# M2Smart NewsLetter

Vol.11

March 2021

M2SMART 5TH JCC ONLINE MEETING

# 5th Joint Coordination Committee (JCC)

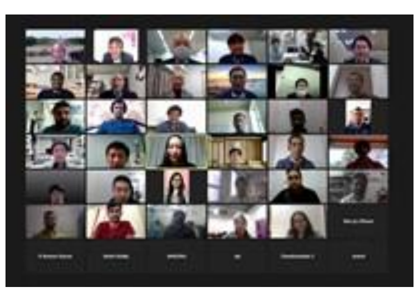
by Haruka Katarao (M2Smart Resident Coordinator)

## 5th JCC Conducted Online!

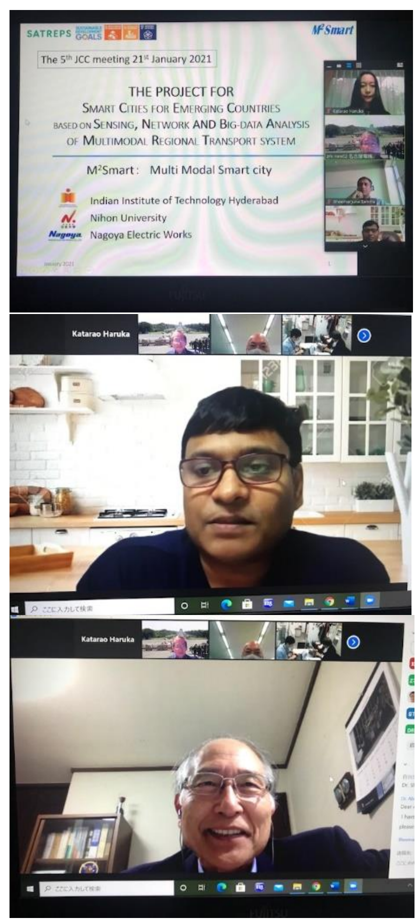
The 5th Joint Coordination Committee (JCC) was conducted online on 21st January 2021. The meetin was welcomed by Prof. Kiran Kuchi, Dean R&D (Deputy of Director) of Indian Institute of Technology Hyderabad (IITH), Mr. Yuki Yoshida, Japan International Cooperation Agency (JICA) Tokyo and Mr. Kazuhiko Aoki, Japan Science and Technology Agency (JST) India. Dr. Tsutomu Tsugoi (M2Smart Project Leader) presented the latest project overview and updated the overall activities.

Then the M2Smart researchers from IITH, Nihon University, Tokyo Institute of Technology, The University of Tokyo and Nagoya Electric Works exchanged their research updates. The group leaders and co-leaders updated their research status & plans for 2021.

Lastly the meeting was closed by Prof. Kiran Kuchi, Dean R&D of IITH and Prof. Masayuki Kamimoto, Research Supervisor of JST with the high expectation of further joint research activities of the M2Smart Project.



*Screenshots of 5th JCC*



# Summary of the 5th JCC: latest project overview and update of the overall activities

by Tsutomu Tsuboi (Project Leader)

We have almost one year activities limitation caused by COVID-19. However, it is fortunate for us to continue our research because all traffic data collection has been done remotely by Internet access and we used these datasets in our common severs for analysis.

The Group 1 has achieved traffic video recognition more than 80%, using AI technology. The 80% traffic video recognition is the original SATREPS target. Group 1 continues to improve their recognition. The Group 2 has strong effort to make traffic flow analysis based on one-year big data collection in Ahmedabad and Hyderabad. Analyzing the Indian traffic flow is not easy task due to chaotic traffic conditions. This research will be the first challenge to analyze such long-term traffic observation in major cities in India. The Group 3 had impact of COVID-19 for IITH test bed support and Ahmedabad field test support. However, the team members have focused on each research topics such as traffic signal control simulation, CO2 emission evaluation by Rickshaws, and paring condition monitoring. The Group 4 made agenda plan of "Hand Book" and fixed the format of its content. The Group 4 shared Handbook template for all research members.

