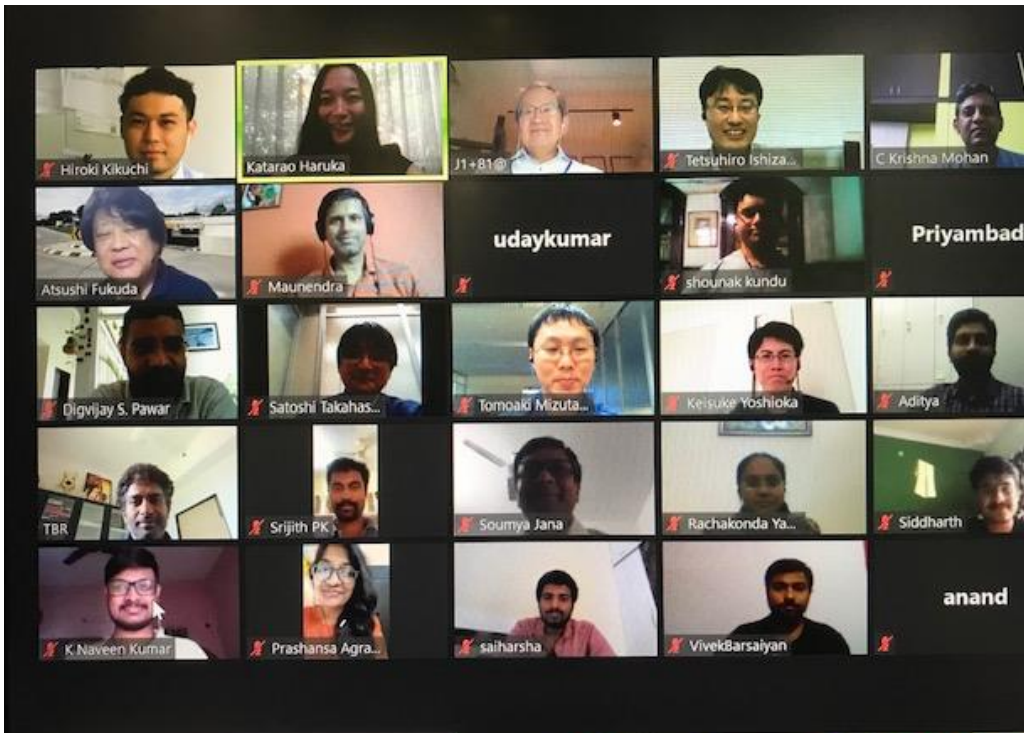


M2SMART PROJECT ONLINE MEETING

M2Smart NewsLetter

Vol.9

Oct 2020

M2Smart Project JST mid-term review and presentation to the Indian Embassy in Tokyo

by Tsuboi Tsutomu (Project Leader)

Continuation of the Project remotely

Japan Science and Technology Agency (JST) Intermidiat Review presnantion was conducted on 22 July in Tokyo and we presented our project research activities to the external reviewers of the Science and Technology Research Partnership for Sustainable Development (SATREPS) organization. As the intermediate review of the SATREPS, we recived "A" score.

Nagoya Electric Works had a meeting with Ms. Mona Khandhar, Minister Economic & Commerce, Indian Embassy in Tokyo and shared our M2Smart Project activities. After the meeting, Ms.Khandhar sent an email to the Commissioner of Ahmedabad Municipal Corporation (AMC) about providing strong support for M2Smart Project and we recived their support comment from the Commisioner of AMC.

