1996

Intellimotion

Keeping up with California PATH Research in Intelligent Transportation Systems

In this issue

5.1

Computer Simulation Issue

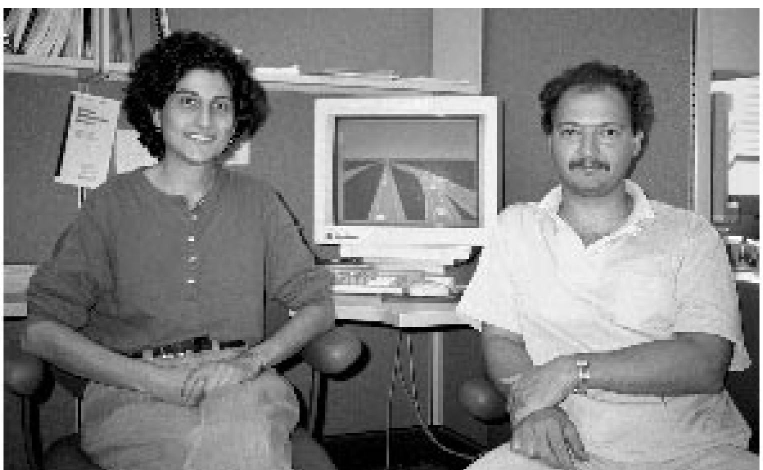
SmartPath Simulation

Delnaz Khorramabadi and Farokh Eskafi
PATH

Building an Automated Highway System (AHS) is a huge task. It involves designing intelligent vehicles and intelligent highways to achieve the desired performance and safety levels. Each proposal for the structure and elements of an AHS must answer the following questions: Is it feasible? Is it safe? Would it perform as claimed? How would the public react to such a system? What is the difference between this proposal and others with respect to some measure of performance?

To test and evaluate such proposals, and to compare them with each other, we can either build the actual elements and test them on vehicles and on the highway, or build a model of the elements and simulate the design.

The first option is obviously expensive and due to limited resources like the length of the test highway and number of equipped vehicles, very few AHS scenarios could be tested in this manner. The second option is much less costly and can be used to model different strategies and configurations; therefore, it has a much wider application domain. But one has to be careful in interpreting the simulation results. A simulation environment simulates what is modeled: if the model is far from reality, then the simulation will not represent reality. Also, due to the discrete nature of any simulation, one can only approximate the continuous elements of the systems.



PATH Researchers Delnaz Khorramabadi and Farokh Eskafi with SmartPath (on monitor)

The SmartPath project was begun in Spring 1991 to address questions of feasibility, safety, and performance. SmartPath provides an environment for testing various controller designs, evaluating their performance, and observing the interaction between the vehicle controllers and the highway. SmartPath output is a comprehensive state description of each vehicle on the highway throughout the simulation.

SmartPath is also a visual simulation package. It provides a graphical interface for viewing the simulated data (vehicles and highway) in a natural way. This interface can ultimately be used to respond to the question of public reactions toward a given scenario or AHS architecture. We are now in the process of releasing the third version of SmartPath. SmartPath3.0 contains three modular applications to facilitate

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PATH—Partners for Advanced Transit and Highways—a joint venture of Caltrans and the University of California, the University of Southern California, California Polytechnic University, and the Claremont Graduate School, and private industry to increase highway capacity and to decrease traffic congestion, air pollution, accident rates, and fuel consumption.

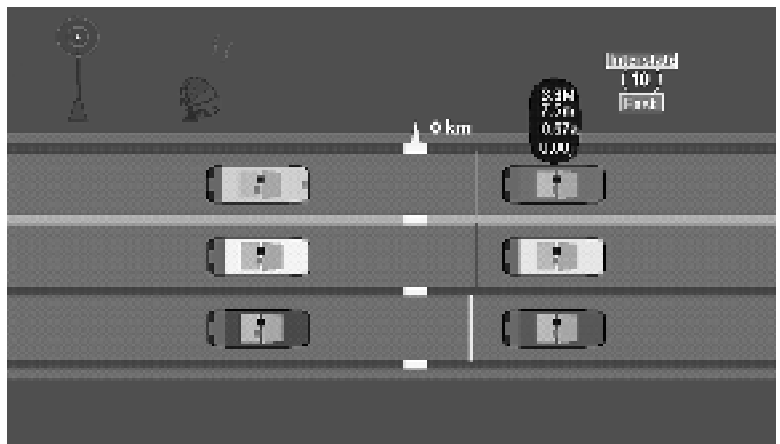
DYNAVIS:
A Dynamic Visualization Environment for Automatic Vehicle Control Systems

Tom Xu
EE-Systems
University of Southern California

When we do simulations or experiments, we need to analyze large amounts of data. Although plotting the data into curves is useful, if there are many plots and the ratio of observation duration to the sampling period is high, the plots may sometimes become messy. Also, the plots are static and there is no explicit connection between them. The dynamic visualization project, launched by PATH in 1991, is developing a more efficient method of analyzing data. The project's objective is to develop software that can animate automated highways, visualize the dynamics of automatic vehicles, and help design and evaluate automatic vehicle systems.

The main idea of dynamic visualization is to take advantage of human spatial intuition. If a picture is worth a thousand words, a moving picture is worth ten thousand. When we see curves on paper, we may not fully understand whether or not the system behavior is good. Moreover, some system characteristics may not be visible by looking at the plots. But when we see a moving picture, we can easily recognize the system performance, based on our intuition. Transforming numeric data into animation enables us to examine large amounts of data with better comprehension and efficiency than any number of plots can provide. This can be very helpful for control design and evaluation.

DYNAVIS goes far beyond simple animation systems by providing a set of tools to perform interactive visualization with on-line modification of many visualization parameters (such as time and space resolution), and to perform on-line simulation. The capabilities of this program greatly facilitate detecting undesirable phenomena in automatic vehicle following (platooning), designing and evaluating vehicle control systems, and comparing the performance of different control strategies.



DYNAVIS– position, velocity, acceleration, and jerk are displayed both numerically (above vehicle) and pictorially. Vertical line indicates desired position.

Two versions of DYNAVIS have so far been developed. Both help users in two main areas. The first is animation and data analysis. The software offers a scene of a three-lane freeway, and can animate three parallel platoons of vehicles. The parallel environments provide a convenient way of comparing the performance of different control systems.

