CLAIMS

1. A method performed by a computing system configured to control an autonomous vehicle, the method comprising:

receiving, by the computing system, from two or more radar sensors mounted at different locations on the autonomous vehicle, radar data representative of a physical environment of the autonomous vehicle;

based on the radar data, detecting, by the computing system, at least one scatterer present in the environment;

based on the radar data determining, by the computing system, a likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle, the determination of the likelihood includes using coherent change detection that uses a sliding window to compare phase returns from the at least one scatterer;

in response to the likelihood being at least equal to a predefined confidence threshold, calculating, by the computing system, a velocity of the autonomous vehicle based on the radar data from the two or more radar sensors, wherein calculating the velocity comprises one of:

determining, by the computing system, an indication that the autonomous vehicle is stationary and controlling, by the computing system, the autonomous vehicle based on the determined indication, and

determining, by the computing system, an angular velocity of the autonomous vehicle and a linear velocity of the autonomous vehicle and controlling, by the computing system, the autonomous vehicle based on the calculated velocity.

2. The method of claim 1, wherein the determining the indication that the autonomous vehicle is stationary is performed in response to receiving an indication that the velocity of the autonomous vehicle is below a predefined velocity threshold.

3. The method of claim 1, wherein detecting the at least one scatterer present in the environment comprises isolating the at least one scatterer from a remainder of the radar data.

4. The method of claim 1, wherein the radar data includes Doppler measurements captured in at least one frame, wherein making the determination of the likelihood that the at

least one scatterer is stationary with respect to the autonomous vehicle based on the radar data comprises making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle based on the Doppler measurements in a single frame of the at least one frame.

5. The method of claim 1, wherein the radar data includes Doppler measurements captured in two frames, wherein the Doppler measurements are estimated to be associated with the at least one scatterer, wherein making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle based on the radar data comprises making the determination of whether a change in the Doppler measurements between the two frames is less than a predefined threshold, the method further comprising:

determining, by the computing system, that the likelihood is at least equal to the predefined confidence threshold in response to the determination being that the change in the Doppler measurements between the two frames is less than the predefined threshold.

6. The method of claim 1, wherein calculating the velocity of the autonomous vehicle based on the radar data is performed in response to receiving one or more of (i) an indication that the angular velocity of the autonomous vehicle is above a predefined velocity threshold and (ii) an indication that a steering angle of the autonomous vehicle is above a predefined angle threshold.

7. The method of claim 1, wherein the two or more radar sensors include a first radar sensor and a second radar sensor,

wherein calculating the angular velocity of the autonomous vehicle is based on a first distance from the first sensor to a geometric centerline of the autonomous vehicle and a second distance from the second sensor to the geometric centerline of the autonomous vehicle.

8. The method of claim 1, wherein the two or more radar sensors include a first radar sensor and a second radar sensor, wherein the radar data includes first radar data from the first radar sensor and second radar data from the second radar sensor, the method further comprising:

before receiving the radar data, and while the autonomous vehicle is moving on a road, causing, by the computing system, the first and second radar sensors to acquire the first and second radar data,

wherein calculating the velocity of the autonomous vehicle based on the radar data comprises (i) calculating a first velocity based on the first radar data, (ii) calculating a second velocity based on the second radar data, and (iii) calculating a third velocity based on the first and second velocities, and

wherein controlling the autonomous vehicle based on the calculated velocity comprises controlling the autonomous vehicle based on the calculated third velocity.

9. The method of claim 1, wherein making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle is based on predefined map data accessible by the computing system, wherein the predefined map data includes a known location of the at least one scatterer in the environment.

10. A computing system configured to control an autonomous vehicle, the computing system comprising:

two or more radar sensors mounted at different locations on the autonomous vehicle; and

a processor configured to perform operations comprising:

receiving, from the two or more radar sensors, radar data representative of a physical environment of the autonomous vehicle;

based on the radar data, detecting at least one scatterer present in the environment;

based on the radar data, determining a likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle;

the determination of the likelihood includes using coherent change detection that uses a sliding window to compare phase returns from the at least one scatterer;

in response to the likelihood being at least equal to a predefined confidence threshold, calculating a velocity of the autonomous vehicle based on the radar data, wherein calculating the velocity comprises one of:

determining an indication that the autonomous vehicle is stationary and controlling the autonomous vehicle based on the determined indication; and

determining an angular velocity of the autonomous vehicle and a linear velocity of the autonomous vehicle and controlling the autonomous vehicle based on the calculated velocity.

11. The computing system of claim 10, wherein the computing system further comprises a movement module, and

wherein controlling the autonomous vehicle based on the calculated velocity comprises causing the movement module to adjust a linear velocity of the autonomous vehicle.

