OHIO TRANSPORTATION CONSORTIUM

NEWS

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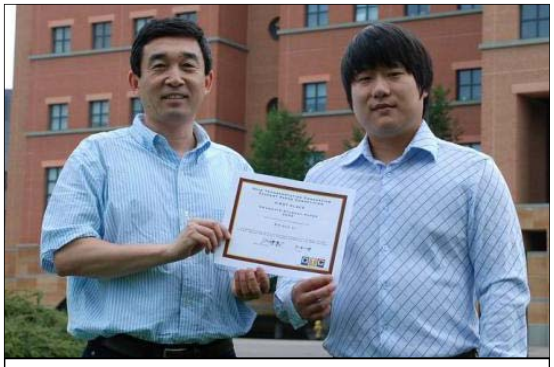
Student Paper Competition Winners



Zhixia Li (right) with advisor Dr. Heng Wei

Jingsi Lang (right) with advisor Dr. Bill Yu

Congratulations to Zhixia Li and Jingsi Lang, winners of the OTC Student Paper Competition. The first OTC-sponsored student paper competition was a success with several undergraduate and graduate students participating. While all of the papers were well researched and written, two papers, one graduate and one undergraduate, were chosen as winners.

Zhixia Li, a PhD student in Transportation Engineering in the Department of Civil and Environmental Engineering at the University of Cincinnati, won the graduate

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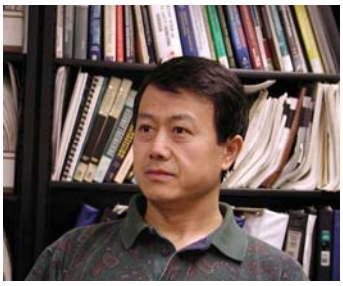
A Message from the Director



As witnessed and anticipated, transportation has entered and will continue to experience a long period of uncertainty because of the economic difficulties challenging the nation. Coupled with the decline of transportation revenue and competition from other sectors, transportation as an industry has to deal with an unprecedented pressure as to where and how to find and use the necessary funds in the transportation reauthorization in front of the increasing investment needs for the deteriorating system infrastructure. The theme of the OTC program, transportation mobility and infrastructure management, helps address transportation problems to promote the economic recovery at the grassroots level. The faculty and students in the OTC participating universities continue to engage in research and education activities to improve the performance of our transportation system and prepare the future workforce; our researchers continue to be featured in local, regional, and national and international level conferences and workshops. As the debate over transportation system financing continues, the OTC strives to provide leadership in understanding, addressing and meeting the local and regional transportation challenges.

Ping Yi

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Ohio Section ITE & Lake Erie Chapter Meeting

The OTC co-sponsored the April joint meeting of the Ohio Section ITE & Lake Erie Chapter at The University of Akron's Martin Center in April. Three graduate students were given the opportunity to present their research and receive feedback from the region's transportation professionals in attendance. Jason Segedy, Director of the Akron Metropolitan Area Transportation Study (AMATS) was the keynote speaker.

Venkata Suresh Raavi and Baoji Wang gave the first student presentation on the topic, "A Novel Approach to Dilemma Zone Problem for High Speed Signalized Intersections". As Raavi explained, safety and efficiency are both major concerns for high-speed intersections. It has been a challenge for Traffic Engineers, over the years, to increase safety without sacrificing efficiency. Intelligent Signal Control System (ISCS) was developed in The University of Akron's Transportation Lab based on the concept of IntelliDrive technology which can improve safety significantly while retaining efficiency. The new intelligent signal control system can address the dynamic dilemma zone problem, thus providing maximum safety at intersections. Every vehicle in the system is addressed to its own dilemma zone boundary rather than addressing a dilemma zone for the entire intersection approach.

Raavi and Wang then went on to explain how this approach works. By obtaining advanced speed information, vehicle classification, and vehicle location of every vehicle for every second in the system in real time, unnecessary extensions can be avoided. Thus, the intersection not only operates more safely, but also more efficiently because of the proposed algorithm logic that utilizes IntelliDrive technology. IntelliDrive test bed was created in VISSIM simulation platform and tested for operational efficiency when safety criteria are met. The ISCS was later compared and tested with the existing dilemma zone protection strategies such as Bierele configuration, SDITE configuration and the most famous Bonneson configuration and proved to significantly increase safety while retaining efficiency.