Finally, all members confirmed SATREPS research completion by the end of March 2022 and Handbook creation task from April 2022 to September 2022. The SATREPS should be completed by the end of September 2022.


*Presentation of the Project overview in the JCC meeting*

# 5th JCC and Project prospects

by Bheemarjuna Reddy Tamma (Co-Project Manager)

Due to prevailing travel restrictions, 5th JCC meeting has to go online. Thanks to the virtual mode of meeting, we have the highest number of participants from India and Japan in this particular edition of JCC. Teams from both the countries presented the work progress made over the past one year and discussed work plans for the final year of the project. Though lockdown has impacted testbed related experimental activities at the very crucial period in the project tenure, the researchers are able to make good progress by making use of datasets gathered before the lockdown and resorting to simulation studies to validate some of the hypotheses. The teams also spent sometime to design the contours of "HandBook" which is going to be one of the key deliverables of the project. Hoping that testbed related activities and field surveys would resume soon to be complete all the pending experiments in the final year of the project and meet the various targets set for the project.

# Group 1: Sensing Technology for Urban mobility

by C. Krishna Mohan (Group 1 Leader), K Naveen Kumar, Pabbathi Uday Kumar, Sai Harsha Yelleni and Jaya Sharma

We have presented improvements in the below-mentioned tasks with the help of both qualitative and quantitative results.

**Vehicle Detection:** We have experimented with different versions of YOLO object detection and improved the vehicle detection model's performance using Ahmedabad Paldi junction data. We are able to achieve a detection accuracy of 83%.

**Vehicle Count:** Implemented vehicle count using an improved vehicle detection model and counted vehicles from multiple directions of different vehicle types at required time intervals at both Paldi junction and IITH Main gate.

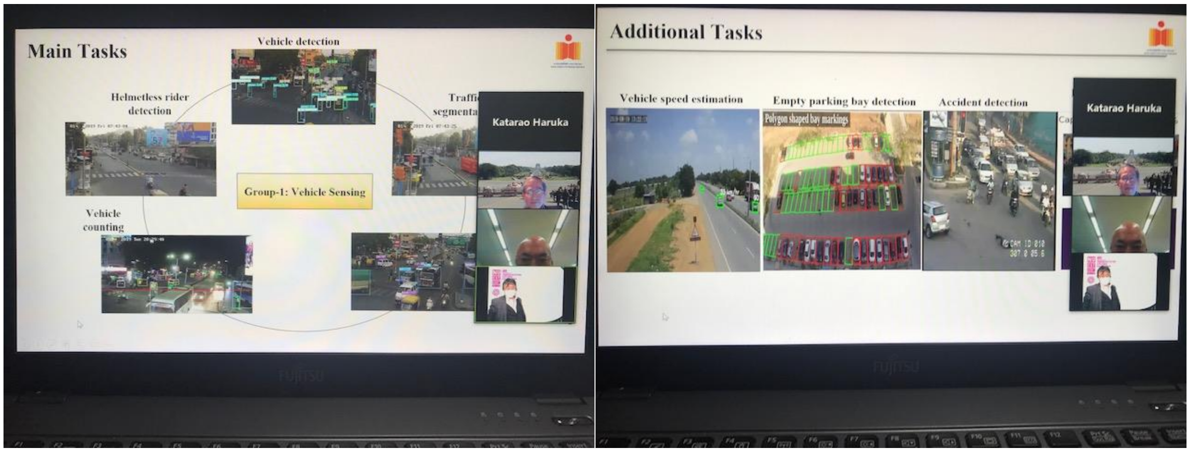
**Vehicle Tracking:** We have reduced identity switches while tracking the vehicles, which helped us in improving the vehicle count module, and also integrated appearance information for better performance which improved overall vehicle tracking accuracy to 62.3%

**Vehicle Speed:** We have started working on vehicle speed by calculating the instantaneous speed of each vehicle passing through the road by using the information of pixel distance moved by each vehicle track for unit time and integrated semantic features such as trajectory smoothness, velocity change, and temporal information for data associated of vehicle tracks.

