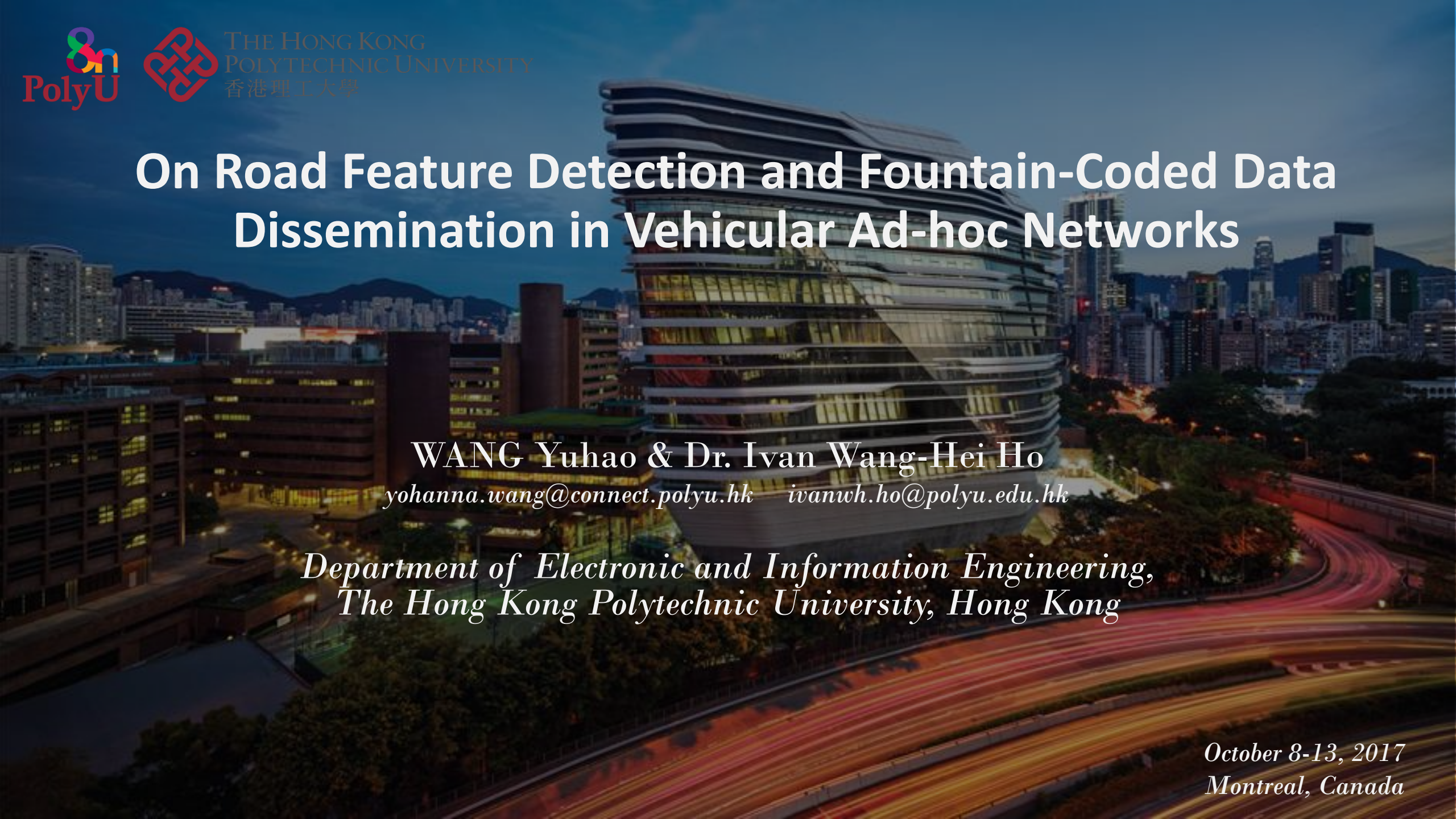


On Road Feature Detection and Fountain-Coded Data Dissemination in Vehicular Ad-hoc Networks

WANG Yuhao & Dr. Ivan Wang-Hei Ho

yohanna.wang@connect.polyu.hk *ivanwh.ho@polyu.edu.hk*

Department of Electronic and Information Engineering,
The Hong Kong Polytechnic University, Hong Kong

October 8-13, 2017
Montreal, Canada

Research background

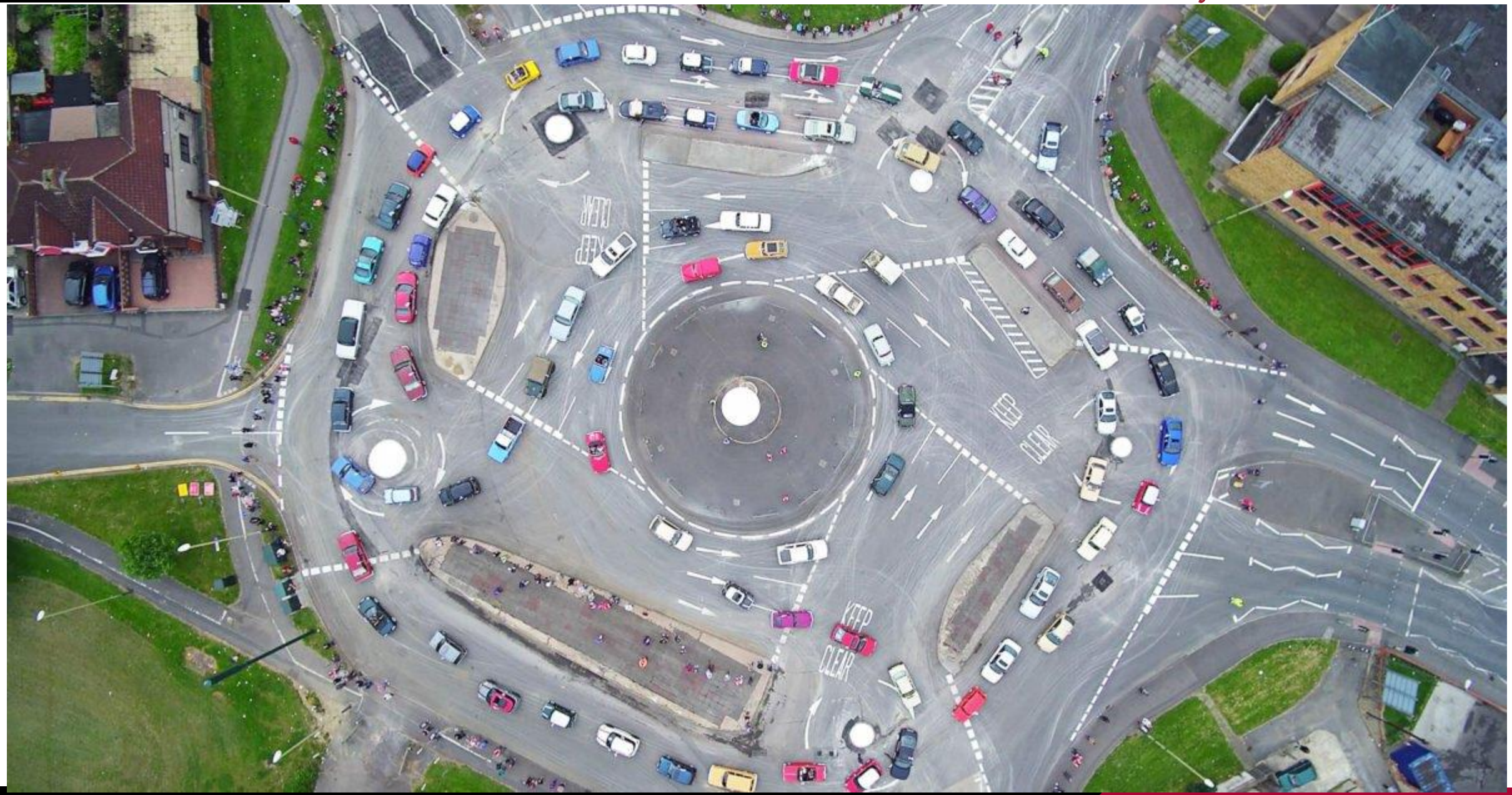
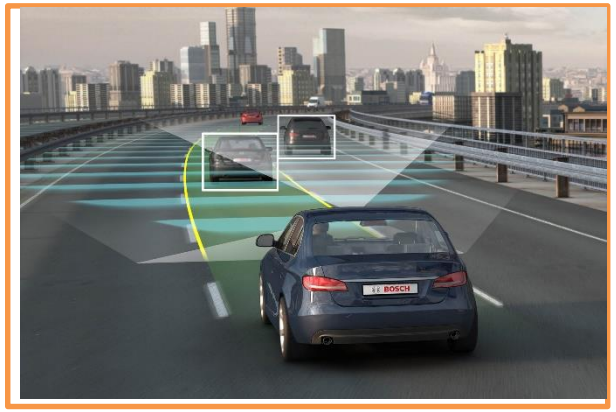
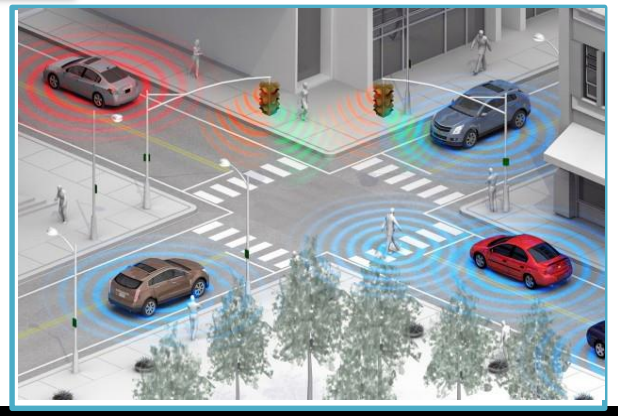


