MEETING AT IITH M2SMART LAB

M2Smart NewsLetter

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M2Smart Lecture at IITB and Internship

by Tsutomu Tsuboi (Project Leader)

M2Smart Project is getting more attention in India!

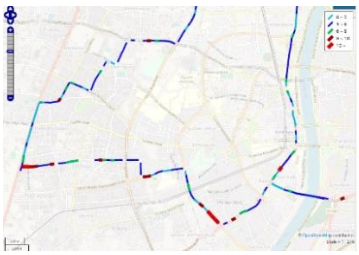
On 24th of July, Dr.Tsuboi was invited to give a lecture at IIT Bombay. This lecture contained the introduction of the M2Smart Project activities and there were 20 students and 6 professors from 7 faculties. Prof. D. Manjesth in the Electronic Engineering (EE) Department of IIT Bombay organized this lecture and exchanged traffic flow analysis information. His laboratory has Indian traffic flow behavior model by vector matrix, which simulates Indian driving movement.

Between 21-22nd of July, Dr.Tsuboi visited Nippon Signal Company which is the metro developer in Ahmedabad.

The road condition monitoring in Ahmedabad by smartphone has been conducted by Dr.Tsuboi.

From 19th of August to 30th, Nagoya Electric Works had an intern from the University of Tokyo Doctor course student who has graduated from IIT Hyderabad Master course. Dr. Tsuboi and his team taught M2Smart traffic flow analysis to him and he enjoyed the research activities. The challenging topic was the comparison between Greenshields model vs Greenburg model of traffic density to traffic speed characteristics based on Ahmedabad traffic flow raw data.

Metro developer Nippon Signal Corp. in Ahmedabad



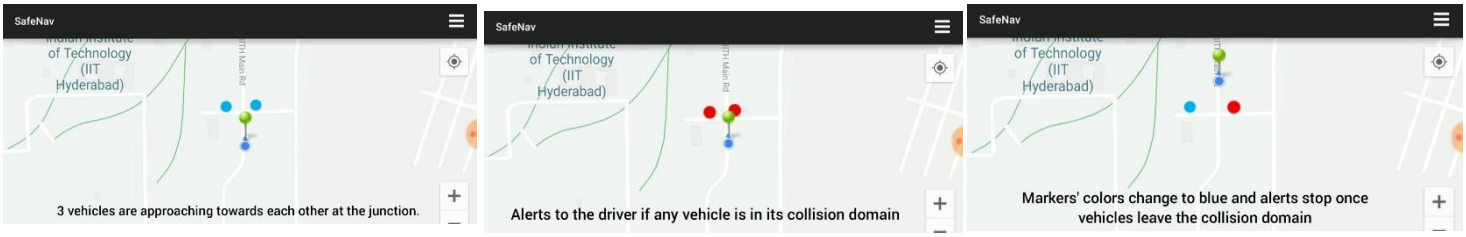
Ahmedabad Road condition Monitoring trial by smartphone

IITH alumni joined Nagoya Electric Works as internship program two weeks in August

Collision Warning System

by Bheemarjuna Reddy Tamma (Group 1, 2 & 4)

The goal of the Collision Warning System is to avoid accidents by giving timely alerts on potentially colliding vehicles sharing the road. Nowadays everyone has smartphones which are having Cellular and Wi-Fi radios. For achieving this goal an Android app titled SaveNav is developed and made available on Google Play. Vehicles can share their location and relevant data in both online mode (4G/Cloud) and offline mode (Peer-to-Peer over Wi-Fi Direct) to nearby vehicles in the collison domain. This app is being extended for giving suggestions about speed and acceleration to drivers, which will help to reduce journey time as well as CO_2 emissions.



Multiscale Monitoring of Urban Air Quality: An Integral Dimension of Smart Cities Initiative

by Soumya Jana (Group 4 Co-Leader)

In recent years, rapid industrialization and increased motor vehicle usage have made several developing cities unsustainable in terms of air quality along with other factors. While air quality is monitored in such cities, monitoring stations are geographically separated, and resulting measurements are often insufficient to infer pollution levels in requisite spatial details. In addition, air quality information is often not communicated to the authorities in a usable form leading to suboptimal policies and inefficient law enforcement. Further, without such information easily available and clear guidance from policy and law, individual and economic activities do not take environmental impact into account, worsening the associated problem.