Chun Shao's student presentation, "On-line Application of Genetic Algorithm in Traffic Network Optimization" addressed the ever-increasing challenge of traffic congestion. As he indicated, traffic congestion due to increased travel demands is a common problem in urban areas across the United States. Among the many solutions to traffic congestion, operational treatment providing more efficient traffic operation is attractive due to its relatively low cost. Besides traditional operation

treatments such as actuated control and signal coordination, adaptive signal control strategies, such as SCATS, SCOOT, OPAC and RHODES have become increasingly popular since the 1980s. Recent improvements in computation power have enabled the application of advanced algorithms in on-line traffic signal control. As a result, GABNOR utilizing Genetic Algorithm is proposed for traffic network optimization in real-time. In GABNOR, the obstacles preventing the application of Genetic Algorithm in real-time have been addressed and possible solutions have been presented. Implemented as computer programs, GABNOR is compared with other control logics and shows competitive optimization ability. The results have been analyzed with statistic tools and the system sensitivity to detection errors and system parameters are also analyzed. Future works are introduced to further examine and improve the performance of GABNOR.

Jason Segedy concluded the evening with his presentation titled, "Regional Planning: Why Now? What's the Promise?" In his speech, he addressed current trends and challenges facing transportation professionals as well as necessary changes in the future. He stressed the need for good planning because, as fuel prices rise, the transit systems must be able to serve more people. Also, cooperative projects, where a variety of communities and organizations are involved, should be investigated.

"How do we serve sprawling and dispersed developments?" According to Mr. Segedy, this is a key question. Population changes including the decline of urban cores, shrinking household size, and suburban and rural growth complicate travel. Most families with children are living in the suburbs or in rural areas, and urban sprawl is spreading to larger lots and scattered developments. Valuable land resources are being consumed by these developments. These low-density developments are straining infrastructure and community services. At the same time, the economic downturn and volatile fuel prices are placing a strain on many families. Also, communities are grappling with higher project costs and lower revenues. However, the transportation infrastructure in Northeast Ohio must be addressed. The system is rapidly aging and maintenance must take priority over expansion. Safety is the first concern. Mr. Segedy stated, "We will focus on a fix it first solution." Existing problems will be addressed before any new ideas will be considered.

Keynote Speaker Jason Segedy (AMATS)

Land use continues to pose a challenge to transportation professionals as well. The region is riddled with poor land usage including low densities, separated uses, too much parking, and useless green space. During a recent AMATS survey, the relationship between pedestrian traffic and local businesses was investigated. The survey found that some retail areas have no sidewalks and people are forced to

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More Sound Method, More Promising Result: New progress reported on the loop data modeling project

By Heng Wei and Qingyi Ai, University of Cincinnati

To date, the research team for the project "Optimal Loop Placement and Models for Length-based Vehicle Classification and Stop-and-Go Traffic" has completed the tasks related to field investigations of the study sites and field data collection (including videotaping and loop data extraction). The data format treatments are nearing completion.

Vehicular trajectory data are highly valuable in a variety of studies of loop sensor data analysis and modeling. In order to extract vehicular trajectory data using the software VEVID, as proposed, reference points are required to be measured in field. The traditional way of setting up reference points is done through marking intervals along both sides of the roadway. While this method works well on local streets, it poses a safety concern on freeways. To eliminate this scenario, a new approach using Global Positioning System (GPS) has been developed and its accuracy has been tested by the University of Cincinnati research team.

