國立陽明交通大學
NATIONAL YANG MING CHIAO TUNG UNIVERSITY
Department of Computer Science

Introduction of Applied Computing And Multimedia Lab

About ACM Lab

- Advisor
  Ching-Chun Huang (黃敬群)
  Department of Computer Science, NYCU
- E-mail
  chingchun@cs.nctu.edu.tw
- Website
  http://acm.cs.nctu.edu.tw/
- Fanpage Facebook
  https://www.facebook.com/Applied-Computing-and-Multimedia-Lab-324057595098662/

Outline

- Introduction of ACM Lab
- Research Topics
- Introduction of Projects
- International Laboratory Co-operation

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Introduction of ACM Lab

Taiwanese students

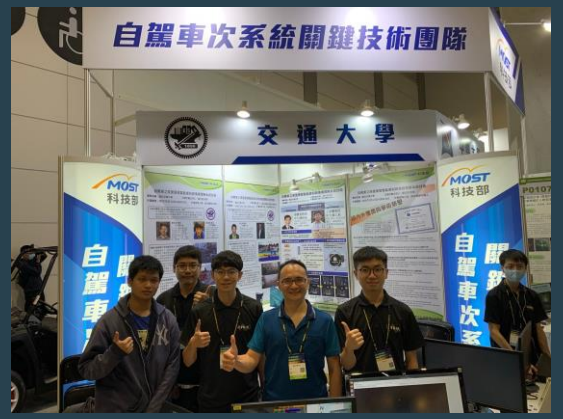
Current students
- 8 Master students
- 2 Researchers

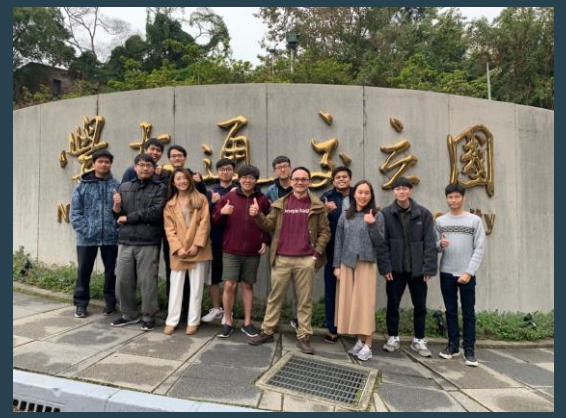
Graduated students
- 21 Master students
- 19 Undergraduate students

