Protocol for Systematic Literature Review (SLR)

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1. Motivation

Autonomous vehicles represent a transformative technology with the potential to revolutionize transportation systems worldwide. However, ensuring their safety and reliability through rigorous testing remains a significant challenge [1]. The fundamental problem addressed by this study is the need for comprehensive test adequacy in test scenarios. Without such test adequacy, it is challenging to determine how effectively a test suite captures the diverse potential behaviors of autonomous vehicles in various scenarios. This insufficiency could lead to the oversight of critical edge cases, such as unexpected pedestrian crossings or complex traffic situations, potentially resulting in unsafe behavior in real-world conditions.

2. Research Method - Systematic Literature Review

We will conduct a systematic literature review on test adequacy for autonomous vehicles [2]. This will involve a comprehensive search and analysis of the existing literature to identify the current methodologies, tools, and metrics used to evaluate test adequacy for autonomous vehicles.   By systematically reviewing and synthesizing the findings from multiple studies, we aim to guide researchers and practitioners in better understanding the state-of-the-art techniques, as well as the challenges, benefits, and tools associated with evaluating test adequacy. This review will provide valuable insights into the challenges and solutions associated with ensuring the safety and reliability of autonomous vehicles in dynamic and complex environments.

2.1 Steps

1. Research Questions Definition
2. Conduct Search
3. Screening of Papers
4. Data Extraction and Synthesis

3. Research Questions Definition

The research questions drive the literature review, and all the following steps are based on them. The process of eliciting and specifying the research questions involves all researchers that participate in the literature review [3].

3.1 Goal-Based Research Questions

- **Purpose**: Comprehend
- **Issue**: Test adequacy
- **Object**: Autonomous vehicle testing
- **Viewpoint**: From the researcher's perspective

3.2 Research Questions

- **RQ1:** What is the state-of-the-art in measuring test adequacy for scenario-based testing involving other vehicles?

- **RQ2:** How is the effectiveness of test adequacy evaluated in autonomous driving testing?

- **RQ3:** What are the potential benefits and challenges of using test adequacy in practical testing environments?

4. Conduct Search

We will use automatic search engines (ACM Digital Library) to collect an initial set of papers.

4.1 Search Strings

((autonomous vehicle OR self-driving vehicle OR autonomous car OR self-driving car OR autonomous driving) AND (test coverage OR test adequacy OR coverage metric OR adequacy metric OR adequacy criteria))

4.2 Search within

Abstract

5. Screening Papers

Screening papers involves passing the complete set of potentially useful papers through a filter, with research articles being preferred. Additionally, we filtered studies to ensure they were published within the last three years. The outcome is a set of relevant papers.

Inclusion Criteria:
• IC1 – Studies focusing on autonomous vehicle testing.
• IC2 – Explicit description of the test adequacy.
• IC3 – Studies that include a software engineering perspective..
• IC4 – Studies providing a certain level of evaluation of the proposed approach (e.g., an empirical assessment, application to a concrete system, etc.).
• IC5 – Studies that are subject to peer review.
• IC6 – Studies written in English.
Exclusion Criteria:
• EC1 – Studies that do not explicitly describe the employed technique.
• EC2 – Tutorial, artifact, short paper (less than 5 pages), keynote, secondary studies, roadmaps, duplicated studies.
• EC3 – Papers that do not address dynamic interactions in AV testing.

6. Data Extraction and Synthesis

The data is extracted from the set of relevant papers. The process demands a scheme containing precise information useful for answering the research questions.

6.1 Data Items to Collect

RQ	Data Item	Description
RQ1	Metadata	Author(s), publication year, title
RQ1	Application Domain	The specific domain within autonomous vehicle testing.
RQ1	Testing Technique	Describe the testing technique used for test adequacy (e.g., metric, framework).
RQ2	Validation Method	Describes what kind of validation method is used to evaluate the effectiveness of test adequacy (e.g., experimentation, mathematical proof).
RQ2	Tooling	Describes what tooling is used to perform the validation, e.g., simulators (CARLA), and theorem provers (COQ).
RQ3	Use Case	Describes what are the use cases that test adequacy is useful or not.
RQ3	Comparison	Describes whether the test adequacy is more suitable than

		other metrics and how.

7. Quality Assurance

To ensure the quality of the research, we follow these measures:
- Protocol validation: Internal validation by peer-reviewing with knowledgeable researchers.
- Validation measures: Inclusion/exclusion of papers, extracted data, and reported results.

8. References

[1] S. Kang, H. Hao, Q. Dong, L. Meng, Y. Xue, and Y. Wu, "Behavior-Tree Based Scenario Specification and Test Case Generation for Autonomous Driving Simulation," in 2022 2nd International Conference on Intelligent Technology and Embedded Systems (ICITES), 2022, pp. 125–131. doi: 10.1109/ICITES56274.2022.9943753

[2] Barbara Kitchenham, O. Pearl Brereton, David Budgen, Mark Turner, John Bailey, Stephen Linkman, Systematic literature reviews in software engineering – A systematic literature review, Information and Software Technology,Volume 51, Issue 1,2009,ISSN 0950-5849

[3] Victor R. Basili, Gianluigi Caldiera, and H. Dieter Rombach. "The Goal Question Metric Approach." Encyclopedia of Software Engineering, John Wiley & Sons, Inc., 1994, Vol. 1, pp. 528-532

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