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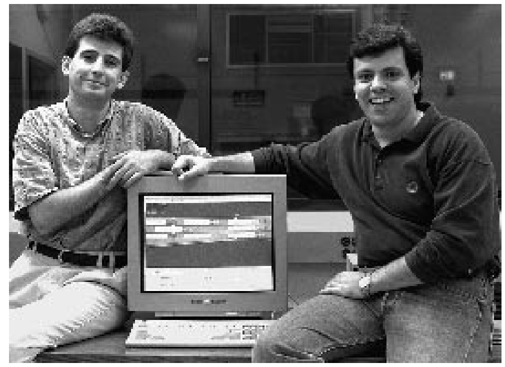
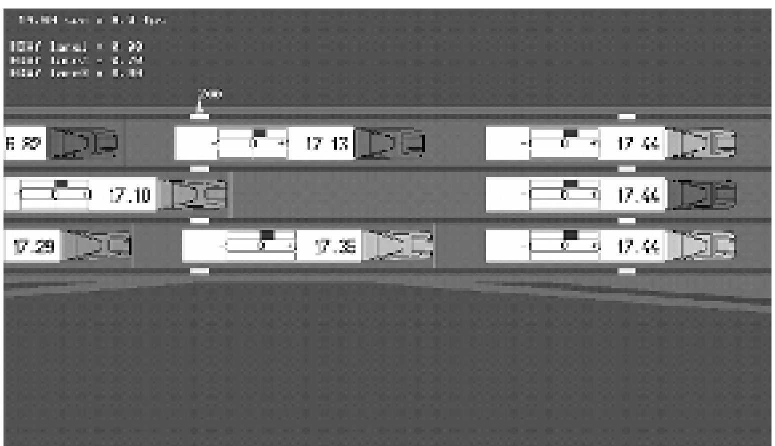
TruckVis:
Truck Visualization



Ogie Yanakiev
Ioannis Kanellakopoulos
Electrical Engineering
UCLA

While SmartPath and DYNAVIS visualize automated passenger vehicles, TruckVis provides visualization of automated heavy-duty vehicles. This software package is being developed by the research group of Professor Ioannis Kanellakopoulos in the Electrical Engineering Department at UCLA. TruckVis is part of PATH's research in automation of commercial vehicles, carried out in a coordinated effort by two research teams led by Professor Masayoshi Tomizuka at the Department of Mechanical Engineering at UC Berkeley and by Professor Kanellakopoulos at UCLA.



TruckVis—on-vehicle readings display speed (in digits), acceleration, and jerk (dynamically changing horizontal bars) on truck trailer tops.

TruckVis, which deals only with the longitudinal motion of heavy-duty trucks, is based on DYNAVIS, and is being developed in several stages. Version 1.0, completed in April 1995, has much of the look and feel of DYNAVIS. It retains many of DYNAVIS's sliders for zooming, time, marker distance, and position error magnification. As the figure below shows, the setting is a three-lane highway, which allows for the comparison of up to three different longitudinal control algorithms at a time. The user can choose between several available algorithms and can select whether one, two, or three algorithms are visualized simultaneously. The visualization data are generated off-line by our Matlab-based simulation models. They consist of the time vector and the position, velocity, acceleration, and jerk vectors for each truck. Because in subsequent versions of TruckVis the trucks will occupy a much bigger portion of the visualization window, the DYNAVIS dials depicting velocity, acceleration and jerk for each vehicle were replaced with on-vehicle readings, displayed on the white surface of the trailer of each truck. The speed is displayed in digits, while acceleration and jerk are displayed by two dynamically changing horizontal bars whose length and direction represent the magnitude and sign of the corresponding quantity. The bars are also color-coded for magnitude and sign. The acceleration bar is colored purple for values between O and 1 m/sec^2, and orange for values between O and –1 m/sec^2. The corresponding colors of the jerk (bottom) bar are blue (O to 1 m/sec^3) and yellow

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PATH Research Presented

Below is a list of some of the conferences or workshops where PATH sponsored research was or will be presented.

International Symposium on the Latest Developments in Transport Economics and Their Policy Implications

Seoul, Korea, July 1995

- Kenneth Small presented "A Discrete Choice Simulation Model of Urban Highway Congestion Incorporating Travel Reliability" The paper was co-authored by Robert Noland, Pia Maria, Koskenoja and Xuehao Chu. The conference was jointly sponsored by the Korea Transport Institute and the Korean Air Transport Research Institute.

The 2nd World Congress on Intelligent Transport Systems '95

Yokohama, Japan, November 9-11, 1995

- Ryuichi Kitamura presented "Transit Pre-trip Information Systems: An Experimental Analysis of Information Acquisition and its Impacts on Mode Use."
- Ching-Yao Chan presented "Integration of Sensor Technologies for Intelligent Occupant Restraint Systems in Automobiles."
- Steven Shladover presented "Recent Steps Forward in PATH Research on Advanced Vehicle Control Systems (AVCS)."
- Wei-Bin Zhang presented "Safety and Efficiency of Automated Highway Systems: A Tradeoff Study."

65th Annual Meeting of the Institute of Transportation Engineers

Denver, Colorado, August 1995

- Peter Martin presented "Real Time Area Wide Link Flow Inference From Link Detection." His co-author was Joseph Perrin.

International Joint Conference on Artificial Intelligence

Montreal, Canada

- Jeff Forbes and Tim Huang presented "The BATmobile project: Towards a Bayesian Automated Taxi." The IJCAI conference is the premier conference on artificial intelligence, is held every two years, and is attended by about 2500 people.

SAE Future Transportation Technology Conference and Exposition

Costa Mesa, California, August 8, 1995

- Seibum B. Choi presented "Throttle and Brake Combined Control for Intelligent Vehicle Highway Systems." His co-author was Peter Devlin. Paper No. 951897.

34th IEEE Conference on Decision and Control

New Orleans, Louisiana, December 13-15, 1995

- Diana Yanakiev and Ioannis Kanellakopoulos presented a PATH-sponsored paper entitled "Variable Time Headway for String Stability of Automated Heavy-Duty Vehicles."