Presentation slide for the JST Mid-term review

Ms. Khandhar and Ms. Kajimoto from Indian Embassy in Tokyo and Mr.Hattori, CEO and Mr.Muto, General Manager and Dr.Tsuboi from Nagoya Electric Works, 6th of July

Real-Time Detection of Motorcyclist without Helmet using Cascade of CNNs on Edge-device

by C Krishna Mohan (Group 1 Leader)

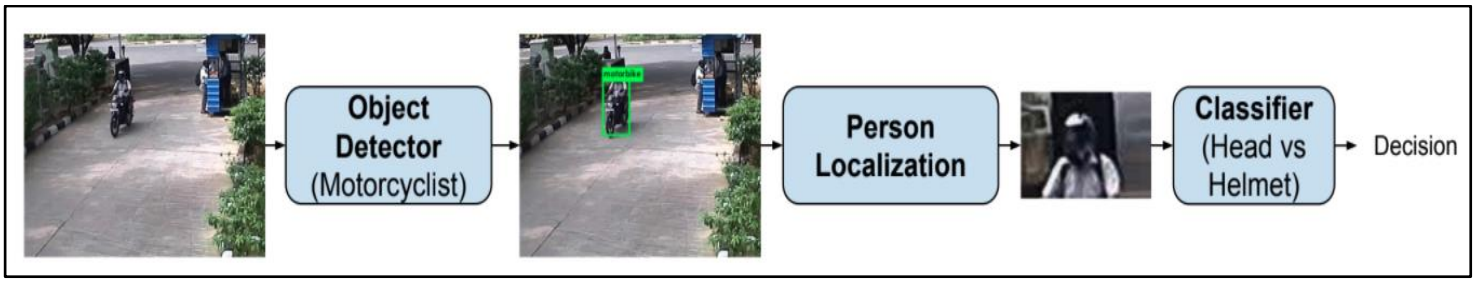


Fig1. Block diagram of proposed framework for the detection of motorcyclists without Helmet

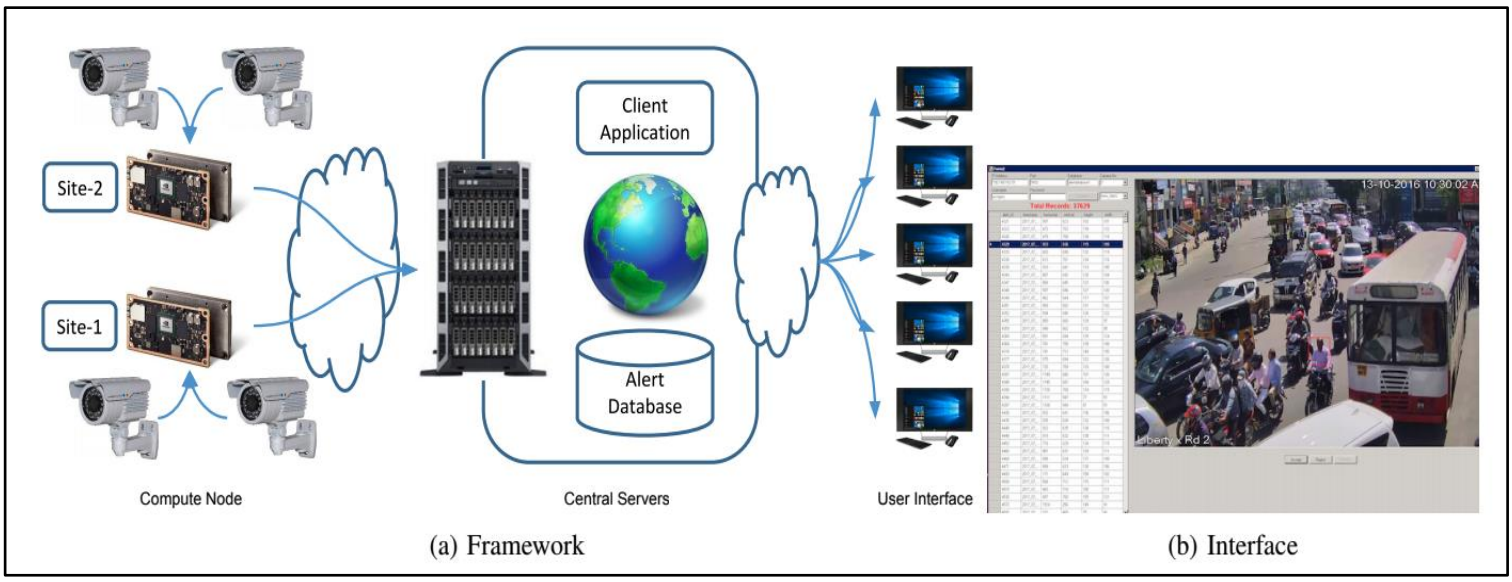
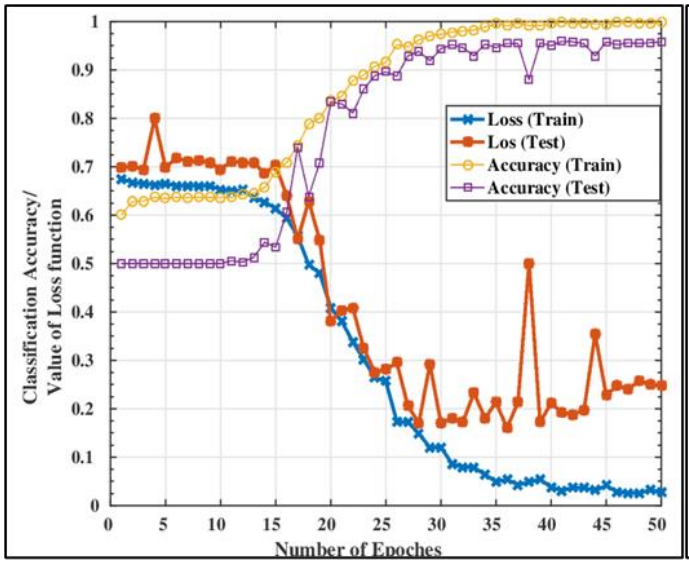


