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The Driverless Vehicle

Sindi A. Wijdan

*Abstract*—This survey paper presents the evolution in the network field and what it achieved by focusing on a new interesting idea in the Internet of Things. Specifically discussing the system of the driverless cars. This paper aim to clarify the expected problems of the Internet of things and the solutions. As, the system can be attacked and how the problem can be solved. The paper review some researches that are related to the topic and display valuable information. Also, we represent the community reaction towards this idea.

*Index Terms*— VSLAM Visual Simultaneous Localization and Mapping.

Lidar Light Detection and Ranging.

OBD On-Board Diagnostics II port.

ECU Electronic Control Unit

EOM Original Equipment Manufacturers

# INTRODUCTION

Internet of Things shapes a big image of the future. It is an important field in developing the life. Over time tasks take less time and less effort to be done due to the Internet of Things. Nowadays many works can be achieved without a human involvement. Every year technology comes up with a new idea and invention that is surprising.

A driverless car is a neoteric invention of Internet of Things. It is a car drives itself without a human operator. It seems like a strange idea came up recently to the world. The driverless car purpose is to take the human form place to another safely. It also let the people do tasks while riding instead of driving. Some companies generated this idea and launched it to the real world. There is a lot of questions about this neoteric system. How did this idea come? How does it work? How can we use it? How will we be prepared for it? And many more questions are being asked.

Driverless vehicle is like the normal vehicles but it concedes human control. VSLAM is the mechanism used in the driverless vehicles. This mechanism make the robot capable to work in the complex situations. It makes the robot recognize its positions and positions of the surrounding objects. The robot collects information about the environment to make its own map and set up the coordinates of the objects and its own position coordinates. VSLAM mechanism relies on sensors, cameras, cloud and so on [1].

Security is an important thing that should be having a role in the autonomous vehicle. Since it is computer systems and connected to a network, it can be attacked. There are some ways to protect the systems presented in this paper.

Many things about the system causes fear for the community. Also, there are many people interested in the system.

# vehicle system design

The intelligent vehicle contains several systems are designed well to simulate the road environment. Each system has its own functions and approaches that collect some type of information. These systems are combined to help each other to give the last work of the vehicle. As the vehicle moves in the road, it needs to know different information about the objects around. For example, it should know the positions of objects and the distance. There are sensors dedicated to find the position and the distance. The systems are dealing with different type of objects. Some objects are stable such as the signs. Other are moving such as other vehicles and pedestrians. I will discuss some of the systems that are used in this vehicle and how they work.

## Hardware architecture

### Camera system

The autonomous vehicle is equipped with cameras to recognize the color of the traffic signals. The resource [2] has described the recognition of the traffic signs due to the shape and colors analysis. Color and shape recognition is important because it gives message to control the car movement depend on the road rules.

There is algorithm to determine the shape of the sign to get the accurate message. It has functions calculate the limits of the shape and rotate it to figure it out. After figuring the shape the vehicle gets the message and work for it. For example, the upside-down triangle sign means yield. When the system finds the upside-down triangle, the vehicle starts slowing down and be aware of the other vehicles.

Color classification is using an approach that deals with the changing of colors. Colors are different during the day and night time. This approach puts the colors in groups considering the color range. It also has two components to classify the color to make it more accurate and safe. If one component failed in determining the right value, the other one successes. Hue is the component for the actual color. The brightness and darkness are depending on how much white and black color on. Saturation component indicates the amount of gray in the color. These two components are independent from each other and each has its own formula. However, both components are working to help each other to get the accurate value. Using two components to get one output is a good way to ensure the result.

Another type of system solves different type of problem. The intelligent vehicle support different type of sensors. Each sensor sends a specific type of rays to receive the required data. Radar, Lidar and Ultrasonic sensors support the sensitivity system of the vehicle.

In the other hand, the cameras lack of reach up to 250 meters. It needs to be developed to enable more anticipatory driving. Weather limitation such as fog, rain or low sun increases the failure risk and needs to be improved.

### Radar sensor

Radar - Radio Detection and Ranging- sensor detects the distance and speed of the objects around. The Radar sensor sends out electromagnetic waves. When these waves hit an object, it returns with revealing how far and how fast the object is. However, the current 2-dimantional Radar is insufficient. Because the horizontally scanning, it is not able to determine the height of the objects. It could be a problem in some cases such as driving under bridges.

