Guest Editorial Advanced Traveler Information Systems and Vision-Based Techniques for ITS

IN THIS FIRST issue of the IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS under the IEEE Intelligent Transportation Systems Society (IEEE ITSS), we continue with the second part of our special issue on recent advances and trends in research and development in ITS technology.

As we have mentioned in our introduction to the first part of the special issue, papers for the special issue have been selected from over 300 articles presented at the 6th Annual IEEE International Conference on Intelligent Transportation Systems in Shanghai, China, from 12 to 15 October 2003. The peer-review process for this special issue was conducted only for the 97 submitted papers, which were extended versions of their conference originals. The review process for papers involved with guest editors as coauthors were handled by one of other guest editors. Among them, 10 papers are from the United States, 16 from Europe, and 71 from Asia (61 are from China, including nine from Taiwan, the total number papers received from China for the Conference were 164). Among the papers selected for the special issue, six are from the United States, six from Europe, and 12 from Asia.

The topics addressed in the second part of this special issue can be divided into two groups for 1) progress in advanced traveler information systems and 2) vision-based techniques for object recognition in intelligent transportation systems.

Progress in Advanced Traveler Information Systems

The first group of papers addresses new methods and application of Advanced Traveler Information Systems (ATIS). Fast and accurate navigation is a ubiquitous need today for mobility and the accelerated Global Positioning System (GPS) availability and application over the last decade have greatly intensified the demand for effective and efficient navigation technology. Edelkamp, Jabbar, and Willhalm present a novel approach for optimal route planning by making efficient use of the underlying geometrical structure, an interesting step towards providing travelers with real-time personal navigation assistance at a large scale. Their approach combines classical artificial intelligence exploration with computational geometry. Given a set of GPS trajectories, it refines the input by geometric filtering and rounding algorithms. For constructing the graph and the point-localization structure, fast scan line and divide-and-conquer algorithms are applied. For speeding up the optimal online search algorithms, the geometrical structure of the inferred weighted graph is exploited in two ways: first it is compressed while retaining the original information for unfolding resulting shortest paths and second it is annotated by lower bounds and refined topographic information. Their approach also considers traffic disturbances that can result in an increase in travel time for the affected area and, in turn, can affect the precomputed information. In their paper, two models for introducing dynamics in a navigation system are discussed. The proposed methods are implemented in their online planning system GPS-ROUTE which provides a clientserver web interface to answer a series of shortest-path or shortest-time queries. Experimental works, although small in scale with moderately sized data sets, have exhibited some effects of the acceleration features by their suggested techniques.

Ability to forecast how the information predicted and provided by ATIS influences time trajectories of network flows is essential in ITS applications. Cho and Hwang formulate a day-to-day network dynamics using the stimulus response formula under the assumption of a daily learning and adaptive travel behavioral process. The time change rate of flow and the difference between the experienced and predicted travel times for a path are depicted as the response and stimulus, respectively, in path flow dynamics. Issues of existence, uniqueness, and stability for the proposed differential equations are briefly discussed. Approximation of a time-varying route choice model is derived from the addressed path-flow dynamics. Threshold effects on path-flow dynamics are encapsulated into the proposed general structure by incorporating a discontinuous stimulus term. Then, a quasi-user equilibrium is achieved when all users feel indifferent between the experienced and predicted travel time provided by intelligent transportation systems. The derived quasi-user equilibrium is reduced to Wardrop's user equilibrium as the threshold effects of path-flow dynamics vanish. It would be an interesting investigation to look into the potential applications of their proposed approach in incorporating analytical heuristics into activity-based traffic modeling and analysis.

Kumar, Singh, and Reddy provide a case study of ATIS through its implementation and application in an Indian city. Comparing to average regular papers published in our TRANSACTIONS, their paper is very application-oriented and might not make it to the Transactions without this special issue. Their paper was recommended by reviewers' desire to include some practical ITS systems, especially those in developing countries, in this special issue. As we know, the objective of ATIS is to provide vital information to travelers regarding traffic regulation, route and location guidance, hazardous situations, safety advisories, and warning messages through emerging

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intelligent computer, communication, and information technologies. Clearly, ATIS requires a large amount of data for processing, analysis, and storage for effective dissemination of traveler information to users. In their paper, the authors addressed those issues with the development of a GIS-based ATIS for Hyderabad City, India. This user-friendly system provides comprehensive information about Hyderabad City, such as road networks, hospitals, government and private offices, stadiums, bus and railway stations, and tourist places within the city limits. Their system can be used effectively in bus stations, railway stations, airports, and tourist information centers, as well as in personal computers to provide information to travelers and to facilitate travel.

