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Project Milestone:

PATH’s CADIS Project Enters Another Phase

Through the California PATH Program, UC Davis researchers are in partnership with Hughes Aircraft Corporation and Caltrans on the CADIS (California Advanced Driver Information Systems) project, to develop guidelines for providing reliable in-vehicle information to drivers. Dr. Paul P. Jovanis and Dr. Ryuichi Kitamura from the Department of Civil and Environmental Engineering, UC Davis, have been working since 1991 in collaboration with Ms. Cheryl Hein, head of the Culver City based Hughes driving simulator facility.

Using Hughes’s driving simulator as a testing tool, PATH researchers tested driver interfaces in a simulated highway environment. Hughes’s driving simulator uses computer generated images, such as roadway segments, traffic control devices, and roadway traffic projected on the screen. The simulator synchronizes the driving subject’s car movements with the traffic scene on the screen. Using the Hughes driving simulator, the ultimate goal of the CADIS activities was to ensure that route guidance information can be provided to drivers with high reliability and safety.

The research project’s primary objective was to study how in-vehicle route guidance system attributes, driver characteristics, and traffic conditions affect driving performance.

continued on page 3
Quo Vadis IVHS?

—A Word from Director Donald E. Ome

One could ask “Can IVHS even be successfully deployed?” Many already asked and more are doing so every day. The nay-sayers range from timid IVHS technologists to outright antagonists.

I would like to suggest the construction of an IVHS Program Development Cycle as a means to provide insight on IVHS deployment prospects. Crystal ball gazing may be entertaining but is never certain. However, indicators exist and extrapolations are possible that offer useful clues and reasonable forecasts about the future of IVHS.

The first example to suggest a rationale is a seeming contradiction that one should look back to see forward. That is, most proponents who attempt to forecast are nervous about overpromising and often scale back already conservative estimates. But the past can be instructive.

The early days of IVHS, just five or six years ago, produced “wild” statements that the 50 largest U.S. cities would be instrumented in a decade. And there was genuine skepticism that consumer markets could be found or that political will was possible. People who prepared the early deployment estimates agonized whether these should be made public in the 1990 Mobility 2000 Dallas Conference documents.

Looking back, almost all estimates have been exceeded and progress is escalating. Field operational tests are proliferating, formal funding is astounding in volume, work in the field number in the thousands, and hundreds of technical papers have been published. Products have been designed and are in the laboratories. Some already have moved to sales forces. Market position jockeying is rampant. The change in aerospace and defense industries coupled with national economic decline and worsening travel conditions have been fortuitous as a stimulus for IVHS work. The message is that so much has occurred in such a short time that the future will probably bring even more dramatic change.

Another way to look at forecasting is a generalized construct of product and system life cycles. This can be portrayed as follows:

![Diagram](image)

The time from 0 to A is one of uncertainty. If the right forces do not coalesce, nothing will happen. But, if they do a chain of events is launched. Time A-B is one of consolidation, research, development, testing and gaining customer support. B-C is the onset of deployment and a flourishing activity on all fronts. C-D signals beginnings of a diminishing market and D-E brings near saturation asymptotic to the upper barrier of available market. Many negative forces can cause the cycle to abort almost any time. Positive forces, such as invention, greater public support, or accelerated deployment can shorten the cycle or cause a break through the upper barrier to start a new cycle.

It is heartening to realize that so many hundreds of dedicated people are changing the dream to reality and that progress is so rapid. We appear to be racing up the cycle curve’s steep slopes with little difficulty and are moving toward full deployment.

There are, of course, scattered storm clouds, but most people in the business choose to see the sunshine instead, and this is as it should be.

UC Davis Researchers Prepare Second Phase of Driver Interface Study

The first phase was a two-year study in which four specific user interface designs ("map guidance devices") were tested. The experiment focused on measuring the extent to which drivers are distracted from following a predetermined route to the given destination by the need to monitor route guidance advice. Specifically, these user interfaces were tested:

- A paper map, 11"x17", of a much higher quality than what is commercially available. The intended route is highlighted.
- An electronic map, 6" color LCD, identical in design to the paper map, located in the center console, to the right of the speedometer.
- Voice communication, advising on turns, in combination with the electronic map.
- Heads up display (HUD), a visual cue (using arrows) that is displayed on the car's windshield when the driving subject is supposed to make a turn, used in combination with the electronic map.

