Texas A&M Transportation Institute

Texas Department of Transportation

PROJECT SUMMARY REPORT

0-7128: Digitizing Traffic Control Infrastructure for Autonomous Vehicles (AV)

Background

High precision road maps are a crucial component to facilitating autonomous driving techniques. Autonomous vehicles (AVs) are experiencing exponential growth. According to the latest forecast from IHS Markit, over 33 million AVs will be on the road globally by 2040, posing a higher requirement to ensure AVs' driving safety. Although current AVs rely on vehicular sensing techniques (e.g., camera, LiDAR, radar), studies have suggested that creating high-quality road maps with precisely digitized traffic control infrastructures (TCIs) (e.g., traffic signs, signals, intersections) is necessary to enhance the safe-driving operations of AVs. Meanwhile, digitizing TCIs is also of great importance for road assets planning and management. However, a readily available database with precisely digitized TCIs is still missing in most areas. Traditionally, TCIs are manually digitized by conducting field studies, which are time consuming and labor intensive. With the advancement of data collection and processing techniques, numerous emerging data sources are becoming available, posing great potential to capture and digitize TCIs more efficiently.

In this project, the researchers developed an effective framework for the digitization, maintenance, and sharing of roadway assets, especially for TCIs (Figure 1). The research team evaluated available solutions (commercial, open-source, and public), investigated potential legal issues, and proposed new approaches by leveraging emerging data sources and techniques. Simulations based on various real-world scenarios were developed to evaluate the benefits of incorporating TCI digitized data in enhancing the safety and operational measures of AVs.

What the Researchers Did

To achieve the project goals, the research team conducted four major tasks during the project period, summarized as follows:

- **Task 2:** The research team systematically reviewed the existing literature on TCI identification and digitization (e.g., intersection, traffic signs, traffic signals) and the interaction between traffic infrastructure and AVs.
- **Task 3:** The research team investigated the state of practice for TCI digitization and identified potential market available data sources for building TCI inventories. The team also identified the possible legal issues associated with the digitization, collection, and sharing of TCI data.

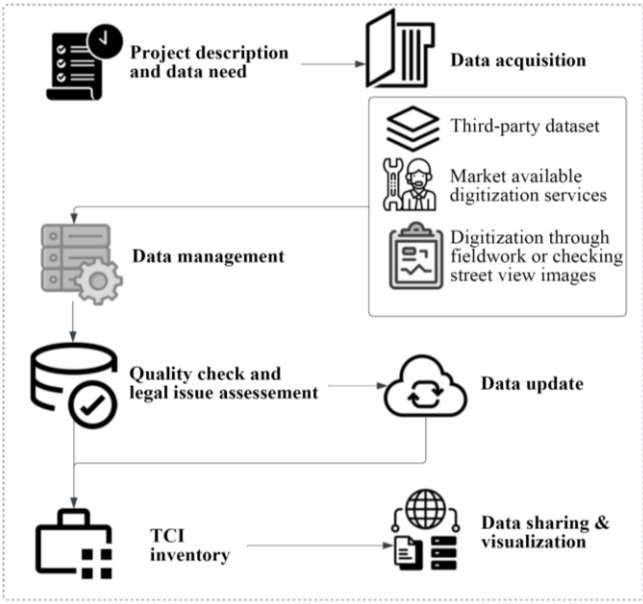

Figure 1. Conceptual Framework for TCI Inventory Establishment and Management.

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- **Task 4:** The research team obtained and evaluated sample digitized TCI datasets from multiple third-party data providers. A framework for digitizing and sharing these datasets was developed in this task.
- **Task 5:** The research team assessed the precision of the TCI datasets by comparing them with the ground truth data, constructed a web GIS-based platform specifically designed for the digitization of TCIs, simulated multiple real-world scenarios, and analyzed the advantages of integrating TCI digitized data to improve the safety measures of AVs.

What They Found

In this study, the research team focused on digitalizing TCI data from diverse sources, including commercial data providers, public agencies, and open-source organizations. The investigation encompassed four testing corridors situated in the Dallas–Fort Worth area. To establish ground truth data, manual extraction from Google Earth Pro was employed for each type of TCI. Subsequently, a data fusion technique known as DBSCAN was applied to merge all individual datasets into a comprehensive combined dataset. The evaluation of this combined dataset demonstrated a notable level of reliability. Notably, among the individual datasets, commercial companies like Mobileye displayed superior overall performance. However, significant disparities in reliability were observed among the individual datasets, particularly concerning stop and yield sign representations. Based on these findings, the researchers concluded that utilizing a combination of different data sources proves essential in achieving a digitized TCI dataset that meets the desired levels of accuracy and comprehensiveness.

The research team developed a web GIS-based application based on the developed TCI data digitization framework (Figure 2). The platform was held on ArcGIS Online (an Esri-developed cloud-based GIS platform) as a central point through which TCI digitization maps will flow. A data management plan was also developed to outline how the data will be collected and how the data will be managed and shared with stakeholders and other entities throughout the project and beyond.

Using MATISSE, a multi-agent-based simulation system, researchers simulated various real-world scenarios and evaluate the benefits of incorporating TCI digitized data in enhancing the safety measures of AVs. Through this validation process, the team gained valuable insights into the potential advantages and effectiveness of TCI digitized data utilization, further reinforcing its significance in promoting safe AV operations.

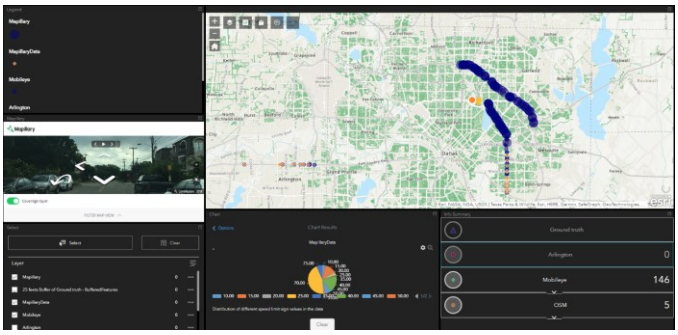

Figure 2. Developed Web GIS-Based TCI Digitization Platform.

What This Means

The research holds significant implications concerning asset inventory and condition since these are vital inputs for various planning and operational products like transportation asset management systems, transportation planning documents, and automated vehicle routing systems. Crucial elements of asset management plans, such as life cycle planning, financial strategies, investment plans, and risk analyses, heavily rely on the accuracy of asset inventory, condition, and performance data.

Through this research, transportation agencies can effectively communicate asset types and locations by establishing a framework for digitizing and sharing TCI data from multiple sources. The resulting inventory data will not only enhance roadway safety but also prove valuable for planning-related research. Accurate digitized traffic control data will notably facilitate autonomous driving techniques and bolster the safety and operational measures of AVs. This research thus plays a pivotal role in advancing transportation practices and ensuring the efficiency and safety of AVs on the road.

For More Information

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