Fig2. The architecture and user interface of the proposed edge computing-based framework for the detection of violators

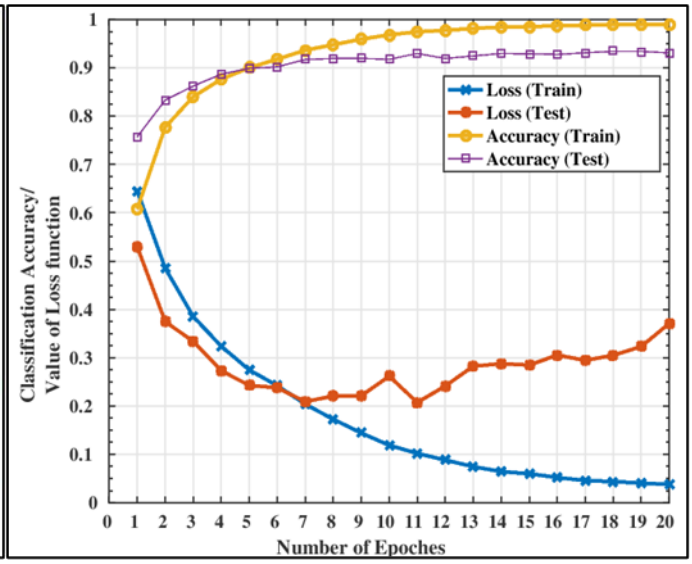
The real-time detection of traffic rule violators in a city-wide surveillance network is a highly desirable but challenging task because it needs to perform computationally complex analytics on the live video streams from a large number of cameras, simultaneously. In this work, we propose an efficient framework using edge computing to deploy a system for automatic detection of bike-riders without helmets. First, we propose a novel robust and compact method for the detection of motorcyclists without helmets using convolutional neural networks (CNNs). Then, we scale it for the real-time performance on an edge-device by dropping redundant filters and quantizing the model weights. To reduce the network latency, we place the detector module on edge-devices in the cameras. The edge-nodes send their detected alerts to a central alert database where the end users access these alerts through a web interface. To evaluate the proposed method, we have collected two datasets of real traffic videos, namely, IITH Helmet 1 which contains sparse traffic and IITH Helmet 2 which contains dense traffic. 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.

