EVTC

Electric Vehicle Transportation Center

Assessing the SunGuide® and STEWARD Databases

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Final Research Project Report
EVTC Project 7 – Assess the SunGuide® and STEWARD Databases

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The objective of the Assessing the SunGuide® and STEWARD Data bases project was to evaluate the feasibility of using the existing software and data bases as platforms for analyzing the attributes of electric vehicles within present and future transportation infrastructure projects and models. The work was conducted by Richard Raustad of the Florida Solar Energy Center.

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1.0 Abstract

This project evaluated the feasibility of using the existing software and data bases as platforms for analyzing the attributes of electric vehicles within present and future transportation infrastructure projects and models. The Florida based SunGuide and STEWARD databases were found to be abandoned and outdated. Thus, the Regional Integrated Transportation Information System (RITIS) database was selected to provide current and detailed vehicle transport data as input for transportation simulation models. Activities included review and formatting of RITIS vehicle transport data to provide vehicle numbers, directions and arrival times for a Florida Turnpike transportation model. A paper using the data was published and is cited below. The concept was to addresses both the system-level scheduling problem and the individual control problem, while requiring only distributed information about EVs and their charging at service stations along a highway.

2.0 Research Results

The project has documented information from the Regional Integrated Transportation Information System (RITIS) database in a format readily adaptable to transportation modeling. This information supplied project modelers with the methodology for accessing and filtering stored vehicle transport data to provide the basis for advanced modeling of transport systems.

The Center for Advanced Transportation Technology (CATT) laboratory at the University of Maryland integrates, archives, and processes transportation data feeds from agencies across the country. This information is shared with various private and public agencies to communicate current and historical transportation information. The three main components to the RITIS system are: 1) real-time data feeds, 2) real-time situational awareness tools, and 3) archived data analysis tools. Access to the RITIS web site (ritis.org) requires Department of Transportation (DOT) authorization when used by non-DOT entities and requires a username and password (data is considered sensitive). The site interactively provides a variety of information as maps, lists, and graphical displays. Archived data can be exported for independent analysis.

For purposes of transportation modeling, archived transit data for vehicle volume and speed were collected for specific locations on the Florida Turnpike. Table 1 shows an example of the exported data as received from the RITIS archive. Figure 1 shows an example of a single measurement location on the Florida Turnpike for vehicle speed and post-processed hourly vehicle volume.

Table 1. Example RITIS Export Data Format

zone_id	lane_number	lane_id	measurement_start	Speed	volume	occupancy	quality
6778	1	14208	2014-07-07 03:00:58.700000-04:00	83	1	0	0
6778	1	14208	2014-07-07 03:01:58.744000-04:00	75	1	0	0
6778	1	14208	2014-07-07 03:19:58.922000-04:00	72	1	0	0
6778	1	14208	2014-07-07 03:22:58.961000-04:00	71	1	0	0
6778	1	14208	2014-07-07 03:36:59.179000-04:00	76	1	0	0
6778	1	14208	2014-07-07 03:43:59.288000-04:00	81	1	0	0
6778	1	14208	2014-07-07 04:06:59.609000-04:00	99	1	0	0
6778	1	14208	2014-07-07 04:10:59.616000-04:00	77	1	0	0
6778	1	14208	2014-07-07 04:17:59.724000-04:00	79	2	1	0
6778	1	14208	2014-07-07 04:19:59.767000-04:00	81	1	0	0
6778	1	14208	2014-07-07 04:34:59.982000-04:00	81	1	0	0
6778	1	14208	2014-07-07 04:40:00.048000-04:00	80	2	1	0