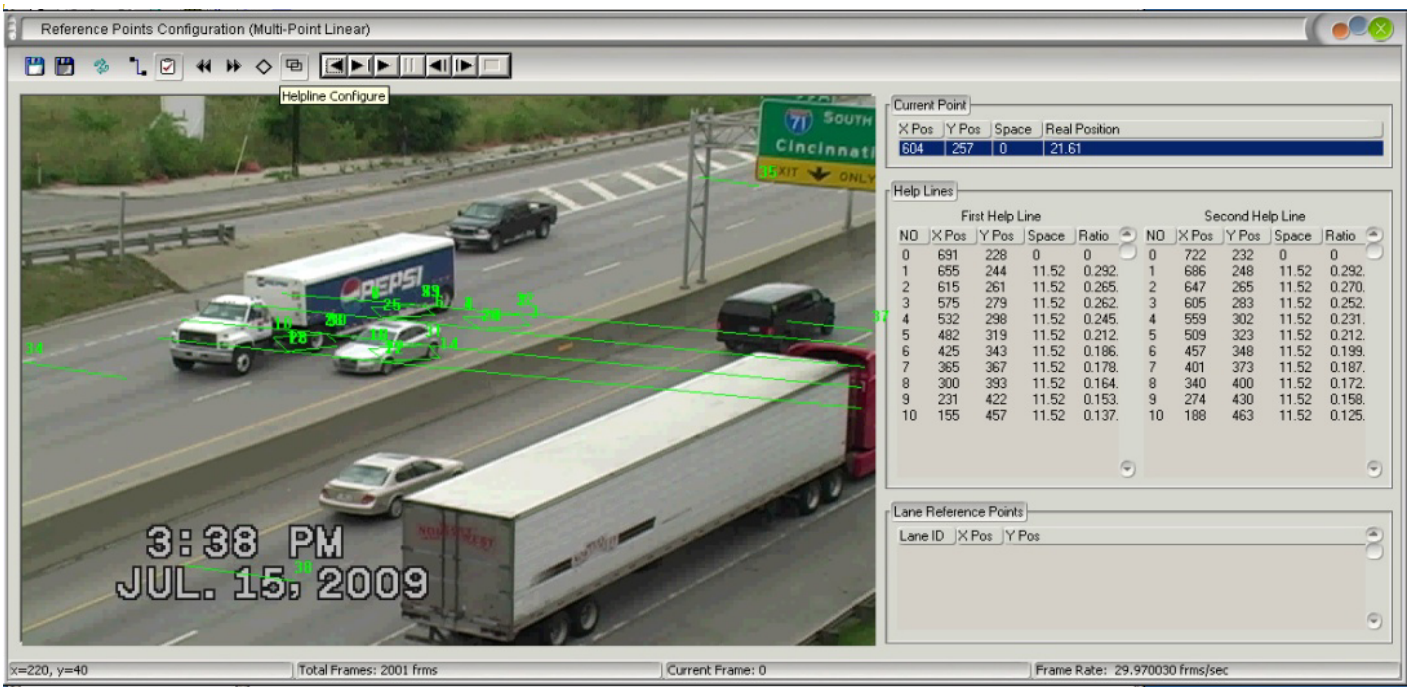
In this new approach, a GPS-equipped probe vehicle is used to replace the work previously done by field staff to mark reference points. The GPS-equipped probe vehicle, with the aid of cruise control, is used to measure the speed. Vehicle positioning from video frames using video-capture and linear perspective drawing techniques are used to determine the reference points using VEVID software. Speed probed by the testing vehicle is used to determine the reference spacing intervals, and then a real-distance coordinate system is formed in VEVID. Since **V**ideo-capture and **P**erspective drawing techniques, **C**ruise control function, and **G**PS-based **P**robe technology constitute such a **S**ystematic approach, this new approach is named as VPC-GPS approach.

The proposed VPC-GPS approach is capable of producing high accuracy reference points for VEVID. Its significant advancement and advantage over the existing methods lie in its elimination of staff physically working in the field so that any crew safety concerns no longer exist. The process of setting up the reference points is also simplified. Unlike other existing methods, the VPC-GPS approach is flexible and applicable to any type of roadways.

Another advantage is the success in identifying "noise" factors to the vehicle classifications that are caused by vehicle lane changing, or malfunction of loops, through comparing the loop data and concurring ground-truth video event data over the loops. **Figure 1** shows a snapshot of extracting vehicle trajectory data from a ground-truth video event file by using VEVID. A modified algorithm has been developed to remove such errors and the initial tests indicate pretty good match with the ground-truth data.