**Helmetless motorcycle detection:** The real-time detection of traffic rule violators in a city-wide surveillance network is a highly desirable but challenging task because it needs to perform computationally complex analytics on the live video streams from a large number of cameras simultaneously. In this work, we proposed an efficient framework using edge computing to deploy a system for automatic detection of bike-riders without helmets. The experimental results show that our method achieves a high detection accuracy of ≈ 95% while maintaining the real-time processing speed of ≈ 22f ps on Nvidia-TX1.

**Smart parking system:** Today parking is a prominent concern with the increase in the number of motorized vehicles. It has significant implications on the entire driving experience and the psychology of the driver. Some of them include a) increased emissions of harmful gases due to continual search for a vacant spot for parking, b) parking on roads, which again causes congestion on roads, which leads to additional traffic, congestion, and frustration, increasing both pollution and risk of road accidents. We proposed an AI-based smart parking solution to guide the drivers to park their vehicles in the detected available parking slots. The proposed solution is automated, requiring bare minimum human intervention, and completely compatible with existing infrastructure (cameras already exist in most parking lots) with an accuracy of 95%.

**Accident Detection:**The probability of an accident is determined based on speed and trajectory anomalies in a vehicle after an overlap with other cars. The traffic incident is referred to as an abrupt change in traffic flow. This is one critical task in video surveillance. It includes various challenges such as occlusion, lighting conditions, camera angles, and not many modeling examples. For this task, Deep Spatio-Temporal Representation for Detection of Road Accident using Stacked Autoencoder is used. The framework automatically learns feature representation from the Spatio-temporal volumes of raw pixel intensity instead of traditional hand-crafted features. The experiments are performed on video clips collected from the City surveillance network and are captured at 30 frames per second. Each video clip starts a few minutes before an accident and contains several minutes after the incident. The first few minutes of video, which includes normal situations, train the model and remain for testing. There are 127138 normal frames, and 863 frames contain partial or full accidents labeled manually. For training 94720, normal frames are used. For testing, we used 33280 frames, 32417 normal, and 863 accident frames. These real accident videos demonstrate the efficacy of the approach.