IEEE Vehicular Technology Conference

Hyatt Regency O'Hare, Chicago, IL, July 26-28, 1995

- Manjari Asawa presented "Throughput analysis of Cellular Digital Packet Data with Applications to Intelligent Transportation Systems." Her co-author was Wayne E. Stark.

SPIE Conference

Philadelphia, Pennsylvania, October 22-26, 1995

- James Bret Michael and Andy Segal presented "Testing and Validation of Sensors for Lateral Control of Vehicles."

Booz Allan Hamilton Workshop for Field Operational Test Evaluators

Washington, DC, Sept 27, 1995

- Art MacCarley of Cal Poly San Luis Obispo attended, with R. Jayakrishna from UCI. The conference brought together representatives of all ATMS, FOT partners and evaluation teams. Booz Allan Hamilton described an evaluation framework and objectives. Jim Parel of the city of Anaheim and John Thai of the city of Irvine also attended, as the respective project directors of the Anaheim and Irvine FOT's.

IEEE 1995 Intelligent Vehicle Symposium

Ypsilanti, Michigan, September 25-26, 1995

- Ching-Yao Chan presented "Sensing Problems in Automotive Occupant Restraint Systems."

Hybrid Systems Workshop

Cornell University, October 1994

- Akash Deshpande presented "Viable Control of Hybrid Systems."

Second European Workshop on Hybrid Systems

Institut National Polytechnique de Grenoble, June 1995

- Akash Deshpande presented "Design and Evaluation Tools for Automated Highway Systems."

American Control Conference

Seattle, Washington, June 21-24, 1995

- Akash Deshpande presented "Information Structures for the Control and Verification of Hybrid Systems."

Conference on Decision and Control 1995

December 1995

- Datta Godbole, John Lygeros, E. Singh, Akash Deshpande and E. Lindsey presented "Design and Verification of Communication Protocols for Degraded Modes of Operation of AHS."

DIMACS 1995

Rutgers University, October 1995

- J. Haddon, D. Godbole, A. Deshpande and J. Lygeros presented "Verification of Hybrid Systems: Monotonicity in the AHS Control System."
- A. Deshpande, D. Godbole, A. Gollu, P. Varaiya presented "Design and Evaluation Tools for Automated Highway Systems."

Asilomar Conference on Signals, Systems, and Computers

Monterey, California, Oct 29 - Nov 1, 1995

- Reynold Wang and Jean Paul Linnartz presented "Design of a Frequency Hopping Spread Spectrum Communication System for an Automated Highway System."

ASCE 1995 Annual Convention and Exposition: Transportation Congress and Construction Congress

San Diego, California, October 22-26, 1995

- Matthew J. Barth presented "The Development of an Integrated Transportation/Emissions Model for Estimating Emission Inventories."
- Mohamed A. Abdel-Aty presented "Impact of ATIS on Route Choice."
- Raghavan Srinivasan presented "Advanced Traveler Information Systems: Opportunities and Risks."
- Stephen G. Ritchie presented "Advanced Neural Network Architectures for Freeway Incident Detection."

California Alliance for Advanced Transportation Systems

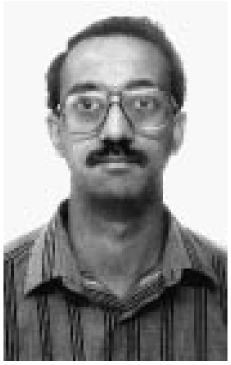
Newport Beach, California, November 1995

- Steve Shladover presented "Advanced Vehicle Control on I-15."

IFAC 1996

San Francisco, California, June 1996

- A. Deshpande and A. Gollu will present "Object Management Systems." OMS Technologies White Paper.




Low-Cost Driving Simulation for ITS In-Vehicle Testing

Raghavan Srinivasan and Paul Jovanis
Institute of Transportation Studies
Department of Civil and Environmental Engineering, UC Davis

Many ITS systems and services require the implementation of displays or controls in the vehicle. These displays and controls, activated by devices called driver vehicle interfaces (DVI), could distract the driver's attention from the road. Driving simulators have been used to test such devices, since testing on actual roads to assess the degree of distraction could pose unacceptable risks to test drivers. UC Davis researchers, in cooperation with industrial collaborators at Hughes Aircraft Company, have used high-fidelity driving simulators to examine driver distraction associated with in-vehicle route guidance and navigation displays. These tests yielded useful results, but were limited both by the need to build physical interfaces for testing in the simulator, and by the relatively high cost of operating the simulator itself.

One way around these limitations is to conduct simulation in a "low-fidelity" environment that sacrifices apparent realism for the ability to test and evaluate more devices less expensively. Simulators of this sort are frequently called part-task simulators, because they challenge the subject with only a portion of the actual driving task. The lowered cognitive and decision-making load of the partial task is compensated for by including a secondary task, such as adding sets of numbers or responding to a visual signal with a keyboard, keypad, or mouse. Hughes Aircraft engineers have developed such a low-cost driving simulator for use in a PATH project on the study of driver distraction associated with in-vehicle route guidance devices. This article describes the simulator and two applications, one for route guidance and a second for collision warning.

A Silicon Graphics Indigo2-Extreme computer system was used in conjunction with Designer's Workbench software from Corypheaus, Inc. to develop the driving simulator. The SGI system's 19-inch monitor was used to display a dashboard and driving scene. The dashboard included a speedometer and a rectangular area (2.4" X 3.8") allocated for displaying the route guidance systems. In tests of route guidance devices using the simulator, subjects performed a primary task, using the mouse to continuously track a black cross-hair randomly moving left or right in the driving scene, and another task, in which they pressed one of the three mouse buttons to record their decision to turn left, go straight, or turn right at intersections in response to the information provided by the system. Data were collected on tracking error, the number of times subjects pressed the wrong mouse button (navigation error), and reaction time to the pressing of the mouse buttons.

Three categories of route guidance systems were tested: electronic route maps, turn-by-turn displays, and audio messages. Electronic maps displayed part of the network along with the route to be followed in a different color. The position of the driver in the roadway network was shown by an icon. Two types of electronic maps were tested.

