Modeling Traffic Impact on Denali Park Road

The movements of hungry bears rarely factor into the carefully calibrated models employed by transportation researchers seeking to optimize traffic flows. But Alaskan brown bear—as well as caribou, Dall sheep, wolves, and other native wildlife—are key elements of a simulation developed by the Minnesota Traffic Observatory (MTO) to help the National Park Service manage the impacts on wildlife and visitor experience resulting from vehicle traffic through Denali National Park.

One of Alaska’s most popular destinations, Denali offers visitors a spectacular glimpse of the state’s natural beauty and the opportunity to view many native wildlife species up close. To preserve the park’s unspoiled environment, private vehicle traffic on the park’s only road is heavily restricted; for most visitors, the only way to experience much of the park is by booking a seat on one of the special tour buses or purchasing a ticket to ride on a park-sponsored visitor transportation shuttle service, which carry them to different destinations along the 94-mile road. But as the number of annual visits to the park increases every year, continuing a trend that began more than 30 years ago with the opening of a paved highway connecting the park to Anchorage and Fairbanks, park managers have found themselves under pressure to re-examine the limit of approximately 10,000 annual vehicle trips. The park road is essentially the only means to bring visitors into the interior of the park.

“The question that arose was, should this annual trip limit be different? Park managers needed to figure out if they could protect the park’s natural surroundings, park wildlife, and the visitor experience all at the same time by adding trips, or by changing the system to make it better,” says MTO lab manager Ted Morris, who joined MTO director John Hourdos and ITS Institute director Max Donath on the project.

To answer this question, the MTO teamed with the University of Vermont’s Park Studies Laboratory as well as biologists and park management from Denali. The MTO developed a model to simulate the complex relationships between traffic patterns and wildlife movements in the park. This simulation is now being used by park managers to answer the kind of “what-if” questions about park use that would be impossible to test in the real world without risk of disrupting Denali’s delicate balance.

Building the model
The key issue in modeling park traffic is the relationship between the movements of wildlife in the park and the experience of park visitors. Park Service officials were concerned that simply increasing the permitted number of vehicle trips in order to give more people the opportunity to view wildlife could backfire by causing wildlife to avoid the park road, or by disrupting the foraging and migratory patterns that support healthy wildlife populations.

The MTO traffic model is a microsimula-
ITS America president tours research labs

Scott Belcher, president and CEO of ITS America, toured several ITS Institute laboratories and discussed current research with University of Minnesota researchers during a June 11 visit to the Minneapolis campus. The morning included brief presentations by several researchers.

Intelligent Vehicles Lab researcher Alec Gorjestani described the development of a prototype Teen Driver Support System (TDSS), which combines driver-assistive functions such as advance warning of dangerous road conditions with the ability to log and report speed violations and other dangerous behavior to parents. HumanFIRST Program researcher Janet Creaser provided an overview of the immersive driving simulator, one of the most advanced simulators in use by any university research organization in the country.

Minnesota Traffic Observatory director John Hourdos led a brief tour of his facility, which includes advanced traffic modeling and visualization equipment and continuous automated monitoring of vehicle movements through a central section of the Twin Cities freeway network.

On May 15, Institute director Max Donath (center) provided a multicultural group of students from Patrick Henry High School in Minneapolis with a University-level class experience—an introduction to robotics. The visit, arranged by the University’s Office of Admissions, was meant to introduce the students to the University of Minnesota as well as encourage them to attend once they graduate.

Rajamani to address IASTED international conference

Institute researcher and mechanical engineering professor Rajesh Rajamani will be the plenary speaker at the 29th IASTED International Conference on Modeling, Identification and Control, to be held in Innsbruck, Austria, in February 2010. He will speak on “Novel Sensors, New Estimation Algorithms and Advanced Controls: Solutions for Improving Highway Vehicle Safety and Mobility.”