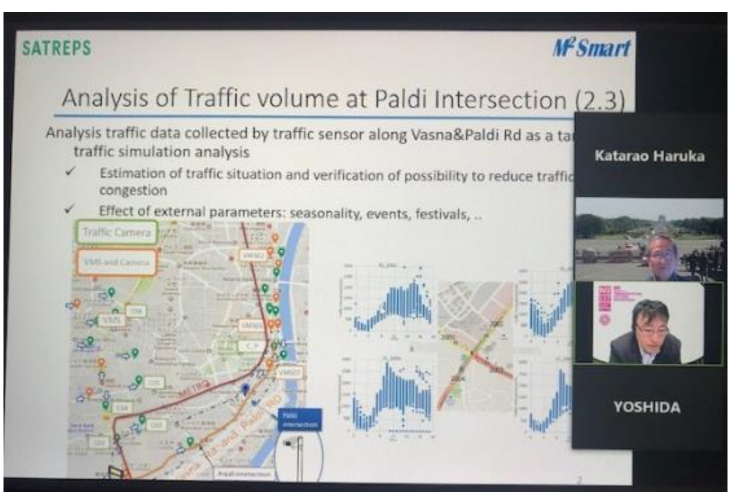

*Group-1 Presentation in the JCC meeting*

# Group 2: Big Data Analysis

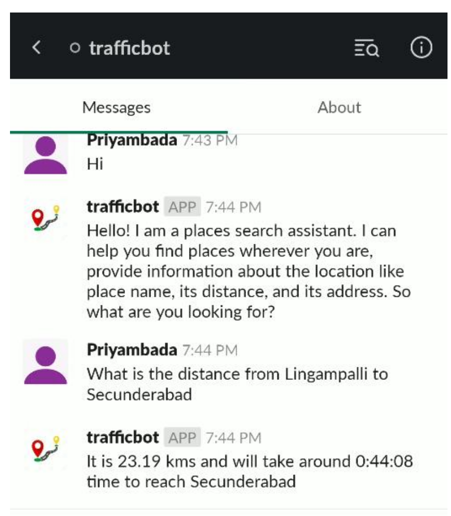
by Tetsuhiro Ishizaka (Group 2 Leader) and Manuendra Sankar Desarkar (Group 2 Co-Leader)

Group 2 of M2Smart project is working on Big Data Analysis – which involves analyzing the traffic data and giving relevant insights, and also aims to give the users information about traffic scenario. The group has analyzed the traffic flow at different junctions of the Ahmedabad city to predict the traffic volume at future hours. Different deep learning models were used to make these predictions. It was observed that the models that consider the temporal and spatial factors were best suited for making the predictions.

The group has also created a dataset to foster research in the direction of identifying future-traffic related posts from social media. The dataset (named L-TWITS) contains social media posts that talk about rallies, marches, road blocks etc. Identifying such posts can help in sending early notifications to commuters so that they can take routing decisions accordingly. The group is also preparing a conversational engine for answering transport-related queries. It is envisaged to be a single platform for answering queries of diverse range such as route finding, distance finding, finding modes of transportations to reach from a source to a target, finding addresses of nearby POIs etc.




*Group-2 Presentation in the JCC meeting*




*Conversational system for answering traffic-related queries*

# Group 3: Advanced traffic operations and management techniques for low carbon society

by Digvijay S. Pawar (Group 3 Leader) and Tsutomu Tsuboi (Group 3 Co-Leader)

Vehicular pollution has grown at an alarming rate due to growing urbanization in India. The air pollution from a vehicle in urban areas, particularly in big cities, has become a serious problem. The main pollutants emitted from vehicles are carbon monoxide (CO), nitrogen dioxide (NOx), and carbon dioxide (CO2), causing serious environmental and health impacts. Auto-rickshaws are an important para transit mode of urban and rural transportation in India. Due to an increase in the number of auto-rickshaws and limited use of control strategies. The rickshaws are emerging as the major source of pollutants in urban and rural areas. The present study measures the real-world emission from three-wheeler auto-rickshaws using a portable emission measurement system (PEMS) for urban and rural traffic conditions as shown in Figure 1.

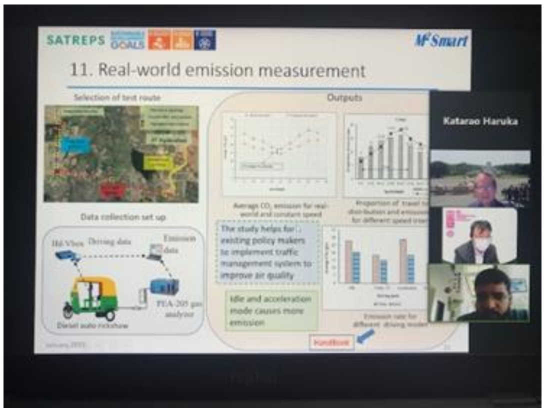
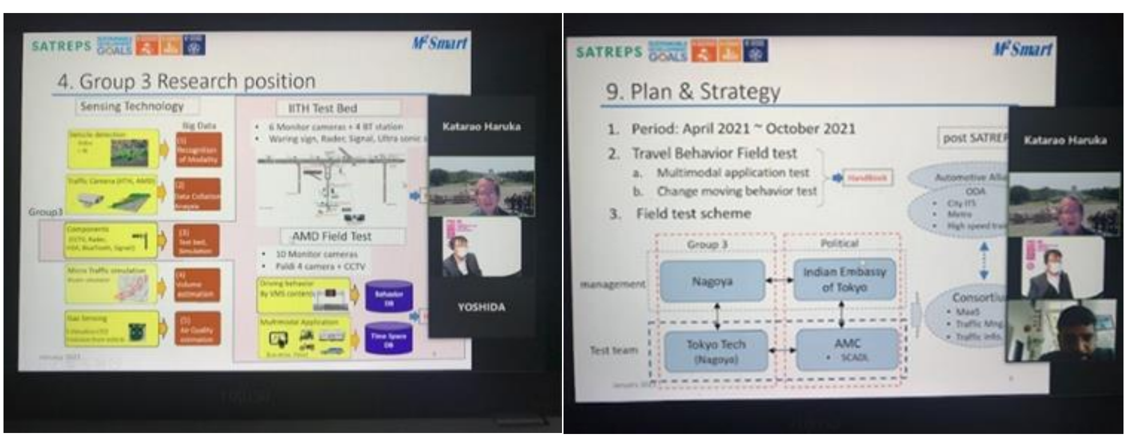