As part of the efforts in modeling traffic congestion patterns using loop data, the ground-

Figure 1



truth video trajectory data is used to study both mixed-vehicle-type time headway and vehicle-type-specific time headway under different traffic conditions, namely, uncongested traffic, congested traffic and all traffic conditions. The results obtained show that the type of lead vehicle and following vehicle will greatly affect the headway. Its result has been adopted to produce a paper manuscript, which will be submitted to a journal or conference in the near future.

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walk on curbs or along the edge of properties. This creates an inconvenience for the pedestrians as well as a safety issue. An improvement in land usage would not only improve pedestrian traffic, but it would also reduce trip length, conserve energy, improve aesthetic quality and promote transit. Mr. Segedy suggested a need to get public and government officials to discuss planning design systems to reduce congestion, improve safety and increase attraction when promoting public transportation.

There are many necessary changes that must be addressed. According to Mr. Segedy, good land use principles must be implemented including strengthening urban cores and retrofitting suburban communities. Transit and rail options must be provided. There must be more discussion regarding what kind of society in which the people of this area want to live. The funding structure should be assessed to consider funding on more of a state level. This may help coordinate efforts among counties as areas on the edge of counties sometimes get overlooked because their needs might be better severed by a bordering county. These, and more, are all issues that the four AMATS centers in Northeast Ohio are addressing to help improve the region.

Real Time Estimation of Turning Movements

By Ping Yi, University of Akron

INTRODUCTION

Turning movements information (TMI) is crucial for many applications such as real-time adaptive signal control and dynamic traffic assignment. However, because of the complexity of vehicular movements at an intersection, coupled with the local lane configuration and signal control strategies, turning movements data are collected manually today in most cases. This manual method is labor intensive, inconvenient, and costly. Existing efforts to improve the problem include solving the intersection based O-D matrix but the results are not reliable because many assumptions are not practical; others also tried to identify vehicle turning movements from detector information but were not able to separate vehicles from the shared lanes. Driven by the need to improve the efficiency and effectiveness of the data collection method, the University of Akron's Transportation Lab has developed and tested an Automatic Turning Movement Identification System (ATMIS) which does not require intensive human intervention as data are collected by the system automatically in real time.

BACKGROUND

An O-D matrix based mathematical formulation of the turning movements problem can be shown as

$$\begin{pmatrix} 0 & b_{21} & \cdots & b_{N1} \\ b_{12} & 0 & & b_{N2} \\ \vdots & & \ddots & \vdots \\ b_{1N} & b_{2N} & \cdots & 0 \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ \vdots \\ I_N \end{pmatrix} = \begin{pmatrix} O_1 \\ O_2 \\ \vdots \\ O_N \end{pmatrix}$$

$$\begin{cases} b_{ij} \geq 0 \text{ when } i \neq j \\ b_{ij} = 0 \text{ when } i = j \end{cases} \text{ where } i, j = 1 \text{ to } N$$

Where,

N the number of legs for the studied intersection

I_i traffic volume going into the intersection at leg i (i = 1 to N)

O_j traffic volume going out of the intersection at leg j (j = 1 to N)

b_{ij} probability for a vehicle entering the intersection from leg i will leave at leg j

(i = 1 to N and j = 1 to N)

(See figure 1 on next page)

This seemingly simple mathematical problem cannot be easily solved. It has been found that when the number of legs is more than 3, multiple solutions exist due to more variables than the number of equations. In addition, the mathematical formulation requires that there be no errors in the traffic volume data at each leg; otherwise, it will become an unsolvable matrix. To address these problems, simplifications need to be applied or additional constraints must be provided.

Instead of O-D matrix, the heuristic data reduction approach to turning movements estimation has been tested by some researchers using detector data at the intersection and the signal status information. The reported accuracy varies, ranging from 10 to 70 percent, depending on if there is a detector at the turning lane and if there is a shared lane at the intersection.

Both of the above methods rely on the assumptions that traffic counts at an intersection

are accurate by the detectors. In practice, data errors do exist due to machine problems, heavy congestion, or human errors.