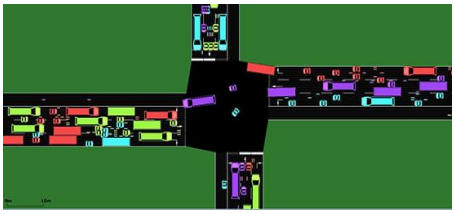
To this end, we envisage an integrated multiscale system that not only makes measurements at traditional monitoring stations, but also complements those with readings from densely-deployed low-cost compact sensors. Subsequently, the proposed system fuses the collected data with the help of suitable transport models to generate detailed pollution maps. Finally, the system would disseminate such maps to the relevant stakeholders with appropriate levels of abstraction. We believe such a systematic architecture, when implemented at the city-scale, will guide design of efficient policy, ensure transparent law enforcement, and maintain meaningful balance between economic development and environmental sustainability.

Intelligent Traffic Light Coordination for Heterogeneous Traffic Scenarios

by Subrahmanyam Kalyanasundaram (Group 2)

Good coordination and management of city traffic has numerous benefits; this can reduce travel time, improve throughput, and also less pollution due to CO and CO_2 emissions. Most major cities across the world deploy different kind of systems to ensure smooth traffic. However, in Indian cities, traffic management presents certain unique challenges. The main reason is the heterogeneity of the traffic situation. We model this using a heterogeneous traffic model to simulate the real time traffic scenarios.

We use the notion of sub lanes to make the simulation more realistic. This models the situation where more than one vehicle in parallel can be simulated in a single lane if its width fits. We simulate the demand using the open source traffic light simulator SUMO. Using this, we adjust the source code to generate traffic demand for our scenarios. We employ a coordinated intelligent traffic light controller, where all the local decisions of traffic lights are updated into common and shared variable. These variables can be accessed by neighboring lights in order to arrive at an optimized decision. Appropriate physical properties such as acceleration, deceleration, maximum speed, space headway, vehicle type are used to calculate the CO and CO_2 emission in the simulation.



Coordination among traffic lights ensures smooth traffic flow and increases the throughput. Simulation results show that coordinated intelligent traffic light controllers perform better than static and actuated controllers in terms of CO and CO_2 emission, waiting time and throughput.

Max Traffic Scenario [1 hour]

	CO (mg)	CO_2 (mg)	Cumulative Waiting Time (Seconds)	Throughput (vehicle/ time)
Static(55,35)	45,220,836	882,081,354	6,194,296	0.33
Static(55,25)	60,765,790	1,128,626,076	9,050,884	0.29
Actuated	23,175,687	532,591,728	**1,977,249**	0.38
Intelligent	**11,159,914**	**332,334,221**	2,052,688	**0.49**

Display proposal for VMS: Effect on driver's psychology

by Shinya Hanaoka and Tomoya Kawasaki (Group 3)

In Ahmedabad, Variable Messaging Sign (VMS) was established in 11 locations as a part of the Intelligent Transportation System (ITS). Until now, the right half of this display panel is showing real-time traffic information which assists drivers' route choice, while the left half of this displays advertisement at this moment. In our research, we would like to examine what type of display would be more meaningful to reduce traffic volume in the city.

Fig1: Example of VMS in Ahmedabad

Background

- Rapid growth of motor vehicle which causes serious congestion and air pollution
- Development of the ass-transit metro system (MEGA): The North-South and East-West corridors are expected to be completed by 2019

Potential displays to reduce the usage of private cars

1) Text with color and the number of lines

Figure 2 shows the example of VMS, which varies the color and the number of massage lines. In our research, we examine the effects of color scheme and message lines of variable message signs on drivers' phycological intentions to give up the usage of private cars.

2) Strong expressions

We can sometimes see the strong expressions such as figure 3. This kind of stimulating pictures will give a great impact on viewers so that they can remember the content of what they have seen. We may apply this idea to the private car usage which has adverse effect on the environment.