An intelligent transportation system is the integration of various advanced technologies such as intelligent computing, network communications, visual representation, visual-based analysis, efficient sensor electronics. Since, motorcycles are an affordable and daily mode of transport, there has been a rapid increase in motorcycle casualties due to the fact that most of the motorcyclists do not wear the helmet which makes it an ever-present danger every day to travel by motorcycle. The main contributions of this paper are, a)Design of a robust and reliable method for detection of moving motorcyclists in real-time using convolutional neural network (CNN) under the various challenging conditions, such as viewpoint, illumination effects, weather change, etc., b)Acceleration of the CNN model used to detect motorcyclists in real-time on the limited-resource embedded device. c)Develop lightweight but powerful CNN model for efficient classification of head (i.e. violator) and helmet, with very limited set of training samples. d)Use of an Edge-computing framework to overcome the communication overhead and network latency.

The proposed framework for real-time detection of motorcyclists driving without helmets is able to perform in diverse surveillance conditions. Also, there is a significant reduction in the number of false alarms because of the use of cascaded CNNs. The placement of the detector modules in the vicinity of the capturing devices in an edge-computing framework reduces the communication overhead and solves the issue of network latency. The experimental results show the efficacy of the proposed approach.



IITH_Helmet_1 classification accuracy during H-Net training



IITH_Helmet_2 classification accuracy during H-Net training

[1] Q. Wang, J. Wan, and Y. Yuan, "Locality constraint distance metric learning for traffic congestion detection," Pattern Recognition, 2017.

[2] Y.-B. Lin and C.-P. Young, "High-precision bicycle detection on single side-view image based on the geometric relationship," Pattern Recognition, vol. 63, pp. 334 – 354, 2017.

[3] D. Singh, C. Vishnu, and C. K. Mohan, "Visual big data analytics for traffic monitoring in smart city," in IEEE ICMLA, Anaheim, California, 18–20 December 2016.

"SafeNav: A Cooperative V2X System using Cellular and 802.11p based Radios Opportunistically for Safe Navigation"

by Suhel Sajjan Magdum, Antony Franklin (G2 and G4), Bheemarjuna Reddy Tamma (M2Smart Co-Project Manager), Digvijay S. Pawar (G3 Leader)

The V2X communication technologies are gaining popularity in recent times for various transport applications such as autonomous driving, collision avoidance, traffic management, etc. All these come with the addition of communication technologies in the vehicle. While there are various communication technologies being considered for V2X each one of them have their own advantages and disadvantages. Relying on a single radio or V2X mode of communication is not desirable in the design of V2X systems of the future. In the absence of dedicated ITS communication infrastructure on the road side, we can rely on other communications technologies such as Wi-Fi Direct for V2V (vehicle to vehicle) communication and 4G/5G for V2N (vehicle to network) communication. If direct V2V communication using Wi-Fi is not possible with other vehicles due to the absence of Wi-Fi or restricted communication range, vehicles can rely on 4G/5G network for indirect mode of communication using V2N. To capitalize the benefits of both V2V and V2N, we proposed a cooperative and distributed V2X architecture based on the radios present in the vehicles (WiFi or cellular) for reliable and scalable communication among the vehicles. Below figure shows the proposed distributed V2X architecture for safe navigation which consists of three layers: vehicles, base stations, and an edge relay server. We can run safety applications in vehicles or offload some tasks to edge server via base stations whenever possible. The effectiveness of the proposed V2X system is demonstrated by developing a collision warning system for safe navigation named SafeNav. Simulation results suggest that using both V2V and V2N modes of communication significantly improves the reliability of safety message exchange and visibility of neighbouring vehicles especially in hybrid scenarios where the vehicles have either cellular or WiFi based radios. An Android app has been developed to further demonstrate the usefulness of the proposed system for collision avoidance in a real-world scenario. Below figure shows a screenshot of SafeNav user interface. We tested the app in a a cross section with three vehicles approaching towards each other. If any of other two vehicles comes into the collision domain, visual and audible alerts are generated by changing the color of such vehicles to red and giving beep sounds.