Research Experiment

Dr. Jovanis and Dr. Kitamura collaborated at Hughes to develop an experimental design that allowed each of the test drivers to drive with each of the four user interfaces on different types of roadways. In particular, the HUD and the electronic map were used in combination, which no one had looked at before for route guidance purposes.

Each subject spent between three-and-a-half and four hours in the driving simulator. In total, 18 subjects (9 male, 9 female) were tested over a two month period. After finishing each experiment, the subjects filled out an evaluation, a workload form, and a measurement scale describing the driver's perception of the devices. After the end of the four hours of driving simulation, the drivers took part in an exit interview.

The events in the driving simulator's visual scene required the driver to respond appropriately in order to prevent getting into an accident. The driving simulation, for example, had vehicles turning in front of the subject's car, pedestrians crossing in front of the car, traffic signals changing from green to amber to red, and traffic crossing from a stop sign on a cross street in front of the subject's car. In each instance, the researchers measured the driver's performance in reaction times, workload ratings (using the NASA Task Load Index), percentage of dwell time on the road (using an eye tracker) and the number of navigation errors. The reaction time findings showed that the paper map overwhelmingly came out worst. The researchers also allowed drivers to tell them which devices they liked best. These results showed that the voice tended to be the most liked, the electronic map second, and the heads up display third. In all the performance tests, the electronic devices were on the whole much safer than using a paper map. Dr. Jovanis says, "A well designed electronic device, along the lines of any of the three we tested, would appear to be an excellent candidate for on-the-road testing."

Along with testing the user interfaces, the research team at Hughes Aircraft developed various urban driving scenarios. The mix of scenes and the elaborate details of the scenes were unique. They represented a real experimental opportunity for researchers to test in-vehicle devices of all kinds. Currently, the researchers have 14 driving scenarios that are approximately 15-20 minutes long. All of these are different and all of these have a mixture of two-lane local streets (30 mph speed limit), four lane arterial streets (40 mph),
Engineering Update

DYNAVIS: A Dynamic Visualization Environment for AVCS Design and Evaluation

Some exciting research has been underway at the University of Southern California that may some day lead to the development of the transportation technologies of the next century. One of the tools that will help enormously in this effort is a dynamic visualization system. Since September 1991, USC researchers have been developing a unique computer program called DYNAVIS that performs complete visualization of highway traffic and compares different vehicle control models.

By transforming the numeric data into an animation, a large amount of data can be examined with better comprehension and efficiency.

What is DYNAVIS?

DYNAVIS is an interactive engineering computer program developed specifically to facilitate the design and evaluation of automatic longitudinal and lateral vehicle control. DYNAVIS provides a set of tools to interactively modify visualization parameters such as time and space resolution. DYNAVIS enhances capabilities to detect undesirable phenomena in automatic vehicle following. It also helps in designing and evaluating vehicle control systems, and comparing controlled system performances. DYNAVIS should be a valuable tool to designers of automatic vehicle following systems. It has already been used to analyze traffic data from simulations and from experiments, and to evaluate and compare vehicle control laws.

How DYNAVIS Works

When researchers run simulations or conduct experiments, they need an efficient method to analyze the output data. For example, consider the simulated or experimental data for a platoon of four vehicles over a period of five minutes. To study the characteristics of this system, the position, velocity, and possibly acceleration and jerk of each vehicle versus time, 16 plots overall, are needed. It is difficult and time consuming to understand the nature of the dynamics and to detect the undesirable system behavior. Therefore, a more efficient and visual method is needed to analyze the data.

The DYNAVIS Computer Simulation

Dynamic visualization is such a method.

The main idea of dynamic visualization is to take advantage of human spatial intuition. By transforming the numeric data into an animation, researchers can examine a large amount of data with better comprehension and efficiency. This can be very helpful in control design and evaluation. Dynamic visualization is used for the evaluation of system performance under worst case scenarios.

In order to have a good visualization of the dynamics mentioned above, an effective user interface is very important. It is a major component of DYNAVIS. It is also a main reason why the dynamic visualization system is much more advanced than a conventional animation system.

Simulation Capabilities

DYNAVIS was developed to aid in the design and evaluation of longitudinal and lateral vehicle control systems. The current version of the program has the following capabilities:

Visualize the dynamics of two or three platoons with up to ten vehicles in each platoon.