Figure1. Real-world emission measurement from auto rickshaws

The study investigates the effect of speed and driving modes (acceleration, deceleration, idle, and cruising) on emission rates (CO2 and CO) (Figure 1). The emission factors obtained from the study were found to be significantly higher than Bharat stage (BS) emissions standards. The insight from the study helps researchers and policymakers to understand the emission factors from different traffic conditions which are necessary to plan appropriate mitigation strategies for better air quality.

The Group 3 has responsible for overall test equipment installation in IITH campus and in Ahmedabad. All test equipment installation has been done by 2019. Therefore, we are able to collect traffic data through internet even under COVID-19 condition. However, some research activities have impact by COVID-19 because of lock-down in Hyderabad IIT campus and Ahmedabad. The biggest impact was Ahmedabad field test.

In terms of Ahmedabad field test, Dr. Tsuboi has visited Indian Embassy in Tokyo to meet Minister for requesting strong support of Ahmedabad field test after COVID-19 control. We succeeded to receive Minister's commitment for our SATREPS field test support and informed to Commissioner of AMC.




Group-3 Presentation in the JCC meeting

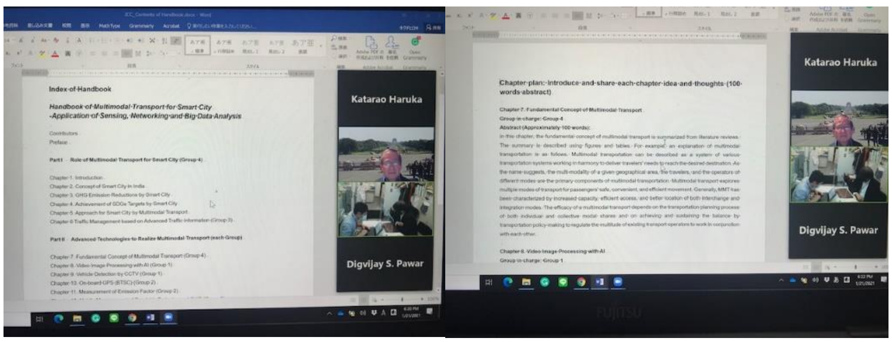
# Group 4: Summary of Handbook

by Atsushi Fukuda (Group 4 Leader) and Hiroki Kikuchi

The provisional title of the handbook is "Handbook of Multimodal Transport for Smart City -Application of Sensing, Networking and Big Data Analysis-". This handbook aims to introduce advanced technologies to realizing smart cities by multimodal transport by summarizing the results of M2 SMART. It consists of two parts of "Role of Multimodal Transport for Smart City" (Part I) and "Advanced Technologies to Realize Multimodal Transport" (Part II).

In Part I, the outline of multimodal transport for a smart city will be introduced. This chapter will summarize the matter related to the smart city such as its concept in India and approach for the smart city by multimodal transport.