Fig.1. https://www.wired.com/2016/08/brilliant-sorcery-englands-7-circle-magic-roundabout/

Research background



Smart city



Challenges:

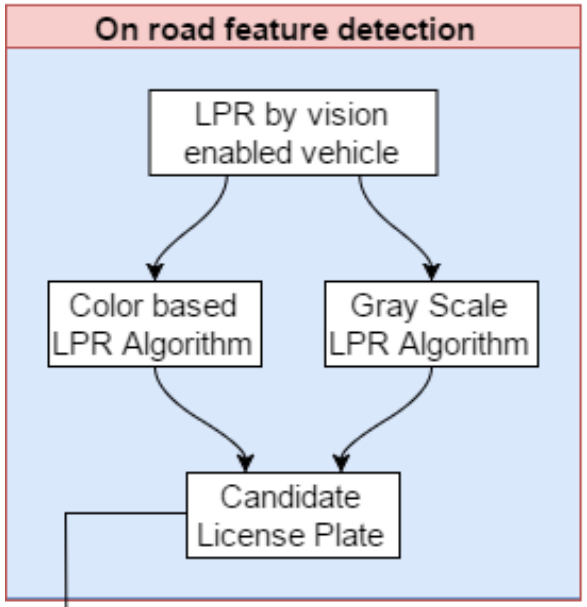
- Robust feature detection system;
- Inter-vehicle communication;
- Efficient data dissemination;
- Realistic vehicular mobility model;

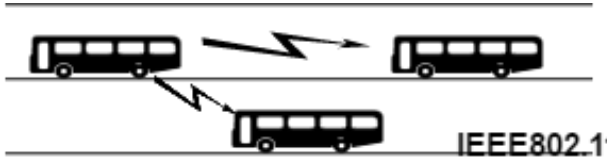
ITS
under
Smart city
framework

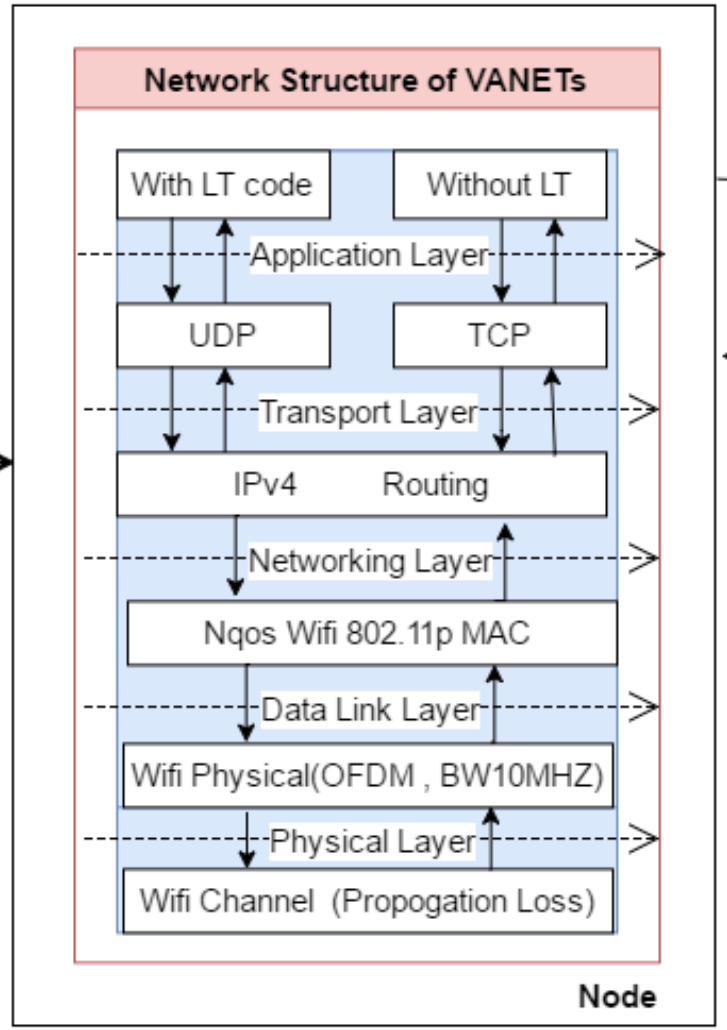
PolyU THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學

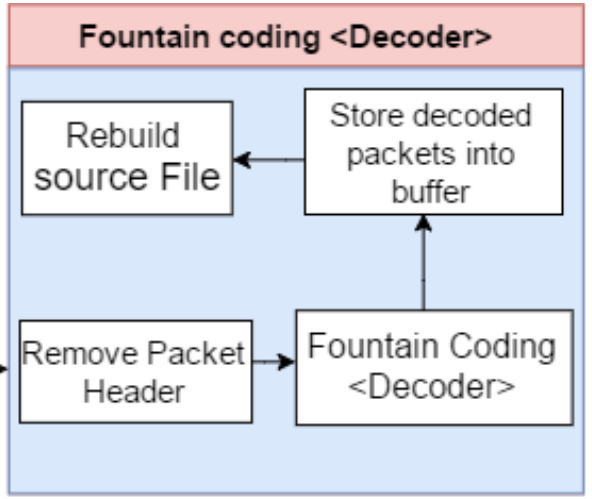
Fig.1. http://www.northamericanbancard.com/blog/mastercards-vision-of-the-smart-city
Fig.2. https://geobrava.files.wordpress.com/2013/03/vehicle-to-vehicle-communication-rendering-623x389.jpg?w=1400
Fig.3. http://editorial.autoweb.com/autowebs-guide-to-adaptive-cruise-control/