The setup of platoons on parallel lanes provides a convenient way of comparing the performance of two different control laws. For example, researchers can easily compare the performance of an automatically controlled vehicle platoon to a platoon driven by human drivers. It also provides a visual way of comparing the performance of two implementations of the same control law with different controller parameters. DYNAVIS can easily be reconfigured to visualize one platoon or two or three platoons with up to ten vehicles in each platoon.

Visualize individual vehicle position, velocity, acceleration, and jerk simultaneously.

Vehicle positions are displayed graphically on a simulated section of freeway, with accurate scaling of the relative positions. The velocity of the vehicles can be identified by the relative velocity of road markers. Acceleration and jerk can also be visualized by looking at the heads of the driver and passenger in each car through the glass sunroof of the car. The driver holds the steering wheel, so his head is in straight during constant acceleration, but it moves if it is subjected to jerk. The researchers assumed that the passenger cannot anticipate any changes in vehicle

PATH Database Partners with IVHS America

This March the PATH Database joined IVHS America as its newest Clearinghouse file. This fully abstracted and indexed database contains more than 4,200 records created by the Library of the Institute of Transportation Studies (ITS) at the University of California, Berkeley. The ITS Library is the oldest and one of the largest academic transportation libraries in North America. Internationally in scope, it contains more than 150,000 volumes, 120,000 microfiches, and other major collections. IVHS America "Reach" software provides convenient access to the PATH Database with a single search key. The IVHS "Theorist", developed by Symen Petries, PATH Database manager, and Michael Kleiber, ITS head librarian, is mounted as a special file on the Clearinghouse and is designed to assist users in subject searching the database. It is also available in printed or diskette versions from ITS Publications.

The PATH Database was created in 1989 as a resource for the California PATH Program in partnership with the California Department of Transportation. Primarily based on the holdings of the ITS Library, the database covers not only all components of current U.S. IVHS initiatives, but also provides a strong historical perspective on the evolution of IVHS research and activity back to the 1950s.

There is extensive coverage of European and Japanese IVHS research and demonstrations with more than 350 abstracts alone relating to the European DRIVE and PROMETHEUS programs. Access is provided to several hundred foreign language publications with full English-language abstracts. A world-class collection, the ITS Library maintains cooperative exchange programs with hundreds of worldwide organizations. More than 120 abstracts are created monthly, including coverage of books, reports, periodicals, conference proceedings, dissertations, newspaper articles, and retrospective materials.

For more information about PATH Database services and products, document delivery, or modem Internet access to the ITS Library's on-line catalog of 126,000 records, contact:

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Simulating IVHS Strategies on the Smart Corridor

The development of ATIS and ATMS are likely to offer substantial opportunities for improving traffic efficiency and reducing congestion in urban areas. However, before any large scale deployment can take place, a number of issues must still be addressed, either through operational field tests or simulation studies. The purpose of this project is to investigate and quantify the likely benefits of real-time traffic signal optimization, freeway ramp metering control, HOV lanes, and route guidance systems, under both recurrent and incident-induced congestion. Traffic simulation and assignment models are particularly valuable for identifying key operational and performance issues and ATMS scenarios.

A team of UC Berkeley-PATH researchers is currently involved in a project directed to simulate the potential benefits of ATIS and ATMS on the real-life Smart Corridor in Los Angeles using the integration model. Integration is a traffic simulation model developed at Queen's University in Canada. It was originally developed to simulate networks combining signalized intersections and freeways under congested traffic conditions. Capabilities to deal with in-vehicle route guidance systems, real-time traffic signal control, and their interactions, have later been added, making integration a powerful and rather unique tool for network analysis in the IVHS context.

Preliminary Investigation

Prior to investigations on the Smart Corridor, Integration was applied to different traffic demand-supply network in order to test the validity of the models. Although Integration has recently been applied in a number of studies (Ontario, Michigan, and Oregon), the PATH project is one of the first applications that does not directly involve the model developers.

The abilities of Integration to simulate oversaturated conditions on freeways was considered a critical model requirement. A series of experiments was performed and the predictions of Integration were compared against analytical solutions and outputs of the FRQI freeway simulation system. The integration model proved to be reliable.

The second critical aspect of the model that was tested was the representation of Integration to representing different behaviors of vehicles with and without access to in-vehicle ATIS. Within the model, it is possible to specify traffic demand in terms of different driver/vehicle types that represent different levels of access to real-time traffic information. A number of model features involved in the representation of ATIS were successfully tested on a simple theoretical network.

