Facility Needs for CAV Testing

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Fundamentals of Automated Vehicle (AV) Testing

– AV testing is different from other forms of vehicle testing
  • Driver inputs no longer dictate vehicle behavior, environments do

– To appropriately test automation algorithms, vehicles need to be immersed in the desired environment

– The availability of specific environments dictates which tests can be performed
Central Question

What features are desired for testing Connected Automated Vehicles (CAVs)?
Central Question
Central Question - Revised

What features are necessary for testing Connected Automated Vehicles (CAVs)?
Stakeholder Survey

• In order to answer this question TRC conducted a large user survey
  ▪ Participants from government and industry

• Questions were asked based on what test scenarios were desired
  ▪ Resulted in a very large amount of data

• This information was initially reduced by identifying the course features necessary for each test scenario
Features Necessary

- stop signs
- intersection warnings
- pedestrian crossing
- heavy truck inspection/weigh stations
- various road signs
- lane transitions
- limited lines of sight
- curve warning
- high speed straight
- variable height
- bridge height warnings
- parking lot
- perpendicular parking spaces
- diagonal parking spaces
- concrete pylons
- snow
- split mu
- guard rails
- cross traffic
- driver immersion
- alleys
- variable lighting
- traffic signals
- pedestrian crossing
- full size city blocks
- on/off ramps
- parallel parking spaces
- limited lines of sight
- curve speed warnings
- rural
- traffic monitoring
- various road signs
- lane transitions
- standing water zones
- driveways
- long approach
- license plate reader
- seamless
- tree lined road
- different lane types
- weight in motion
- merge lanes
- rumble strips
- different lane types
- roundabout
- environmental
- weight in motion
- rumble strips
- environmental
- roundabout
- highway
Sorted by Environment

guard rails  merge lanes  first/last mile  V2V  long approach  seam sealer
alleys  driver immersion  terrain variations  ITS  traffic signals
cross traffic  fog  weigh in motion  variable height  rain rice  variable lighting
split mu  light blocking  lane number transitions  pedestrian crossing
various road signs  rural  pedestrian crossing
full size city blocks
 cul-de-sac  high speed  straight lines  perpendicular parking spaces
parking garage  suburban  heavy truck inspection/weigh stations  parallel parking spaces  clover leaf
jersey barriers  various intersection angles  tunnel
cart corrals  urban  temporary courses  pedestrian crossing
tunnel  urban  temporary courses  pedestrian crossing
brine  freezing rain  standing water
stop signs  on/off ramps  pedestrian
intersection  tree lined road  round-about

TRC
Main Environments with Features

Main Environments

- tunnel
- rural
- parking lot
- other road users

- suburban
- highway
- intersection
- ITS
- temporary courses
- urban
- environmental
Example test Scenarios

- Suburban
  - First/Last mile

- Urban
  - Path planning
  - Vehicles parked on street
  - Limited lines of sight and substantial background scatter

- Highway
  - Merging/ exiting
  - Lane shifts
  - Platooning

- Intersection
  - Intersection collision avoidance
  - Freight preference
  - Determining right of way
    - Four way stop
    - Right on red

- Rural
  - Tighter curves than on highway
  - Tree cover/ limited lines of sight

Example test Scenarios

- Parking lot
  - Parallel and perpendicular parking
  - Navigating with limited reference points
- Tunnel
  - Sharp changes in lighting
  - Signal blocking/ reflection
- Temporary courses
  - Defined with cones or stripes to create unique geometries
- Other road users
  - Pedestrians
  - Cyclists
  - Animals
- Environmental
  - Effects of environmental conditions on sensors
  - Behavior of control algorithms under different roadway conditions
    - Low friction, obscured lane markings, etc.
- ITS
  - Deployable RSUs to add infrastructure connectivity to all testing environments
A SMART Ecosystem for Connected & Autonomous Vehicles

TRC SMART CENTER  SMART MOBILITY CORRIDOR

#SMARTCOLUMBUS

The SMART Center

Phase 1 completion in 2017

The SMART Center
Phases 2 & 3
The SMART Center
THANK YOU!