
Estimate C	The global autonomous vehicles market revenue is expected to grow at a CAGR of 39.6% during the forecast period 2017-2027 reaching $126.8 billion by 2027. Source: (PM News Wire)

User Viewpoint

Business Value

How does this use case impact an organization’s performance?

Imagine a world where our streets and highways are full of driverless trucks and cars moving in perfect sync with each other. Road traffic accidents caused by human error will become a thing of the past. Our daily commute to work will be stress-free and safe – we'll get into our cars, enjoy a cup of coffee, read the latest news, interact with other passengers, and even catch up on some sleep! The American public had this dream already some 70 years ago (see Figure 1). We'll arrive relaxed and refreshed at our destination and step out of our vehicles and directly in through our office door. We'll leave the car to find an available parking space autonomously.

Improved safety: Research indicates that up to 90 % of road traffic accidents are caused by the driver. Advocates for driverless vehicles use statistics like this to argue that autonomous systems make better and faster decisions than humans. They also claim that self-driving vehicles will always monitor and adapt to varying traffic and weather conditions, and will avoid obstacles in the road, doing all this with more diligence, speed, and safety than human drivers.

Lower environmental impact: With fewer cars and more efficient fuel consumption, autonomous systems are programmed to minimize environmental impact. Self-driving vehicles can achieve lower emissions. This, of course, benefits the environment and puts less stress on the road network.

Higher efficiency: Traffic can flow faster and congestion can be reduced with autonomous driving. Using a vehicle to- vehicle communication, autonomous systems can set high speeds and intelligently avoid busy routes. With fuel efficiency achieved by optimized driving and by conveying, owners of driverless vehicles can reduce their carbon footprint and motoring costs by approximately 15 %.

Greater comfort: In an autonomous vehicle, the driver becomes a passenger. He or she doesn't have to watch the road ahead but can rest and enjoy other activities. This also makes self-driving vehicles a very attractive form of transportation for the elderly, underage, people with physical disabilities, and even the intoxicated. Parking a car used to be stressful and time-consuming… but now the self-driving vehicle can find a parking space and, later, return to a specified pickup point all on its own.

Source: (DHL.com)

System Capabilities & Requirements

What are the typical capabilities in this use case?

Enabling higher efficiency through data-driven analytics and predictions. High uptime and connection security for reliable data collection and real-time analytics. Robust navigation and situational analysis capabilities are essential for autonomous vehicles.

Deployment Environment

Where is the ’edge’ of the solution deployed?

It can be deployed to the environment of warehousing operations, outdoor logistics operations, line haul transportation and last-mile delivery.

Stakeholder Viewpoint

Investment Decision Makers & Influencers

Which organizations, departments, or individuals typically makes an investment decision and allocates budget?

The logistics companies are the investment decision makers for the autonomous vehicles. They decide to purchase it to help them with warehousing operations, outdoor logistics operations, line haul transportation and last-mile delivery.

System Operators

Which organizations, departments, or individuals are responsible for operating and maintaining the system?

The logistics companies are typically the system operators. If they outsource this service to a service company than the service company will be the system operators.

System End Users

Who are the regular users of the system?

The logistics companies are typically the system end users. If they outsource this service to a service company than the service company will be the end users.

External Data Users

Which external stakeholders are provided with limited access to the data?

Autonomous vehicle manufacturers and industrial researchers could be the external data users.

Technology Viewpoint

Sensors

What sensors are typically used to provide data into the IoT system, and which factors define their deployment?

The perception systems or AD sensors are primarily categorized in two forms:

1. Proprioceptive sensors (responsible for sensing of vehicle's state like wheel encoders, inertial measurement unit etc.)

2. Exteroceptive sensors (responsible for sensing the ambient surrounding like cameras, LiDAR, RADARs, ultrasonic, etc.)

Vision-Based (Cameras):- Camera-based systems are either mono-vision i.e. having one source of vision or stereo-vision i.e. a set of multiple (normally two) mono-vision cameras just like human eyesight. Depending upon the needs, they may be mounted on the front grilles, side mirrors, and rear door, rear windshield etc. They closely monitor the nearby vehicles, lane markings, speed signs, high-beam etc. and warn the driver when the car is in danger of an imminent collision with a pedestrian or an advancing vehicle. However, the most advanced camera systems do not only detect obstacles but also identify them and predict their immediate trajectories using advanced algorithms.

Source: Mobileye

RADAR:- Both short-range and long-range automotive-grade RADARs are used (mostly in the narrow-band i.e. 27–77 GHz) for AD applications. Short-range radars, as the name indicates, 'senses' the environment in the vicinity of a car (~30m) and, especially at low speeds; whereas, long-range radars cover relatively long distances (~200m) usually at high speeds. Generally, the radar sensor acquires information from nearby objects like distance, size, and velocity (if it is moving) and warns the driver if an imminent collision is detected. Should the driver fails to intervene within the stipulated time (post-warning), the radar's input may even engage advanced steering and braking controls to prevent the crash. The high-precision and weather-agnostic capabilities of radars make them a permanent fit for any autonomous vehicle prototype, notwithstanding the ambient conditions. Going forward, with the introduction of ultra wide-band radar technology (high frequency ~100 GHz), radars will provide more accurate information, be smaller, cheaper and more reliable.