The proposed ATMIS makes use of a video detection system and signal information. By tracking each detector's status and traffic signal code second by second, the algorithms built in ATMIS calculates vehicle turning movement in real-time. The detector configuration for a typical four-leg one-lane intersection is shown, where the white detectors are placed close to the stop bar at each flowing in lane to detect vehicles arrival at the intersection; the gray detectors are placed at each flowing out lane to detect vehicles leaving the intersection. When a vehicle passes the intersection, a pair of detections from arrival detector (white) and leaving detector (gray) will be marked for a possible movement as exemplified in the table below ***(see figure 2 and table 1 below).***

Figure 1

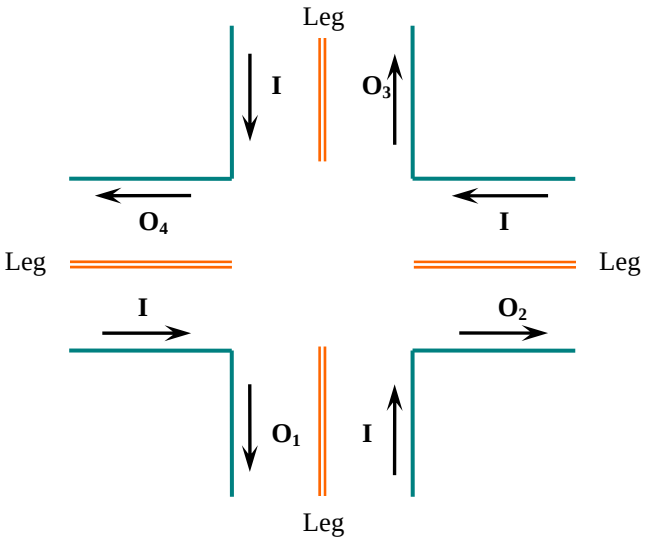

Figure 2

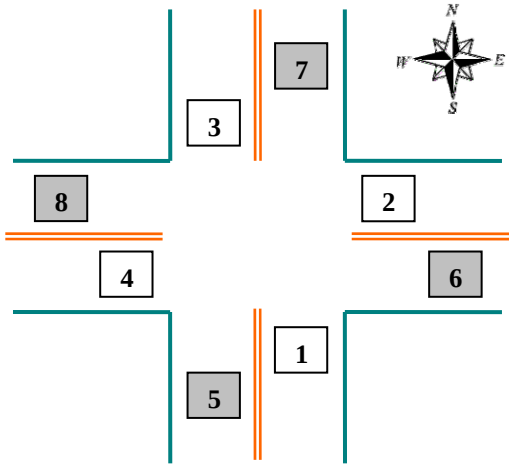

Table 1: Description of turning movements in Figure 2

Arrival Detector	Leave Detector	Turning Movement	Abbreviation
1	7	Northbound Through	NBT
1	6	Northbound Right Turn	NBR
1	8	Northbound Left Turn	NBL
2	8	Westbound Through	WBT
2	7	Westbound Right Turn	WBR
…	…	……	……