International students

Current students
- 2 Master student

Graduated students
- 2 PhD
- 6 Master students





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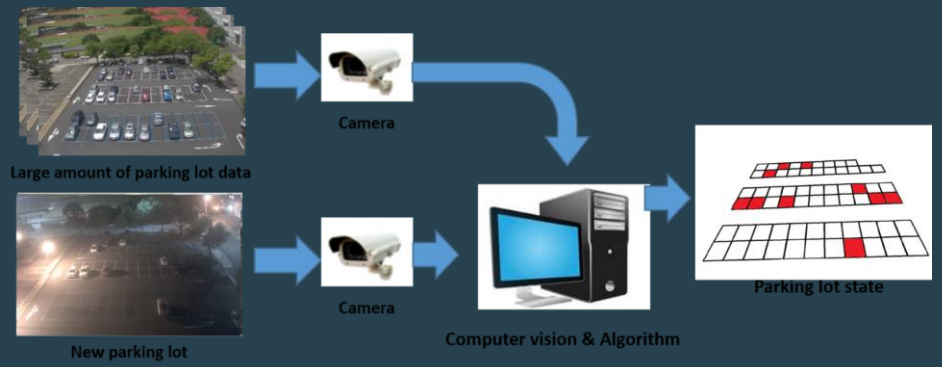
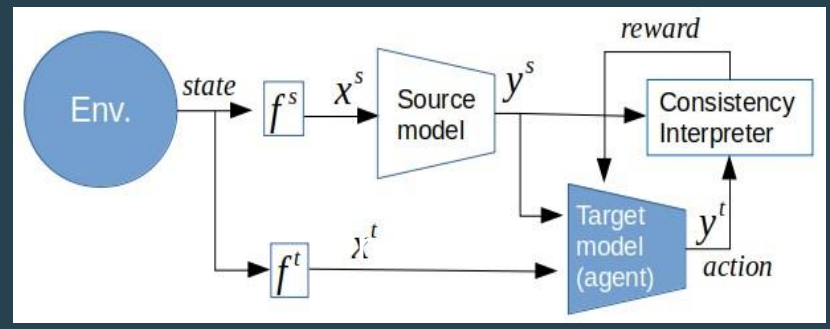
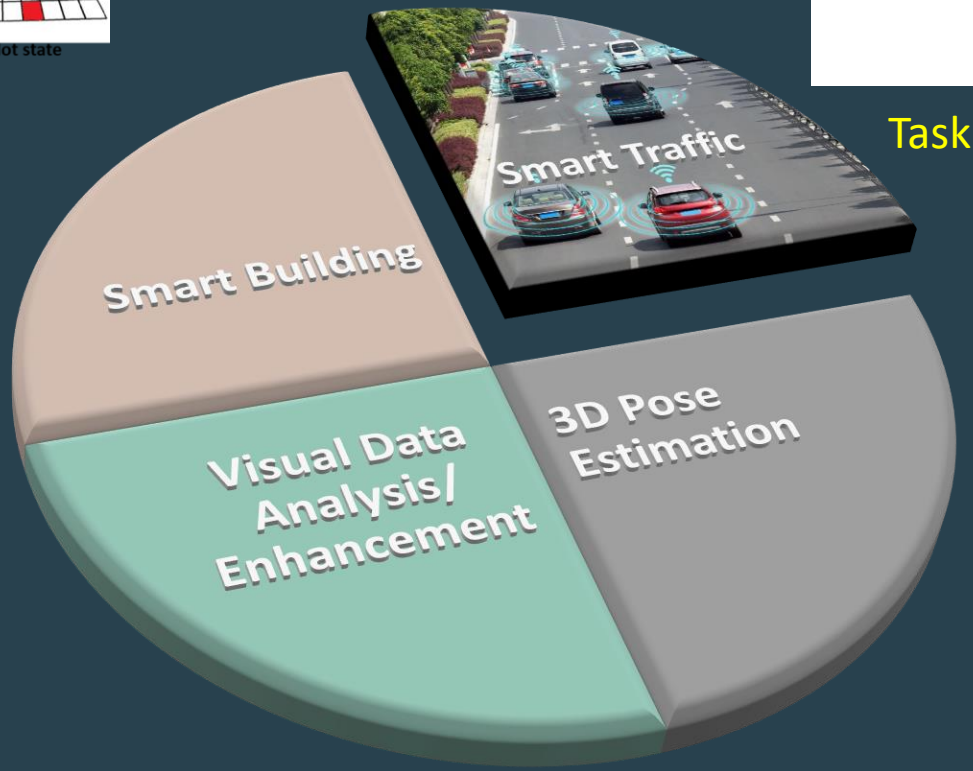
Research Topics – Smart Traffic

