Technical Article

The Pulse of the City: Get Smarter Detection and Tracking for Intelligent Transportation Systems with mmWave Sensors

Prajakta Desai

Just as we leverage sensing technologies to measure individual's breathing and heart rates, cities can actually benefit from the same technology. One of the key aspects of a smart city is a sensor-equipped intelligent transportation system that monitors the city's "health" – tracking traffic data and parking meters for enforcement, traffic light prioritization and incident management as shown in Figure 1.

Figure 1. Intelligent Transportation Systems Help Monitor the "Health" of the City through Intersection Monitoring and Parking Spot Detection

Intelligent sensors serve as the heart of intelligent transportation systems to track traffic congestion and keep traffic flowing, especially at intersections and on highways. These sensors must possess these features:

- Accuracy, to measure extended range, velocity and position of vehicles or pedestrians.
- Robustness, including imperviousness to weather conditions, darkness and sunlight.
- Integration in order to optimize real-time assessment and corrections.
- Ease of use, with reference code and sample performance to accelerate deployment.

TI's innovative millimeter-wave (mmWave) technology is an over-the-air sensing solution for traffic monitoring, with an inherent capability to measure range, velocity and position information to determine a vehicle's distance from intersections, as well as its speed and lane occupation. The new and updated Traffic Monitoring Object Detection and Tracking Reference Design Using mmWave Radar Sensor with the IWR1642 includes an onboard C674x digital signal processor that enables detection of objects, while the Arm® R4F processor enables the tracking of vehicle range and velocity over time. See Figure 2.