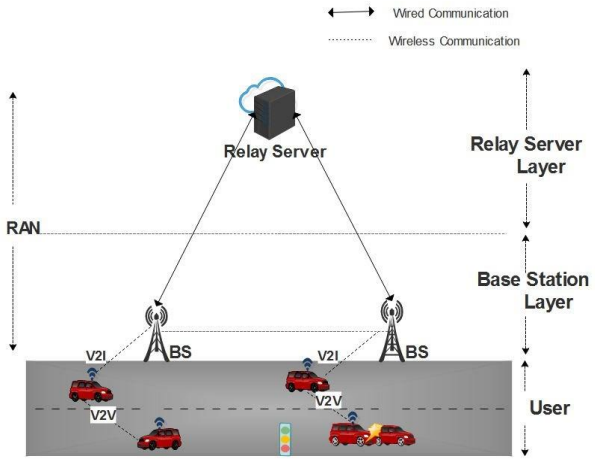


Fig: Distributed V2X architecture for safe navigation

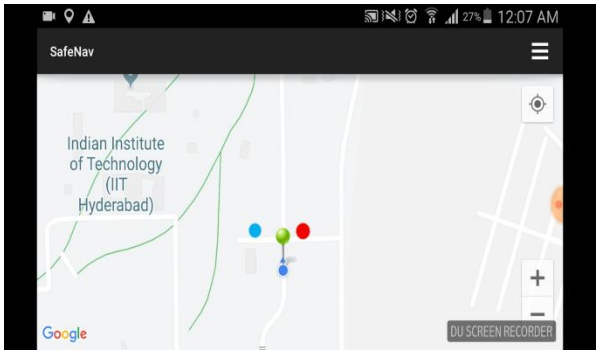


Fig:SafeNav: Android App demonstrating three vehicles approaching at a junction

Network Traffic State around Paldi Intersection using Historical Traffic Data and Microscopic Fundamental Diagram

by Tesuhiro Ishizaka (Group 2 Leader)

The main goal of group 2 is to generate insights to help in better city and travel planning to avoid congestion based on not only available information obtained from various sources, but also estimated traffic state using various cutting edge-technogoly and theoritical traffic modeling. One trial of applying theoritical traffic modeling into rich historical traffic camrea data is shown in this newsletter as a part of group activites. The histrical traffic data using the traffic camera covers the area in west side of Ahamedabad citiy, including the Paldi intersection where is our main target point. However, The traffic volume, speed et al collected by the traffic seonsor show only perspective of traffic state which is expressed on local spot area under traffic camera. On the other hand, the Microscopic Fundamental Diagram(MFD) to express network traffic state had been proposed by Carlos F. Daganzo(2007). We applied this model into the histrical traffic data around Paldi insetersection to express wide network traffic state. We expect it might be one tool to analyze and evaluate impact on traffic imporvement by Various Message Sign Boards. Anyway,in first trial of applying MFD, the general fundamental diagram and MFD was drawn in the figure. In furthure study, we should consider quality of histrical traffic data and also the theoritical condition of MFD.

Fig. General Fundamental Diagram of spot area under traffic camera

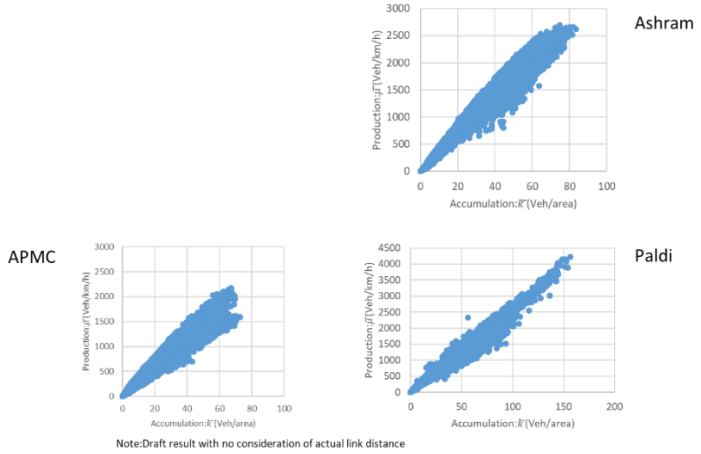


Fig. Microscopic Fundamental Diagram in three area surrounded Paldi intersection

Incident Detection From Social Media Targeting Indian Traffic Scenario Using Transfer Learning

by Maunendra Sankar Desarkar (Group 2 Co-Leader), Shounak Kundu and Priyambada Ambastha