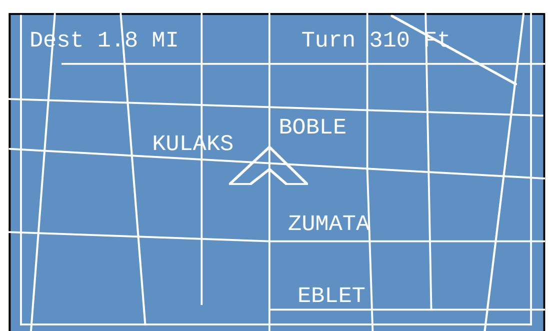


Figure 1. Type 1 electronic map shows names of street traveled as well as all cross streets.

The type 1 map (Figure 1) contained names for only the street currently traveled and all cross streets; the type 2 map contained the names of all streets. Both the maps provided information on distance to the turn and distance to the destination. Turn-by-turn displays provided information specifically for each turn instead of displaying a network. Four types of turn-by-turn display were tested, varying in message content and format. All showed distance to the destination and distance to the turn in a text format. The type 1 turn-by-turn display (Figure 2) contained turn street name, turn direction (in the form of an arrow), intersection geometry symbology, and count-down bars to indicate distance to the turn graphically. The type 2 turn-by-turn display (Figure 3) was all text. The

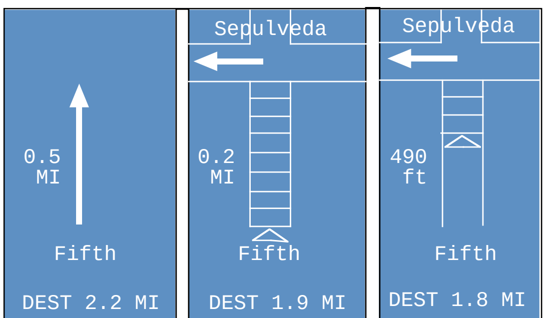


Figure 2. Type 1 turn-by turn display shows street name, direction, intersection geometry, and distance.

type 3 turn-by-turn display did not provide street names, but did provide the count of intersections to the next turn. Type 4 was similar to type 1, but without the count-down bars, and without turn intersection geometry.

Audio messages provided information on the distance to the turn, direction of turn, and turn street name. There were very few navigation errors when using the audio systems, which remain one of the most preferred and effective route guidance methods. The type 1 electronic map (with fewer street names) had lower tracking error than the type 2 electronic map. It was clear that for typical route following, the simplified map (with only nearby streets labeled) offered adequate navigation capability and less distraction from the driving task. Subjects identified the more complex map as more useful for route replanning.

Figure 3. Type 2 turn-by turn display, which is all text, performed worst.

Of the four turn-by-turn displays that were tested, the most effective display was the one that used countdown bars to indicate distance to the turn and provided turn intersection geometry (type 1 display). This display had the lowest tracking error, fewest navigation errors, lowest reaction time, and was most preferred. The type 4 display (similar to type 1 but without countdown bars) was second best. The text-based display (type 2) and the display without street names (type 3) performed worst. The text display system had the highest tracking error, indicating that it was the most distracting. The type 3 display had the highest reaction times (to the pressing of the mouse buttons), and the highest number of navigation errors. Based on these results and the information obtained during exit interviews, it can be concluded that text-based displays (of the type tested in the experiments) and displays without street names are not recommended for route-following.

Another set of ITS devices with potentially direct safety benefits are systems that warn drivers of impending collisions. Such systems will include a radar or some other set of sensors along with software to process the sensor signals and determine which objects represent potential threats. Once the assessment is made, there must a mechanism to clearly and unambiguously notify the driver of the potential crash. As part of a larger project sponsored by the National Highway Traffic Safety Administration, UC Davis researchers are using low-cost simulators to display a variety of collision warning alerts including visual (both text and icons), auditory (speech, simple tone, and complex sounds called “earcons”) and combinations of visual and auditory. These tests will be

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SmartPath Simulation

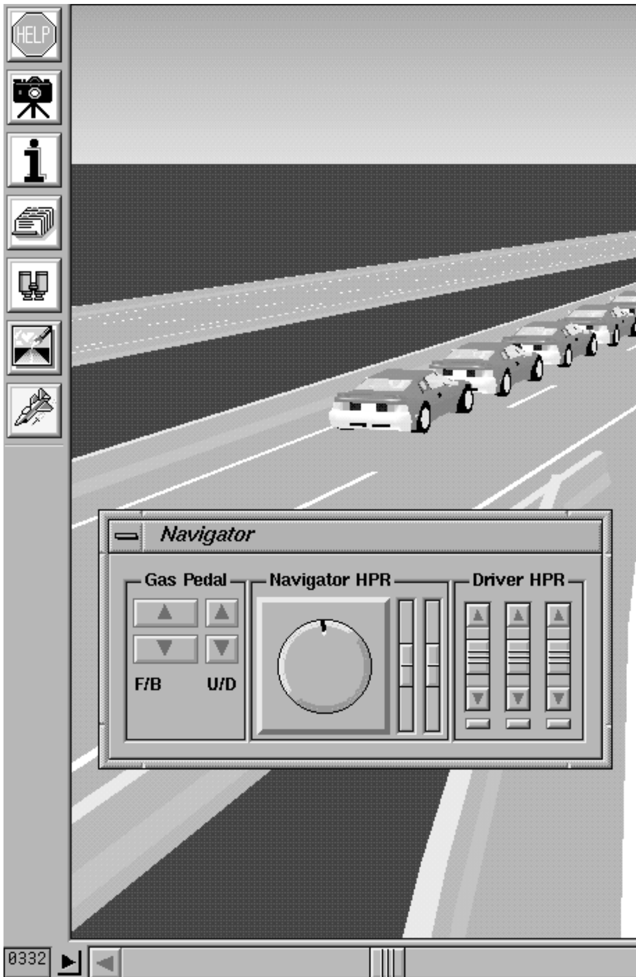
continued from page 1

modification and enhancement of the package: the simulator, highway designer, and animator. SmartPath modules are loosely coupled, and the coupling is well-defined. The Shladover-Varaiya proposed AHS hierarchy is fully implemented within SmartPath3.0.

