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Commentary

Limitations and Solutions for Autonomous Driving Vehicles towards Level 5

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DESCRIPTION

Around the world, companies are working hard to develop the highest level 5 of autonomous driving vehicles. Level 4 is currently the highest level for commercialized vehicles, and the achievement of level 5, defined as the ability to drive fully autonomous everywhere under all conditions, seems to be just around the corner. However, a major barrier stands in the way, and a different dimension may be required. Tesla is trying to achieve level 5 by using AI to machine-learn data accumulated from its own vehicles. Meanwhile, an attempt is also being executed to produce the high-precision 3D data, which digitizes all physical information about the terrain, buildings, signs, traffic lights, etc., where vehicles pass, and try to achieve fully automated level 5 by concentrating AI on the behavior of people and passing vehicles. An area where current AI cannot perform or has tremendous barriers is the ability to predict in advance the occurrence of an accident or near miss on a route after inputting the route from the starting point to the destination, and to indicate what driving maneuvers and plans would prevent the accident or near miss from occurring if it is calculated that an accident or near miss would occur. AI may be able to calculate the probability of an accident from vast amounts of past data. However, once the probability of an accident has been calculated, it cannot indicate how the accident could be prevented. This particular capability cannot be possessed even by humans and is an unknown area that is not well understood. I studied accident prevention by investigating and analyzing accidents at the scene of accidents, and by elucidating the mechanisms of accidents. During my tenure at the Japan Transport Safety Board (JTSB), I investigated and analyzed a large number of marine accidents as an accident investigator, and further conducted postgraduate research aiming at finding methods to prevent accidents before they happen. One of my findings was that accidents do not occur randomly nor by chance, but occur according to an accident model that shows the accident mechanism. In the case of ships, the research has shown that accident contributing factors differ by the type of accident, such as collision, grounding, fire, capsizing, etc.; that the accumulation of data on accident contributing factors can clarify accident patterns; and that measures to prevent accidents can be known in advance [1]. The accident models used for ship accidents are the same models used in the field of aircraft [2,3]. The fact that accident rates had reduced were published in the field of aircraft [4,5], providing evidence that accident investigation analysis and accident prevention measures that focus on the mechanism of the accident are effective. After retiring from the JTSB, I undertook work related to safety of university education and research at the Okinawa Institute of Science and Technology Graduate University (OIST). In the course of my work at OIST, I was also in charge of accident investigation and analysis, and found that the mechanism of accidents occurring at university laboratories, during outdoor research activities, regardless of location and time, can be explained by the same accident model as accidents on ships [6,7]. Based on these findings, I have advocated the importance of accident investigation and analysis focusing on the mechanism of accidents regardless of industry, and the use of contributing factors obtained from these analyses in accident prevention measures in order to reduce the number of accidents and victims [7]. What is required to achieve level 5 in the autonomous driving vehicles is to develop a system that focuses on the mechanism of accidents, predicts various types of accidents and near misses such as collisions, personal injury and fire, and makes these predictions turn into an infinitely safest direction by taking some actions. The accident mechanism includes the criteria for discontinuing the operation and the countermeasures to be taken [1,7]. In other words, prior to operating the vehicle, by entering the route into the system, the vehicle itself will be able to self-corrects its safe operation and driving plan, and at the same time to inform the passenger or operator of this revised plan. For instance, when it is raining heavily, the route from starting point A to destination B would be inputted and, due to the high probability of river flooding along the route being travelled, the calculated prediction is that the vehicle will depart from A and travel *via* C to arrive at B and so on, which would safely transport people and goods to their destination.

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