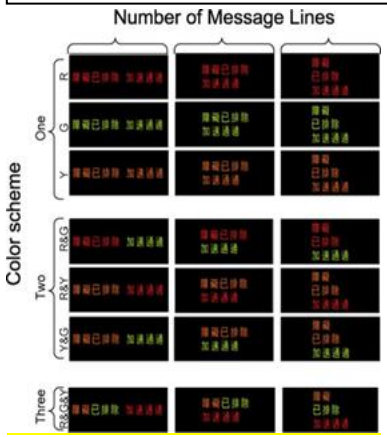


Fig2: Example of VMS by color and lines

Fig3: Example of strong expressions in Tobacco industry

Research Direction

Considering that the objective of this VMS display research is to encourage drivers to avoid using private cars even if it is not easy to be realized. From the background, we can see that Ahmedabad is a city with excessive motor vehicles which cause severe traffic congestions. The newly constructed/planned MEGA further encourage the government to promote modal shift to public transportation. At this time, our research is to utilize this VMS to promote the usage of local public transportation including local bus and MEGA. We will conduct experiments such as simulating tests to check the effects of these information shown on the VMS.

At the same time, the way that the information is shown is another subject to us. Besides, how these factors in the message concerning to driver's response time and comprehension to the VMS is a point of this research. We will try to find out the best combination of these elements to show an effective VMS display.

Driving Cycle Development for e-Rickshaw and Energy Consumption from Longitudinal Vehicle Dynamic Characteristics

by Digvijay S. Pawar (Group 3 Leader)

This study presents driving cycle and energy consumption for a three-wheeler electric rickshaw in heterogeneous traffic conditions typical of developing countries. Vehicle speed, acceleration-deceleration, distance, latitude-longitude were recorded per second with a frequency of 10 Hz using HD V-box mounted on an e-rickshaw. The Electric Rickshaw Driving Cycle (ERDC) is constructed by connecting the most representative (average driving characteristics with a variance <5%, compared to raw data) micro-trips until a driving cycle duration of 1800 s is reached. The ERDC is then compared to Indian Driving Cycle (IDC) and World Motorcycle Test Cycle (WMTC) by mean values of the driving characteristics. The average speed of the ERDC (18.33 kmph) is about 5 times lower than both the standard driving cycles. The average acceleration (0.598 m/s2) and deceleration (-0.608 m/s2) are also found to be lower compared to the standard driving cycles. From the ERDC, a Speed-Acceleration Frequency Distribution (SAFD) was plotted, and an idle time of 13% was observed in the selected stretch. Further, the driving cycle along with other road and vehicle characteristics such as grade, rolling resistance and internal force are used to estimate the energy consumption (150.74 Wh/km) during travel. Maximum power required to move the vehicle on this driving cycle was found to be 22.82 KW for a cycle distance of 8.1 km. The insights from this preliminary study can be used to understand and model the performance of e-rickshaw, in terms of fuel consumption and driving characteristics, compared to other fossil-fuel driven automobiles.

GPS enabled Video Vbox

Figure. Instrumented test vehicle

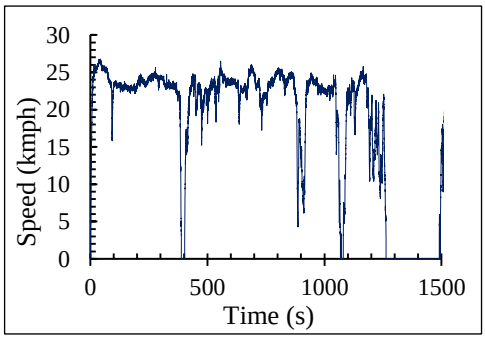


Figure. Developed version of new Electric Rickshaw Driving Cycle

Dr. Digvijay S. Pawar at the Eastern Asia Society for Transportation Studies (EASTS) 2019 Conference

Presentation of Big-data Analysis at the Eastern Asia Society for Transportation Studies (EASTS) Conference 2019

By Tetsuhiro Ishizaka (Group 2 Leader) and Anand Kakarla

This study presents the route segment performance using a big data of BRT in Ahmedabad regarding topics 2. It's important to calculate reliability as an index to measure the service level of public transportation. However, these service reliability metrics can't account for spatio-temporal dynamics. Further, a comprehensive measure that can isolate inefficient location and temporal zones is necessary to strategize preventive measures.

