



中国汽车技术研究中心有限公司

China Automotive Technology and Research Center Co., Ltd.

Progress Report of
“Other Road User”

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Performance-relevant ORU Property Generalization Standard and Principle

Physical

1. Mobility (fixed/mobile)
2. Dimensions
3. Path (fixed/free)
4. Visual markings
5. Audible signals
6. Light signals
7. Visibility
8. Vulnerability
9. Location

Functional

1. Personal transport
2. Mass transit
3. Transport of children
4. Commercial goods
5. Dangerous goods
6. Exceptional cargo
7. NRMM
8. Emergency
9. Law enforcement

Behavioral

1. Relative speeds
2. Trajectories
3. Predictability
4. Authority
5. Legal exemptions
6. V2V relationships

Demonstration of Property Based Approach

ORU cases	Physical	Functional	Behavioral
School buses	<p>1. Dimensions: Medium - large.</p> <p>2. Visual markings: Uniform striking colors(yellow), specific vehicle livery and marks</p> <p>4. Light signals: Warning lights and stop arms, could stretch out the stopping signs to warn the ego vehicle behinds cannot overtake the school bus</p> <p>6. Vulnerability: High</p>	<p>2. Mass transit</p> <p>3. Transport of children</p> <p>10. Public service</p>	<p>1. Relative speeds: slow(<50kph outside campus, <10kph in campus)</p> <p>2. Trajectories: stop at the dedicated stations</p> <p>3. Predictability: predictable when loading/unloading students</p> <p>4. Authority: High right of way(during operation)</p>
Trams	<p>1. Dimensions: No longer than 5 carriages</p> <p>2. Visual markings: Different with other vehicles</p> <p>7. Location: only move on the dedicated rails</p>	<p>2. Mass transit</p>	<p>1. Relative speeds: slow(<20kph)</p> <p>2. Trajectories: operate on dedicated trails</p> <p>4. Authority: High right of way than regular cars(with specific crew help direct its transit)</p> <p>6. V2V relationships: could interact with traffic light</p>
Dangerous goods vehicles	<p>1. Dimensions:</p> <p>2. Visual markings: Specific graphics and text need to use to identify dangerous goods.</p> <p>5. Visibility: Some dangerous goods are not easy to be identified robustly</p> <p>8. Velocity: the max. vehicle velocity shall be no more than 80km/h on highway and 60km/h on other road types</p>	<p>4. Commercial goods</p> <p>5. Dangerous goods: regular cars should keep safe distance with these vehicles.</p>	<p>1. Relative speeds: Lower than speed limit.(20%)</p> <p>2. Trajectories: Drive on the right side(China)</p>
Ambulances	<p>2. Visual markings: Specific livery and markings</p> <p>3. Audible signals:</p> <p>4. Light signals:</p>	<p>8. Emergency</p> <p>10. Public service</p>	<p>1. Relative speeds: high</p> <p>4. Authority: High right of way, cannot be overtake by rear vehicles</p> <p>5. Legal exemptions: can violate traffic rules when necessary</p>

Demonstration of Property Based Approach

ORU cases	Properties Requirements for Each Case	Safety Requirements(Tentative)
School buses	<p>1.ADS should detect the object, and complete classification and decide whether that is stationary or not.</p> <p>2.ADS should keep a safe distance when detecting that the object is slowing down, especially when prepare to load or unload pupils around the dedicated stations.</p> <p>3.ADS should adopt more cautious strategy, not overtake when it is driving on the lane or neighbor lane just behind the object, even stop thoroughly.</p> <p>4.The ADS should recognize the dedicated pathways upon its ODD (e.g. reserved lane for bus).</p>	<p>1.The ADS should detect, recognize accurately and provide space to minimize collision risks with objects capable of movement within its ODD.</p> <p>2.The ADS should detect visual markings and signals and respond in accordance with functions and authorizations of vehicles that may operate within the ODD of its features.</p> <p>3. The ADS should predict the intents of vehicles and vulnerable road users and response safely.</p> <p>4.The ADS should respond in accordance with traffic rules to objects with special functions and authorizations.</p> <p>5.The ADS should recognize pathways and related infrastructure designed to separate modes and lanes of traffic.</p>
Trams	<p>1.The ADS should recognize pathways and related infrastructure designed to separate modes and lanes of traffic.</p> <p>2.The ADS should recognize the dedicated pathways upon its ODD (e.g. railway for tram).</p> <p>3. The ADS should respond in accordance with traffic rules to the approaching trams or other rail-borne vehicles.</p>	
Dangerous goods vehicles	<p>1.ADS should be able to detect the position, classification, status of object and keep safe distance especially during overtaking or following closely and have hard brake ability once the goods drop down suddenly.</p> <p>2.ADS should avoid driving for a long time just in blind areas side /for example, right side in China. when the object moves ahead.</p>	
Ambulances	<p>1.ADS should be able to detect, classify the object, and keep a safe distance from the object, not overtake if drive just behind the object.</p> <p>2. The ADS should give the way to the object if the later is detected to move quickly as well as alarm sound continuously.</p> <p>3. Visual, audible, and light signals should be detected to identify if it is running emergency task</p>	

Summary & Next steps

The research suggests a properties-based approach to safety requirements relevant to ORU generally involving requirements to detect safety-relevant physical properties and to respond in accordance with traffic laws and ORU safety needs. We expect to provide further information on ORU properties and their application to general safety requirements.

In general, we may explain the intentions with examples in **the following way**:

- We considered **the physical, functional, and behavioral properties** of a wide range of ORU cases.
- We identified **common properties** across the ORU cases and some **special properties** of subsets of cases and individual cases.
- The common physical properties provide the basis for recognizing different ORU.
- The functional and behavioral properties provide the basis for understanding safety-relevant issues.
- We provide some examples for possible **general safety requirements** to suggest that ADS should detect safety-relevant properties in order to determine safe responses to the presence of objects displaying the properties.
- This approach would enable FRAV to define safety-relevant properties that ADS should detect and to define ADS performance requirements (responses) based on the properties that can be objectively tested.