### Lidar sensor

Lidar - Light Detection and Ranging – sensor scans the environment around using a non-visible laser beam. This beam is sensitive to the low intensity which it can reveal the small objects such as small animals, pets and kids. It visualizes a 3-dimantional picture of the object. By the way, the laser beam that is used in Lidar sensors is not harmful. However, Lidar sensor is combined with the camera system which it detects the type of object.

### Ultrasonic sensor

Ultrasonic sensor is imitating the navigation process of bats. It sends out sound waves. When the waves hit an object, it returns echo. Therefore, it determines the exact position of the object. Whereas, it plays an important role in automated parking. Ultrasonic sensors work only in the very low speed situation. So, they achieve the goal perfectly and do not need to be improved.

### Cloud

All these sensors cannot reach objects more than 250 meters. Cloud server help the vehicle to be aware of the distant traffic jam. Where it offers a map of the current time which gives accurate data. The received data is a collection of reports that were recorded by other intelligent vehicles. It is also a type of sensor due to providing the vehicle with an image of the surrounding environment.

## Software architecture

Driverless vehicle has a software system that relates to the hardware system. It is important to control the vehicle movement. There are three basic components are setup in the vehicle.

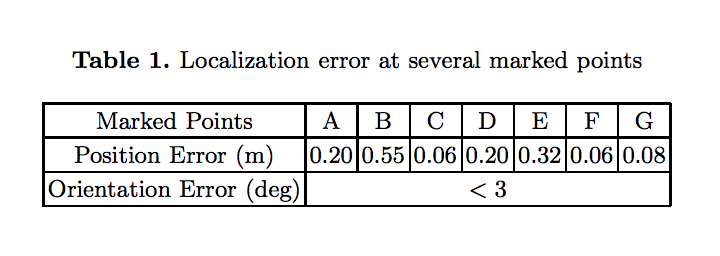
### Navigation module

The vehicle navigates on a common road network. The routes from any origin to any destination are generated a-priori as a set of points. The choices of routes are made online depending on the request from the mobility on demand scheduler. The obstacles detected from the sensors are incorporated as a rolling cost map centered on the vehicle. The cost is propagated radially outward with an exponential function. At the low level, speed and steering control are separated. For the speed control, the vehicle considers the following input before planning for next action: the average cost function that is present within a defined area in front of itself and the curvature of the path. The waypoint follower is implemented using a pure pursuit control [3].

### Localization

Localization is important for the autonomous navigations. The navigations mostly depend on GPS. The GPS is not very efficient because it may not work in some areas like urban areas. Because of the tall building, blocking the satellite could happen. There is a way to fix this problem by using an alternative approach to using GPS is to generate a high-fidelity map of the area to be navigated using a high-resolution range scanner. However, this approach needs more funds and power [3].

In the “Autonomy for Mobility on Demand” research, they tested an algorithm of an autonomous vehicle in the campus environment [3]. Whereas, there was some errors in location estimate that are plotted in table 1[3]. As they noticed that the estimation error is small which it is less than 0.6 meters. The estimation is quite accurate less than 3 degrees to the ground truth.



### Perception

“For autonomous driving, having a good perception of moving objects on the road is extremely important. Figure 8 shows a typical scenario the vehicle has to navigate in. The problem of detecting pedestrians, moving vehicles and static obstacles in cluttered, dynamic and time-varying lighting conditions is extremely complex. In addition, often the on-board sensing is occluded due to the presence of big trucks, buses or other environmental features. While vision systems can detect features more reliably, often ascertaining the distance of the features becomes difficult. On the other hand, while the laser range finders are quite accurate in detecting the distance to the obstacle, they are not well suited to disambiguate similar shaped obstacles like moving pedestrians or a static lamp-post [3].”

# security

As driverless car is a combination of computer systems, it needs to be highly secured. The security of the driverless vehicle is important for several reasons. One of the reasons is the increasing of the demand. When customers find it highly secured, their quantity would increase. Another point, the IoT is produced to help people and ease the life. Furthermore, reducing risks.