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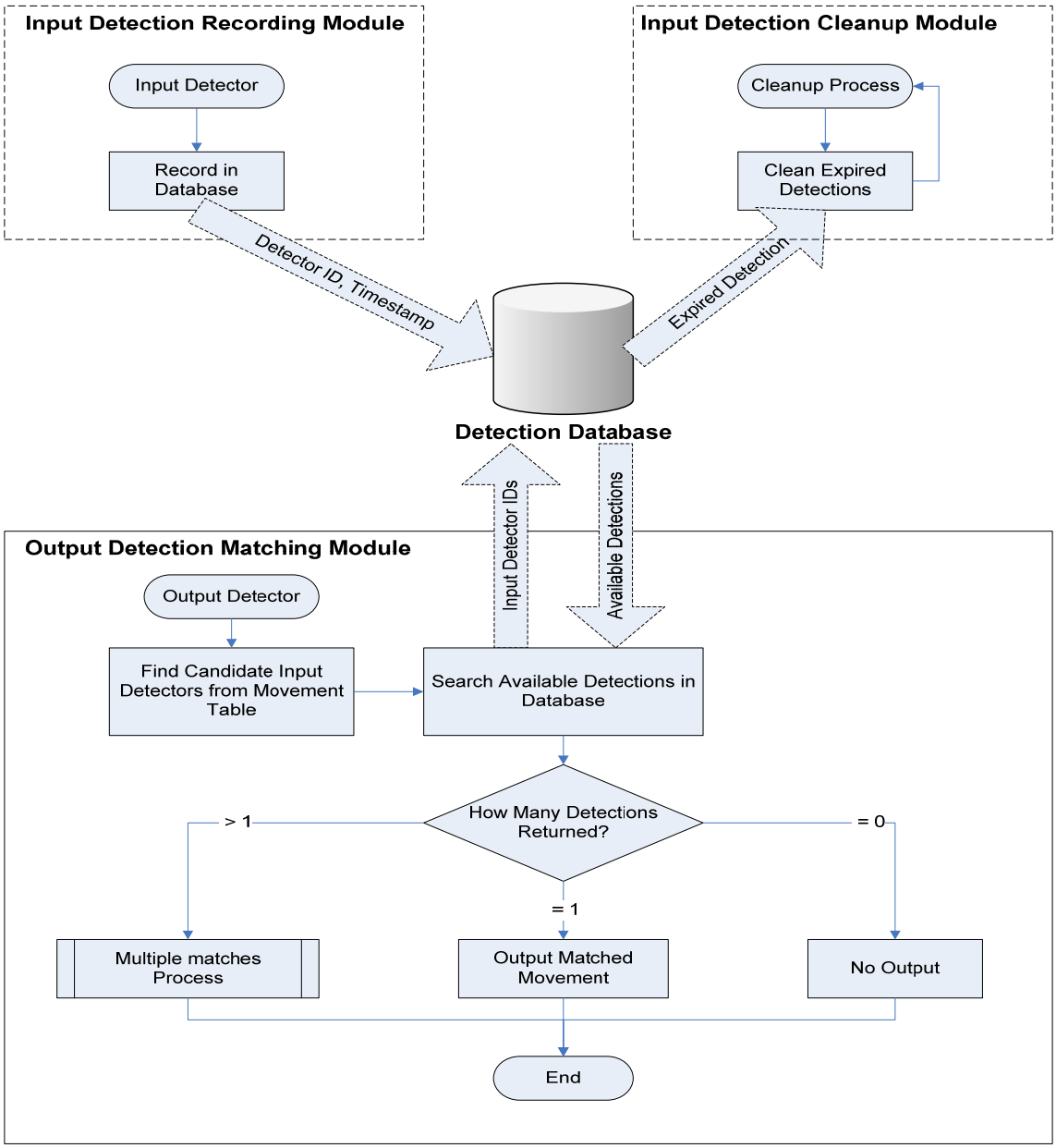

Figure 3

The algorithm built in ATMIS is illustrated as working steps in the flowchart ***(figure 3 above)***, which is independent of the geometric layout of the intersection, such as shared lane and irregular intersection (more than four legs or odd shape). The algorithm is also designed to tolerate detection errors due to missing or double counts.

Results from lab and field tests are very encouraging. In repeated lab tests, the average error (compared with ground truth) is between 2~5%. The effort on field tests is limited because of the difficulty accessing the video detector information, however, at two intersections in Akron, Ohio, where ATMIS is applied in real time, the average error for one hour is between 5~8%. Additional development and test work is

Experimental Study on the Use of Lime Sludge for Construction: An example for Sustainability

By: Jingsi Lang

Drinking water treatment plants annually produce a significant amount of lime sludge during water purification procedures. This sludge is typically stored in lagoons and disposed of as solid waste. This presents a significant economic burden to daily operations. This study investigates a sustainable development strategy from the beneficial utilization of this material. An experimental program is implemented to address the technical issues related to the application of this material in the construction of soil embankment, where lime is commonly used as soil stabilizers. Specific topics associated with the engineering applications of lime sludge treated soils include: the effects of dry versus wet mixed procedures for the introduction of lime sludge into soils, procedures to determine the optimal content of lime sludge, and the long term durability of lime sludge treated soils under freezing-thawing cycles. This study aims to help develop a sustainable strategy to utilize lime sludge for routine construction activities.