In Part II, the developed individual methodologies for the smart cities by multimodal transport will be presented with some case studies. This chapter will introduce 10 developed technologies such as video image processing with AI, Variable Message Systems (VMS), and mobile applications for multimodal transport.




*Group-4 Presentation in the JCC meeting*

# Travel Time Prediction and Route Performance Analysis in BRTS based on Sparse GPS Data

by Anand Kakarla, Tetsuhiro Ishizaka (Group 2 Leader), Atsushi Fukuda (Group 4 Leader), Soumya Jana (Group 4Co-Leader)

A Bus Rapid Transit System (BRTS) with ear-marked lanes potentially provides efficient public transportation, and helps in controlling urban traffic congestion. While travel time prediction (TTP) is essential in a BRTS, existing algorithms generally assume GPS logs available at short uniform intervals. However, those are rarely evaluated on BRTS in emerging economies, where logged GPS data could be available at sparse no uniform intervals. To fill the gap, we study the efficacy of certain well known ML models, namely, Random Forests (RF), Light Gradient Boosting (LGB), and Extreme Gradient Boosting (Xgboost, XGB) in utilizing historical data. Performance of those ensemble learning methods is compared with that of conventional travel time prediction (CTTP) method, which uses historical averaging. It was found that XGB was superior to other methods at hand, and the prediction error by approximately 60% compared to the CTTP method. Alongside improving the experience of commuters, the proposed XGB-based TTP method also improves the estimation of intersection crossing time (ICT), which potentially leads to efficient traffic policy making.

We furnish in Figure 1, the scatter plot of TT predicted by XGB against recorded value of TT, and observe a high correlation coefficient of 99.4\%. The fraction of unexplained variance (FVU) also has a desirably low value of 1.2\%.

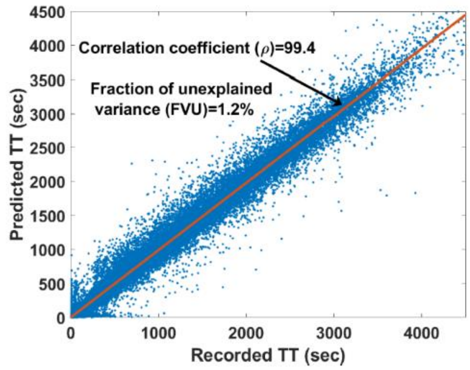



*Figure 1. TT predicted by XGB model versus recorded TT.*

# Wi-Fi based Road Traffic Monitoring System with Channel Hopping Functionality

by Anshika Chourasia, Bheemarjuna Reddy Tamma (Co-Project Manager) and Antony Franklin A (Group 3)

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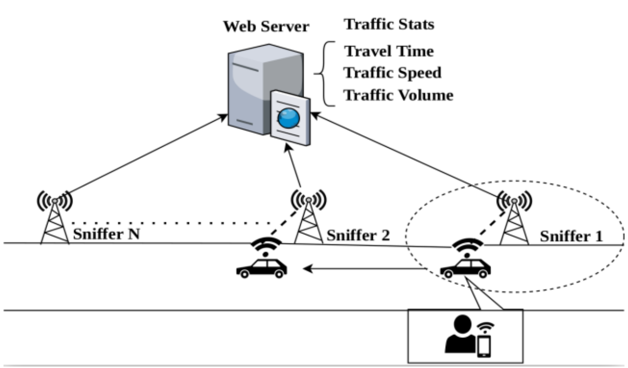
We have presented a paper titled "Wi-Fi based Road Traffic Monitoring System with Channel Hopping Functionality" in the 7th international workshop on Intelligent Transportation Systems (ITS), COMSNETS 2021 held in Bengaluru, India in online mode. This paper utilises a Wi-Fi based road-side sniffer system for estimating the traffic stats on roads i.e., travel time, average speed, and the total volume of road segments. Wi-Fi has been gaining momentum in traffic stats estimation for the past few years because of the ubiquitousness of smartphones.