The SmartPath simulator provides two sets of constructs: primary and secondary. The primary constructs provide the most basic functionalities within SmartPath. They are the core and the backbone of SmartPath, and could not be altered without extensive modification and reprogramming. At the center of the primary constructs is a scheduler that synchronously schedules the AHS control layers, i.e., network, link, coordination, and regulation layers. The scheduler provides wake-up calls for the layers at every simulation sample time. Within each layer there should be a routine waiting for the respective layer's wake-up calls. The representation of the highway structure (sections, lanes, and geometric segments) and the implementation of basic sensors for detection of vehicles are among the primary constructs of SmartPath. We also provide an event-delivery system among layers, which enables us to send commands from one layer to another.

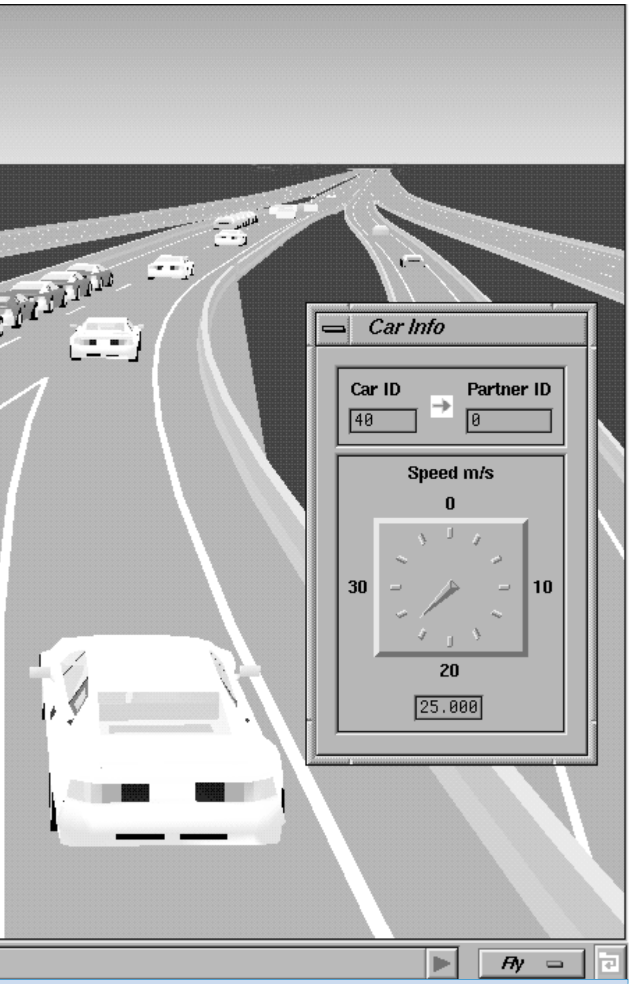
With these primary constructs it is possible to model different AHS strategies, insofar as the interactions between different layers are modeled after existing SmartPath layers. For example, one can test the design of an autonomous vehicle in SmartPath by implementing the decision-making algorithms in the coordination layer, and the execution of the decisions in the regulation layer. The SmartPath scheduler, highway, sensors, and event delivery system are not dependent on specific controllers. In fact, we used the above technique to create a new autonomous vehicle by replacing SmartPath's coordination layer controllers with a rule-based algorithm (developed in CMU) for decision-making.

The secondary constructs that SmartPath provides are communication facilities between the highway and vehicles, vehicle-to-vehicle message transmission, realistic sensors on the vehicle and roadside, and protocols and controllers for three maneuvers: merge, lane change, and split. These secondary constructs make SmartPath a full simulation package



SmartPath—the user can drive a selected vehicle using a co

for the Shladover-Varaiya AHS design, however, they could be easily modified or replaced to simulate other designs. SmartPath3.0 is capable of simulating mixed traffic, i.e., vehicles with different control algorithms interacting with each other. Also, every vehicle within SmartPath can operate in multiple modes (automated, manual, rule-based, etc.), which allows us to observe the behavior of the vehicle and surrounding vehicles when such a mode transition happens. For example, we have used the animator to choose a vehicle and send the "change mode to Manual" command to it. The picked vehicle then can be manually driven by the user. With this simulation, we could generate some scenarios and anomalies (such as a rapidly decelerating or a stopped vehicle) and observe how the automated traffic will respond to them. The work now being done on the SmartPath simulator is the modeling and implementation of different Entry/Exit configurations and the required infrastructure: stop-signs, check-in and check-out stations, barriers, etc. SmartPath3.0 is accompanied by a new animator program. The animator runs on Silicon Graphics machines and is now an IRIS Performer based program. The program provides the user with a view of the highway and the simulated vehicles. The user navigates through the scene using the mouse or a control panel. Vehicles can be selected and followed, and communication messages between the vehicles, and their speed and acceleration, can be observed during the simulation. The interactive mode of the animator allows the animation and simulation programs to run simultaneously and to communicate with each other. In this mode, the user can drive a selected vehicle using a control panel and obtain instant feedback from the simulator.



ntrol panel and obtain instant feedback from the simulator

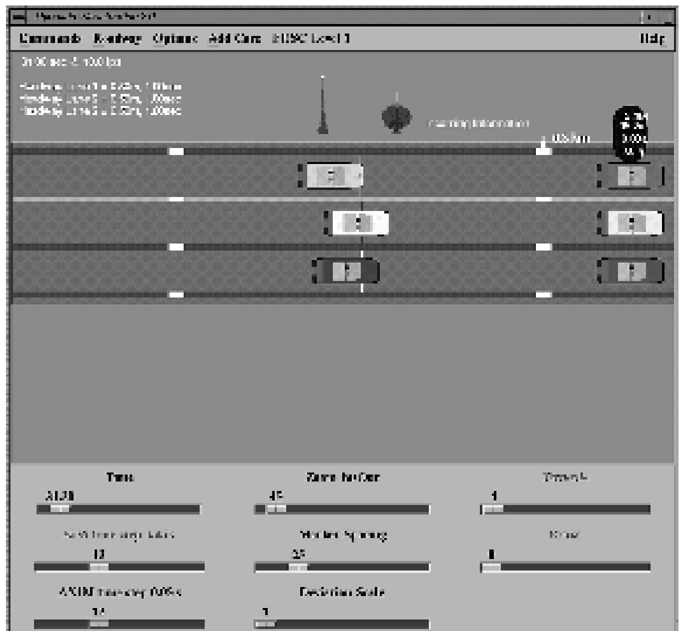
We are also in the process of adding a graphical highway designer to SmartPath. Currently, a highway is constructed by dividing it into segments and defining each segment characteristics in an ASCII file. The new designer would facilitate this process by providing a visual tool to select various geometric segments, connect the segments, and modify their characteristics interactively.