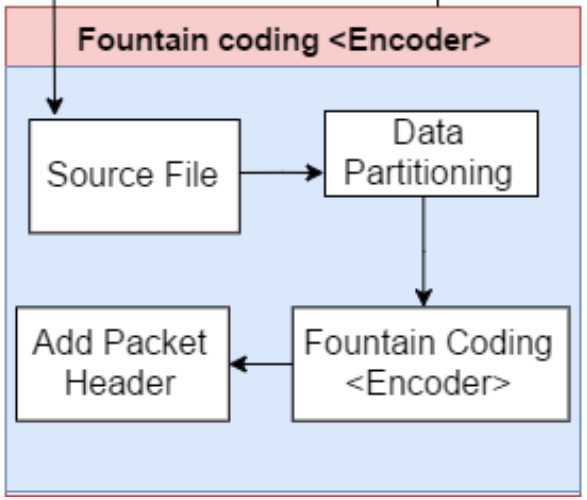
System framework

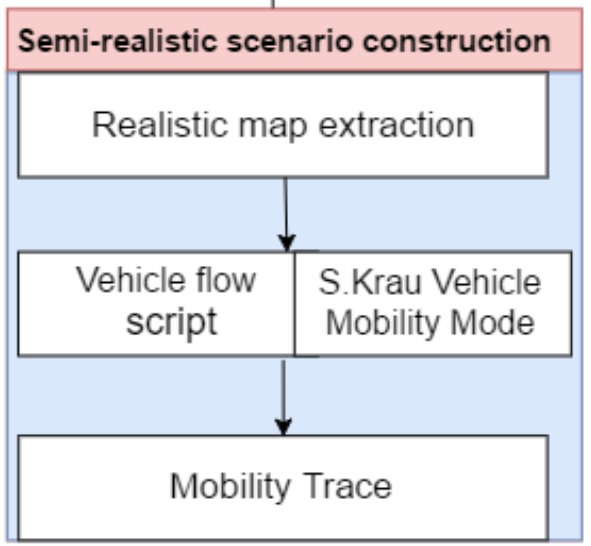


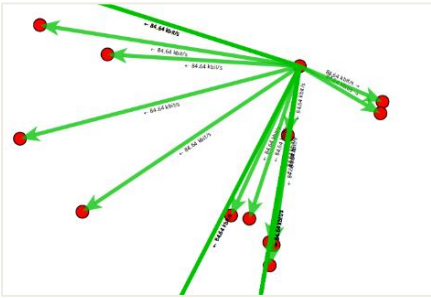


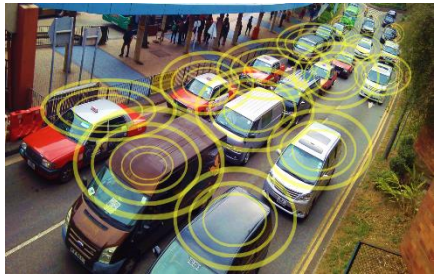


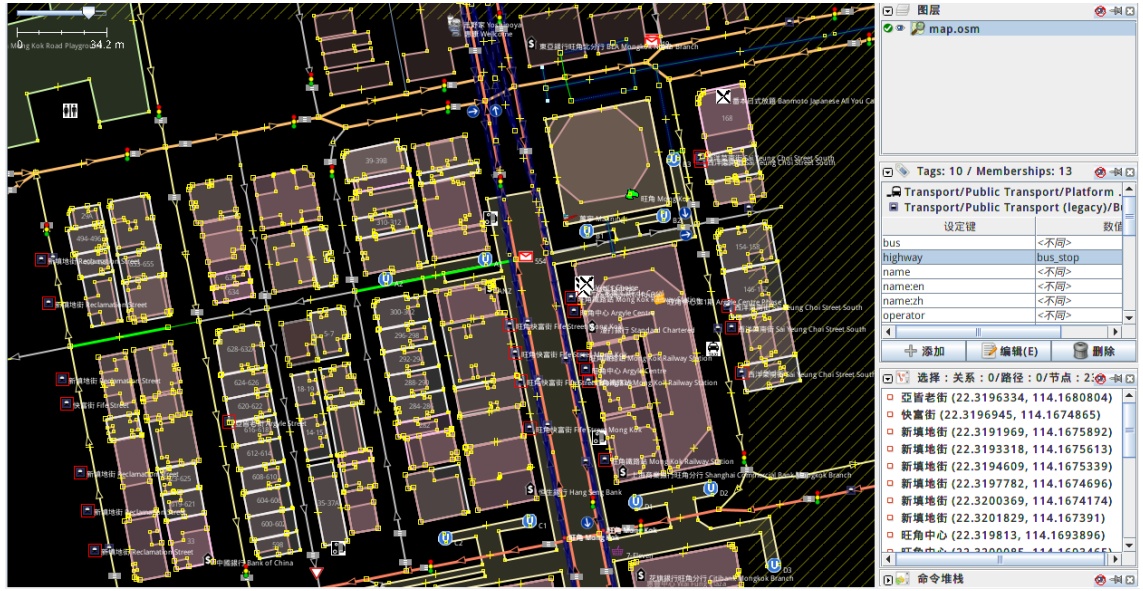




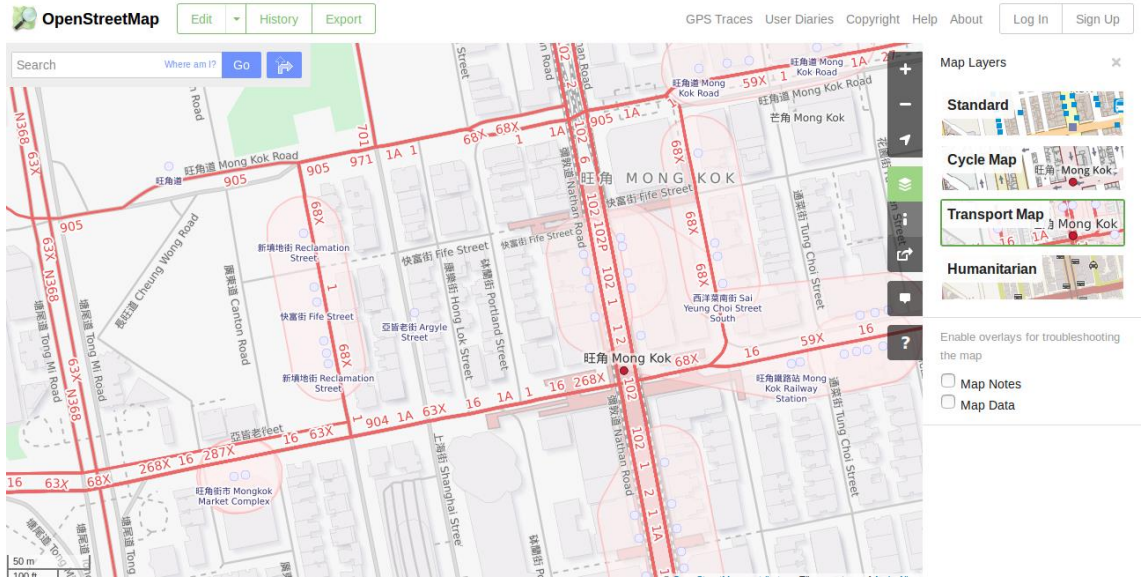




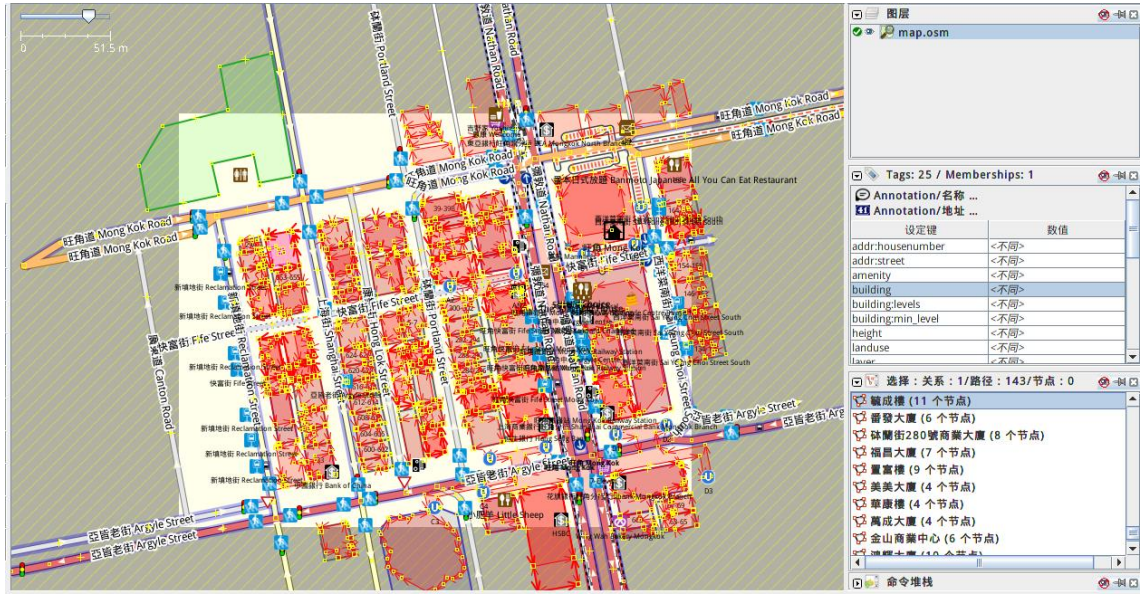




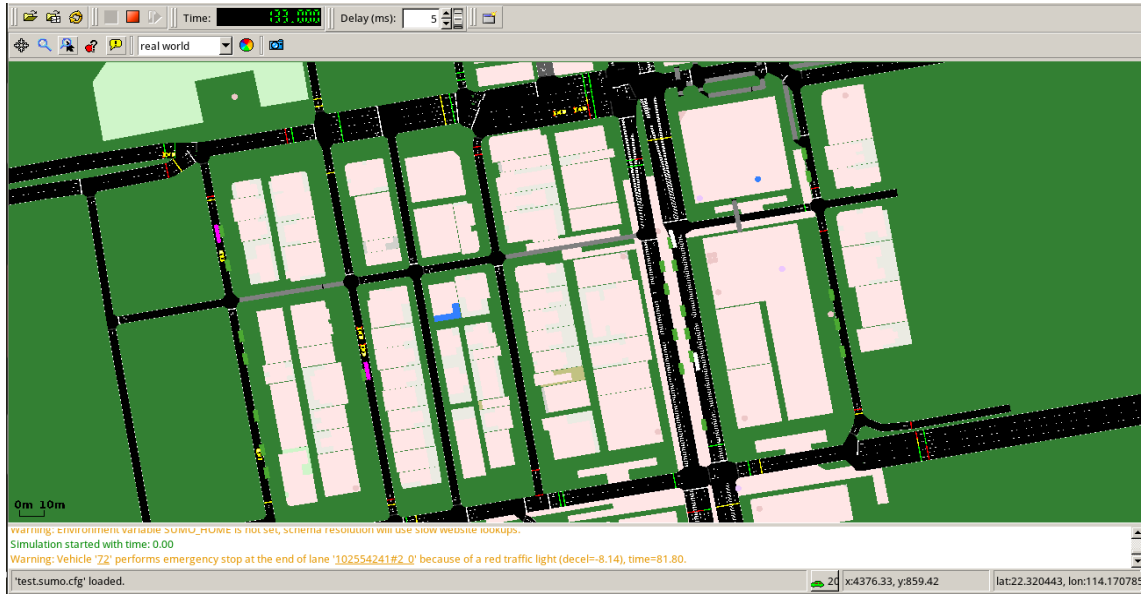
(a) Traffic infrastructure