Tang and Gao propose an improved but simple nonparametric regression algorithm (INPRA) for forecasting traffic flows and its application in automatic detection of traffic incidents. Basically, the INPRA is constructed based on the searching k-nearest neighbors for a state vector, and its main advantage lies in forecasting through possible trends of traffic flows, instead of just current traffic states as commonly used in previous forecasting algorithms. Various simulation results indicate the viability and effectiveness of the proposed new algorithm. Furthermore, several performance tests conducted using actual traffic data sets demonstrate that INPRA's average absolute forecast error, average relative forecast error and average computing time are among the smallest compared to other forecasting algorithms.

Vision-based Techniques for Object Recognition in ITS

Vision-based techniques for object recognition in ITS have become one of most popular research topics recently. Video-based surveillance systems have a wide range of applications for traffic monitoring and in other ITS areas, since they provide more information as compared to other sensory systems. In their paper, Kumar, Ranganath, Huang, and Sengupta describe a complete real-time rule-based behavior-recognition system for traffic videos. This system will be useful for better traffic rule enforcement by detecting and signaling improper behaviors, which is capable of detecting potential accident situations and is designed for existing camera setups on road networks. The system is based on the analysis of 2-D image features and derived 3-D position and motion features. A moving target-segmentation scheme that is dynamically updated and gives good shadow-detection results is presented. The segmentation results are used to obtain 2-D image features of the target. A novel approach to target classification in traffic videos using Bayesian networks has been proposed. For behavior recognition, two types of interactions have mainly been considered. One is interaction between two or more mobile targets in the field of view (FoV) of the camera. The other is interaction between targets and stationary objects in the environment. The framework is based on two types of a priori information: 1) the contextual information of the camera's FoV, in terms of the different stationary objects in the scene and 2) sets of predefined behavior scenarios, which need to be analyzed in different contexts. The system can recognize behavior from videos and give a lexical output of the detected behavior. It also is capable of handling uncertainties that arise due to errors in visual signal processing. Their approach has yielded very good classification results. Using the tracking results and the results of classification, world coordinate estimates of target position and velocity are obtained, which are accurate to within a small error of 5 % of ground truth.

In his paper on obstacle detection using stereo vision, Ruichek focuses on a multilevel- and neural-network-based stereo-matching method for real-time detection with linear cameras. A multilevel neural method for matching edges extracted from stereo linear images is proposed. The method described performs edge stereo matching at different levels with a neural-network-based procedure. At each level, the process starts by selecting, in the left and right linear images, the most significant edges, i.e., those with the largest gradient magnitudes. The selected edges are then matched and the obtained pairs are used as reference pairs for matching less significant edges in the next level. At each level, the matching problem is formulated as an optimization task in which an objective function, representing the constraints on the solution, is minimized with a Hopfield neural network.

Safety in traffic environments is always a great concern for both pedestrians and drivers. Xu, Liu, and Fujimura address the problem of pedestrian detection and tracking with night vision using a single infrared video camera installed on the vehicle. To deal with the nonrigid nature of human appearance on the road, a two-step detection/tracking method is proposed. The detection phase is performed by a support vector machine (SVM) with size-normalized pedestrian candidates and the tracking phase is a combination of Kalman filter prediction and mean shift tracking. The detection phase is further strengthened by information obtained by a road-detection module that provides key information for pedestrian validation. Improvements are made through an optimum combination of detection and tracking, the representation of pedestrian candidates with contour instead of region, pedestrian detection based on leg movement, and combination of a motion-based method and SVM classification. The feasibility of their approach is investigated by experimental comparisons.

Finally, He, Liu, Ma, and Li describe an automatic extraction method of container identity codes based on template matching. Due to various noises and objects imposed in acquired images, the container code can hardly be extracted. In their approach, the container image is initially filtered with both adaptive linear and nonlinear filters in order to reduce noise so that the candidate text lines can be properly located. Then, a series of standard templates are applied according to the standard align modes of the container identification (ID) codes. Finally, the align mode of each candidate text line is obtained and then matched with those standard templates and the container ID codes are extracted. Experimental esults show that their method can segment the container ID codes with high accuracy.

Again, a special issue in a journal such as the IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS can only publish a small number of papers, presenting unpublished original work that was completed in time for the special issue. Although we have made every effort to include a broad spectrum of recent ITS research, the coverage is by no means comprehensive. Last but not least, we would like to take this

opportunity to express our gratitude to all reviewers of the special issue for their time and effort.

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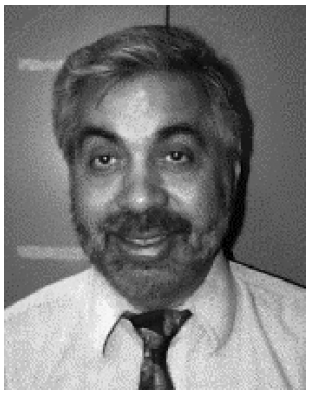

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