New England University Transportation Center Final Report

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This report documents our research on the conceptual framework of an integrated transportation system with a prototype application under the framework.

Conceptual framework of an integrated transportation system

The framework of the integrated transportation system is summarized as follows:

Level	Proc. unit	Coverage	Sensor/Comm.	Simulation	Objective	Control strategy
Global	TOC	An entire transportation system	Loop detectors Video cameras Other sensors	Macroscopic	Mobility	Proactive system control to improve mobility
Local	RSU	A highway segment An intersection A freeway merge	GPS/LPS DSRC Others	Microscopic	Mobility Safety	Cooperative local control to improve mobility and safety
Vehicle	OBU	A vehicle and its surrounding	GPS/LPS DSRC Others	Nanoscopic	Safety	Attentive vehicle control to improve safety

Keys TOC – traffic operation center; GPS – global positioning system; RSU – roadside unit; LPS – local positioning system; OBU – on-board unit; DSRC – dedicated short range communications

Three levels of control are involved in this framework. At the global level, a high-level simulation at the TOC gathers pieces of traffic information from the field sensors, generates a system-wide overview, and preview system evolution in the near future, e.g. the next half to one hour, with the assistance of available traffic prediction techniques. As a result, the simulation output could assist traffic managers to identify potential problems in advance, test control strategies, and take preventive actions before the problems build up. At the local level, an RSU keeps a high resolution local map, communicates with all vehicles within range, and exchanges information with the TOC. A low-level simulation could run at the RSU to preview local traffic operation in the near future, say five to ten minutes, with the assistance of short-term traffic prediction techniques. The simulation result enables the RSU to communicate with drivers and coordinate them to move in an orderly, efficient, and safe fashion. At the vehicle level, a vehicle communicates with an RSU within range as well as other surrounding vehicles. Therefore, this vehicle knows its surroundings (from other vehicles), its local context (from the RSU), and the global context (from the TOC via the RSU). A ground-level simulation could run in this vehicle to integrate information from other vehicles, the RSU, and the TOC (via the RSU). The simulation result enables the driver to preview his/her position and surroundings in the next half to one minute. In addition, the simulation could assist driving by suggesting control strategies or taking partial or full control of the vehicle.

A Prototype of VII-Enabled Intersection Collision Warning System

A prototype of VII-enabled intersection collision warning system was developed which constitutes a local-level traffic control system in relation to the above framework. Vehicle collisions at intersections account for a large percentage of overall traffic accidents, a good portion of which are fatal. A large number of these accidents can be avoided by a warning system which makes a driver aware of potential collisions on the road, thus allowing the driver enough time to prevent such situations.

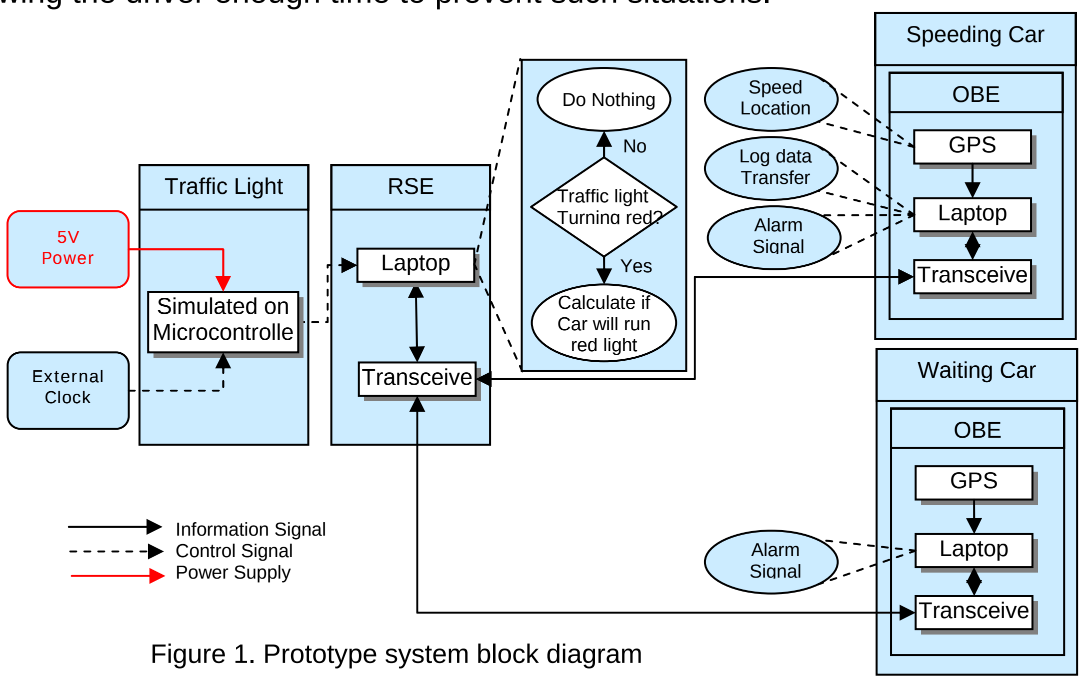

Figure 1. Prototype system block diagram

The concept of operation of the prototype is the following: (a) When a vehicle (the moving car) approaches the intersection near the end of green interval, the signal box (RSE) is warned of traffic light turning red. (2) A message sent from RSE to the moving car (OBE), asking for speed and position of the OBE. (3) OBE responds by sending back the requested speed and location information. The RSE then calculates whether moving car is likely to run red light. (4) If yes, vehicles on the conflicting approach (such as the waiting car) will be warned of the potential danger. The study included selection of VII enabling technologies, design of the prototype system including system requirements, principle of operation, system block diagram (see Figure 1), and system algorithms. Field tests are conducted and the test results showed that the system passed all tests and performed well within suitable parameters.