LiDARs:- In layman terms, LiDARs are "light-based radars" that send invisible laser pulses and ascertain their return time to create a 3D profile around the car. Unlike cameras and radars, LiDARs do not technically detect the nearby objects; rather they "profile" them by illuminating the objects and analyzing the path of the reflected light. This, when repeated over a million times per second, yields a high-resolution image. Since LiDAR sensor uses emitted light, its operation is not impaired, notwithstanding the intensity of ambient light which means same intensity in night or day, clouds or sun, shadows or sunlight. The result is a greater accuracy of perception and high resilience to interference. Currently, the LiDAR sensors come at a very high price. The LiDAR alone makes the entire sensor suite that goes into a vehicle exorbitantly high. For example, the Google driverless car features a high-quality Velodyne's LiDAR costing $75,000. In future, with solid-state technology coming in, the cost will come down drastically making LiDARs indispensable for any AV.

Source: Velodyne LiDAR

Ultrasonic:- Ultrasonic sensors use the same "time of flight" principle as RADAR do, except for the fact that the former uses high-frequency sound waves instead of microwaves. Ultrasonic emissions are effectively sounded waves with frequencies higher than that audible to the human ear, suitable for short to medium range applications at low speed. Using echo-times from sound waves that bounce off nearby objects, the sensors can identify how far away the vehicle is from said object, and alert the driver the closer the vehicle gets. Automakers are already using these sensors, albeit only for the short-range applications. For example, Tesla's Model S sedan is equipped with 12 long-range ultrasonic sensors that provide 360-degree vision to augment the forward facing RADAR system, in order to enable its Autopilot system.

Source: Bosch

Wheel speed sensors:-Wheel speed sensors are designed for the rollover sensing application. They record the speed of the wheels by measuring accelerations both in the vehicle's longitudinal and vertical axis and communicate this information to the driving safety systems. It can detect a vehicle rollover event using the angular rate signal and a rollover sensing algorithm. Wheel speed sensors can be either passive i.e. with an additional power source or active. The initial anti-lock braking systems (ABS) relied on passive sensors whose signal could only be evaluated within the 5-10 mph speed range. Nowadays active sensors are becoming more popular because of their "digital" nature that is used by the control unit directly, without the need for conversion. Active wheel sensors also supply more precise speed information, which can be used by other vehicle electrical systems, such as navigation devices.

Source: Bosch

Analytics

What types of analysis are typically used to transform data into actionable information?

Real-time analytics of the environment to enable autonomous vehicles that interact with their surroundings which include adaptive cruise control, emergency braking, pedestrian detection, collision avoidance, traffic sign recognition, lane departure warning, cross traffic alert, park assist, surround view, and rear collision warning.

Cloud & Edge Platforms

What factors define the cloud and edge platforms used to integrate the solution?

Edge devices integrated into the vehicles combined with an uplink to cloud servers for data storage.

Connectivity

What factors define the connectivity solutions used to provide both device-to-device and device-to-cloud communication?

To get past the hurdle of indoor navigation, early solutions used wire technology, where the vehicle is fitted with a radio sensor that receives radio waves transmitted by a wire that is embedded in the floor of the warehouse. Improving on this, guide tape technology used markers such as colored images around the aisles that a camera on the driverless vehicle recognizes for navigation. Other similar tactics included using magnets and sensors to guide the vehicle in the right direction. The best and most common method today and in the future is to rely on a mixture of depth cameras and lasers on the vehicle; these devices constantly scan and capture the environment to identify vehicle's position and any obstacles.

User Interface

What factors define the interfaces available to the system users?

User interface for passengers different from remote control operators.

Data Viewpoint

Data Sources

How is data obtained by the system?

IoT sensors and tracking devices reporting about location and condition of the vehicle. Algorithms and processing to make decision.

Data Types

What data points are typically collected by the system?

Location coordinates, motion patterns, vehicle condition data, detection of near-by objects.

Data Requirements

What other requirements define data behavior?

Object detection must be instant. Location data must be available in real-time to be able to adapt the calculated best route to changing conditions.

Implementation Viewpoint

Business & Organizational Challenges

What business challenges could impact deployment?

Safety is a top issue in the minds of the auto industry and the consumers and is the biggest reason why companies and consumers hesitate to adopt the technology. In a survey conducted, nearly half (49%) of consumers said they don't currently feel confident in AV (Autonomous Vehicles)s' abilities to navigate them safely and, perhaps because of that lack of confidence, 55% said they are unlikely to consider purchasing an AV.

On the safety front, there were two top concerns, among several possibilities: 84% of respondents said they are concerned about vehicle-software malfunctions in AVs, and a close 80% said the same about potential hardware malfunctions. Meanwhile, cybersecurity concerns with AVs are also on consumers' minds, according to the survey results. For instance, 77% said they would be concerned about their AV being hacked and taken over, and 75% said they are concerned about having their personal data stolen from an AV.

Source:(Alix Partners)

Companies currently shy away from investing vast amounts of resources into this area because of the safety, security concerns, legal liabilities and high fees.

Integration Challenges

What integration challenges could impact deployment?

LIDAR (Light detection and Ranging) technology is a sophisticated one that needs installing and integrating with the car. There are various challenges that is associated with this piece of equipment, such as in the case of being situated on the headlights: dirt, accident, water might damage the LIDAR. Bad weather also affects the correct functioning of this technology.

Installation Challenges

What installation challenges could impact deployment?

Similar to the integration challenges, most of the technology associated is sophisticated thus requiring a big investment both in time and resources in order to transform a car into an autonomous one.

Regulatory Challenges

What regulatory challenges could impact deployment?

Currently, there are many regulatory challenges regarding autonomous cars, such as accidents. Should the self-driving car hits something/someone who exactly is liable is still a question.

IoT ONE Use Case

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