For a demonstration of SmartPath sample animations, click on SmartPath: Simulation and Visualization on the PATH World Wide Web home page at http://www-path.eecs.berkeley.edu.

DYNAVIS

continued from page 2

Each platoon can have up to 10 vehicles. Users can input the data, which may be from off-line simulation or from experiment, to DYNAVIS to animate the simulation and experiment. During the animation, users can visualize each vehicle's longitudinal position, velocity, acceleration, and jerk simultaneously. The positions of all vehicles are displayed graphically on a simulated section of freeway, with accurate scaling relative to the freeway lanes and vehicle size. The velocity of the vehicles can be identified by their motion relative to road markers, and by the speedometers. The acceleration and jerk are visualized both by meters and by the head reaction of driver and passenger. There is a vertical line for each vehicle to indicate the vehicle's desired position. By looking at the difference between a vehicle's actual position and desired position, users can easily evaluate the performance of the system. Users can control the animation in many ways. They can choose the number of platoons, and the number of vehicles in each platoon. They can start, stop, go back, and replay at any point of interest. They can adjust animation speed over a wide range, on-line. They can also zoom in or zoom out to focus on a section of a platoon, or to get an overall 'helicopter' view. DYNAVIS animation enables the users to analyze and evaluate the performance of their systems more efficiently.



DYNAVIS–users control the animation and simulation with pull-down menus and slider bars.

The second area is simulation. Simulation and animation are conducted at the same time. The data generated from simulation is animated and evaluated immediately. Users can interactively control the simulation in much the same way they control the animation. They can apply throttle angle or brake to change a vehicle's speed, or turn a steering wheel to change a vehicle's lateral position. They can choose different makes and models of car to form a platoon, and can add or remove a vehicle from a platoon. They can change the roadway commands for headway and speed, and can change such freeway configurations as on-ramp, off-ramp, and slope. They can also change automation levels, from a single designated auto lane with vehicles using only intelligent cruise control to multiple auto lanes with fully automatically controlled vehicles. To aid in simulation, the software offers a simple but realistic vehicle dynamic model and a simple vehicle controller, which are written in a separate sub-program. The users can substitute these with their own models and controllers.

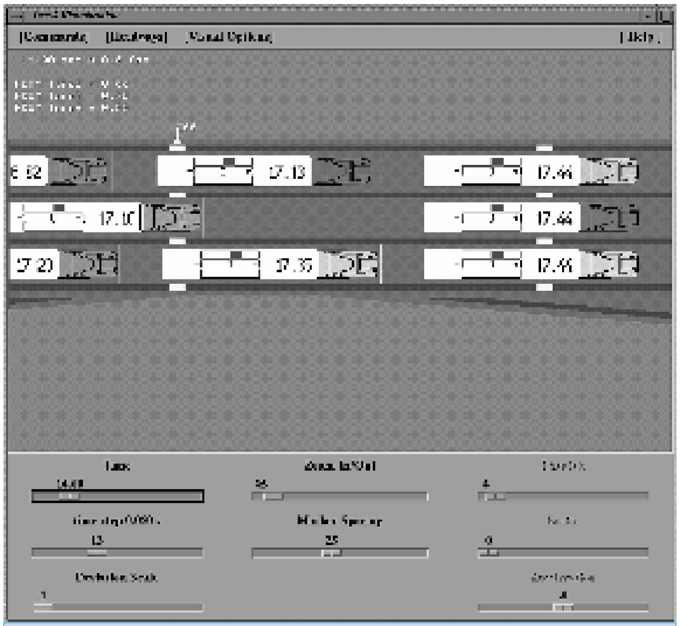
In summary, DYNAVIS is a integration of simulation and animation. Users can conduct animation and simulation interactively, and hence increase efficiency in data analysis and controller design and evaluation. It is anticipated that DYNAVIS will be a valuable tool to designers of automatic vehicle following and platooning systems.

TruckVis

continued from page 3

(O to –l m/sec^3). When the acceleration or jerk exceeds the limits of ±1, the respective bar continues to grow in length, but becomes red to indicate operation outside the usual region.

Version 2.0 of TruckVis, now nearing completion, will visualize the full lateral and longitudinal motion of trucks around a closed track. It will have two graphics windows: the Overview Window, a small window in which the whole track is shown with the trucks depicted as small color-coded dots, and the Main Window, which will be very similar to the current main window of TruckVis 1.0. When the user clicks on one of the truck-dots in the Overview Window, the Main Window will zoom in on that truck, so that the user can watch the detailed motion of that truck and any neighboring ones. This way the user will be able to instantly switch from one group of trucks to another in the Main Window, in order to watch the ones that are traversing the most interesting parts of the track. The closed track was designed with the help of Professor Tomizuka and his Ph.D. student Chieh Chen, who suggested a track shape representative of the turns found on most highways.



TruckVis shares DYNAVIS's sliders for zooming, time, marker distance, and position error.

One of the major challenges in the development of TruckVis was the decision to switch from the IRIS GL graphics library, on which DYNAVIS was created, to the OpenGL library. The reason is that IRIS GL is proprietary to Silicon Graphics workstations, while OpenGL is now supported by a number of other vendors including Sun, Hewlett-Packard, IBM, and DEC. To this end, the original DYNAVIS code had to be ported to OpenGL. The latter is a vendor-neutral application program interface (API) providing 2D and 3D graphics functions. OpenGL and IRIS GL differ in several major areas. The most important advantage of OpenGL is its window-system and operating-system independence: it contains no windowing, pop-up menus, event handling, font file formats or cursor handling. The responsibility for this is transferred to the window or the operating system. IRIS GL provides calls for handling fonts and text strings. Although OpenGL can render text, it does not provide a file format for fonts. In addition it has a utility library that contains routines for rendering quadratic surfaces and non-uniform B-splines (NURBS). Also, OpenGL is network transparent. A defined common extension to the X Window system allows an OpenGL client on one platform to run an application across a network off another platform's OpenGL server.

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Note to libraries and indexers: beginning with this issue, Intellimotion is switching from an academic to a calendar year. This (IM 5.1) is the first issue of 1996: IM 4.4 was the last issue of 1995.