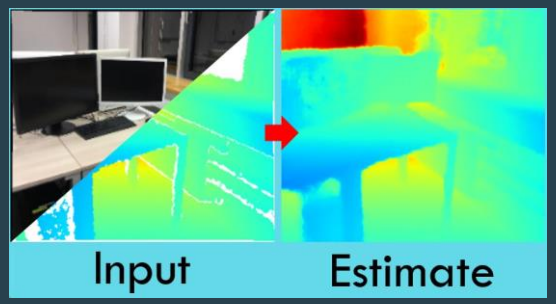


Domain Adaption Parking Lot System
2019 ~2020

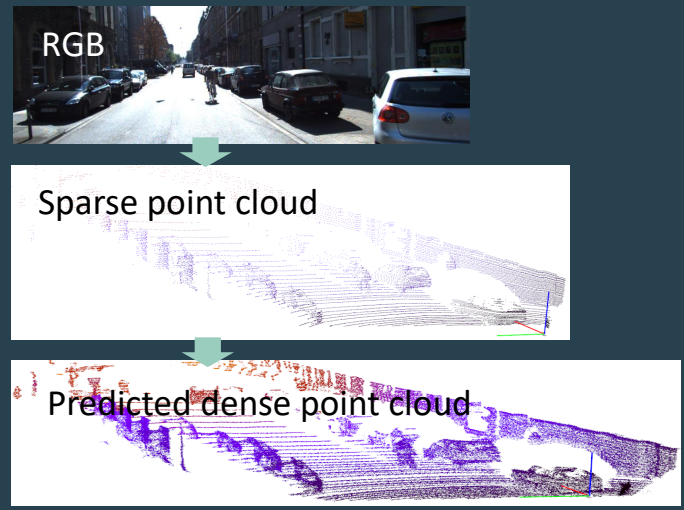


Task Consistency Parking Lot System
2020~2021



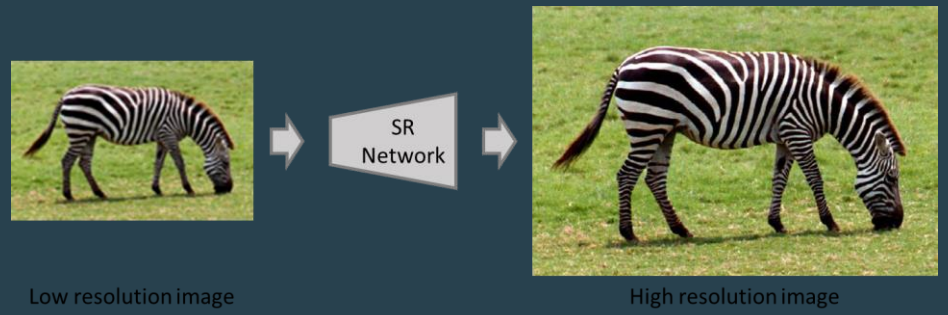


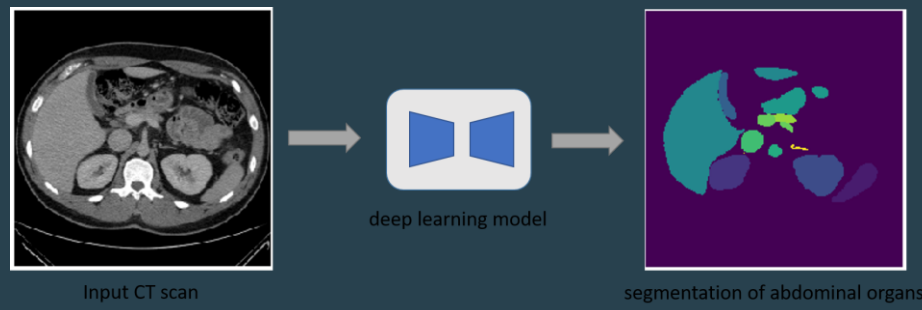
Depth Completion
2018 ~



Autonomous Vehicle
2016 ~ 2022