The researchers found out that the intelligent vehicles can be hacked. Whereas, the vehicle should be owned by human, there is a way to connect with the vehicle’s system. The driverless car and the cellular dongles plugged into the OBD-II port is hackable which it was unpredictable.

The OBD-II port started to extract diagnostic information and support the right to repair [4]. It could allow the hackers to mess with the vehicle control such as brakes. In the second page of “A Balanced Approach for Securing the OBD-II Port” resource under OBD section. Markham and Chernoguzov say, “It was designed to allow repair shops to connect with engine controls to perform diagnostics and gather emissions related information. Few envisioned the OBD port as a means of remotely injecting commands which could affect brakes, steering or acceleration [4].”

The OBD-II port is a source of data that is vulnerable and could be attacked. It is easy to use. First, plug the device in the car's OBD-II port. Second, Turn the car on. Third, Enable Bluetooth on the phone. Fourth, search for "OBD-II" and pair with it (pin 1234). Last, run the download App with simple settings and wait until it connects your car's ECU successfully. The OBD-II was tested to determine the necessary requirements to secure the vehicle. Here are the requirements that was determined:

* To support diagnostics, the low required the OEM to provide an OBD-II port.
* Read access to vehicle data by providing the third parties such as insurance companies
* Enable OBD device providers the ability to offer vehicle-related services via the OBD port. The industry must balance access with vehicle security and safety concerns.
* Provide the vehicle owner the ability to use mobile apps to retrieve information from their vehicle.
* Deliver vehicles which are safe. The safety of modern automobiles requires that they have cyber security to protect them from malicious commands or data injected via the OBD port. This implies these derived requirements.
* Provide a means to test and certify the CAN messages injected by an OBD connected device such as insurance dongle and diagnostic tool).
* Provide a means to authenticate a device plugged into an OBD port. For example, determine the manufacturer of the device and the model number.
* Determine and enforce the OEM approved access rights for the authenticated device relative to the OBD port. For example, the device can read all data but only write to the body control modules.

There are some technologies can be used to improve the security of the system. Combining the public key cryptography and access control to provide an authenticated access control function for the OBD port.

# community reaction

As every new idea or invention comes up to the world, some people become excited and others are not. Driverless vehicles have supporters and opposes. It is important to discuss the community opinions for several reasons. Every individual think differently which it gives different opinions and ideas. The public opinion can add more unexpected problems. It gives the experts more problems to study to improve the invention.

There are some positive reactions and some negative. As the driverless vehicle idea came out to people, they reacted to it.

## Cons.

* Since the autonomous vehicle does not rely on human operator, driving job opportunity would be decreased.
* People cannot trust the autonomous cars due to the ability of being attack.
* The autonomous vehicle may not be able to prevent the other vehicles mistakes.
* It could make more traffic since every individual want to have their own vehicle. As they want to stay alone in the vehicle to be more comfortable doing their tasks. No more ride-sharing.

## Pros.

* Reduce the traffic which the vehicle could drive at 60 mph, three feet behind another vehicle.
* Since the autonomous vehicle relies on fuel, it would reduce using fuel due to the gently brakes.
* The autonomous cars may not need to park. It drops the passengers and go.
* Driverless cars are more affordable than ride-sharing because the passengers would not pay to the driver not even tips.
* Reduce the risk of attentions lack and preoccupation while driving.
* Autonomous vehicle is a sufficient idea for people with disability.

As the community react to the driverless idea. We can come up with pros and cons. To restrict the pros and cons, there are few things that people focused on. The community need somethings to be offered in the vehicle while they are traveling. In other hand, there is many things the community is afraid of. The desires are all about being comfortable while safely travelling and arriving on time. The unwanted things or unpleasant are unsecured, loss of time and risk. These requirements are considered and need to be improved. People should know about the improvements.

Many people do not read the instructions of the new devices. It makes lack of their information which it makes they think the device does not work well or not as they thought. Wherefore, there should be advertisement or information that are easy to understand by the public.

# Conclusion

In conclusion, driverless car designed to achieve the rules of safety driving. It uses several systems to make the vehicle simulate the road environment. It also has some security issues that could be solved. As the autonomous vehicle was tested, there are some observations should be studied to improve the vehicle performance.

Acknowledgment

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