Field Operational Tests of Vehicle Assist and Automation Technologies

California-Oregon VAA Team

Ching-Yao Chan and Wei-Bin Zhang

5th National BRT Conference
Las Vegas
August 22, 2012
FTA and RITA JPO Vehicle Assist and Automation Demonstration Program

- Addresses deployment issues
- Assesses benefits and costs through revenue-service operations

California-Oregon
- BRT and HOV applications
- Lane guidance and precision docking
- Magnetic and GPS technologies

Minnesota
- Bus on highway shoulder application
- Steering assist
- DGPS technology

San Diego
- Bus on highway medians
- Lane guidance and collision warning
- Vision technology
Why VAA for BRT?

- **Problems and Challenges**
  - Right-of-way purchase costs are high and increasing
  - Transit agencies seek safe and cost-effective transit systems
  - Transit customers demand high-quality transit service

- **Potential Benefits**
  - Reduced right-of-way requirements and infrastructure costs (potential go-no-go decision)
  - Reduced accidents
  - Reduced operating and maintenance costs
  - Smoother ride and level boarding for faster travel and reduced dwell time
  - “Rail-like” status
    - More attractive to choice riders
    - Encourage transit oriented development
Review of Previous Work

- R&D on AHS
- Lane Assist Systems for Bus Rapid Transit: Needs and Requirements
- Lane Assist Systems for Bus Rapid Transit: Technical Scan Tour to Europe
- Lane Assist Systems for Bus Rapid Transit: Interface Requirements
Review of Previous Work (Con’d)

• Automated Bus demonstration in 2003
  -- To capture imagination of stakeholders and the public at large, and to energize public and private decision makers toward VAA
  -- Three-bus platoon with fully automated functions

• Demonstration of Lane Assist and Precision Docking Systems at ITS World Congress 2005 in San Francisco
Magnetic Marker System

• Subject to interference
  – Missing magnets (detectable)
  – Unwanted magnets (detectable)
- Not compatible with crashed asphalt
- Require infrastructure installation with $10-25k per lane mile
- No maintenance
PATH Development: Vision-based Guidance Technology
PATH DGPS/INS/Magnet System
Technology Selection

Criteria

- Operating conditions
  - Weather
  - Road surface conditions

- Safety and reliability requirements
  - Reliability
  - Fail-Safe (sensing) vs. Fail-Soft (system)

- Performance requirements
  - Tracking and docking accuracy
  - Robustness

- Maintenance requirements

- Life cycle costs

Selection:

- Magnetic marker reference/sensing as primary sensing technology (for both AC Transit and LTD applications)
- Combined with GPS to demonstrate fused sensing technologies (AC Transit application)
VAA Project Background

- **Participants**
  - FTA, Caltrans, Transit operators (AC Transit & Lane Transit District), UCB/PATH, Industrial subcontractors

- **Two guidance technologies:**
  - Magnetic sensing
  - DGPS based

- **Project goals**
  - Demonstrate the technical merits and feasibility of VAA technology applications
  - Access benefits and costs

- **Project durations**
  - Component development, system integration and refinement primarily in the first two and half years
  - Revenue operation starts 2012
VAA Project Scope

**LTD, Eugene Oregon**
- 2.5 miles of single/double dedicated ROW
- One 60ft New Flyer BRT bus
- Functions to be tested:
  - Lane guidance for on dedicated BRT lane
  - Precision docking

**AC Transit**
- A 3 mile section of HOV lane, on the California Highway 92 freeway from Hesperian Blvd. to the San Mateo Bridge toll plaza
- Two MCI (50ft) coaches
- Functions to be tested:
  - Lane guidance on HOV lane
  - Guidance through toll bridge

**Full range of VAA applications for BRT**
- Highway and urban BRT applications
- Precision docking and guidance
- Very low to highway speed (65 mph)
- Degrees of driver assist
VAA FOT in Revenue Service
-- Design & Development for Deployment

• Revenue service elevates design requirements of automated control
  – Apply product development methodologies (reliability + maintainability)
    • Prefer to use embedded controllers and sensors
  – Emphasize on safety design (redundancy + fault detection/management)
    • Fail-safe and fail-soft

• Deployment requires professional installation
  – Installation not to degrade bus normal operations
  – Normal maintenance to be straightforward (visual inspection, fault reporting, data collection)
  – Most repairs could be conducted by transit personnel (spare part replacement)

• Deployment requires the handling of all operational modes
  – Work in all possible operational conditions and scenarios (different drivers, speeds, weather, traffic conditions, transition methods, …)
  – Detect and manage all (known) faults

• Revenue service demands addressing any (new) issues
  – Work through operational and other issues (e.g., policy, legal, institutional) with transit agencies
VAA Test (Oregon): Lane Transit District
Precision Docking + Lane Guidance
LTD Automated Bus (New Flyer, 60’)
VAA System Installation/Configuration

- J1939 connection
- Buzzer (2)
- Indicators (2 sets)
- Switch & button
- Instrument Cabinet
- Control computer (2)
- Actuator controller
- HMI controller (2)
- GPS
- Yaw rate gyro
- Steering actuator
- Front & rear magnetometer sensor bars (2)
LTD Automated Bus Yard Track Results: LTD First Test Drives

- LTD Yard Track: testing, training and calibration
LTD Automated Bus Preliminary Results: Docking Performance on Replicated Stations
Testing on BRT Corridor
Summary

• The VAA FOT addresses deployment issues and benefits/costs through revenue-service operation
• California-Oregon team selected magnetic guidance as the primary guidance technology based on thorough evaluation and technical merits
• Full range of VAA applications for BRT is to be field tested
  – Highway and urban BRT application
  – Precision docking and guidance
  – Very low to highway speeds (65 mph)
• FOT will begin in the fall/winter of 2012
Questions

• Please contact Wei-Bin Zhang

wbzhang@path.berkeley.edu