The next step of the study was to apply Integration to the Smart Corridor. Due to time, resource, and data constraints only a subsection of the Smart Corridor was coded. The study area involves about nine miles of the Santa Monica Freeway (I-10) with associated ramps and two parallel arterials, Washington Boulevard and Adams Boulevard. Also included in the network are nine major streets connecting Washington, Adams, and the freeway. This network was simulated under typical incident-free morning peak conditions, providing a baseline for evaluating the performance of the system with various ATMS and ATIS strategies.

ATMS and ATIS Investigations

In addition to the base reference conditions (no ATIS, no ATMS), five different control strategies were modeled and tested under the same demand level and under recurring congestion only (incident-free):

1. Base conditions;
2. Ramp metering control;
3. Real-time traffic signal optimization;
4. Combined ramp metering and signal optimization;
5. Route guidance;
6. Combined ramp metering and signal optimization and route guidance.

In Scenario 2, time-of-day fixed-time ramp metering plans were determined for eastbound I-10 by first running the FRQI model. Ramp metering slightly decreased the overall trip time (-1.8%). In Scenario 3, cycle lengths and splits for each controlled intersection were optimized every 3 minutes. This strategy slightly decreased the overall trip time (-1.3%). Scenario 4 caused arterials to experience a significant increase in trip time (+11.3%) while the freeway trip time was reduced by 5.6%. This suggests that some traffic had been diverted from the freeway to the arterials.

In Scenario 5, the system performed better, as the overall trip time was decreased by 3.8%. However, the best overall system performance was experienced in Scenario 6, when combining ramp metering, signal optimization and route guidance. Significant trip time savings (6.1%) were obtained in this case.

Integration has proven to be a good tool to simulate freeway ramp metering, real-time traffic signal control, route guidance systems, and their interactions, in a freeway corridor environment under congested conditions. Although the results of this study were obtained for specific network demand and control patterns, findings should also be valid for general conditions. The availability of route guidance systems to drivers in a congested network was found to result in significant total trip time savings even under incident-free traffic conditions. Additional savings can be achieved when route guidance is used in combination with ramp metering and traffic signal optimization.

This research was performed by Professor Alfred F. Matt and Youssef Candes of the Institute of Transportation Studies, University of California, Berkeley. For more information about this project, please contact the researchers at:

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California PATH showcased its program at the IVHS America Third Annual Meeting, held in Washington, D.C., on April 14-17, 1993. PATH provided regular updates on research and development in various fields, and visitors an excellent opportunity to learn about the PATH program and its widely based IVHS research efforts. PATH exhibits attracted many visitors, and PATH researchers and staff participated in various aspects of the annual meeting, including a “PATH” AVCS Research session. PATH researcher Wai-Bin Zhang presented a paper on “Safety Implications for Human Back-up in AVCS.”

The PATH exhibit attracted many visitors to its computer demonstrations of the SmartPATH, DYNAVIS, and Integration simulation models (presented in order by Delnae Kheramian and Farokh Esfahani) from UC Berkeley. Petros A. Ioannou and Alex Kananiz from USC, and Youngho Lee from UCI. In addition, Dr. Husseyin Abut, San Diego State University, presented a video on image processing and data communications on I-15 HOV lanes and Wai-Bin Zhang presented a video on lateral control and longitudinal control. The exhibit included a display panel graphically depicting PATH’s university-public-private partnership through photographs and illustrations highlighting current PATH research on AVCS and ATM. PATH researchers Hong Kong Lo, Mark Miller, and Jacob Tsao were on hand to answer general and technical questions individually.

The inaugural issue of the IVHS Journal, Vol. 1, No. 1 (1993) was distributed at the meeting. The issue included “Automated Highway System Experiments in the PATH Program” (pp. 63-97) as one of the journal’s review papers.

Michael C. Kleiber, ITS head librarian (UC Berkeley), a consultant for IVHS America, demonstrated the use of the newly installed PATH database as part of the IVHS clearhouse database.

Conference Review

IVHS America Roundup

CADI$S$

Cont'd from page 2

and four lane-parkways (55 mph). These driving scenarios, according to the researchers, are more elaborate than any others in the U.S.