In this paper, authors analyzed the service reliability of Ahmedabad BRT across both space and time by diving the route into stop to stop level segments. Subsequently, a relative performance measure for a particular route which incorporated multiple metrics was obtained using data envelopment analysis (DEA). Measures including average travel time and peak deviation were used in this analysis.

Based on the scores for each segment, the underperforming locations were identified and ranked. Finally, the DEA scores were compared against BTI to demonstrate its non-triviality and uniqueness. When the segments were ranked according to DEA and BTI, it that DEA indicated distinct ranks. DEA indicates that segment 10 is underperforming compared to segment 14 while BTI indicates otherwise. This is probably because of BTI not considering peak deviation. Furthermore, DEA scores were verified with the corresponding traffic conditions and it was observed that segment 6, 10, 11 handle larger traffic volume and resulted in bad scores. Such DEA analysis can be used when interaction between factors contributing to reliability is unknown.

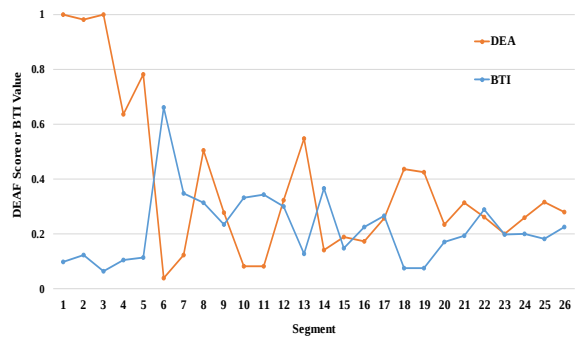


Figure. DEA scores and BTI values of all the segments

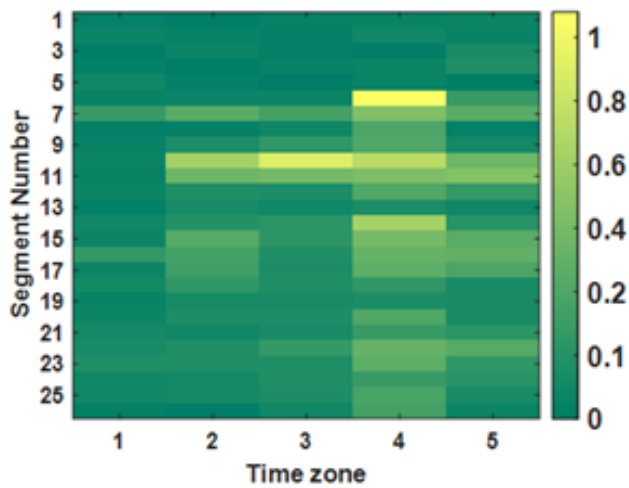


Figure. BTI across both space and

Table. Comparing performance ranks according to DEA and BTI

Rank	Top 10 segments according to DEA	Top 10 segments according to BTI	Rank	Worst 10 segments according to DEA	Worst 10 segments according to BTI
1	1	3	1	6	6
2	3	18	2	11	14
3	2	19	3	10	7
4	5	1	4	7	11
5	4	4	5	14	10
6	13	5	6	16	8
7	8	2	7	15	12
8	18	13	8	23	22
9	19	15	9	20	17
10	12	20	10	17	9

Poster Session of the Eastern Asia Society for Transportation Studies (EASTS) Conference 2019 in Colombo

by Atsushi Fukuda (Group 4 Leader), Tetsuhiro Ishizaka (Group 2 Leader), Keisuke Yoshioka (Group 3), Hiroki Kikuchi and Xin Guo

At the EASTS Conference 2019 in Colombo, the three poster presentations related to the M2Smart project were carried out on the session (3) and (4) on September 10 and 11.

Two of them focused on the behavior and characteristics of Auto-rickshaw passengers based on the pre-MMA experiments and/or questionnaire survey. Especially on the result of questionnaire survey of pre-MMA experiment, more than 60% of participants relatively felt dissatisfaction on waiting time inside auto–rickshaw after riding until departure. These factors were drastically improved by providing auto-rickshaws as a feeder service timely assigned by the MMA and other call service.

One of them presented the possibility of CO_2 reduction by micro traffic simulation analysis under the assumption of demand shifting to other routes based on VMS message. To carry out the simulation, estimation of OD traffic volume by using traffic data extracted from traffic counts and drone observations were tried.