(b) Bus routes



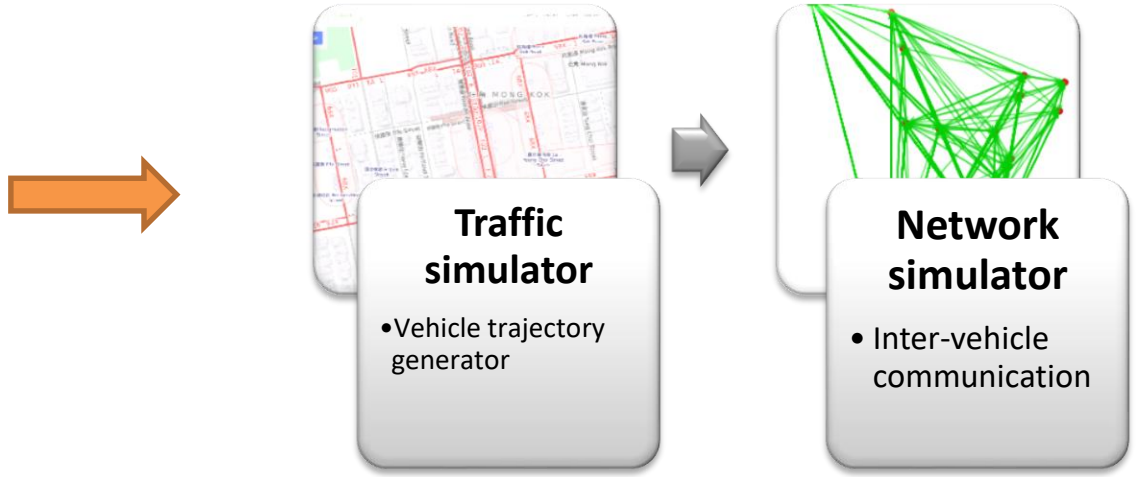
(c) Building topologies



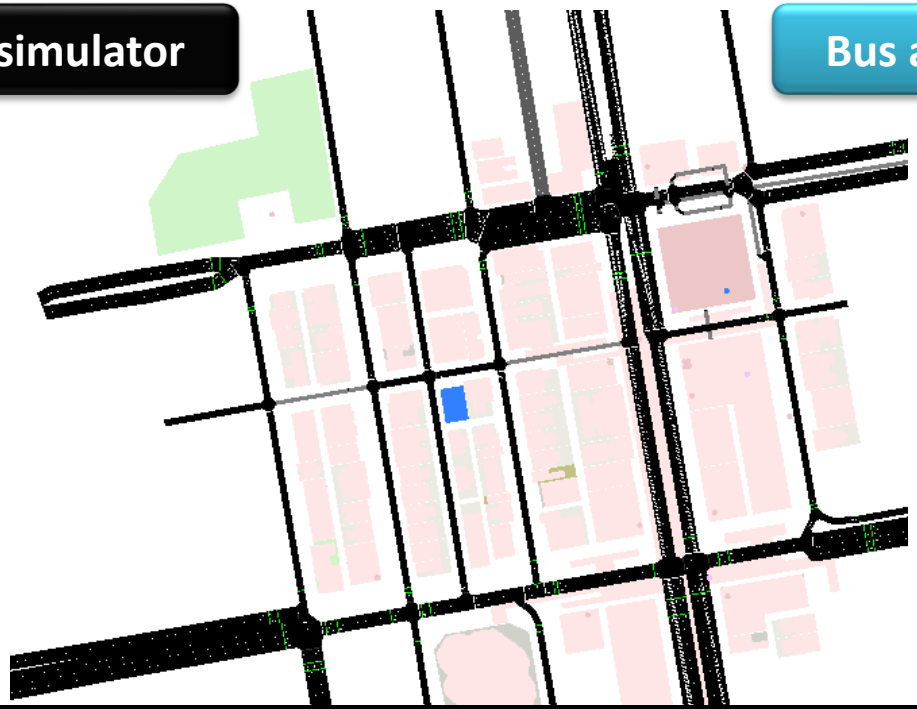
(d) Traffic scenario

Mobility model

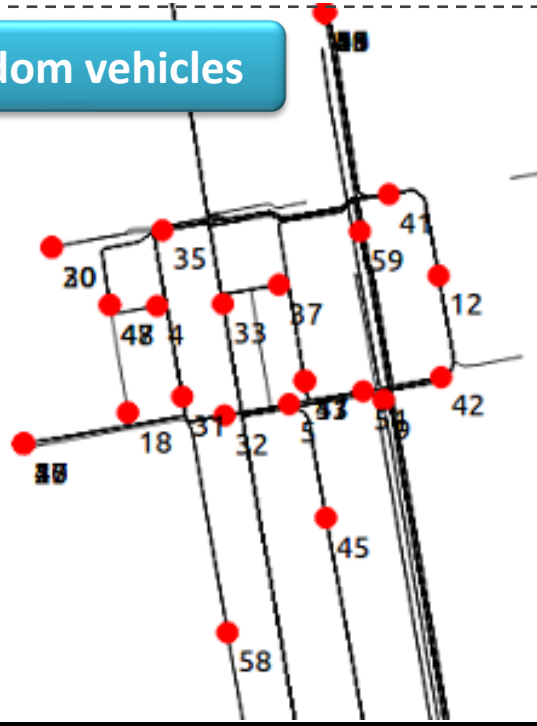
Area	Width	Height	Circumfe-rence	Buildings
10.110 ha.	274.441m	433.396m	1.565km	143
Bus Stations	**Traffic Lights**	**Bus lanes**	**Total nodes**	**Total edges**
23	29	78	282	110



