Intelligent Sensor Network Platform for Transportation

TRANSPORTATION TRANSFORMATION

The Fourth Industrial Revolution (IR4.0). IR4.0 is a technical revolution that is ushering in the development and implementation of technology and innovation that enables things like Artificial Intelligence (AI), The Internet of Things (IoT), Nanotechnology, Robotics and 3D printing. Through AI human intelligence is simulated through machines that are programmed to think like humans and mimicking their actions. Through IoT systems are interrelated and objects connected on the internet to collect and transfer data over a wireless network without human interaction. Through Nanotechnology we can see and control individual atoms and molecules in which everything on earth is made up of. By utilizing Robotics, we can design, construct, and use a machine to perform tasks normally done by humans. By utilizing 3D printing a user can have access to the full three-dimensional printing capabilities using a fabrication process that decreased the production time for making things like eyeglasses. As these innovations are implemented, we can begin to see the benefits that innovation brings to business and the global economies. The transportation industry is estimated to become one of the first domains in which the public will be asked to trust the reliability and safety of IR4.0 technology through the implementation of artificial intelligence (AI) applications which enables driverless cars and other autonomous transportation solutions.

A few key deployed technologies have already catalyzed the widespread adoption of algorithm-driven artificial intelligence in transportation transformation due to their decreased costs of ownership and improved accuracies within the transportation sensor technology market. The scale and diversity of data collected from individuals and populations has grown exponentially even though there has been limited utilization of technology that offers universal connectivity and low-latency applications to do real-time analysis of traffic patterns and near-instantaneous route calculations. With the implementation of the Dalet intelligent sensor network framework within your transportation company you will be able to coordinate tens of thousands, or even millions of ridesharing and self-driving technology data processes as it operates alongside other applications and technical data processes in high-density urban areas.

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Our framework leverages the design of networks that utilizes a Software-Defined Networking (SDN) solution on unlicensed 60 Ghz millimeter Wave (mmWave) band technology which gives us the ability to immediately provision on-demand access. This is possible because a SDN framework uses software-based controllers or application programming interfaces (APIs) to communicate with underlying hardware infrastructure and direct traffic on a network. Which means that the SDN can create and control a virtual network or control traditional hardware using software to control the routing of data packets through a centralized server. The mmWave technology is a band of the radio spectrum between 57 GHz and 64 GHz that can be used for high-speed broadband access and the enablement and utilization of Intelligent Edge computing technology that is a distributed, open IT architecture that features decentralized processing power, enabling mobile computing and Internet of Things (IoT) technologies that ushers users into the new technological revolution being implemented in iR4.0.

SDN provides agility and the ability to create policy-driven network supervision and dynamic reconfiguration driven by an intelligent network automation framework. SDN's greatest advantage is that it allows the creation of a framework to support more data-intensive applications like big data and virtualization. From the perspective of transportation networks, which often leverage 60 GHz Millimeter-Wave (mmWave) unlicensed spectrum at the wireless edge, SDN will dramatically increase the number of possible connections and the available paths through the network, allowing an optimal scaling of network traffic to the requirements of hyper scaled cloud infrastructures.

Studies indicate that as vehicles become better drivers than humans, city-dwellers who work from home will drive less which could cause a decrease in the ownership of personal vehicles. It is estimated that by 2030, changes to how people live, and work will not be limited to transportation via cars, trucks, and railways but are likely to include flying vehicles (in beta testing now) as well as the adaption of robotic technology referred to as Carebots. While these technological innovations are on the horizon for future deployment and implementation globally it doesn’t come without considering the social, political, and ethical consequences of these technologies.

INTELLIGENT VEHICLES

Global Positioning Systems (GPS) was introduced to fleet tracking applications in the 1990s after President Bill Clinton signed an executive order in 1996 that enabled GPS satellite system for use by civilian applications as well as the military. That same decade Mazda introduced the first-ever GPS system for automotive navigational use. In-car navigation devices have since become a fundamental part of the transportation infrastructure. Besides

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assisting drivers in their route selection and navigation, GPS systems now provide massive amounts of transactional data to technology companies and cities about transportation patterns. The widespread adoption of smart devices with GPS technology has further increased user connectivity and increased the amount of location and transactional data.