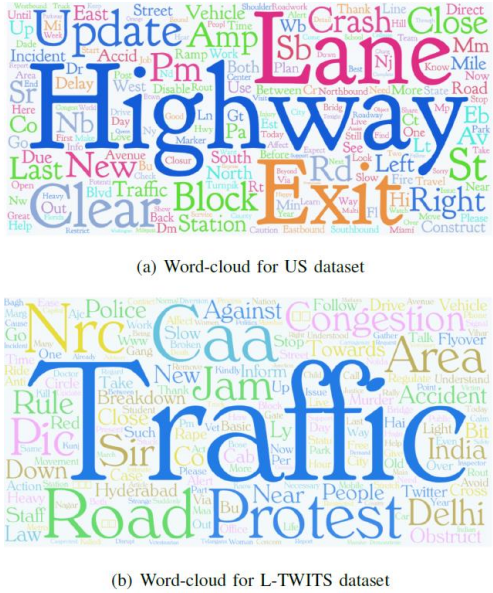
We have presented a paper titled "Incident Detection from Social Media targeting Indian Traffic Scenario using Transfer Learning" in The 23rd IEEE International Conference on Intelligent Transportation Systems on September 21st, 2020. The conference was to be held at Rhodes, Greece but due to unforeseen circumstances of the Covid-19 pandemic, the conference was hosted at a virtual platform. In this paper, we have addressed the road congestion problem by developing a system to detect traffic congestion in India using Twitter. Twitter has been gaining momentum for research in event detection for the past several years because many commuters, as well as traffic authorities, tend to post traffic-related updates in real-time.

Since there is no such traffic-tweet dataset for the Indian traffic scenario, we developed one such dataset using 3 different techniques. The dataset contains posts that talk about traffic incidents such as accidents, infrastructure damage, and also about future planned events that can impact traffic flow concerning different Indian regions. The dataset has been labelled into two classes- Traffic Incident (TI) and Non-traffic Incident (NTI). We call our dataset as L-TWITS (Labelled-TWeets for Indian Traffic Scenario).

Figure 1 shows the word clouds for our dataset and an existing dataset collected from the US. It can be seen that the prominent words present in our dataset are different from that in the US dataset. However, heavy usage of location mentions like highway, lane, street etc. in US tweets and marg, road, flyover etc. in Indian tweets indicate contextual similarity between many terms in the data acorss the two datasets. We can observe that factors affecting Indian traffic are road jam, congestion, protests, accidents, broken down vehicles etc. and for US, words like crash, block, roadworks, construction, disabled vehicles etc. are cited as reasons for traffic incidents.

Basic practice in literature for traffic event detection problems is to collect a large amount of data, obtaining its annotation and then further analysis for event extraction. Such approaches often require a considerable amount of time for labelling the data. To address this shortcoming the proposed method uses a Transfer learning-based classifier that generally performs well even with less data. ULMFiT model has been used as a Transfer Learning approach for classifying the tweet samples into "Traffic incident related" or "Non-Traffic incident related" category. The performance of different deep learning

Figure 2: Map with markers for the tweet locations



(a) Word-cloud for US dataset

(b) Word-cloud for L-TWITS dataset

Figure 1: Word cloud distribution for the datasets

algorithms on our dataset are shown in Table 1. It can be seen that ULMFiT performs batter than the other methods in terms of Precision, Recall and Macro-F1 score. Figure 3 shows the performance of the ULMFiT algorithm for different sizes of the training data. One can observe that ULMFiT can surpass the performances of the CNN and LSTM methods by just using 50% of the training data from the new dataset. To summarize, experimental results on our labelled dataset show that ULMFiT outperforms other classification models even with very small number of training data making our model a convenient one for extracting traffic-related information targeting Indian scenario. A validation dataset is created which contains tweets associated with heavy rains, floods and religious events from India. ULMFiT performed with 0.87 F1-Score for TI class in validation dataset which indicates that the model is not biased towards protest like traffic events and performed similarly on random data sample of different events.

