Ph.D. in Information Technology
Thesis Defense

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Room Alpha, Building 24

Giovanni CIARAMITARO – XXXVI Cycle

NAVIGATION-ASSISTED COMMUNICATION AND SENSING SOLUTIONS FOR CONNECTED AUTOMATED VEHICLES

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Abstract:

The advent of Connected Automated Vehicles (CAVs) has ushered in a new era of transportation, promising enhanced safety and efficiency. To realize the full potential of CAVs, robust and reliable communication and sensing solutions are imperative. This thesis addresses these critical challenges by developing innovative methods for Vehicular-to-Vehicular (V2V) communication and sensing in the context of CAVs.

The thesis commences with a focus on position-assisted methods for millimeter-wave (mmWave) V2V beam alignment. mmWave frequencies are a key enabler for vehicular communication, as they are able to provide high data rate and low latency, but its effectiveness is contingent on accurate beam alignment. The high path loss, indeed, requires the implementation of reliable directional communications, which is a challenging task considering the high mobility of CAVs. A novel approach is proposed that leverages precise positioning information, obtained from on-board sensor fusion, and V2V communication, to enable seamless and accurate beam alignment. This method significantly improves the reliability of V2V communication, reducing communication overhead and enhancing the overall connectivity of CAVs.

The thesis then delves into the topic of automotive perception. To this aim, Synthetic Aperture Radar (SAR) technology offers the ability to capture high-resolution images of the surrounding environment, providing useful data for exteroceptive sensing and decision-making in CAVs. This research focuses on the development of a navigation-assisted SAR system, specifically tailored for vehicular applications, exploiting the abundant data provided by on-board sensors. The experimental assessment shows that the proposed system enhances the perception capabilities of CAVs.

Finally, a centralized cooperative localization algorithm is designed to synergize communication, sensing and localization. This algorithm harnesses data from multiple vehicles within a network to collectively refine the localization accuracy. By combining inter-vehicular data stream and imaging-based perception, the algorithm fosters a comprehensive understanding of the CAV's neighbors, ensuring that each vehicle maintains a precise and up-to-date representation of the network topology. The localization algorithm shows the relevant role that cooperation can play in fostering

the accuracy of navigation and the benefits brought by relative position information provided by imaging sensors.

In summary, this Ph.D. thesis contributes a holistic framework for communication and sensing solutions in the context of connected automated vehicles. It begins by optimizing mmWave V2V communication through position-assisted beam alignment, extends this improvement to the realm of automotive perception, and culminates in a centralized cooperative localization algorithm that integrates these technologies. The research presented herein lays the groundwork for CAVs to operate safely and effectively in diverse and dynamic environments, propelling us closer to the realization of a connected, automated, and safer transportation future. These advancements represent a step forward in the development of the next generation of intelligent vehicles.

PhD Committee

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