Research Conclusions

The project's principal conclusion was that any of the three electronic driver interfaces was much preferred to the paper map. The paper map resulted in a much higher number of errors. People missed turns much more frequently than with any of the three electronic devices. Second, workload ratings indicated that the paper map was the hardest to use. In general, the voice-electronic map combination was judged the best. Voice was most liked among participants. The HUD did not do as well as expected because of flaws in the user interface design, and as a result, was evaluated poorer in preference and for the workload necessary to use it effectively.

Future Plans

With Phase I completed, the researchers are able to devote a significantly greater portion of their resources in Phase II to testing a broader range of use interface device options, such as the readability of letter size, local visual preferences for user interface devices, and voice-driven interfaces. In particular, the researchers want to look more extensively at voice interfaces, including design issues, such as message content, length, and gender; urgency; tuning; mechanical voices versus high quality but

PATH Focuses on System Studies of Advanced Highway Automation

In the United States, only California PATH researchers are studying advanced highway automation from a systems approach. PATH researchers are focusing on research areas ranging from sensors, control, and simulation, to experimentation. The objective is to help alleviate California's traffic congestion and accidents.

Professor Pravin Varaiya from the Department of Electrical Engineering and Computer Sciences, UC Berkeley, is a key contributor to the research being conducted at PATH on the design and analysis of an automated highway system, which means a highway in which there is enough intelligence in the vehicles and on the road so that most of the driving decisions are computerized. Thus, computers would control the movement of vehicles so that they wouldn't get in each other's way. Additionally, roadside computers would coordinate the flow of traffic in sections of the highway by sensing congestion or incidents and then relaying that information to the vehicles' computers. Most of these traffic decisions would be highly automated, although the computer systems would provide ways in which the driver or passenger could manually intervene in automated vehicle movement decisions.

In an automated highway, vehicles have longitudinal and lateral control and may use platooning as a way to coordinate the movement of multiple vehicles. The roadside controllers, which look at the overall traffic flow in order to maintain a steady flow, should be placed about 1/2 mile or so apart on the roadside. These simple radio-like devices would obtain measurements from the roadside and could broadcast the number of vehicles, flow rates, average speed, etc. If an incident has occurred, then they could broadcast to the cars in the 1/2 mile road section, saying, e.g., “Conditions are bad. Slow down to 30 mph.” Or the left-and-lane ahead is blocked, so you should change lanes now.” The roadside controller is not yet available experimentally, but its control function is being studied through simulation.

In Varaiya's research, platooning is used as a way of coordinating the movement of neighboring vehicles so that theoretically, up to 15 vehicles might be extremely tightly spaced. The reason for this is to increase the capacity of a lane. Thus, 15 vehicles per hour, researchers believe an automated platooning scenario could get up to 6,000 vehicles per lane per hour, which is three times what is possible with manual driving. Platooning means that vehicles are tightly or loosely spaced is not important. The key idea is that the vehicle need to be able to coordinate by having information about vehicles that cannot be directly seen or sensed.

Using platooning and its associated movement maneuvers, i.e., merge, split, and change lane, Varaiya's current research focuses on building models and designing control procedures that the computer should allow in order that each car performs properly. Ultimately, these models and procedures would be coded that decide, based, based...
Engineering Update

**SmartPATH**

(continued from page 1)

on all the measurements, what vehicle actuator signal the computer should command, i.e., how much acceleration, braking, and steering is needed. The target is development of software for carrying out the desired control procedures.

After designing those procedures, analytical testing (e.g., statistical analysis) is conducted to see if the procedures will be efficient and safe. The second part of the testing uses computer simulation. Varaity and his students developed SmartPATH (see PATH Technical Memoandum 96-3), an automated highway system simulator, using many more vehicles than are currently experimentally available, each one of which is controlled in the simulation by the procedures that were designed. Then the simulation is run under varying conditions to see that the traffic is going smoothly, that there are no traffic accidents occurring, and so forth. The simulation results per vehicle on the road its position, speed, and acceleration every 1/10 second.

The actual experimental work involves four-vehicle platoon performance tests using specially equipped Lincoln Town Cars. The four cars have automated acceleration and braking (but manual steering). During a performance test last summer on the I-15/105 lanes north of San Diego, California, the in-vehicle computer was programmed and measurements were taken to see if what was predicted through analysis and through simulation actually checked out experimentally. Experiments were conducted on controlling the vehicles at constant longitudinal spacing. Performance results showed control of the vehicle distances within one to two meters, while the cars were moving between 55-75 mph, but because only four cars were used, there was a limit to how much testing could be done (see Infodiffusion, Vol. 2, No. 1, for a more technical explanation of the vehicle following experiment).

