New AI enables autonomous vehicles to adapt to challenging weather conditions

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Researchers at Oxford University's Department of Computer Science, in collaboration with colleagues from Bogazici University, Turkey, have developed a novel artificial intelligence (AI) system to enable

autonomous vehicles (AVs) achieve safer and more reliable navigation capability, especially under adverse weather conditions and GPS-denied driving scenarios. The results have been published today in *Nature Machine Intelligence*.

Yasin Almalioglu, who completed the research as part of his DPhil in the Department of Computer Science, said, "The difficulty for AVs to achieve precise positioning during challenging adverse weather is a major reason why these have been limited to relatively small-scale trials up to now. For instance, weather such as rain or snow may cause an AV to detect itself in the wrong lane before a turn, or to stop too late at an intersection because of imprecise positioning."

To overcome this problem, Almalioglu and his colleagues developed a novel, self-supervised deep learning model for ego-motion estimation, a crucial component of an AV's driving system that estimates the car's moving position relative to objects observed from the car itself. The model brought together richly-detailed information from visual sensors (which can be disrupted by adverse conditions) with data from weather-immune sources (such as radar), so that the benefits of each can be used under different weather conditions.

The model was trained using several publicly available AV datasets which included data from multiple sensors such as cameras, lidar, and radar under diverse settings, including variable light/darkness levels and precipitation. These were used to generate algorithms to reconstruct scene geometry and calculate the car's position from novel data. Under various test situations, the researchers demonstrated that the model showed robust all-weather performance, including conditions of rain, fog, and snow, as well as day and night.

The team anticipate that this work will bring AVs one step closer to safe and smooth all-weather autonomous driving, and ultimately a broader

use within societies.

Professor Niki Trigoni, from the Department of Computer Science at Oxford University, who co-supervised the study, said, "The precise positioning capability provides a basis for numerous core functionalities of AVs such as motion planning, prediction, situational awareness, and collision avoidance. This study provides an exciting complementary solution for the AV software stack to achieve this capability."

Professor Andrew Markham (Department of Computer Science, Oxford University), also a co-supervisor for the study, added, "Estimating the precise location of AVs is a critical milestone to achieving reliable autonomous driving under challenging conditions. This study effectively exploits the complementary aspects of different sensors to help AVs navigate in difficult daily scenarios."

More information: Yasin Almalioglu, Deep learning-based robust positioning for all-weather autonomous driving, *Nature Machine Intelligence* (2022). DOI: 10.1038/s42256-022-00520-5. www.nature.com/articles/s42256-022-00520-5

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