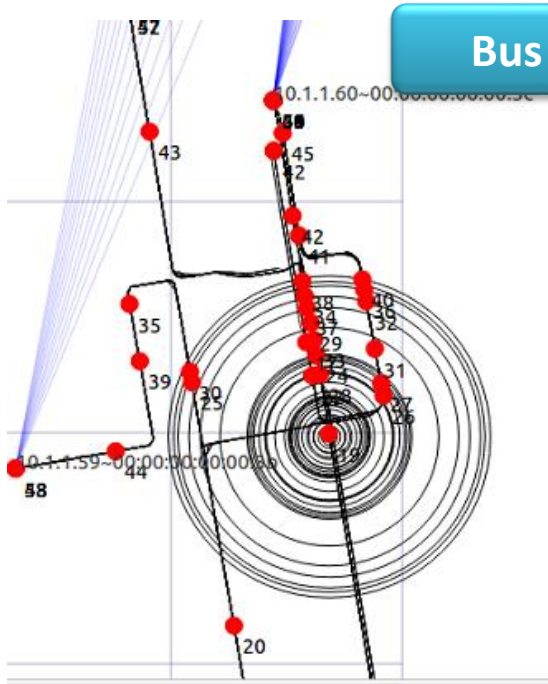
Traffic simulator



Bus and random vehicles



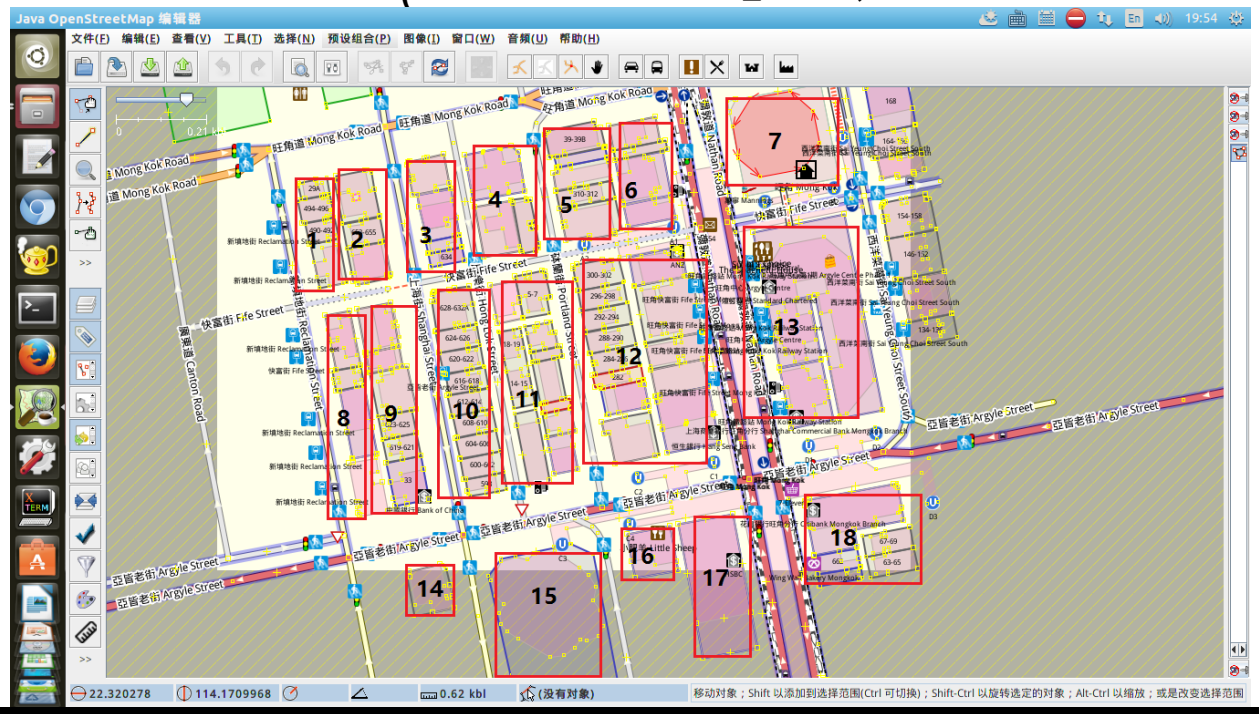
Bus only

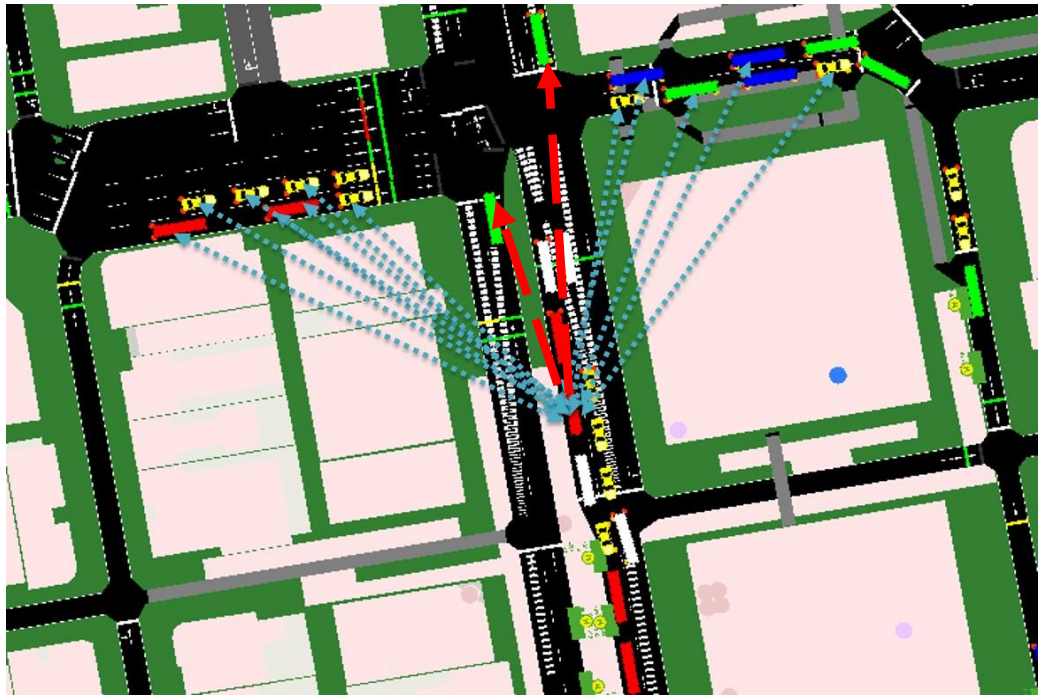


Building propagation loss

- **High frequency** (5.9 GHz);
- **Weak diffraction** ability;
- **Communication** can be affected by the **obstacles** in the urban scenario;

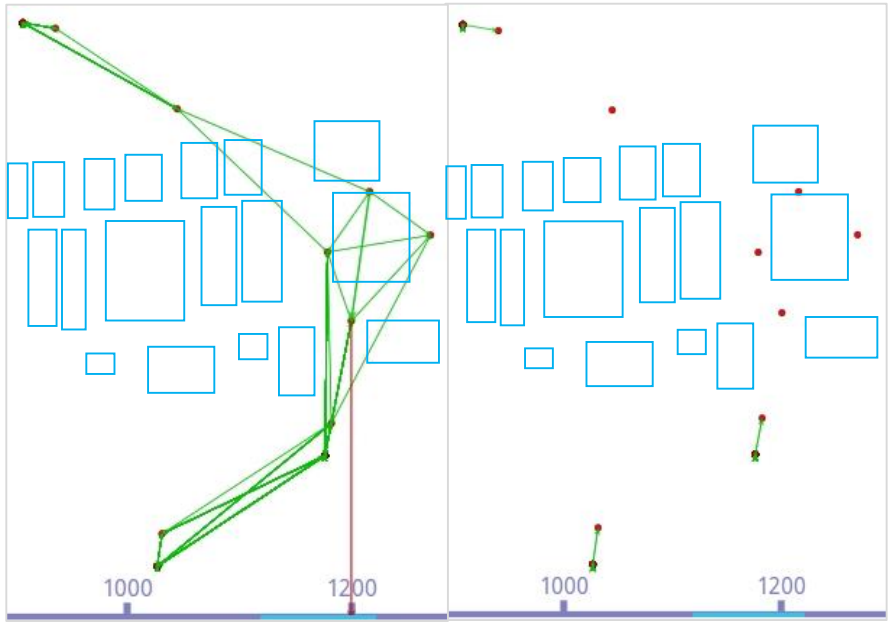
$$L_{V2V} = \begin{cases} ITU, & LoS \\ ITU + 2 \times Wall\_Loss, & NLoS \end{cases}$$

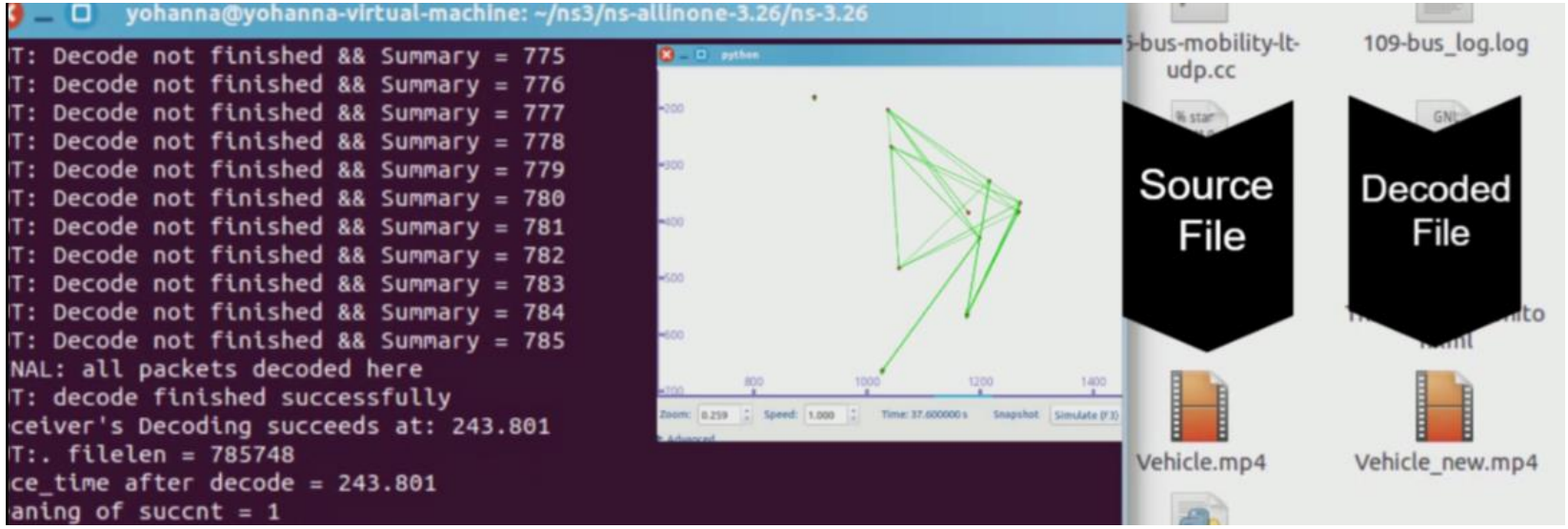




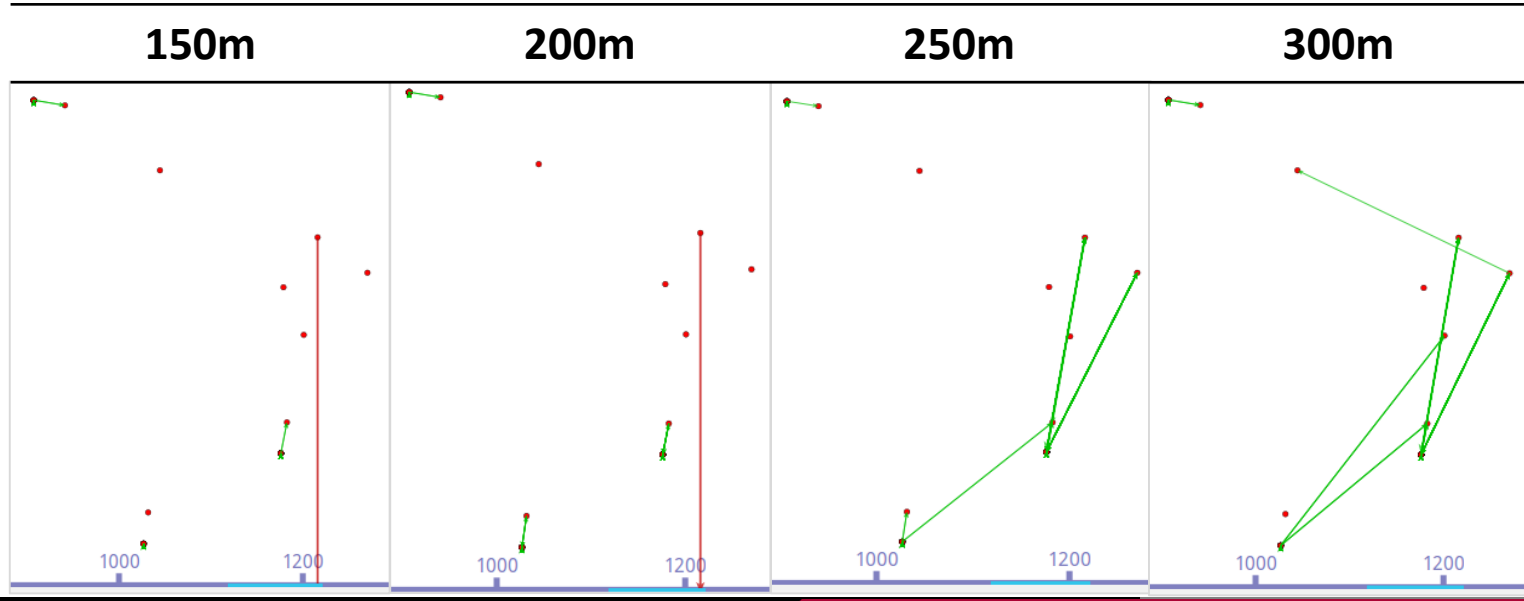
1. ▶ Get the position of Vehicle_a(x_1, y_1) and Vehicle_b(x_2, y_2);
2. for ($\alpha = 0.1; \alpha < 1; \alpha = \alpha + 0.1$)
3. {
4. Position_c(x, y)=($(\alpha x_1 + (1-\alpha)x_2), (\alpha y_1 + (1-\alpha)y_2)$);
5. ▶ Acquire the Mong Kok building boundaries;
6. if (c(x, y) drops into the building boundaries)
7. { loss model = NLoS; $L_{V2V} = ITU + 2 \times$ Wall_Loss;}
8. else {break;}
9. }
10. loss model = LoS; $L_{V2V} = ITU$;

