This is the second part of two parts of this Special Issue on Intelligent Vehicle Navigation (iVN).

The use of in-vehicle navigation systems continues to rise globally. The capability of these systems in terms of positioning accuracy and navigational services and their sophistication in terms of system design and reliability have also advanced over time. This has been possible due to iVN supported by enhanced navigation sensor and digital spatial road network data and intelligent navigation algorithms. Conventional methods for vehicle navigation have employed GPS as the main tool integrated with Dead Reckoning (DR) sensors (in various configurations) and 2D spatial (map) data using map matching algorithms. Recently, other techniques that employ technologies of opportunity including wireless positioning, 3D spatial (e.g. city) models together with vision systems (cameras and videos) have emerged, to improve navigation performance in areas where GPS is unable to deliver the required performance. The challenge here is how to integrate the various systems, sensors and databases to achieve optimal navigation performance.

This second part of the special Issue of the Journal of Transportation Systems on iVN continues the theme of the first part and presents research that addresses aspects of the problem of vehicle navigation including integration of GPS with other sensors and databases for improved vehicle navigation.

This Issue contains four papers. The first paper, “Intelligent geo-localisation in urban areas using GPS, 3D-GIS and vision” by Cappelle, C., El Najjar, M.E.B., Pomorski, D., Charpillet, F., demonstrates the feasibility of integrating GPS with 3D spatial (city) model and vision systems (camera) for vehicle navigation. Instead of using data from the common DR sensors of vehicle odometer and a gyroscope for positioning during periods when GPS only navigation is not possible, the proposed system determines the vehicle position by DR (distance and direction data) from the 3D spatial model calibrated by real images from an on-board camera. Tests using real-world data collected in Nancy in France show that the performance offered by 3D spatial model/camera system in terms of positioning accuracy is similar (i.e., average error 4m) to that of the GPS calibrated odometer/gyroscope system during GPS outages. Further research is required to characterise fully the performance in different operational environments.

The second paper, “Methods to detect road features for video-based car navigation systems” by Choi, K-H., Cho, S.I., Kim, S.H., Park, S.Y., Park, J.H., Park, J.H., Lee, K.S., presents a framework to detect road features in different road conditions using advanced methods including Support Vector Machines (SVMs) and Bayesian network models. The detection such road features is fundamental to support sophisticated navigation services such as providing directional information to the drivers and assisting them to change lane at the appropriate time before turning to the left or right at the downstream junction. The proposed algorithms are capable of identifying lane markings (e.g., either dotted or solid), colours of lane markings (e.g., either a white line or a yellow line), sidewalks and the lane on which a vehicle travels. The results suggest that the algorithms identify the road features correctly 98.5% of the time in good road conditions (i.e. when only a few cars are on the road) and
76.8% of the time during bad conditions (i.e. when many cars are on the road and with frequent lane change manoeuvres).

The third paper, “Development and application of an enhanced Kalman filter and GPS error correction approach for improved map-matching” by Xu, H., Liu, H., Tan, C-W., Bao, Y., proposes an improved Kalman filter approach to effectively correct GPS errors with the aim of reducing errors in map-matching. Realising GPS errors may not follow a white Gaussian distribution for the best performance of Kalman filter, the authors used the difference of GPS errors between two consecutive fixes, which is a white Gaussian distribution, in their approach. The developed method uses data from the vehicle's historical trajectory and digital map in the improved Kalman filter so as to reduce both bias and noise in GPS measurements. Map-matching results using real-world data from two metropolitan cities in China suggest that the average positioning error is 21.7m for the case of GPS data without applying the correction achieved from the Kalman filter. This reduces to only 1.6m with the corrections applied, a level suitable for many high accuracy ITS applications.

The fourth paper, “Defining a freeway mobility index for roadway navigation” by Zhu, W., Boriboonsomsin, K., Barth, M., proposes a Navigation Mobility Index (NMI) that measures the navigational freedom of drivers between a source-destination pair or an area within a road network. Two factors are critical to the development of the indices: (1) the weighted number of paths between a source-destination pair and (2) the attractiveness of a path to a driver in terms of the path length. Node-NMI quantifies the degree of navigational mobility (i.e., travel freedom) between a single node to all other nodes within a network and area-NMI quantifies the area-wide measure of navigational mobility while considering all nodes in an area. While the node-based NMI can be beneficial to an individual driver, area-based NMI is useful for the overall planning purposes such as identifying links that are critical to the mobility of road users and designing the layout of road network more efficiently.

The papers presented in both parts of the Special Issue are testimony to the considerable momentum in research and development activities in Intelligent Vehicle Navigation (iVN) and its underpinning technologies, data and methods. It is our hope that the papers capture some of the major recent developments in iVN and that they act as a further stimulus for future research and development. Future processes and algorithms, in addition to accounting for limitations in both technology and data, should be flexible to accommodate rapid developments in the quality and quantity of the sensor outputs and spatial network data. Furthermore, there is increasing availability of a variety of systems, sensors, and databases including 3D spatial models, vision technology, wireless positioning, and enhanced and new global navigation satellite systems. This presents the interesting research and development problem of the specification of an architecture for iVN that is optimal in terms of technical performance, cost and efficiency.