Rajamani’s diverse interests include adaptive cruise control algorithms (Sensor, Winter 2002), novel narrow commuter vehicles (Annual Report, 2006), and piezoelectric vehicle detectors (Sensor, Spring 2009), among other topics.

ITS Institute research featured at 2009 CTS Research Conference

Numerous ITS Institute research projects were featured in presentations at the 2009 CTS Transportation Research Conference May 19–20. The annual event was held this year at the Bloomington Sheraton Hotel; in 2010, the conference will return to RiverCentre in St. Paul.

A breakout session on traffic management theory was moderated by former ITS Laboratory manager Lowell Benson. Presentations at the session were:

- “Improving Transportation Network Link Flow Estimates Using a Heuristic Gaussian Process Method” (Hui Xiong, civil engineering)
- “Development of the Next Generation Stratified Ramp Metering Algorithm for Minnesota Freeways Based on Density” (Nikolas Geroliminis, civil engineering)
- “Smart Signal Theory” (Henry Liu, civil engineering)

Three breakout sessions were devoted to research connected to the Minnesota Urban Partnership Agreement, a cooperative effort of the U.S. Department of Transportation and Minnesota stakeholders including Mn/DOT and the ITS Institute to reduce congestion along Twin Cities commute corridors. ITS-related presentations included:

- “Bus Rapid Transit Technologies for Cedar Avenue and I-35W” (Craig Shankwitz, Intelligent Vehicles Laboratory)
- “Telecommuting and the UPA” (Adeel Lari, Humphrey Institute of Public Affairs)

A session on vehicle detection and measurement systems, moderated by Minnesota Traffic Observatory director John Hourdos, included presentations on:

- “Wireless Mesh Sensor Network for Vehicle Tracking in an Intersection” (Taek Kwon, electrical and computer engineering, Duluth)
- “Portable, Low Cost Intersection Traffic Measurement and Surveillance Station” (Ted Morris, Minnesota Traffic Observatory)

For news coverage of CTS Transportation Research Conferences and more information, visit the conference Web site at www.cts.umn.edu/events/researchconf/.

Campus visit introduces high school students to robotics

On May 15, Institute director Max Donath (center) provided a multicultural group of students from Patrick Henry High School in Minneapolis with a University-level class experience—an introduction to robotics. The visit, arranged by the University’s Office of Admissions, was meant to introduce the students to the University of Minnesota as well as encourage them to attend once they graduate.
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...in which individual vehicles are modeled as independent entities that operate according to a set of internal rules. In this type of simulation, traffic characteristics such as speed and demand are implemented as probabilities; thus, microsimulations yield accurate pictures of traffic patterns by aggregating the results of multiple model runs. The Denali model is unusual in that traffic densities are extremely low compared to the urban street networks often studied using microsimulation, and because it deals with traffic disruption due to wildlife sightings. The Denali model includes components for road geometry, vehicle operation, and wildlife encounters.

The road geometry model, based on Geographic Information Systems (GIS) data, incorporates designated stopping points as well as scenic rest stop and viewing areas. The model includes special rules for passing on narrow road sections and near mountain passes, where safe inter-vehicle distances must be maintained.

The vehicle operation model, based on Global Positioning System (GPS) data from Denali tour buses, includes behavioral attributes that specify how vehicles pass each other, as well as the way buses keep apart to avoid driving through road dust that obscures the passengers’ view.

In order to collect data on wildlife encounters, researchers installed touch-screen input devices in buses so drivers could easily log the reasons for stopping, including the type of wildlife they were stopping to view. These reports were combined with GPS data, enabling the researchers to analyze how various types of wildlife sightings in different locations affected the buses.

GPS collars fitted on bears and Dall sheep by wildlife biologists were another source of data for the model. The model tracked the vehicle-free gaps when animals could cross the park road without encountering motor vehicle traffic.

GPS data revealed that when multiple buses stop to view wildlife, the later buses tend to remain stopped for longer periods of time. This “bunching” behavior was built into the model. Private vehicles in the model behave differently at wildlife encounters, passing around stopped buses and other vehicles after a short viewing session when traffic conditions permit.