Research Topics – Visual Data Analysis/Enhancement





Medical Image Analysis
2018 ~2019

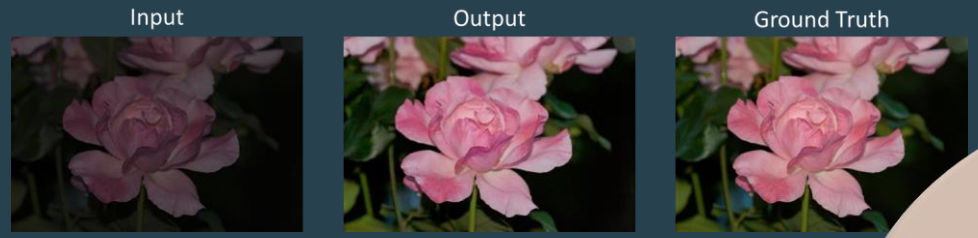
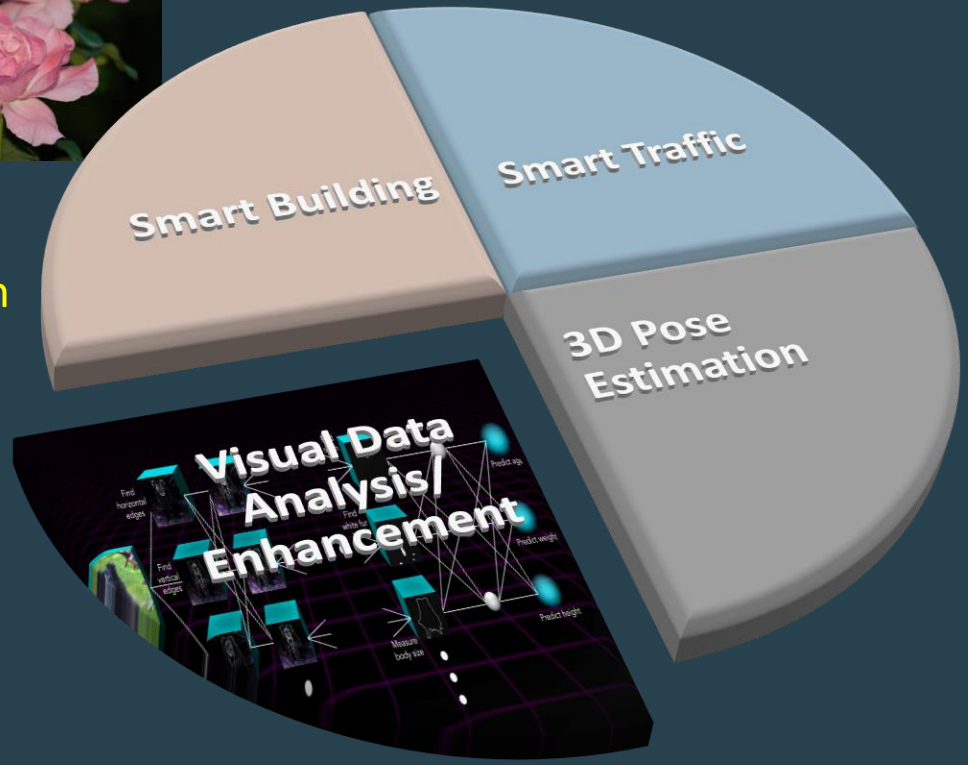
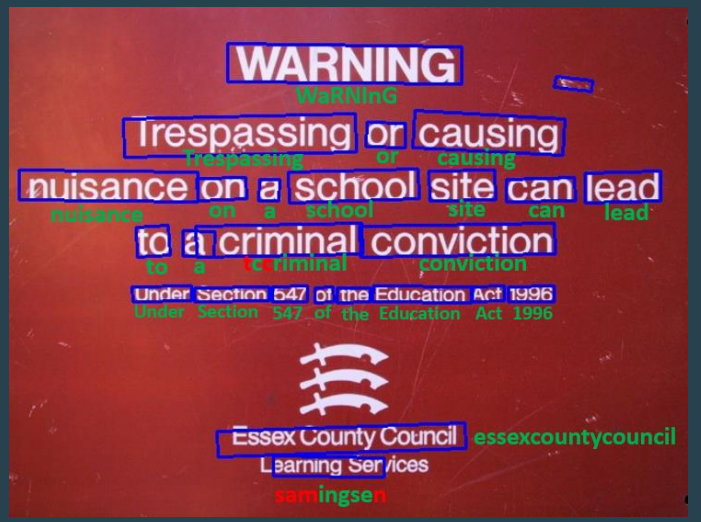


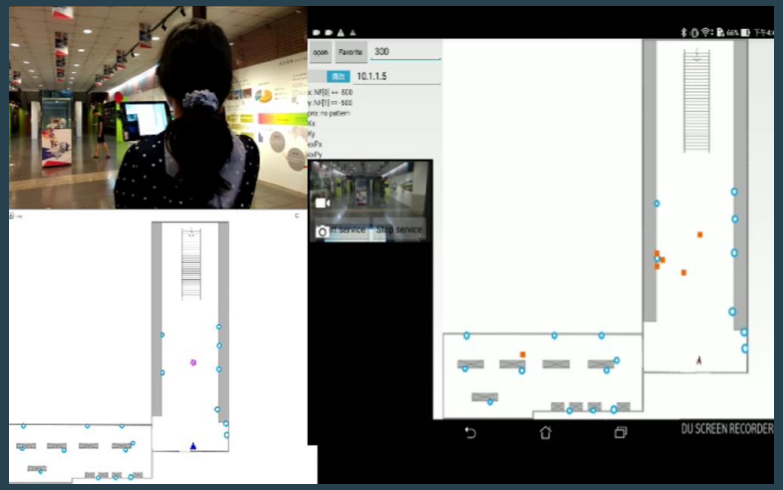
Image Super-resolution/Enhancement/Restoration
2018 ~ 2021