The third aspect of Professor Varaity's research is developing sensors and communication technologies for highway automation. Ultrasonic sensors are being evaluated to determine the distance to the vehicle in front. The ultrasonic sensor is based on technology developed by Polardoid for the automatic focusing of their cameras. The second sensor being developed is an infrared sensor also for distance measurement. The third sensor being developed is a microsensor for measuring acceleration. Currently, an infrared communication link between vehicles is being developed as an alternative to the radio for the communication links between vehicles.

Varaity's research rests on the hypothesis that increasing highway capacity and safety can be realized by replacing concrete with advanced highway automation. Smoother traffic rather than congested traffic is another advantage.

Environmentally, Caltrans calculates that currently in California congestion increases fuel consumption by 750 million gallons a year. If nothing is done soon, in 12 years that excess fuel consumption will increase to two billion gallons a year. The benefits of someday deploying an advanced highway system would be increased capacity, improved safety, less fuel consumption—nicer environment to live in!

This article was based on information provided by Professor Pravin Varaiya, United Aircraft, and Dibesh Khanna, Department of Electrical Engineering and Computer Sciences, UC Berkeley. For further information, please write to these researchers at:
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**DYNAVIS**

(continued from page 4)

DYNAVIS can display animation with apparent resolution of thousands of frames and with any chosen time step. It achieves this by employing linear interpolation to compute data for time instants that fall between existing frames. In this effect can reduce or increase the speed of animation since DYNAVIS displays animation at a fixed fast frame rate, regardless of the chosen simulation time step. This enhances the visualization of continuous motion as well as the apparent time resolution.

Change the scale by which any position deviations are magnified.

When the controller algorithm is nearly perfect, the position error may become very small. By magnifying any remaining errors the user can evaluate the performance of his design and iterate until he or she is fully satisfied.

Courblyeer's zoom factor and thus the range of the road and the section of the platoon that is displayed.

This allows the viewer to focus on a specific vehicle in the platoon instead of getting an overall bird's eye view. In the current version of DYNAVIS the researchers have the following choices: a vehicle is highlighted by frame advance is also available. The time step of the animation changes by adjusting a knob on a logarithmic scale.

The data set does not need to include data points for every frame that can be displayed. DYNAVIS can display animation with apparent resolution of thousands of frames and with any chosen time step. It achieves this by employing linear interpolation to compute data for time instants that fall between existing frames. This effect can reduce or increase the speed of animation since DYNAVIS displays animation at a fixed fast frame rate, regardless of the chosen simulation time step. This enhances the visualization of continuous motion as well as the apparent time resolution.

Change the scale by which any position deviations are magnified.

The effect of this article was provided by Professor Panos A. Iannucci, director of the Center for Advanced Transportation Technologies, Department of Electrical Engineering Systems, 1947. The research was conducted by Professor Zhiguo Xiao, in collaboration with Dr. John Huang, Dr. Petros Ioannou, Mehmet Meced, and Alex Kamari.

For more information about this project, please contact Professor Ioannou at:
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local motion

PATH welcomes three new additions to our staff in the last few months.

Helen E. Bey has accepted a permanent position in the PATH Administration Office after working for several months through the University Temporary Assistance Program, and will continue her work on coordinating quarterly reports and assisting in other areas of the PATH Office.

Hong Kam Lo came to PATH in February from the IVHS Project Office at Oak Ridge National Laboratory. He is working on projects related to Advanced Traveler Information Systems as an assistant research engineer. He received his Ph.D. in civil engineering and master’s degrees in civil engineering and city and regional planning from the Ohio State University.

Robert Tam joined the PATH Program in April as an associate development engineer. He is an assistant to Dr. Randolph Hall and a project manager in system engineering and ATMIS. Tam received his Masters degree in mechanical engineering from San Jose State University and comes to us from the NASA Ames Research Center.

Kwang Soo Chang has left the PATH Program for a faculty position at the Hong Ik University, in Seoul, Korea. Kwang Soo coordinated the experimental research on longitudinal vehicle control.

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