Sensor technology is not new to automobiles. Even automobiles built in the early 80s had sensors that monitored the internal states of various vehicle functions such as speed, acceleration, and wheel position. Sensor-enabled applications already had functionalities that combined real-time sensing with perception and decision-control systems such as anti-lock braking systems, airbag control, traction control systems, and electronic stability control. Automated capabilities have been introduced into commercial vehicles gradually since 2003 and are summarized in the table below:

Automated Functionality Release Summary

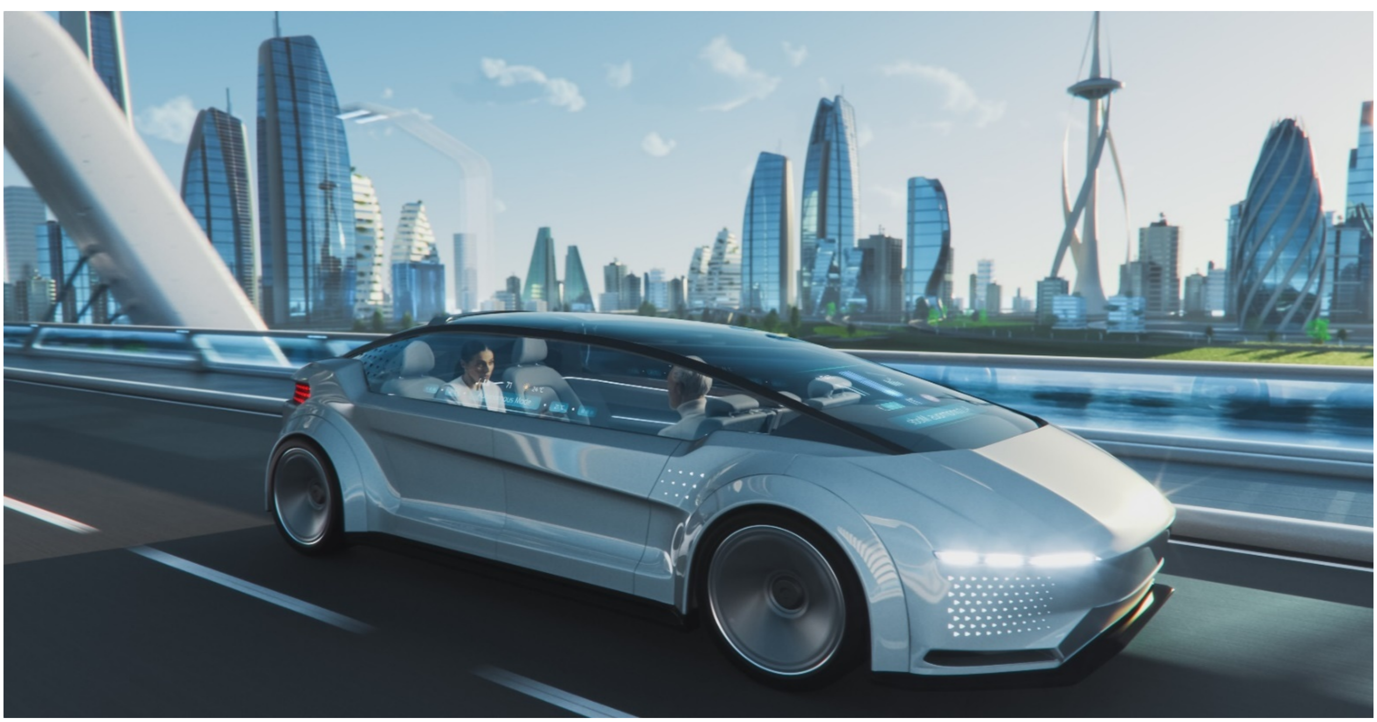
Parking Intelligent Parking Assist System Since 2003
Parking Summon Since 2016
Arterial & Highway Lane departure system Since 2004 in North America
Arterial & Highway Adaptive cruise control Since 2005 in North America
Highway Blind spot monitoring 2007
Highway Lane changing 2015
An average automobile in the US today is predicted to have over one hundred sensors. Some of the sensor technology in cars today is made up of:

- Gyroscopes which detect the deviation of an object from its desired orientation which helps cars detect when they have veered out of a lane.
- Accelerometers which is a sensing device that measure a moving object's acceleration and detects the frequency and intensity of human movement that enables a car to speedup or slow down depending on situational need.
- Ambient Light Sensor (ALS) which provides measurements of ambient light intensity by matching it to how the human eye responds to light in many different lighting conditions to help people see clearly at night and daytime while driving.
- Humidity sensors reduce misting on windows to make it easier to see objects when windows fog up.
- Radio Detection and Ranging (Radar) sensors that send out radio waves that detect objects and gauge their distance and speed in relation to the vehicle in real time to decrease the likelihood of accidents from occurring

These intelligent applications can assist drivers or completely take over well-defined driving activities for increased safety and comfort. Intelligent cars today can perform automated functions like park themselves, perform adaptive cruise control on highways, steer themselves during stop-and-go traffic, and alert drivers about objects in blind spots during lane changes. Vision and radar technology (LiDAR) were leveraged to develop pre-collision systems that let cars autonomously brake when the risk of a collision is detected. Deep learning also has been applied to improve automobiles' capacity to detect objects and perform classification in the environment and recognize sounds.

SELF-DRIVING VEHICLES

Since the 1930s, science fiction writers have dreamed of a future with self-driving cars but building them has been a challenge for the artificial intelligence community since the 1960s. By the 2000s, the dream of autonomous vehicles became a reality in the sea and sky, and even on Mars, but self-driving vehicles existed only as research prototypes in labs. Driving in a city was considered to be a problem too complex for automation due to factors like pedestrians, traffic density and congestion, and the many unexpected events that can happen outside of the vehicle’s control. Although some of the technological components required to make such autonomous driving possible were available in 2000 and some autonomous car prototypes existed, few predicted that mainstream companies would be developing and deploying autonomous vehicles by 2015. During the Defense Advanced Research Projects Agency's (DARPA) first "grand challenge" in 2004 on autonomous driving, research teams failed to complete the designated challenge in a limited desert setting partly due to network latency issues that prevented real-time control of the vehicles. However, in eight short years, from 2004 to 2012, surprising progress occurred in both academia and industry through advancements in sensing technology and perceptual machine learning which has helped to speed up the progress in self-driving vehicles. Companies like Google's autonomous vehicles and Tesla's semi-autonomous cars are driving on city streets today. Google's self-driving cars are completely autonomous and have logged close to 2,000,000 miles, over 300,000 miles of it without an accident. Tesla has been incrementally improving their cars' self-driving capability with each software update. Their cars are semi-autonomous, with human drivers expected to stay engaged and take over if they detect a potential problem. It is not yet clear whether this semi-autonomous approach is sustainable because as people become more confident in their cars' capabilities, they are likely to pay less attention to the road and become less reliable at critical junctures. The first traffic fatality involving an autonomous car in June of 2016 brought this question into sharper focus,



especially when hundreds or thousands of these autonomous vehicles will be navigating high-density urban areas.

Sensing algorithms have already equaled or exceeded human performance for capabilities. Automated perception, including vision, is at a human level of performance for well-defined tasks such as recognition and tracking. Advances in perception will be followed by algorithmic improvements in decision-making capabilities such as planning. The adoption of self-driving capabilities is not limited to personal transportation only, we are seeing self-driving and remotely controlled delivery vehicles, flying vehicles in beta, and trucks. Peer-to-peer transportation services like ridesharing service providers are also utilizing self-driving technology. Beyond self-driving cars, advances in robotics are facilitating the creation and adoption of other types of autonomous vehicles including drone operations.