Experiments

The Denali model has been used to study the impacts of different road use scenarios proposed by the park managers, comprising increases in bus service of between 10 and 50 percent daily. The model was able to show how different traffic levels would affect the visitor experience by placing more vehicles in the field of view from many locations and by altering the way vehicles “bunch” at scenic stops and wildlife sightings. In addition, the model revealed how increased traffic would affect wildlife by changing the gaps available for crossing the park road.

Within the model, wildlife encounters were created by mapping georeferenced encounters logged by drivers in time and space for a sample of peak season days. The encounters in the simulation essentially generate traffic incidents that trigger vehicle stops; the durations of the stops differ depending on whether the vehicle is a bus or a private vehicle.

Initial results from the simulation suggest that the system will reach a breaking point near the 50 percent traffic increase level, according to Morris. For example, wildlife crowding levels that were determined by the University of Vermont social science team to approach unacceptable levels increased by nearly 70 percent along the more frequented routes in scenarios based on traffic increases of 40 to 50 percent, compared to relative increases of 10 to 20 percent for the other service increase scenarios. Gap crossing opportunities for sheep also fell sharply for one of the critical crossing locations.

Further scenario case studies are being examined to understand the sensitivity of these findings to scheduling demands and wildlife encounters along the road. The research team is currently determining if the model is capable of finding schedules with increases in service that still preserve the social and biological capacity indicators predicted by the simulation at base level conditions. The park also plans on conducting a Before-After-Controlled-Impact study (BACI) utilizing an alternative service level that is guided by the simulation results. Similar data will be collected during this study period, allowing the MTO researchers to validate the simulation model as well as to assess the ability of the park to monitor impact indicators of crowding and wildlife. Park management will then have a rational basis to determine proper usage levels as well as more proactively manage visitor use impacts that result from using the buses.

In the future, researchers hope the findings of this study can help protect and preserve not only Denali, but other parks as well—while keeping them accessible to visitors. The traffic simulation from the Denali Park study could be used as a framework for a tool to help any park facing crowding and capacity issues assess the potential impacts of visit limits.

Morris says their research may shape how the park is used for decades to come. “It is so important that wilderness areas are preserved,” says Morris. “On one hand, in Alaska, 13 percent of the entire economy is tied to Denali Park, yet at the same time Denali is one of the few true wilderness areas left for future generations to experience.”

Wildlife and humans frequently cross paths in Denali. Traffic management aims to balance the demands of tourism and the needs of healthy wild animal populations.
New online game explores world of traffic management

A new traffic control game developed by the ITS Institute and Web Courseworks lets high school students try their hand at working in the engineering and transportation field.

“Gridlock Buster” is a traffic control game that incorporates tools and ideas that traffic control engineers use in their everyday work. Players must pass a series of levels while acquiring specific skills for controlling the traffic and ensuring that delays don’t get out of hand. For example, a player might need to manage a high volume of traffic passing through an intersection, where long lines form if vehicles don’t get enough green-light time. The more drivers are delayed, the more frustrated they get—causing the game’s “frustration meter” to rise. Sound effects and animation simulate cars honking and drivers’ fists shaking to illustrate the realistic results of backed-up traffic queues.

The game is based on work by Chen-Fu Liao, the ITS Institute’s education systems engineer. The goal is to provide a fun way to engage students in the traffic engineering field, teach what is involved in traffic grid management, and make transportation interesting and relevant.

UPCOMING EVENTS

For more information, visit www.its.umn.edu/events

Fall 2009 Advanced Transportation Technologies Seminar Series

Biweekly presentations cover research projects from the ITS Institute’s core science and technology areas—human factors, intelligent vehicles, traffic modeling and management, sensing, communications, and controls. Streaming video available on the ITS Web site.

October 8 Steve Shladover, Research Engineer, California Partners for Advanced Transit and Highways (PATH)

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