Figure. Micro traffic simulation

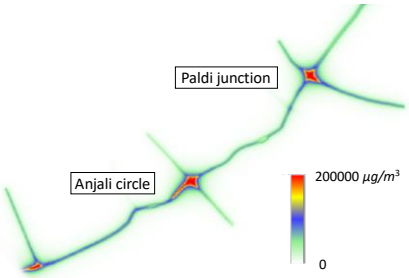
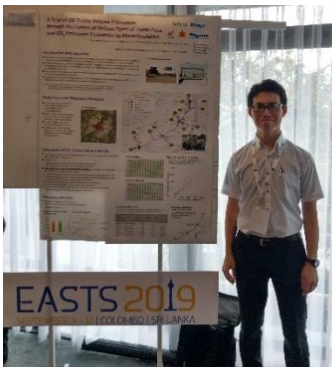
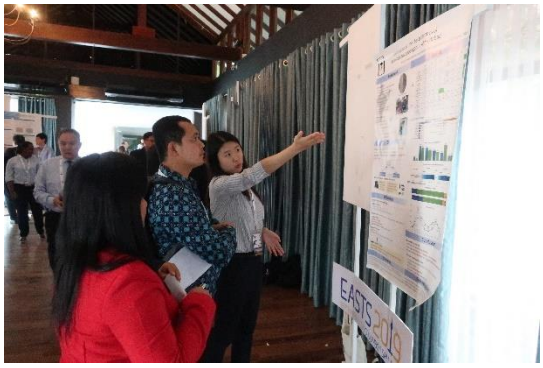
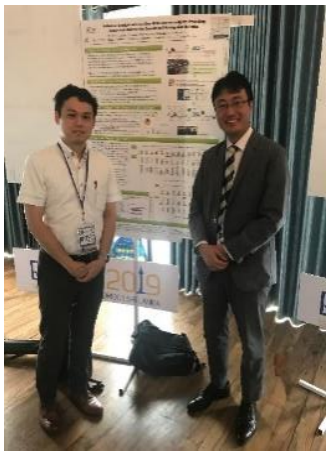


Figure. CO_2 emission distribution







Photos: Poster Presentation at the EASTS Conference 2019

Publications

Journal

- Tsutomu Tsuboi, "Quantative Analysis Method of Traffic Service by Traffic Congestion under Developing Country", International Symposium of Transport Simulation (ISTS'18) and the International Workshop on Traffic Data Collection and its Standardization (IWTDCS' 18).
- Tsutomu Tsuboi, "Quantative Traffic Congestion Analysis Approach in Ahmedabad", Advances in Science, Technology and Engineering Systems Journal Vol. 4, No.2, July 2019.

Conference papers

- Debaditya Roy, Tetsuhiro Ishizaka, Krishna Mohan Chalavadi, Atsushi Fukuda, "Vehicle Trajectory Prediction at Intersections using Interaction based Generative Adversarial Networks", Conference: 2019 22nd Intelligent Transportation Systems Conference (ITSC).
- Ryohei Hashimoto, Anand Kakarla, Tetsuhiro Ishizaka, Atsushi Fukuda, "Analyzing Route Segment Performance Based on Multiple Indicators Using DEA: A Case Study on Ahmedabad BRT", The 13th International Conference of Eastern Asia Society for Transportation Studies, 2019.

Conference poster presentation

- Tetsuhiro Ishizaka, Anand Kakarla, Atsushi Fukuda, Digvijay S. Pawar and Hiroki Kikuchi, "Analysis on Last One-Mile Connectivity by Providing Auto-rickshaw Feeder Service and Navigation in India", The 13th International Conference of Eastern Asia Society for Transportation Studies, 2019.
- Xin Guo, Tomoya Kawasaki, Shinya Hanaoka, "Clarification of the characteristics of Auto-rickshaw passengers in Ahmedabad", The 13th International Conference of Eastern Asia Society for Transportation Studies", 2019.
- Keisuke Yoshioka, "A Trial of OD Traffic Volume Estimation through the Fusion of Various Types of Traffic Data and CO_2 Emissions Estimation by Microsimulation", The 13th International Conference of Eastern Asia Society for Transportation Studies, 2019.

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