Hamed Benouar

Pete Hansra

Caltrans Liaison Personnel Changes

Hamed Benouar, Caltrans' Resident Manager for the PATH Program, is now Caltrans' new Advanced Highway Systems Office Chief, as well as a new member of the National Automated Highway Systems Consortium Program Managers' Council. Hamed remains as PATH's Caltrans Liaison and the Caltrans interim project manager for the National Intelligent Transportation Systems Architecture Development Program. He was previously Chief of the Caltrans Office of Advanced Communication and Electronic Systems, and also served as Chief of the Caltrans Division of Rail.

Pete Hansra currently assists Hamed in leading the PATH/Advanced Vehicle Control and Safety Systems branch in Caltrans' Division of New Technology and Research. Pete's responsibilities include contract monitoring and resolving all issues concerning PATH. Pete has 13 years of public and private sector experience in the electrical/electronics/transportation field, and has worked with software and hardware in design, construction, operations, and research. He is assisted by Ray Patron and Bill Okwu.

Ford Donates New WindStar Van

Ford Motor Company has donated a new 1995 WindStar minivan to PATH for use in aerodynamic testing. This donation was made possible through the efforts of Mr. Gene Farber and Bob Mazzola of Ford. Ford also previously provided the set of Lincoln Town Cars that form the mainstay of PATH's test fleet. The vehicle's first assignment will be full-scale aerodynamic testing, performed by a team lead by Prof. Fred Browand of USC with funding from PATH. This pioneering work will use four completely functional vehicles to evaluate the drag benefits of closely spaced platoons.

PATH Director Pravin Varaiya hands over the keys to PATH's new Ford WindStar. L to R: USC grad student Patrick Hong, Prof. Browand, Prof. Varaiya, PATH Program Director Steve Shladover.

PATH Visitors

Among many guests from other research organizations, governments, and private corportations during the fall were the following:

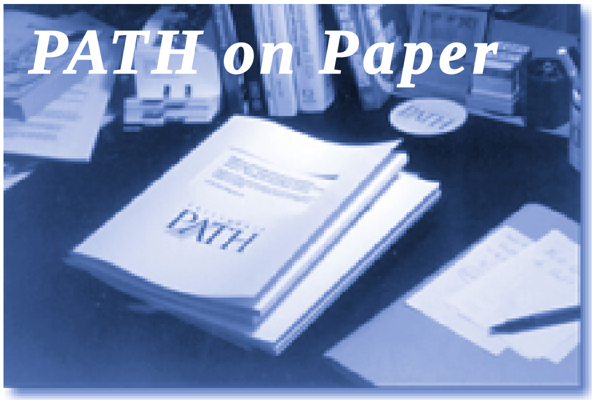
September 13
Yoshitaka Ishizuka, Manager, Marketing Development Headquarters, Nihon Keizai Shimbun, Inc. Yoshikazu Noguchi, International Fellow, ITS America

September 25
Alan Arai, Senior Engineer, Power Systems Group, IMRA America, Inc.
Masaaki Suzuki, Senior Manager, IMRA America
Takaaki Nakazawa, Technical Associate Director, General Manager of Technical Planning Office, Aisin Seiki Co.
Naoji Sakakibara, Product General Manager, Strategic Product Planning Group, Aisin Seiki Co.

September 28
28-member delegation from Vereinigung der Strassenverkehrsämter/Association of Road Traffic Offices (Switzerland), headed by President Viktor Erni and Vice-President François Beljean, is addressed by PATH Program Director Stein Weissenberger

October 20
Ted Buttner, President Coastcom Corporation
Adib Kanafani, UCB ITS Director
P. Diane Frank, General Manager Coastcom

September 22
PATH Researchers Han-shue Tan and Satyajit Patwardhan assist UCB Professor Masayoshi Tomizuka in hosting guests from Nissan Motor Co. (Japan): Hiroshi Ueno, Principal Staff Engineer, Vehicle and Human Factors Research, Nissan Research & Development, Inc. (USA), Eiichi Yaguchi, General Manager, Vehicle Research Laboratory, Nissan Research Center, Masugi Kaminaga, Engineer, Product Development Dept., Dr. Yasuhiko Nakagawa, General Manager, Research Planning and Promoting Department, Nissan Research Center



Below is an update on some recent PATH publications.
A price list that includes research reports, working papers, technical memoranda, and technical notes can be obtained from the: Institute of Transportation Studies Publications Office
University of California
109 McLaughlin Hall, Berkeley, CA 94720
510-642-3558, FAX: 510-642-1246.

Abstracts for all PATH research publications can be obtained via the PATH World Wide Web home page on the internet:
http://www-path.eecs.berkeley.edu

PATH Research Papers

UCB-ITS-PRR-95-22	Longitudinal Control – Phase 1, Kwang Soo Chang, August 1995, $15.
UCB-ITS-PRR-95-26	Fault Detection and Identification with Application to Advanced Vehicle Control Systems, Randal K. Douglas, Jason L. Speyer, D. Lewis Mingori, Robert H. Chen, Durga P. Malladi, Walter H. Chung, August 1995, $15.
UCB-ITS-PRR-95-27	Longitudinal State Estimation for a Four-Vehicle Platoon, A.W. Merz, August 1995, $15.
UCB-ITS-PRR-95-28	Macroscopic Roadway Traffic Controller Design, C.C. Chien, Y. Zhang, A. Stotsky, S.R. Dharmasena, P. Ioannou, August 1995, $10
UCB-ITS-PRR-95-29	Turning Movement Estimation in Real Time (TMERT), Peter T. Martin, September 1995, $25.
UCB-ITS-PRR-95-30	Traffic Control for Automated Highway Systems: A Conceptual Framework, J.-S. Jacob Tsao, September 1995, $10.
UCB-ITS-PRR-95-31	A Staggered-Diamond Design for Automated/Manual-HOV Highway-to-Highway Interchange, H.-S. Jacob Tsao, September 1995, $5.
UCB-ITS-PRR-95-32	Adaptive Vehicle Traction Control, Hyeongcheol Lee, Masayoshi Tomizuka, September 1995, $15.
UCB-ITS-PRR-95-33	An Integrated Physical/Link-Access Layer Model of Packet Radio Architectures, Andreas Polydoros, September 1995, $20.
UCB-ITS-PRR-95-34	A Machine Vision Based System for guiding lane-change maneuvers. Final Report, Jitendra Malik, Dieter Koller, Tuan Luong, October 1995, $10.
UCB-ITS-PRR-95-35	The Aerodynamic Performance of Platoons: Final Report, Michael Zabat, Nick Stabile, Stefano Frascaroli, Frederick Browand, October 1995, $25.
UCB-ITS-PRR-95-36	Socio-economic Attributes and Impacts of Travel Reliability: A Stated Preference Approach, Kenneth A. Small, Robert B. Noland, Pia Koskenoja, November 1995.
UCB-ITS-PRR-95-37	Modeling and Control Design for a Computer Controlled Brake System, H. Rasa, Z. Xu, P. Ioannou, B. Yang, November 1995.
UCB-ITS-PRR-95-38	Investigating Intelligent Transportation Systems Strategies on the Santa Monica Freeway Corridor, Vinton W. Bacon Jr., John R. Windover, Adolf D. May, November 1995.
UCB-ITS-PRR-95-39	Investigating Intelligent Transportation Systems Strategies on the Santa Monica Freeway Corridor: Technical Appendix, Vinton W. Bacon Jr., John R. Windover, Adolf D. May, November 1995.
UCB-ITS-PRR-95-40	Intelligent Sensor Validation and Sensor Fusion for Reliability and Safety Enhancement in Vehicle Control, Alice Agogino, Kai Goebel, Satnam Alag, November 1995.

