Formal Models for the Conceptualization and Characterization of Use Cases for the Autonomous Vehicle

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1. CONTEXT

Autonomous vehicles (AVs) perceive the environment with different kinds of sensors (Camera, Radar, Lidar...).

They must evolve in:

- unpredictable environment,
- dynamic context,
- with strong interaction.

Describe & generate different use cases. → Validate the decisions of the algorithms. → Ensure the safety (AVs, occupants, others road users).

2. OBJECTIVES

QUESTION: How can we generate the use cases to cover all the situations that the AVs may meet?

The main objective of this thesis is to develop a complete approach allowing:

- Conceptualization and characterization of use cases → Ontology construction methods.
- Formal modeling of use cases (scenarios).
- Automatic generation of use cases.

3. ONTOLOGY

Methodology of the ontology construction:

1. Identification:
   - Identification of the concepts and relationships in the domain of interest.
   - Production of precise unambiguous text definitions for such concepts and relationships.
   - Identification of terms to refer to such concepts and relationships.

2. Representation:
   - Commit to the basic terms that will be used to specify the ontology.
   - Choose a representation language.

3. Integrating Existing Ontologies.

4. USE CASE – CUT IN

Concept: Entry

Definition: a lane which allows vehicles accessing a highway to accelerate until integrating the highway flow.

Attributes:

- Geometry.
- Topography.
- Length.
- Width.
- Maximum speed.

Relationships:

- Composition relationship:
  IS_COMPOSED (C,E) : C is composed of the elements in the set E where
  \[ C = \text{Entry} \]
  \[ E = \{ \text{Acceleration section, Maneuvering section, Bevel} \} \]

- Location relationship :
  FOLLOWS (C₁, C₂) : C₁ follows C₂ where
  \[ C₁ = \text{Bevel} \]
  \[ C₂ = \text{Maneuvering section} \]
  \[ C₂ = \text{Acceleration section} \]

5. FUTURE WORK

FORMAL METHODS: techniques with a mathematical foundation for the specification, development and verification of software and hardware systems.

REFERENCES