PLANNING ON-DEMAND INTERACTIVE TRANSPORTATION

Recently, the United States Department of Transportation (DoT) raised discretionary grants of up to $1 billion to modernize and create a New American Infrastructure with an emphasis on transportation sustainability and equity. The US DoT plans to award millions of dollars to cities and states to demonstrate ways in which new smart city technology and data can be used to reimagine the eco-friendly movement of people and goods.

Most of these initiatives would require an intelligent edge sensor-based network with extremely low latency that can support connected vehicles with a high level of safety while using car-to-car and car-to-human communication in highly dense urban environments. When this vision becomes reality, advances in multi-agent coordination, collaboration, and planning will have a significant impact on the future development of the intelligent transportation system more reliable and efficient.

Today, fully established rideshare services such as Uber and Lyft, and more recently robotic delivery services are great examples of pivotal application use cases for sensing with low-latency connectivity, and artificial intelligence with algorithms for matching drivers to passengers or cargo by location, including suitability (reputation modeling) with competitive dynamic pricing.

Rideshare services will evolve into other business niches as cars become smarter. And when cargo drones become widely available, they will also utilize intelligent sensor-based networks that run predictive algorithms and machine learning at the edge of the network. Moreover, networks will need to also support other algorithms for modeling and sensing human attention and to support communication and coordination between humans and machines.

Smart transportation services will affect where people choose to live, reduce pollution by reducing peak traffic flows, and allow cities to plan other ways to fully utilize and redesign public properties for eco-friendly use. This will likely increase the freedom and mobility of different subgroups of the population, including youth, elderly and disabled.

As autonomous vehicles become more widespread, the question arises of how we will secure autonomous vehicles, the sensor grids, and the networks managing the grids. In an environment where safety depends on strict standards and regulatory compliance, all the applications have to be certified to work at optimal performance under adverse conditions before their deployment. Autonomous vehicles and the connected grid-transportation infrastructure will become an attractive target for hackers, so everything possible must be done to detect and mitigate new vulnerabilities. Ethical questions are also involved in how to program cars to act in situations in which human injury or death is likely or inevitable.

Despite these advances, the present infrastructure in most cities is very old and incapable of handling the new technologies. A handful of cities have started to implement smart-city technologies to leverage sensors to optimize these new applications. As of now, there is no standardized technology framework used across all cities, but this has presented a great opportunity for advancing innovation in the mmWave unlicensed 60Ghz sensor-based applications and systems. There are vast opportunities to deploy intelligent platform infrastructure market. This is because this market provides for a fully automated network that leverages AI technology that enable the self-awareness functionality to manage the delivery of services that meet promised SLA commitments. This will yield safety benefits, reduce insurance costs, improve traffic patterns, reduce pollution (including greenhouse gas emissions) and create a framework for the city of the future.

COMPANY PROFILE

Dalet Access Labs is a leading Network As A Service (NAAS) provider. We utilize an Intelligent Sensor Network framework to enable digital educational transformation by providing intelligent broadband and networking solutions that enable educational institutions to leverage technological advances in natural language processing, virtual reality, augmented reality, and machine learning to enhance teacher and student learning environments. We use industry 4.0 applications that give an unparalleled customer user experience. As the complexity of network infrastructures and application bandwidth usage increases, the ability of the network operators to conform to stringent SLAs will potentially be challenged. We will make it possible for even the most demanding Fourth Industrial Revolution (IR4.0) services to be successfully deployed by leveraging self-organizing, smart-decision sensors at the edge of the network. This allows for optimal performance, and our self-defending proactive management algorithm to continuously learn and adapt to user behaviors while identifying and protecting against potential outages and threats.

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