Modeling Dynamic Dilemma Zones and Its Applications

By: Zhixia Li

Dilemma zone is dynamically featured both in location and length at high speed signalized intersections due to varying driving behaviors in response to yellow indications. Constant contributing factors are traditionally assumed to compute a dilemma zone, and it is hard to reflect its dynamic characteristics, while arbitrary dilemma zone locations are possibly generated. To overcome this problem, the paper presents a novel approach for modeling dynamic dilemma zones, which identifies varying values of dilemma zone contributing factors, i.e. acceleration rate, deceleration rate and driver's perception reaction time, under different approaching speeds by using observed vehicle trajectory data. A case study was conducted at a high speed intersection in Fairfield, Ohio. Time-based yellow-onset trajectories were obtained using video-capture-based techniques and were then used to calibrate the dynamic dilemma zone model. Two alternative sets of ground-truth data with focus on different levels of driving aggressiveness were established for the model calibration. The calibrated dilemma zone model well reflects the real-world dynamic driving behaviors with varying values of contributing factors. As an application, dilemma zone lookup charts were developed based on the calibrated models. These charts provide a user-friendly tool for checking the location and length of a dilemma zone for a specific speed in response to a certain yellow duration. Another important contribution is the definition and modeling of the concept of Dilemma Conflict Potential (DCP). DPC quantitatively measures the dilemma hazard for each vehicle in terms of the probability of traffic conflict. Six scenarios are considered for describing the DCP, and each has its specific equation that models the DCP with vehicles' yellow-onset speeds and positions. The speed and location information considered in DCP provides a more comprehensive measure of dilemma hazard than traditionally using the "number vehicles in dilemma zone". Significantly, the methodology used in this paper is capable of satisfying the needs of states in the U.S. for updating their local dilemma zone tables, and it also establishes a solid basis for developing the optimal dilemma zone protection strategies.

Behind the Research

OTC partner universities' students gain valuable hands-on research experience

Mr. Qingyi Ai is currently a Ph.D. student in Transportation Engineering in the Department of Civil and Environmental Engineering at The University of Cincinnati (UC). He received his B.S. in Civil Engineering from Huazhong University of Science and Technology (China) in 1998 and M.S. in Transportation Engineering from Beijing University of Technology (China) in 2006. Mr. Ai joined the Graduate School at UC in September of 2007. Under the supervision of Dr. Heng Wei, he has completed his course work and passed the Ph.D. qualifying exam in May 2009. Mr. Ai is currently working with Dr. Wei on the OTC project in dual-loop data analysis, ground-truth video-based trajectory data of the observed traffic over the studied loop stations, congestion modeling using loop data, and modeling vehicle classifications using dual-loop data.

Before coming to the United States, **Mr. Cong Feng** received his bachelor's degree from the Department of Civil Engineering, Tsinghua University, Beijing, China. While in China, he worked as an intern for a construction company in Guiyang and as an intern for a design institute in Beijing. Currently, he is pursuing his PhD in Transportation Engineering at The University of Akron. He is in his third year at the UA transportation lab and his current research areas include traffic signal coordination and traffic flow theory. His next research topic will be transportation system reliability analysis. Mr. Feng is a student member of ASCE and he currently achieved EIT (Engineer In Training).

After working for over ten years in the banking industry, **Mr. Michael Dunbar** decided that he was ready for a new career path. He is currently a Master's Degree student in Geography at Kent State University. His thesis topic, "Examining Place Attachment to the Great Lakes", addresses how people relate to and interact with their environment. He is also interested in transportation and understanding how people move and flow through society. His hope is to be able to contribute to the improvement of that movement. In an effort to achieve that goal, he has worked closely with Dr. David Kaplan on his OTC-funded research project, "Linking Sustainable Transportation in a University Community".