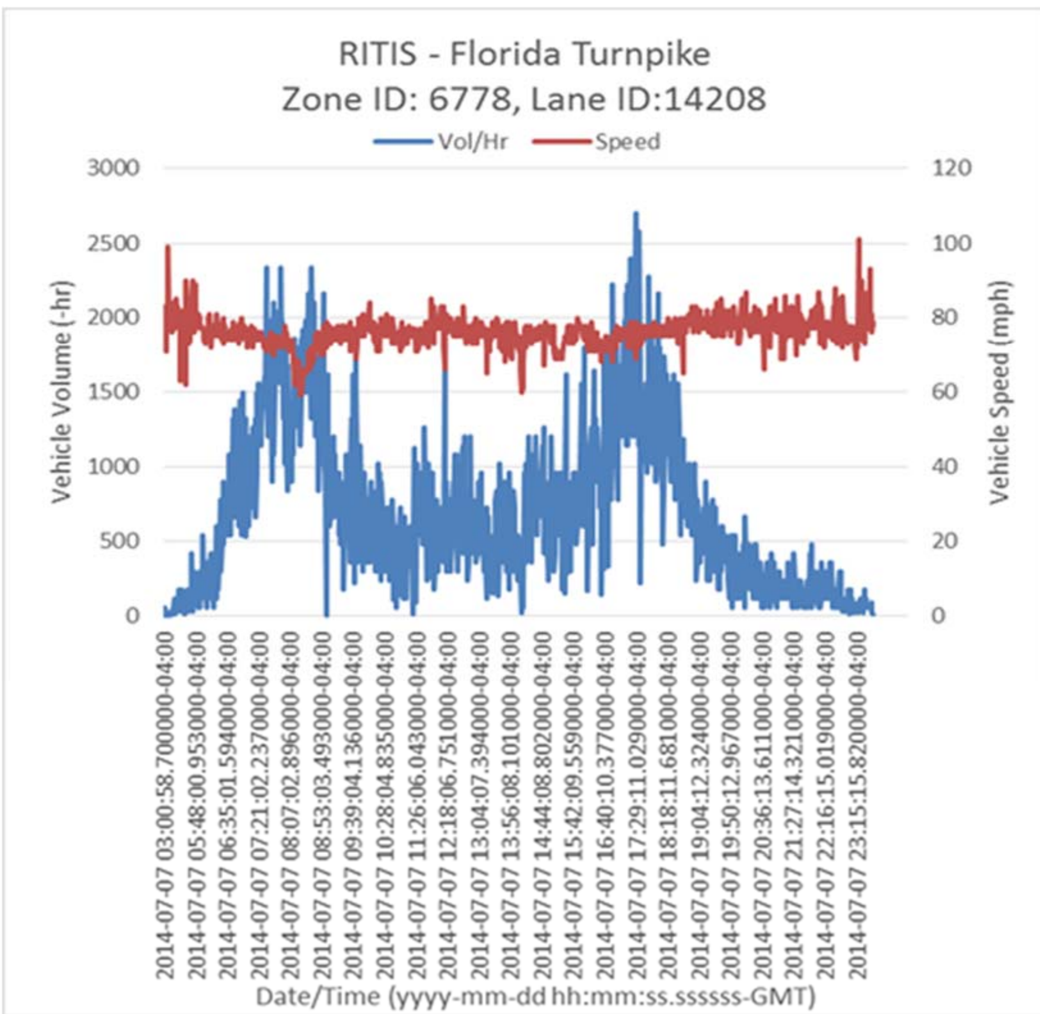

Figure 1. Example RITIS Post-Processed Vehicle Volume and Speed Information

The data collected were used as input to the Florida Turnpike transportation model and were organized according to the zone ID and lane location (see Table 1). These data were initially non-chronological and required organizational post-processing. Additionally, other key metrics (e.g., vehicle volume per hour) also required post processing to calculate the desired values. For example, using the vehicle speed data and associated time stamp, a vehicle volume per hour could be calculated.

Use of multiple locations on the Florida Turnpike (i.e., zone ID) provided a macroscopic view of vehicles traveling along this roadway. Figure 2 shows a schematic representation of roadway throughway, exit and entrance. The RITIS data were used to define these model inputs for Florida Turnpike service plazas (Figure 3) and to determine queuing information for optimally locating EV charging stations.

The Florida Turnpike also collects one-time measurements annually to document plaza volume as a percentage of roadway volume. This data set was used to define the potential plaza entrance volume based on RITIS archive data. For example, a specific service plaza may have approximately 10% volume based on roadway thoroughfare. This percentage multiplied by the RITIS measurement, along with an estimation of the percentage of EV's traveling the roadway provided an input to the EV charging station queuing model.

The application of the RITIS data was then used as the real world application of a simulation model. The simulation models are presented in two published papers referenced below. These papers address both the system-level scheduling problem and the individual control problem, while requiring only distributed information about EVs and their charging at service stations along a highway.

The process used was to first develop a higher-level distributed scheduling algorithm to optimize the operation of the overall charging network (Reference 1). The scheduling algorithm uses only local information of traffic flows measured at the neighboring service stations (nodes). This process allows for the adjusting of the percentage of EVs to be charged at individual stations so that all the charging resources along the highway are uniformly utilized and the total waiting time is minimized. Next, a lower level cooperative control law is designed for individual EVs to decide whether or not an EV should charge its battery when approaching a specific service station by meeting the published scheduling level while taking into account its own battery constraint. Analytical designs are presented and performance improvements are illustrated using the simulations.

The second paper extends the distribution algorithm to schedule neighboring EV flows into neighboring charging stations so that all EVs are appropriately served along the highway and the charging resources are uniformly utilized. A distributed decision making policy is developed to influence the aggregate number of EVs entering any given service station so that each EV makes the appropriate charging decision. Finally, the RITIS traffic data for the Florida Turnpike was used to validate the model (Reference 2).