The figure given below shows the proposed sniffer system which passively collects Wi-Fi packets sent by the smartphones present inside vehicles. Sniffers capture the Medium Access Control (MAC) addresses of the devices and send them to a remote ITS server for further analysis. The uniqueness of these MAC addresses helps in tracking devices and thereby estimate the traffic stats in points of interest.

Compared with the other state-of-the-art static techniques, a dynamic (i.e. channel hopping) algorithm is proposed for travel time and average speed estimation on road segments using Wi-Fi probes. Hopping Interval (HI) is the time duration after which the sniffer's Wi-Fi radio is changed to one of the available channels in the unlicensed ISM band on which Wi-Fi radios operate on. Among all the 11 channels in the 2.4 GHz ISM band, three orthogonal channels have been chosen for the channel hopping set. It is concluded through simulations that the estimation error depends on the HI and the segment's average traffic speed. According to the current traffic, choosing HI's optimal value increases the system's performance.



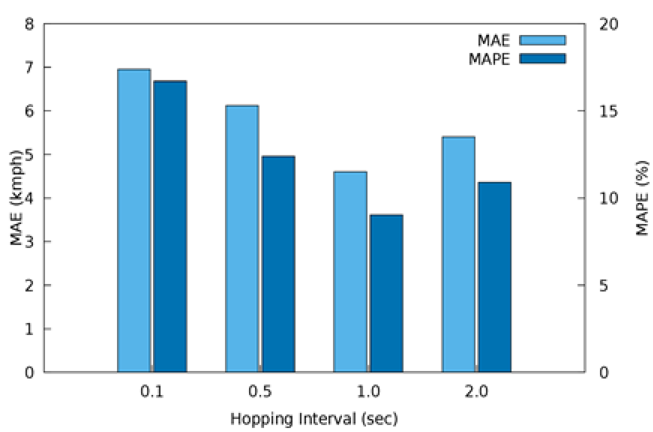




*Fig: System Architecture*

*Fig: Variation in Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) with Hopping Interval for the average traffic speed of 55 kmph*

# Message from Graduating RA

## Traffic Sensing using LiDAR

by Vivek Barsaiyan

I would like to thank Prof. P. Rajalakshmi for giving me this opportunity and her guidance. I also would like to thank "M2Smart: Smart Cities for Emerging Countries based on Sensing, Network and Big Data Analysis of Multimodal Regional Transport System", JST/JICA SATREPS, Japan" project for supporting throughout the journey. I am also thankful to my entire team - Bhaskar Anand and Mrinal Senapati for their collaborative work.

I have worked on different LiDAR point cloud datasets. Point cloud gives the 3D perception of the surrounding environment, further useful for multiple computer vision applications viz object detection, classification. I have also explored multiple online available datasets (KITTI dataset) to understand features available in the point cloud and their application for multiple deep learning algorithms (SqueezeSeg, Point Net). I was also involved in different experiments done using Ouster LiDAR on the IITH campus.

# Publications

## Journals

- Tsutomu Tsuboi, "Design of Cities and Buildings - Intelligence, Sustainable and Resilience Built Environment -Traffic Flow Analysis and Management", IntechOpen, DOI: 10.5772/intechopen.9508, Mach, 2021.
- Tsutomu Tsuboi, "Traffic Congestion Triangle" Based on More than One-Month Real Traffic Big Data Analsysis in India, Advances in Science, Technology and Engineering Systems Journal ISSN:2415-6698), Vol.5 Issue 6, pp.588-593, November, 2020.
- Tsutomu Tsuboi, "Visualization and Analysis of Traffic Flow and Congestion in India", Open Access Journals-Infrastructire, (ISSN 2412-3811), March, 2021.

## Conference presentations

- Anand Kakarla, V. S. K. R. Munagala, Tetsuhiro Ishizaka, Atsushi Fukuda, Soumya Jana, "Travel Time Prediction and Route Performance Analysis in BRTS based on Sparse GPS Data" VTC 2021-Spring, Virtual Conference. (Virtual presentation date : 25 April 2021)

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