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Early-Warning System for Safe Lateral Maneuver of Bicycles

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In this abstract we demonstrate the design of a novel warning system to assist cyclists in identifying dangerous situations. The system uses low-cost of-the-shelf components, making it an efficient, yet effective early-warning system. Cycling is one of the most popular modes of transportation and will be the future trend for sustainable mobility because it is cost-efficient and has positive impact on health and the environment. Despite these benefits and dedicated cycling infrastructure in certain countries, cycling safety remains an important concern due to the high number of cycling accidents. Lateral maneuvers on bikes with improper assessment of the surroundings typically cause various accidents. During the process of such maneuvers, the rider must look back for any approaching vehicles and assess its attributes such as speed and distance before making a decision. This action may have a detrimental influence on safety, since the rider will be unable to focus on the path in front, and it may also cause the rider to drift to the side. In addition to this, the rider must also make reliable control decision within a short period of time, which is hard in many situations.

Our proposed system alerts cyclists of rear approaching hazards and help remove false positives. It combines a millimeter wave(mmWave) radar sensor in the rear, ultrasonic sensors on either rear-sides of the bike and a haptic device on each handlebar. The mmWave radar is used to detect and monitor the parameters such as speed, distance, and angle of the approaching vehicles in the rear. Two ultrasonic sensors are used as an efficient solution to detect vehicles and obstacles that are close to the rear wheel of the bike, at the blind spot of the mmWave radar. The haptic devices provide feedback to the rider by vibrating on the side of potential maneuvering hazard. Its intensity varies based on the level of the threat. We assess the threat of each approaching vehicle based on a combination of Time-to-Collision (TTC) and Minimum-Safe-Space (MSS) metrics. MSS compensates the shortcomings of TTC in situations where an observed vehicle is at proximity to the host bicycle and is travelling at a similar speed. By integrating several sensor modalities, the system detects both short range and long range hazards and provides a user friendly interface with low power consumption and fast speed, independent of weather conditions.