자율주행을 위한 센싱 및 움직임 제어에 관한 현존 기술들

모흐모우드 [1,2], 강현수 [1*]

1 충북대학교, 2 헬완대학교

Mahmoud.Gohar1992@m-eng.helwan.edu.eg, *hskang@cbnu.ac.kr

Existing Technologies of Sensing and Moving Control for Autonomous Vehicles

Mahmoud Abdelkader Bashery Abbass[1,2], Hyun-Soo Kang[1*]

1 Chungbuk National University.

2 Helwan University.

Abstract

This paper presents the main concepts for the autonomous vehicles field, including the idea of using a redundant number of sensors (i.e., sensor fusion) in self-driving cars and how this idea will affect the selection of the suitable algorithm to perform the tasks with fast response and accurate performance. In addition, the future expectations and impacts of this technology on different societies are declared based on previous research.

Ⅰ. Introduction

Nowadays, autonomous vehicles in general and self-driving cars in specific represent one of the hottest topics in the research field. It needs deep thinking about the data collection and processing, trajectory planning and executing, and dealing with fuzzy situations, that may be faced by cars, to identify and perform the best maneuver scenario [1]. The way to achieve a fully autonomous car as shown in Figure 1, passes through different levels based on the degree of complexity and degree of human monitoring or controlling the system [2,3].

Level	Name	Dynamic Driving Task (DDT): Sustained lateral and longitudinal vehicle motion control	Dynamic Driving Task (DDT): Object and Event Detection and Response (OEDR)	DDT Fallback	Operational Design Domain (ODD)
Driver performs part or all of the DDT					
0	No Driving Automation	*Driver*	*Driver*	*Driver*	N/A
1	Driver Assistance	*Driver and System*	*Driver*	*Driver*	Limited
2	Partial Driving Automation	***System***	*Driver*	*Driver*	Limited
Automated Driving System (ADS "System") performs the entire DDT (while engaged)					
3	Conditional Driving Automation	*System*	***System***	*Fallback-ready user*	Limited
4	High Driving Automation	*System*	*System*	***System***	Limited
5	Full Driving Automation	*System*	*System*	*System*	**Unlimited**

Figure 1. Automation levels of autonomous car [2,3].

It is clear that the target of recent research, performing a completely functional autonomous vehicle. But, the challenges in this are huge. Because it needs an optimum solution between hardware challenges (e.g., sensors, and processing units) and software challenges (e.g., algorithms, and data processing). So, in the next section, the different technologies and challenges will be explained with an interaction declaration between them.

Ⅱ. Existing Technologies

Unfortunately, there is no specific sensor that can perform all requirements for self-driving cars, because of the physical limitations of each one as shown in Figure 2. Herby, a redundant number of sensors (e.g., radar, camera, GPS, LIDAR) are used to give more flexibility and deep vision for the system, which is called a sensor fusion concept [4]. But, these redundant sensors generate huge data that need too much time to be proceed with traditional algorithms. So, the solution comes with artificial intelligence algorisms (e.g., machine learning, and deep learning) that can be performed very fast and accurately with big data.

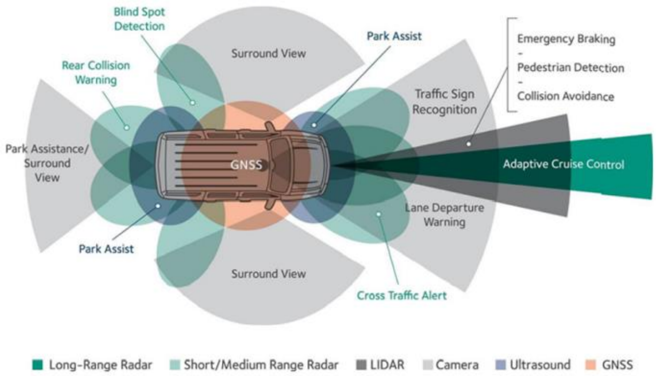

Figure 2. Example for self-driving car sensors including functions and limitations for each one [3].

From the above paragraph, the total layout for interacting between different components of self-driving cars, can be expressed in Figure 3, which declares the difficulty of these tasks to perform perfectly together.

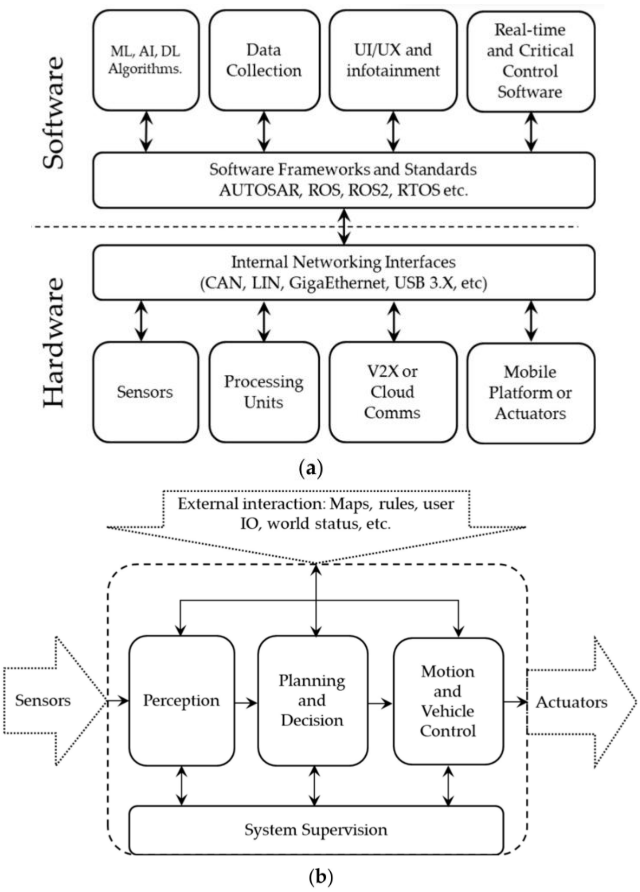

Figure 3. Main architecture for self-driving cars (a) hardware and software integration, and (2) data flow throw all system [4].

Finally, the impact of autonomous vehicles on any society will appear in reducing the number of accidents, reducing fuel consumption and increasing the lifetime for the car due to accurate control, and the human or driver will be more productive because of increasing the level of comfortability [2].

Ⅲ. Conclusion

The fully autonomous vehicle is a difficult challenge because it depends on many factors related to the interaction between sensors and algorithms to map the relations between car actions and the environment. In addition, the achieving of a compromise solution that fulfills a precise and fast performance for the overall system during handling fuzzy cases. Herby, the redundant sensors must be used to perform sensor fusion, and processing data using machine learning and deep learning algorithms, because they generate accurate results from big data in no time. Now, the most important question is, are the researcher can make an autonomous vehicle system that can learn to drive like a human? and the answer will be given in future work.

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