12. The computing system of claim 10, wherein the computing system further comprises a movement module, and

wherein controlling the autonomous vehicle based on the calculated velocity comprises causing the movement module to adjust a steering angle of the autonomous vehicle.

13. The computing system of claim 10, wherein the computing system further comprises a movement module, and

wherein controlling the autonomous vehicle based on the determined indication comprises providing, to the movement module, an instruction that, upon receipt by the movement module, causes the autonomous vehicle to remain stationary.

14. The computing system of claim 13, wherein the movement module includes an inertial measurement unit (IMU) including one or more of an accelerometer and a gyroscope, and

wherein the instruction includes an instruction for the movement module to deny receipt of signals from the IMU.

15. The computing system of claim 10, wherein the computing system further comprises a display mounted on an interior of the autonomous vehicle, and

wherein controlling the autonomous vehicle based on the calculated velocity comprises providing, on the display, an indication of one or more of the calculated angular velocity and the calculated linear velocity of the autonomous vehicle.

16. An article of manufacture including a non-transitory computer-readable medium having stored thereon instructions that, when executed by a processor in a computing system, causes the computing system to perform operations comprising:

receiving, from two or more radar sensors mounted at different locations on the autonomous vehicle, radar data representative of a physical environment of the autonomous vehicle;

based on the radar data, detecting at least one scatterer present in the environment;

based on the radar data, determining a likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle;

wherein the determining the likelihood includes using coherent change detection that uses a sliding window to compare phase returns from the at least one scatterer;

in response to the likelihood being at least equal to a predefined confidence threshold, calculating a velocity of the autonomous vehicle based on the radar data, wherein calculating the velocity comprises one of:

determining an indication that the autonomous vehicle is stationary and controlling the autonomous vehicle based on the determined indication; and

determining an angular velocity of the autonomous vehicle and a linear velocity of the autonomous vehicle and controlling the autonomous vehicle based on the calculated velocity.

17. The article of manufacture of claim 16, wherein the determining the indication that the autonomous vehicle is stationary is performed in response to receiving an indication that the linear velocity of the autonomous vehicle is below a predefined velocity threshold.

18. The article of manufacture of claim 16, wherein detecting the at least one scatterer present in the environment comprises isolating the at least one scatterer from a remainder of the radar data.

19. The article of manufacture of claim 16, wherein the radar data includes Doppler measurements captured in at least one frame, wherein making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle based on the radar data comprises making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle based on the Doppler measurements in a single frame of the at least one frame.

20. The article of manufacture of claim 16, wherein the radar data includes Doppler measurements captured in two frames, wherein the Doppler measurements are estimated to be associated with the at least one scatterer, wherein making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle based on the radar data comprises making the determination of whether a change in the Doppler

measurements between the two frames is less than a predefined threshold, the operations further comprising:

determining that the likelihood is at least equal to the predefined confidence threshold in response to the determination being that the change in the Doppler measurements between the two frames is less than the predefined threshold.

21. The article of manufacture of claim 16, wherein calculating the velocity of the autonomous vehicle based on the radar data is performed in response to receiving one or more of (i) an indication that the angular velocity of the autonomous vehicle is above a predefined velocity threshold and (ii) an indication that a steering angle of the autonomous vehicle is above a predefined angle threshold.

22. The article of manufacture of claim 16, wherein the two radar sensors include a first radar sensor and a second radar sensor,

wherein calculating the angular velocity of the autonomous vehicle is based on a first distance from the first sensor to a geometric centerline of the autonomous vehicle and a second distance from the second sensor to the geometric centerline of the autonomous vehicle.

23. The article of manufacture of claim 16, wherein the two or more radar sensors include a first radar sensor and a second radar sensor, wherein the radar data includes first radar data from the first radar sensor and second radar data from the second radar sensor, the operations further comprising:

before receiving the radar data, and while the autonomous vehicle is moving on a road, causing the first and second radar sensors to acquire the first and second radar data,

wherein calculating the velocity of the autonomous vehicle based on the radar data comprises (i) calculating a first velocity based on the first radar data, (ii) calculating a second velocity based on the second radar data, and (iii) calculating a third velocity based on the first and second velocities, and

wherein controlling the autonomous vehicle based on the calculated velocity comprises controlling the autonomous vehicle based on the calculated third velocity.

24. The article of manufacture of claim 16, wherein making the determination of the likelihood that the at least one scatterer is stationary with respect to the autonomous vehicle

is based on predefined map data accessible by the computing system, wherein the predefined map data includes a known location of the at least one scatterer in the environment.