PATH Working Papers

UCB-ITS-PWP-95-11	Vehicle as Probes, Kumud K. Sanwal, Jean Walrand, August 1995, $10.
UCB-ITS-PWP-95-12	Analysis, Design, and Evaluation of AVCS for Heavy-Duty Vehicles: Phase 1 Report, Diana Yanakiev, Ioannis Kanellakopoulos, August 1995, $10.
UCB-ITS-PWP-95-13	Fuzzy Logic Control for Lane Change Maneuvers in Lateral Vehicle Guidance, Thomas Hessburg, Masayoshi Tomizuka, October 1995, $5.
UCB-ITS-PWP-95-14	TravInfo Field Operational Test Traveler Information Center (TIC) Study (Technology Evaluation Element) Implementation Plan, Mark A. Miller, Randolph Hall, November 1995.
UCB-ITS-PWP-95-15	Organizing for ITS: Computer Integrated Transportation Phase 2: Results for Commercial Vehicle Operators, Randolph Hall, Indrajit Chatterjee, November 1995.

PATH Technical Notes

Tech Note 95-06	Engine and Transmission Modeling for Heavy-Duty Vehicles, Diana Yanakiev, Ioannis Kanellakopoulos, August 1995, $15.
Tech Note 95-07	An AVHS Link Layer Controller for Traffic Flow Stabilization, Perry Li, Roberto Horowitz, Luis Alvarez, Jonathan Frankel, Anne M. Robertson, November 1995.

PATH Seminars

These interdisciplinary seminars are usually held every Wednesday at noon in 3110 Etcheverry Hall on the UC Berkeley campus. For an invitation, please contact Mireille Broucke, *mire@moonlight.eecs.berkeley.edu*.

PATH seminar annoucements are available on the PATH World Wide Web home page, which can be accessed by entering the URL *http://www-path.eecs. berkeley.edu*. For more information on a particular seminar, please contact the authors at their respective departments.

August 18
Motorcycle Rider Model by Uses of Neural Network System
Prof. Kageyama, Nihon University, Japan

September 15
Decision Aids for R&D Proposal Evaluation
Alan Sicherman, Lawrence Livermore National Laboratory
Dr. Sicherman described a decision aid paradigm that has been developed and used successfully in a variety of government agency and national laboratory contexts to streamline, make more defensible, and document the complex R&D funding decision process. The paradigm can be applied incrementally in a modular fashion, and includes components for rank ordering individual proposals and selecting a portfolio of proposals.

September 22
An Inventory of Information Systems/Technologies of California
Transit Agencies
Mark Hickman, PATH

September 29
Decision Support Systems for Managing and Applying ITS Research
Joy Dahlgren, PATH

October 24
VITA II - The Daimler-Benz Demonstrator for Autonomous Driving in the European PROMETHEUS Program
Axel Fuchs, Daimler-Benz Research and Technology North America, Inc.
The latest research results on vision-based autonomous driving in the European Prometheus program. Functionalities such as obstacle detection, lane following, and traffic sign recognition, as well as the interaction of functions, behaviour control, safety issues, and system architecture were discussed.

Nov. 17
PREATRP–Procedure for Review and Evaluation of Advanced Transportation Research Proposals
Mohamed Al-Kadri, Caltrans
PREATRP has been designed to help Caltrans review ATS and ITS proposals from PATH and other sources. The proposal evaluation process is improved greatly by using this procedure, which asks critical questions and scores answers according to well-established evaluation criteria. The criteria are based on the New Technology and Research Program mission, philosophy, stated goals, and research priorities.

Low-Cost Simulation

continued from page 7

used to screen alerts, identifying the most promising candidates for testing in a high fidelity simulator and, eventually, for the best devices, in the field.

Driving simulators, both high and low fidelity, are important tools to conduct assessments of ITS devices without endangering the safety of test subjects. Even as ITS moves towards the deployment of some systems, the increasing capability of table-top computing is likely to make low cost simulation both more powerful and affordable for the wide range of technologies that are still in development.

Coming Soon...

- ***A special issue featuring sensor work at PATH***
- ***Conference Updates***
- ***New Publications***

. . . and more!

TruckVis

continued from p 11

Silicon Graphics provides a small, auxiliary library that can be used to replace simple windowing, event handling, and color map loading calls but cannot handle more sophisticated tasks necessary for visualization. Thus, a mixed X/OpenGL strategy was adopted, in which OpenGL is used for rendering and X is used for windowing, event handling, fonts, etc. Since IRIS GL is neither binary nor source compatible with OpenGL, the above conversion was nontrivial. For example, since OpenGL has no file format for fonts, each digit of the velocity displays on the truck trailers is rendered separately using polygons, in addition to the fifteen to twenty polygons used to render each of the trucks.

Intellimotion

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