Mr. Sudhir Itekyala is currently a M.S. student in the Transportation Engineering program in the Department of Civil and Environmental Engineering at the University of Cincinnati (UC), under supervision of Dr. Heng Wei. His responsibilities for the OTC project include field videotaping data collection and modeling analysis for traffic congestion patterns and vehicle classifications. He received his B.S. in Civil Engineering in 2003 from Jawaharlal Nehru Technological University, Hyderabad, India. He joined the Graduate School at UC in 2007 and has passed his M.S. proposal exam in June 2009.

Mr. Dontae A. Dorsey is currently a senior student in the Department of Water Resources Management at Central State University. He also worked as a student assistant in establishing the Air Quality Laboratory in Central State University. He is currently working on the OTC sponsored project *"On-Road Mobile Source Pollutant Emissions: Identifying Hotspots and Ranking Roads"* in traffic data gathering.

Mr. John Wesley Davenport is currently a junior student in the Department of Water Resources Management at Central State University. He had participated in the National Nuclear Security Administration Hyperspectral Workshop (2008 summer) and Evaportranspiration in Southwestern USA Project of United States Bureau of Reclamation (2009 summer) in the capacity of undergraduate research assistant. He also worked as a student assistant in establishing the Air Quality Laboratory in Central State University. He is currently working on the OTC sponsored project *"On-Road Mobile Source Pollutant Emissions: Identifying Hotspots and Ranking Roads"* in traffic data gathering.

Mr. Andre' Morton is currently a senior student in the Department of Water Resources Management at Central State University. He received his B.A. in Speech Communications from Miami University of Ohio in 2001 and M.A. in Communication Studies from Bowling Green State University in 2003. He had participated in the National Nuclear Security Administration Hyperspectral Workshop (2008) and Evaportranspiration in Southwestern USA Project of United States Bureau of Reclamation (2008-2009) in the capacity of undergraduate research assistant. In 2009 he completed a summer co-op internship with the Northeast Ohio Regional Sewer District (NEORSD). The co-op experience consisted of analysis of bid contracts and requests for proposals for improvements to be made to NEORSD facilities and developing excel spreadsheets of cost saving measures implemented at three NEORSD facilities from 2003-2009. He is currently working on the OTC sponsored project *"On-Road Mobile Source Pollutant Emissions: Identifying Hotspots and Ranking Roads"* in ranking of roads based on on-line mobile pollutant emissions using neural network.

Mr. William Meade is a Masters Degree student in the Institute of Environmental Science at Miami University in Oxford, Ohio. He received his B.S. in Water Resources Management from Central State University in 2007. Mr. Meade joined the Graduate School at Miami University in August of 2007; he has completed all of his coursework and will graduate in December 2009. Mr. Meade is working on the emission modeling component of the OTC sponsored project *"On-Road Mobile Source Pollutant Emissions: Identifying Hotspots and Ranking Roads"* which eventually became his Masters research project work.

WINNERS continued from front page

paper competition with his paper entitled, "Modeling Dynamic Dilemma Zones and its Applications". Mr. Li joined UC in January 2007 and is under the advisement of Dr. Heng Wei. His research interests include traffic operations and control, intelligent transportation systems, and geographic information system applications in transportation. Prior to joining UC, Mr. Li was an ITS software engineer in the R&D department, Shanghai Baosight Software Co., Ltd. in China. He received a B.E. degree in Electrical Engineering from Sun Yat-Sen University, China in June 2003. In addition, he holds two patents in China and is currently a student member of ITE and NACOTA.

Jingsi Lang's paper, "Experimental Study on the Use of Lime Sludge for Construction: An Example for Sustainability", was chosen as the winning undergraduate paper. Miss Lang is a senior undergraduate student in the Department of Civil Engineering at Case Western Reserve University and is advised by Dr. Bill Yu. She was involved in the Case Support of Undergraduate Research & Creative Endeavors Program and has done research with Department Profess Dr. Bill Yu on the topic of Beneficial Use of Lime Sludge during the summer of 2008.

Abstracts for each of the winning papers are included in this issue of *OTC News* and full transcripts of the papers can be found on the OTC website at www.otc.uakron.edu.

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