Inter-vehicle communication

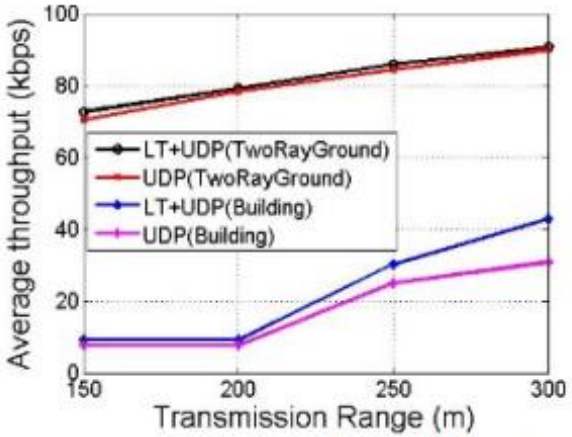




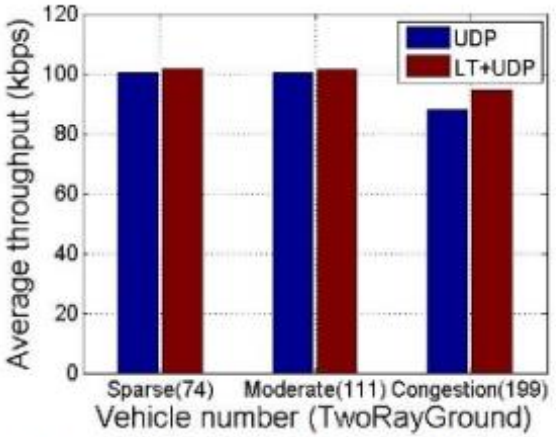
- **Data dissemination with fountain code**
- **Network connectivity**
  - ➢ Two-ray ground propagation loss
  - ➢ Building propagation loss model
- **Various signal transmission range**



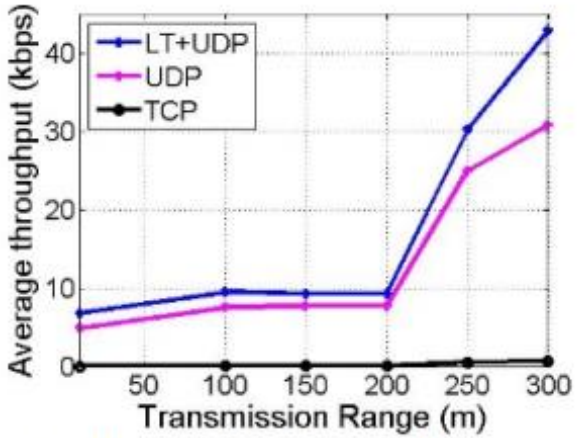
Average throughput comparison between UDP-LT, UDP and TCP



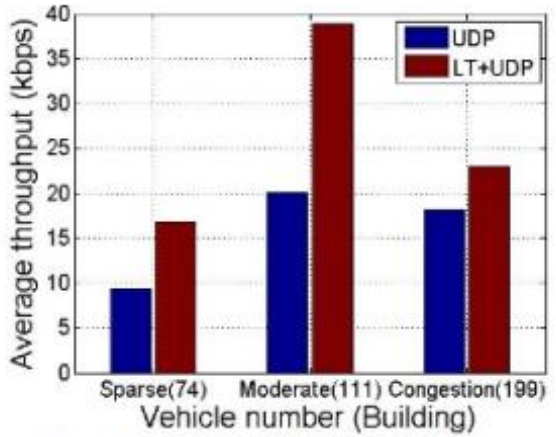
(a) (Sparse traffic condition)



(b) (Various traffic conditions)



(c) (Sparse traffic condition)



(d) (Various traffic conditions)

Parameters	Values
Routing protocol	GPSR (Greedy Perimeter Stateless Routing)
Propagation loss model	Building loss model/Two-ray ground + Range loss model
Transmission range	10-300m
Carrier frequency / MAC protocol	5.9 GHz / IEEE802.11p
Vehicle number	60 (30 pairs)

Image classification

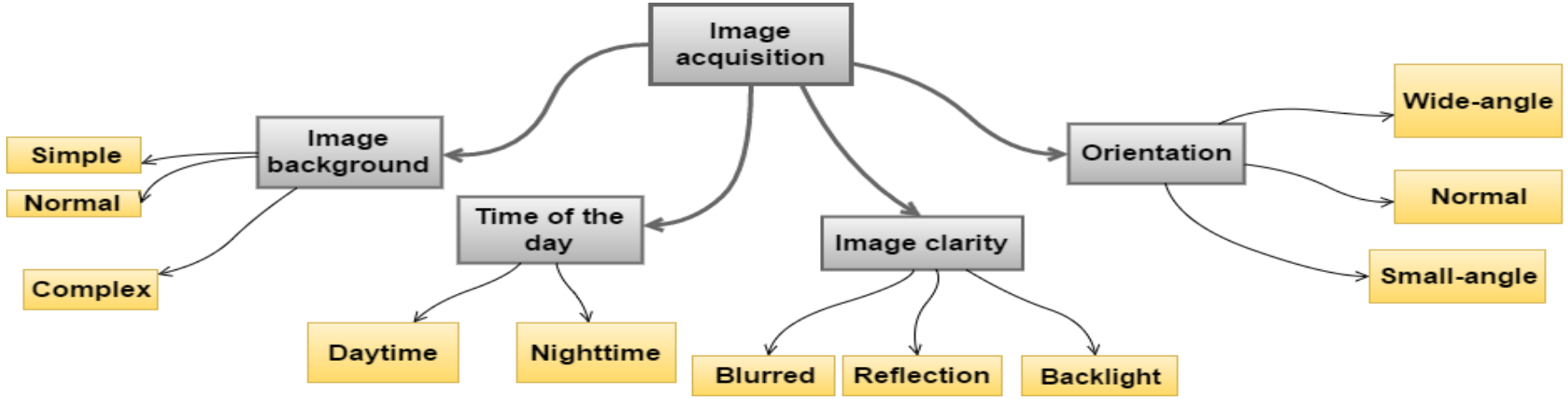
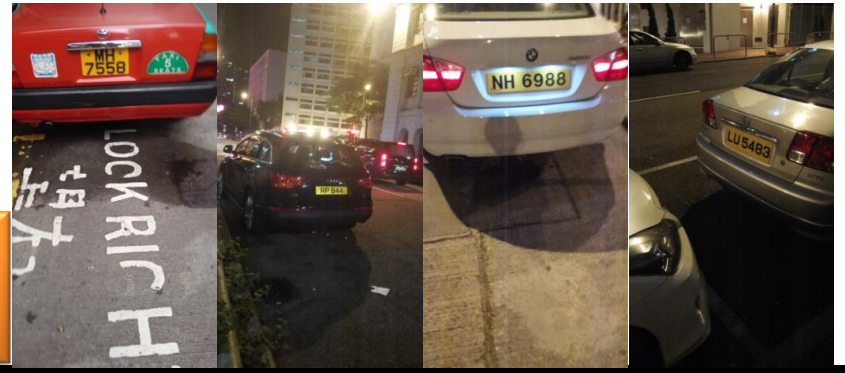


Image background

Image orientation

Image taken time



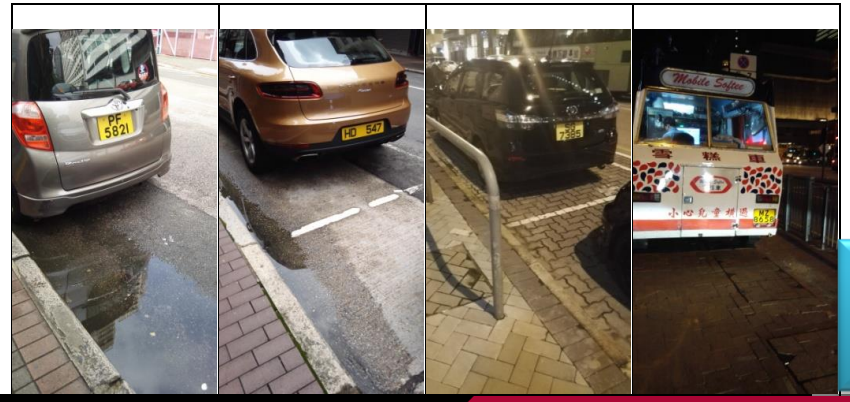
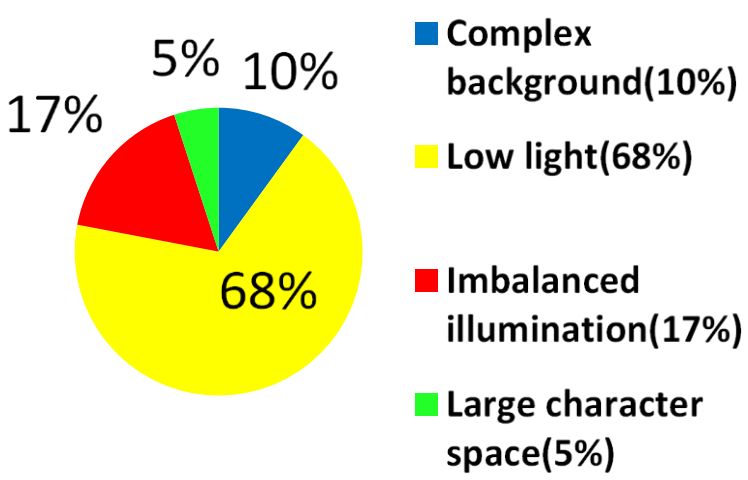