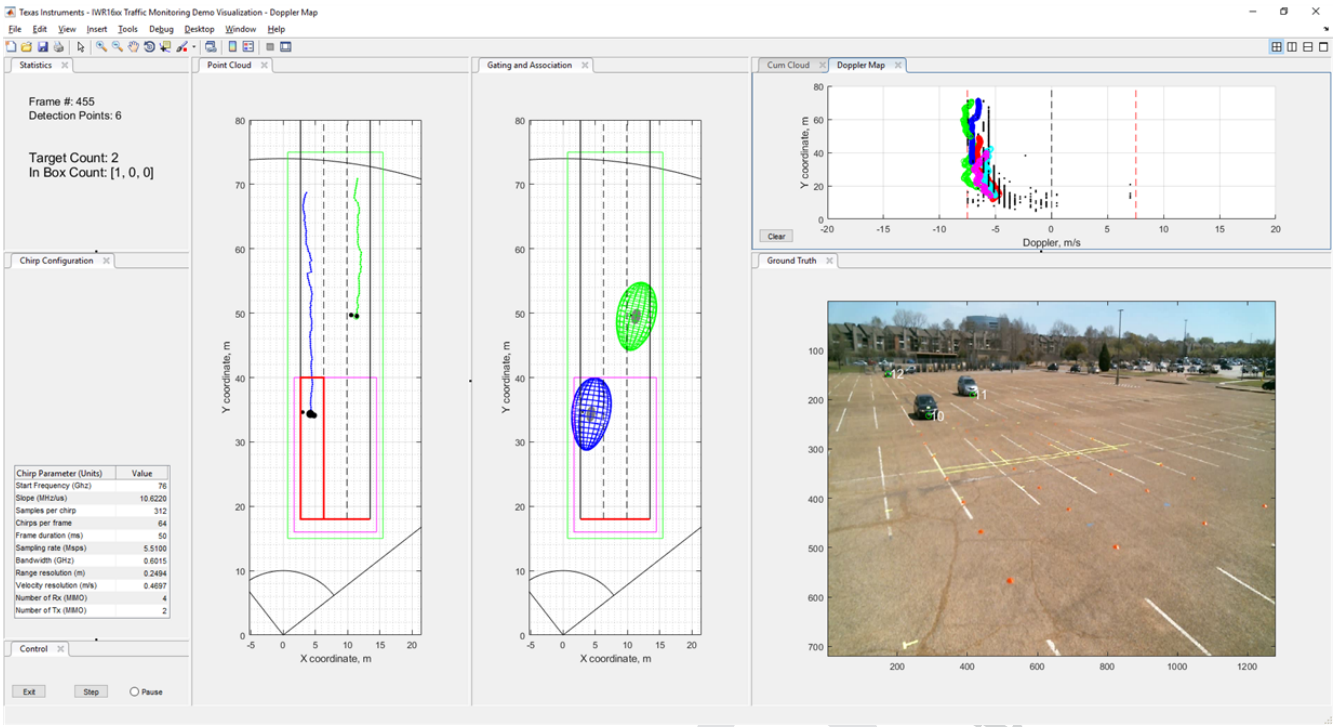

Figure 2. The Graph on the Left Clearly Shows the Detection and Tracking of the Two Cars in the Picture Using the IWR1642

With this new design, TI makes it easier to use mmWave radar sensors in a variety of traffic monitoring applications (see Table 1). For example, a sensor that can monitor vehicle speeds on a highway might make it possible to remotely issue tickets to speeding cars and reduce the possibility of dangerous situations for law enforcement. In order to do that, however, the sensor must be able to accurately detect the velocity of various objects at different distances, enabled by the Vmax extension algorithm added to the design.

This same functionality would improve the accuracy of a sensor monitoring an intersection, enabling it to better anticipate the number of vehicles approaching. This functionality can enable green-light control, creating a smoother flow of traffic with fewer starts and stops and making it easier to ticket those who run red lights.

The reference design also features an advanced detecting and tracking algorithm that enables the sensor to maintain a history of where a particular object has been, making it easier for the sensor to more accurately distinguish between multiple cars or other objects in a dense urban environment.

With a 35cm range resolution, the solution is capable of detecting various objects at different distances up to 200m. In addition, a 50cm-per-second velocity resolution enables accurate tracking of vehicles in a single lane up to 200kph for highway monitoring, with higher speed limits and vehicles in multiple lanes up to 70kph for green-light control and enforcement at intersections.

A 120-degree field-of-view (FOV) capability with a 15-degree angular resolution enables a wider detection view of cars or pedestrians approaching an intersection. The sensor can keep an eye on multiple parking spots, so drivers know whether it's worth it to go down that one aisle in the parking garage, or if they're better off just going up a floor.

Table 1. TI's mmWave Sensors Provide Key Advantages for Intelligent Transportation Systems

	mmWave performance with the IWR1642		Application benefit
Accuracy	Tuning range	76-81GHz	Narrow beam to avoid clutter and provide >3x higher range/velocity performance versus 24GHz
	Max range (resolution)	200m (80cm)	Accuracy of detecting various objects at different ranges
	New max velocity (resolution)	195kph for single lane (47cm/s) 80kph for multilane (30cm/s)	Highway monitoring with higher speed limits Accurately track vehicles at the Vmax speed for green-light control and enforcement at intersections
	Max FOV (resolution)	120 degrees (15-degree angular resolution)	Wider detection view of cars and pedestrians at or approaching intersections Wider angle enables sensing of multiple parking spots for occupancy detection
Robustness	Environmentally robust to rain, fog, light		Maintain performance in challenging weather conditions
Integration	Onboard DSP New advanced detection and tracking algorithms	R4F processing with built-in algorithms	Ultra-small form factor is 9x smaller than legacy radar systems, which makes installation easier and more cost-effective for cities and municipalities Tracks history of the object to distinguish between multiple cars or objects in a dense urban environment
Ease of use	Reference designs, experiments, labs for development TI E2E™ Community support		Reference designs with design guides, schematics, bill of materials, software and test results to help reduce time to market

The innovations packed into the IWR1642 mmWave sensor system can help you address the challenges in intelligent transportation systems, that will help you focus on creating a differentiated end product.

Get started today and accelerate your development to production with the IWR mmWave platform.

Additional Resources

- To start developing your intelligent transportation system using mmWave sensor systems:
  - Download Traffic Monitoring Object Detection and Tracking Reference Design
  - Order the IWR1642-BOOST evaluation module.
  - Download the IWR1642 data sheet.

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