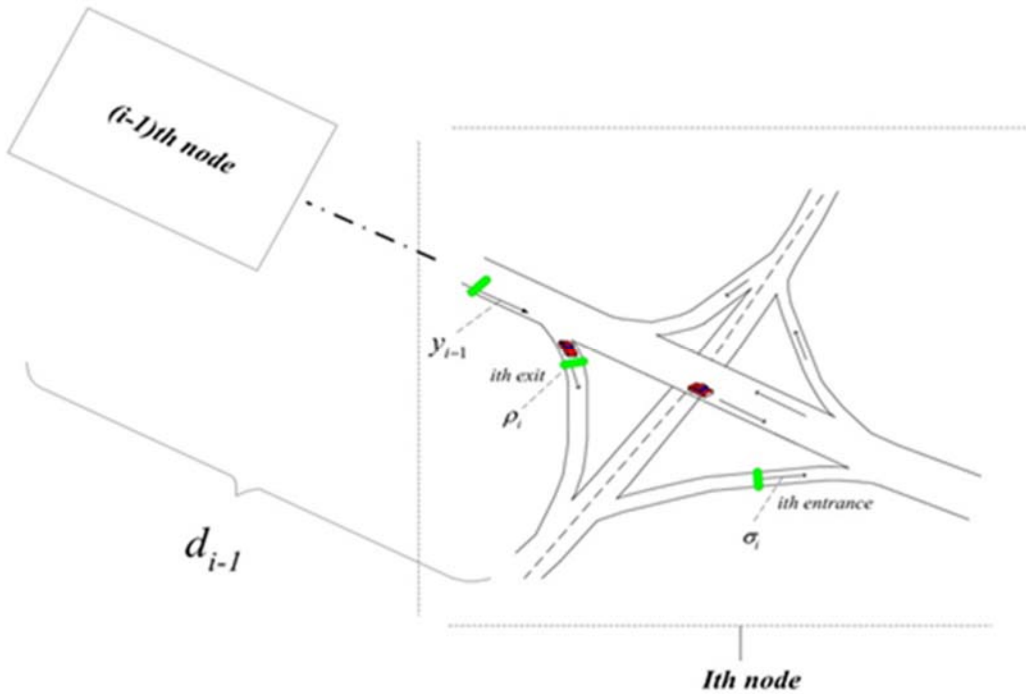

Figure 2. Schematic Representation of Nodal Transportation Model

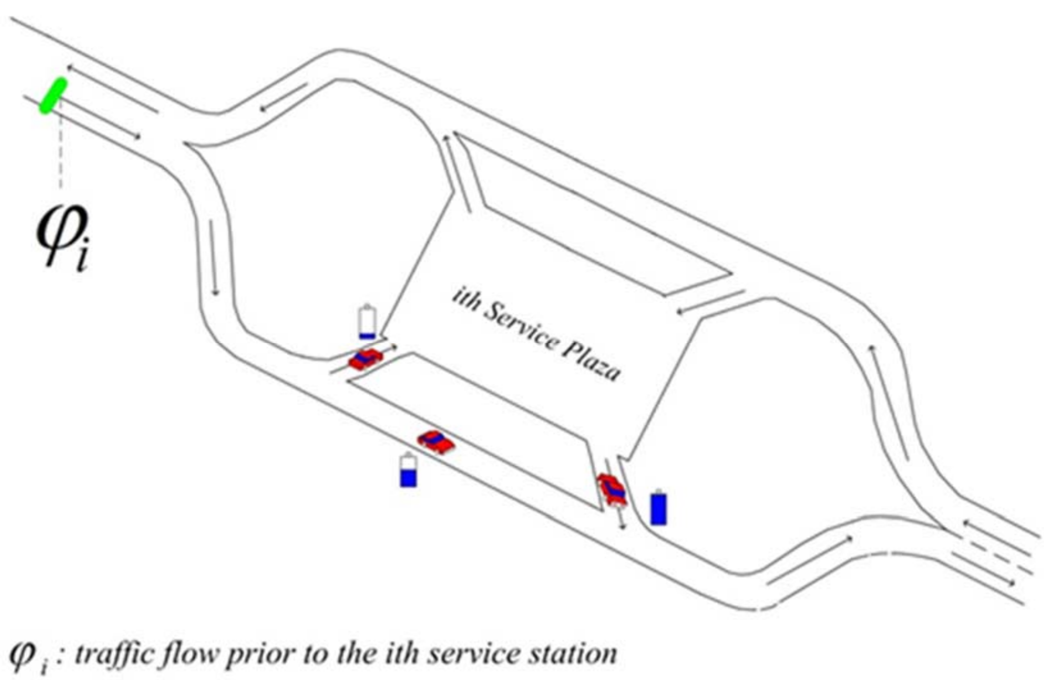

Figure 3. Florida Turnpike Service Plaza Transport Model

2.0 Impacts/Benefits

The use of historical measured transportation vehicle transport data allows more accurate modeling of transportation systems. Although these data may be protected due to sensitive information, DOT may authorized its use for appropriate purposes.

3.0 Reports

1. Gusrialdi, A., Qu, Z., Simaan, M. (2014). "Scheduling and cooperative control of electric vehicles' charging at highway service stations." Decision and Control, 2014 IEEE 53rd Annual Conference. DOI: 10.1109/CDC.2014.7040403.

2. Gusrialdi, A., Qu, Z., Simaan, M. (2017). "Distributed Scheduling and Cooperative Control for Charging of Electric Vehicles at Highway Service Stations." IEEE Transactions on Intelligent Transportation Systems. DOI: 10.1109/TITS.2017.2661958.