Image clarity

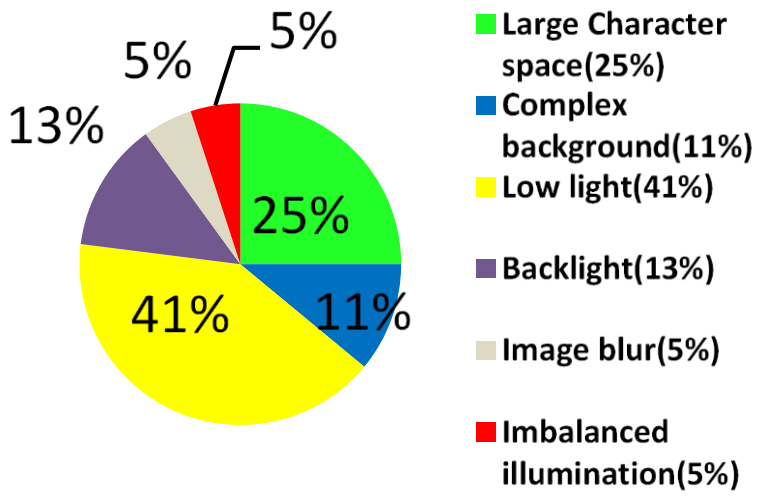
- **Comparison between colour and gray-scale system**

Factors leading to the failure of detection

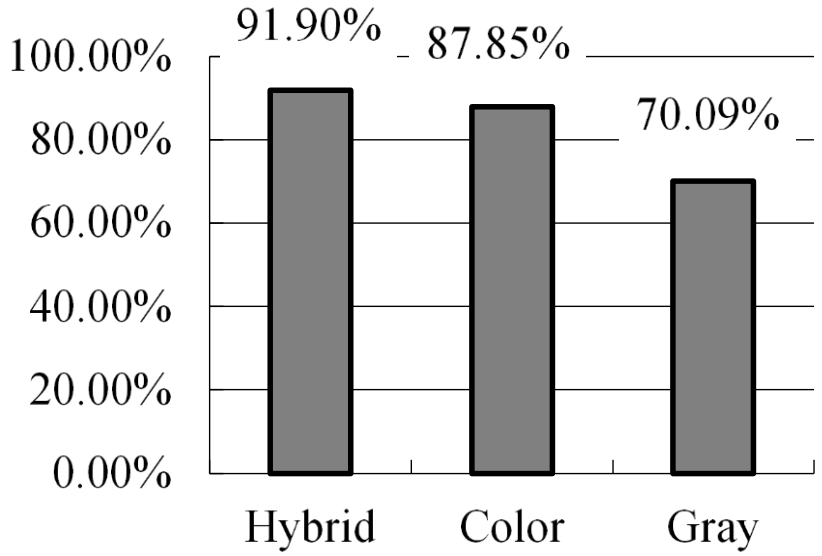
Color-segmentation system



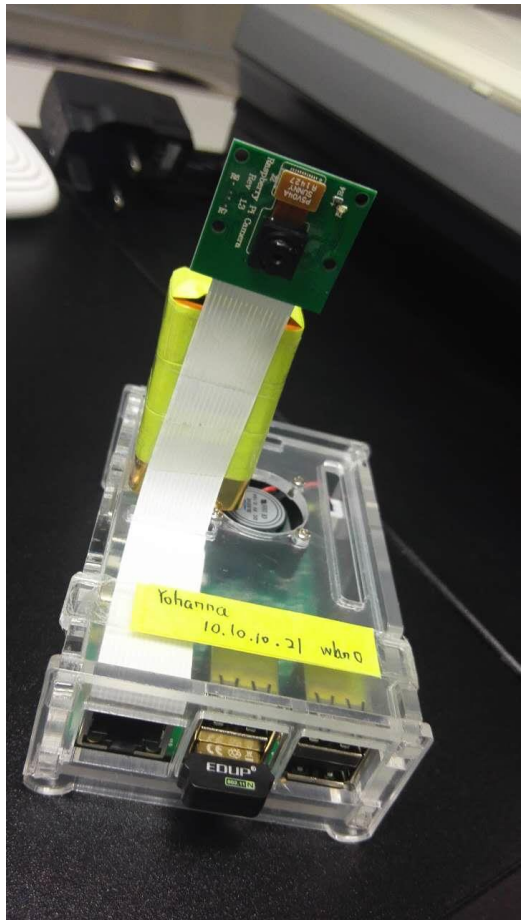
Gray-scale edge detection

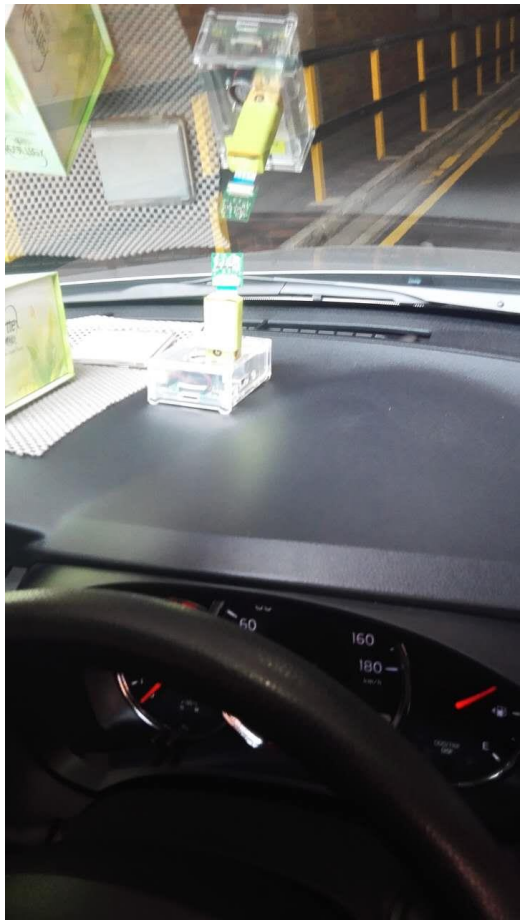


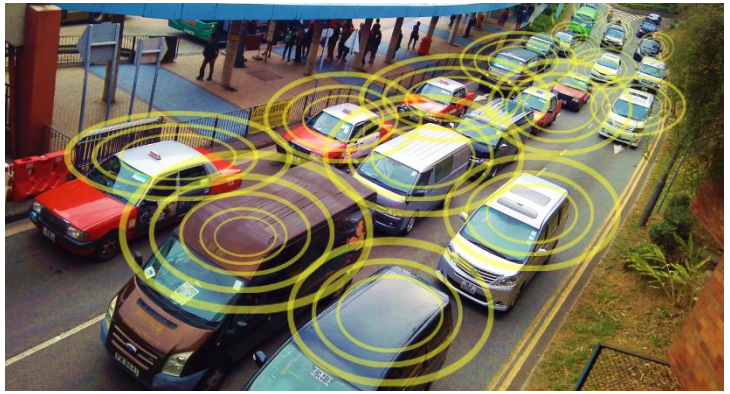
Successful location rate comparison



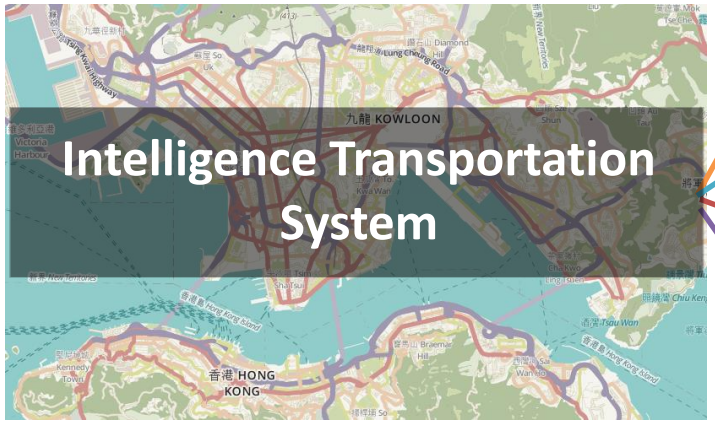
- **Raspberry Pi—VANET on-board unit**
  - ➢ On-road feature detection;
  - ➢ Real-time video streaming;