Model	Precision	Recall	F1-Score (TI Class)	Macro Avg F1-Score
CNN	0.77	0.64	0.70	0.78
LSTM	0.79	0.74	0.76	0.82
ULMFiT	**0.84**	**0.89**	**0.86**	**0.90**

Table 1: Performance cmparison between different algorithms on the L-TWITS dataset

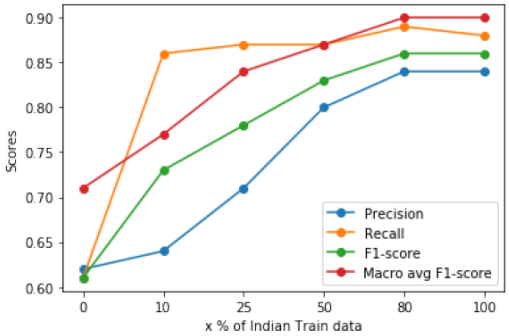


Figure3: Performance of ULMFiT on L-TWITS test set. x-axis

Publications

Conference presentation

- Debaditya Roy, K. Naveen Kumar, C. Krishna Mohan, "Defining Traffic States using Spatio-temporal Traffic Graphs", The 23rd IEEE International Conference on Intelligent Transportation Systems, September 20-23, 2020, Virtual Conference. (Virtual presentation date :22 September 2020)
- Dinesh Singh, C. Vishnu and C. Krishna Mohan, "Real-Time Detection of Motorcyclist without Helmet using Cascade of CNNs on Edge-device", The 23rd IEEE International Conference on Intelligent Transportation Systems, September 20-23, 2020, Virtual Conference. (Virtual presentation date :23 September 2020)
- Suhel Sajjan Magdum, Antony Franklin, Bheemarjuna Reddy Tamma, Digvijay S. Pawar, "SafeNav: A Cooperative V2X System using Cellular and 802.11p based Radios Opportunistically for Safe Navigation", The 23rd IEEE International Conference on Intelligent Transportation Systems, September 20-23, 2020, Virtual Conference.
- Priyambada Ambastha, Maunendra Sankar Desarkar, "Incident Detection From Social Media Targeting Indian Traffic Scenario Using Transfer Learning", 23rd IEEE Intelligent Transportation Systems Conference, IEEE ITSC 2020, Rhodes, Greece, September 20-23, 2020. (Virtual presentation date: 21 September 2020)
- Tsutomu Tsuboi, Noriaki Yoshikawa, "Traffic flow analysis in Ahmedabad (India)", Case Studies on Transport PolicyVolume 8, Issue 1, March 2020, pp.215-228. DOI: 10.1016/j.cstp.2019.06.001
- Tsutomu Tsuboi, "Quantitative Traffic Safety Analysis for India by Japanese Experience", Sociology Study Jan.-Feb. 2020 Vol.10, No.1, pp.1-14. DOI: 10.17265/2159-5526/2020.01.001
- Tsutomu Tsuboi, "Traffic Congestion Analysis and Occupancy Parameter in India", International Conference on Data Analytics and Management: An Indo-European Conference (ICDAM-2020), June 18, 2020.
- Tsutomu Tsuboi, "New Traffic Congestion Analysis Method in Developing Countries (India)", 6th International Conference on Vehicle Technology and Intelligent Transport Systems (VEHITS), 2-4 May 2020.
- Tsutomu Tsuboi, "Challenge of Traffic Flow Analysis in India by Traffic Theory", The 8th World Sustainable Froum 2020, 16 September 2020.

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