Precision Following for Vehicle Platooning Applications

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About SwRI
❖ ESTABLISHED: 1947
❖ STAFF: >2700
❖ GROSS REVENUE FY2015: >$592M
❖ FY15 Projects: >6,300
❖ CAMPUS: ~4.86 km² (1200 Acres) in San Antonio, TX
❖ LABS/OFFICES: > 204,400 m² (2.2M ft²)
❖ Over 1,235 Patents; 40 R&D 100 Awards
❖ FY15 IR&D: $7.2M, 194 projects

Organizational Characteristics
❖ Independent and nonprofit [501(c)(3)]
❖ Revenue provided by R&D contracts
❖ Broad technological and scientific capabilities
❖ Decentralized organization
❖ Internal research encouraged
❖ Unique Client-Oriented intellectual property policy
Localization

- **Absolute**
  - GPS
    - Differential
    - Subscription corrections

- **Relative**
  - Vision/LIDAR sensors
  - Lane line detection
  - Road sign detection

- **Map-based**
  - A priori information
    - Time to create
    - Data storage
    - Accuracy over time
  - Variety of sensors
  - Potentially higher resolution and/or reliability
Importance of Precision Following

- Platooning with human lead driver for nearer term
  - Operating in areas where no a priori maps exist
  - Higher reliability that maps haven’t changed
- Fuel efficiency not only dependent on longitudinal offset, but lateral offset becomes increasingly important as separation distance decreases
Ranger (Downfacing Camera-based Absolute Localization)

- Low cost novel localization approach that uses maps, based on features in the road’s surface, to provide 2cm precision for vehicle localization without GPS.
- Enables precision control of an automated vehicle, or convoy of vehicles, between 1-3cm.
- Robust to surface occlusions, up to 70%.
- Map size (salient features) ~10MB/km. Can be infrastructure, cloud, or V2V sourced.
- Less susceptible to errors due to dynamic environments than forward looking localization approaches.
- Tested in numerous environments to include under the Cobo Center and on the streets of Detroit, in parking garages, on private facilities.
- Has been installed and tested on Class VIII trucks, passenger cars, military vehicles, and forklifts.
- Now in Gen3 Kit form. Algorithms licensable under customer-focused, reasonable terms and conditions.

US Patent: 8,725,413
Ranger Matches Pavement “Fingerprints”
Where Will RANGER Work?

- Complex Road Networks
- High Speed Freeways
- Tree Covered Roads
- Freeway Interchanges
- Surface Streets
- Parking Structures
- Urban Canyons
- Tunnels
- Underpasses
RANGER Works On Any Type of Vehicle
Ranger Video

Localization System Using a Ground Facing Camera
SwRI’s Automated VIII Truck with Ranger

Autonomous Trailer Docking
Ranger Convoy Following

A HMMWV equipped with a Ranger system leads the way. The autonomous MTV receives Ranger feature data from the lead vehicle.

The HMMWV creates a RANGER route and broadcasts it to the follower. The route consists of the geometry of the leader’s path and ground features from the sensor.

The MTV matches features from its Ranger sensor to the Ranger features from the leader to register the leader’s path in its own frame of reference.
25mph Following Video

Ranger Convoy Following Performance

Distance Traveled Between Ranger Matches

Lateral Offset of Vehicle from Leader Path

Lateral Offset of Vehicle from Leader Path

Path Traveled with Lateral Offset