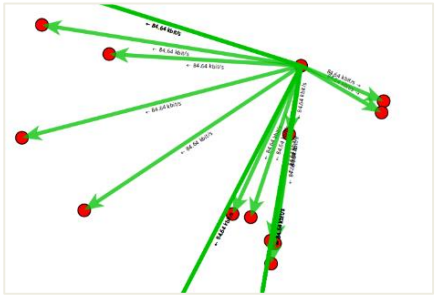


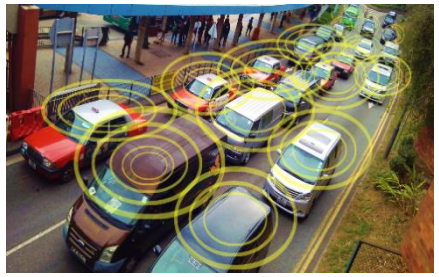


- **Conclusion**



- Data dissemination (Remote Control)
- On-road feature detection
- Vehicular Ad-hoc Network
- Semi-realistic scenario





Conclusion

- A **robust LPR Algorithm** with a **successful location rate** of **91.90%;**
- A **fountain coding based data dissemination protocol**. Can achieve an average throughput of **62 times** faster than **TCP** and more than **28% faster** than **UDP** under VANET scenario; And
- Data dissemination through **Mong-kok scenario** with **synthetic mobility traces** and **building penetration loss** model

Bus lane occupancy monitoring system

◆Destination Node—Police patrol cars

◆ Relay Node-Normal bus

◆Source Node—Vision Enabled bus

◆Others — object car

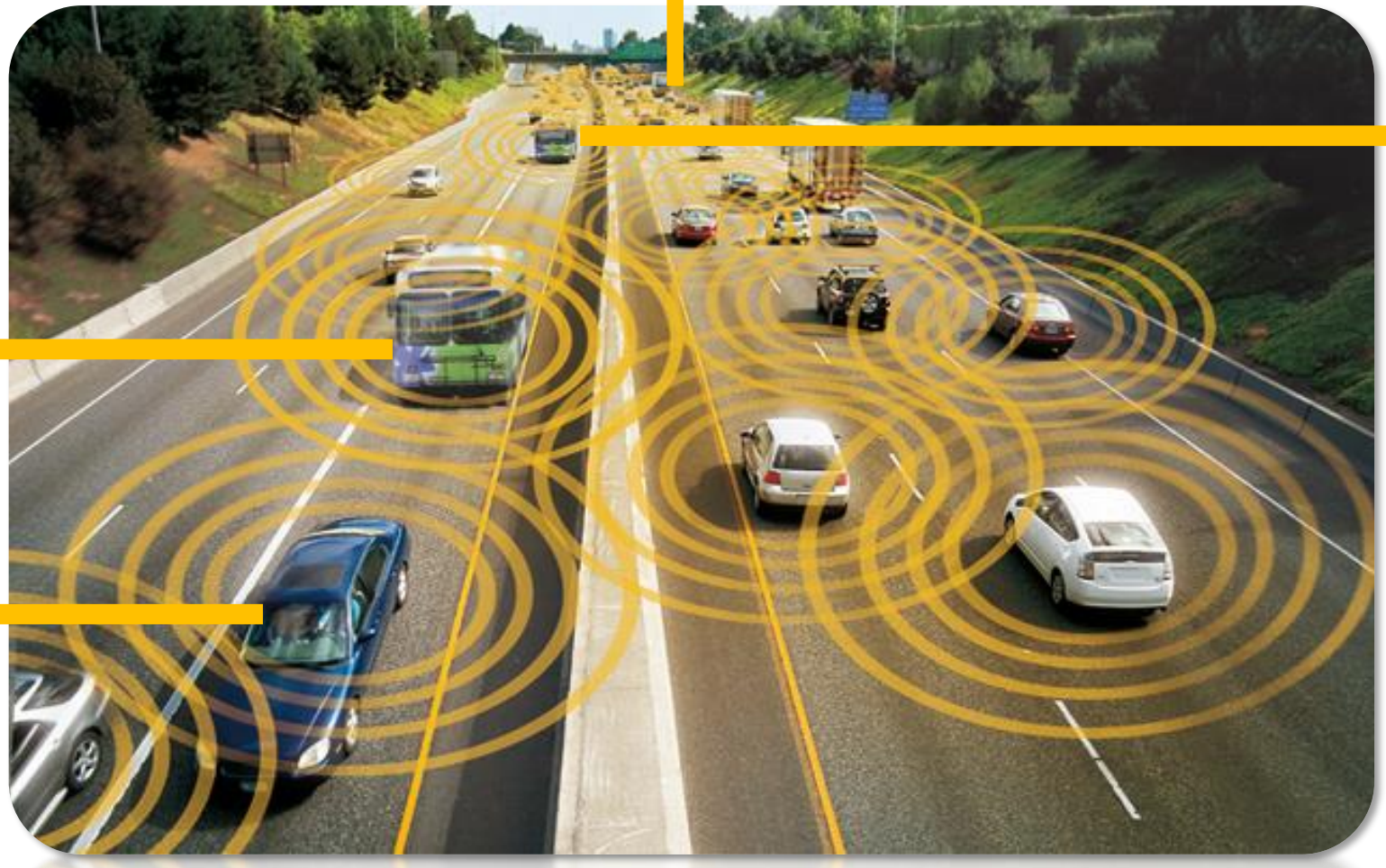
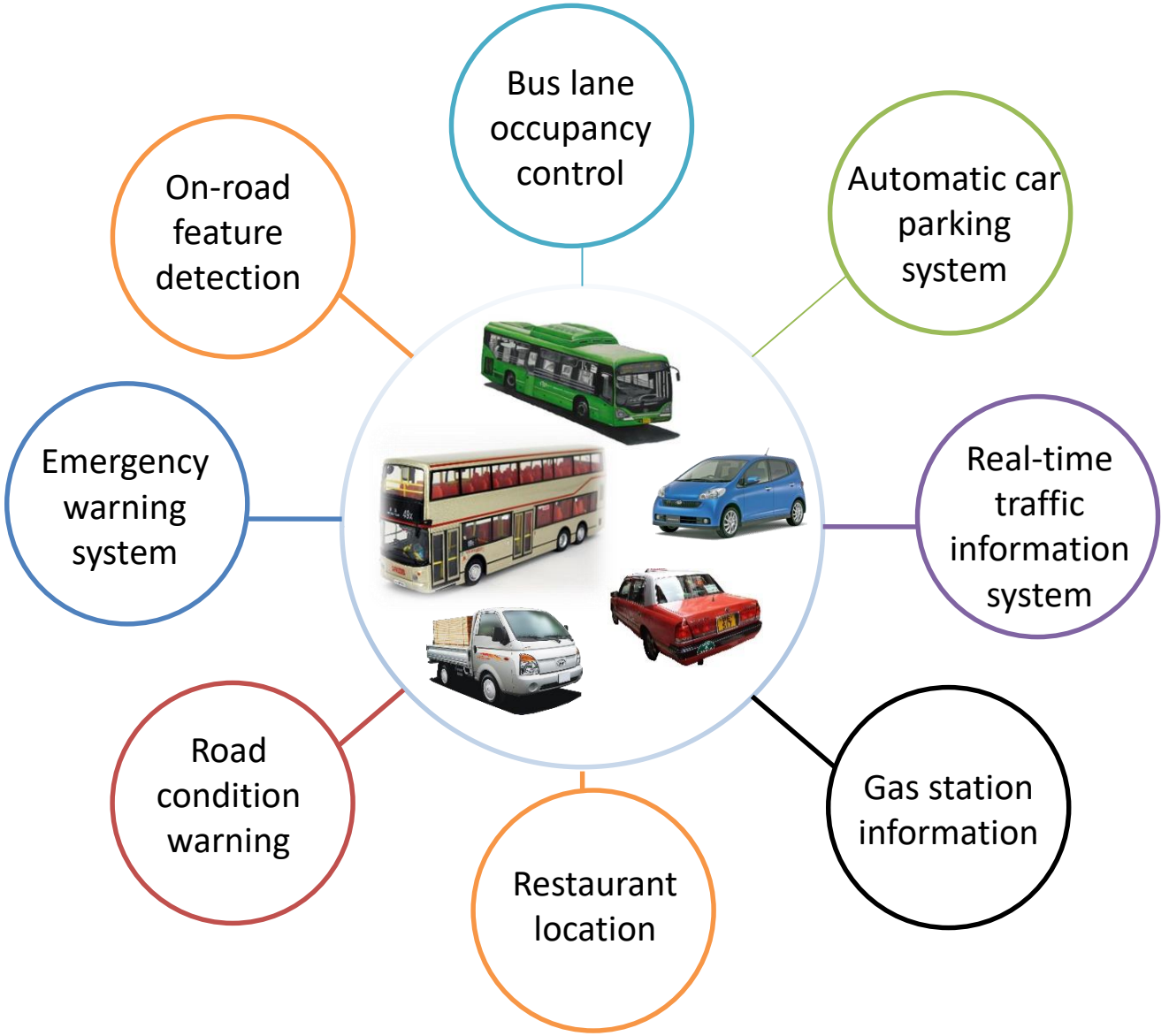


Fig.1. http://www.hirain.com/attached/ckfinder/userfiles/images/zizhuwang1.jpg

- **Applications**



Thank you!