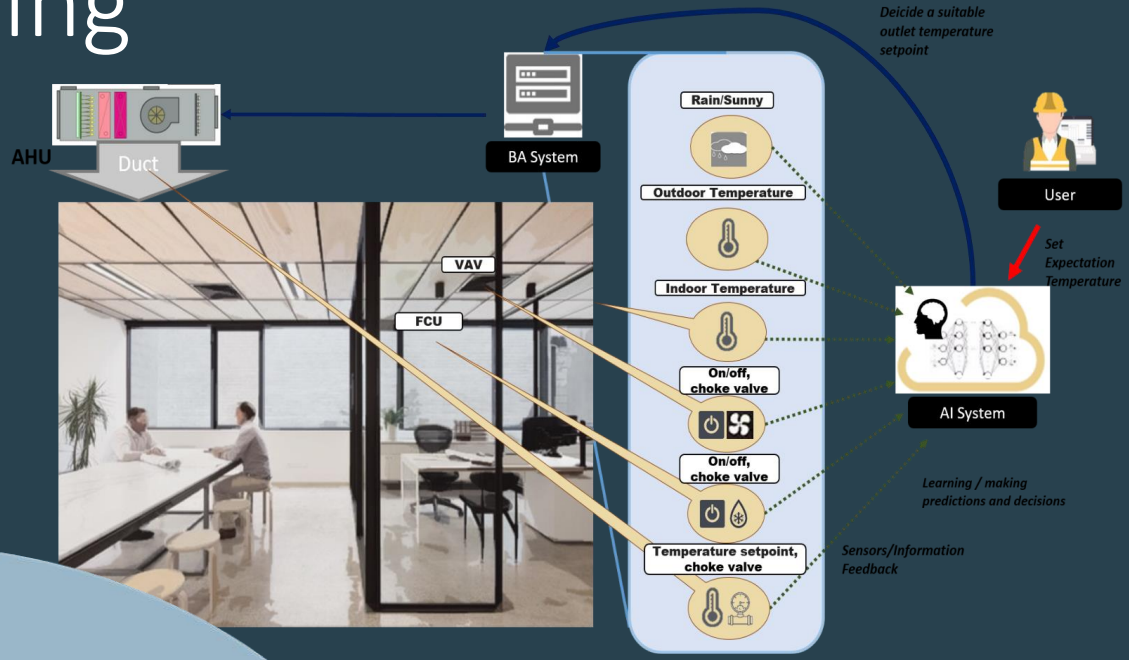


Optical Character Recognition
2018 ~2019

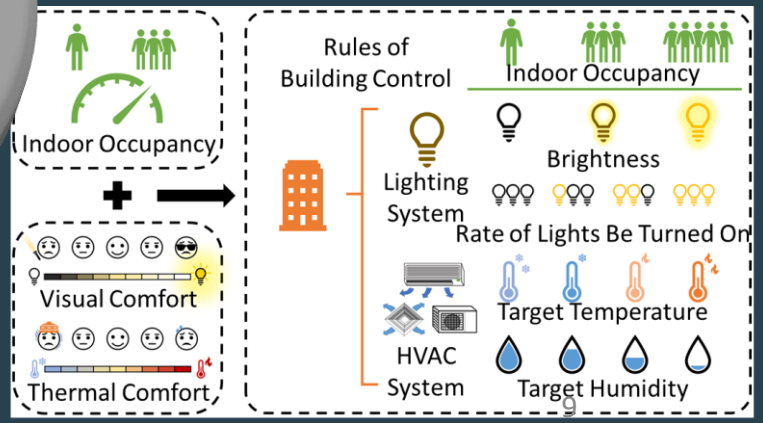
Research Topics – Smart Building



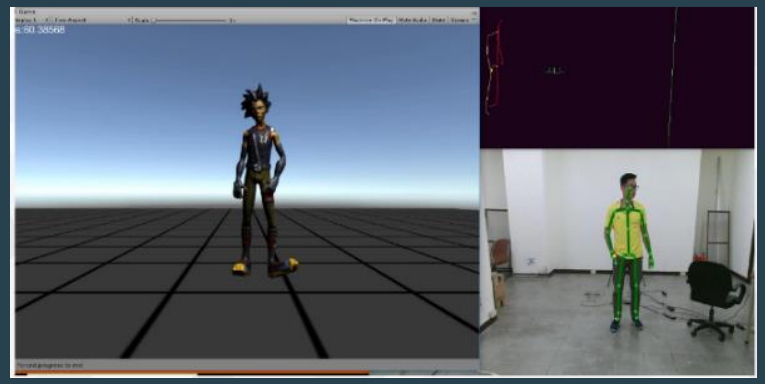
IoT Wearable Device for Localization and Guidance System 2018



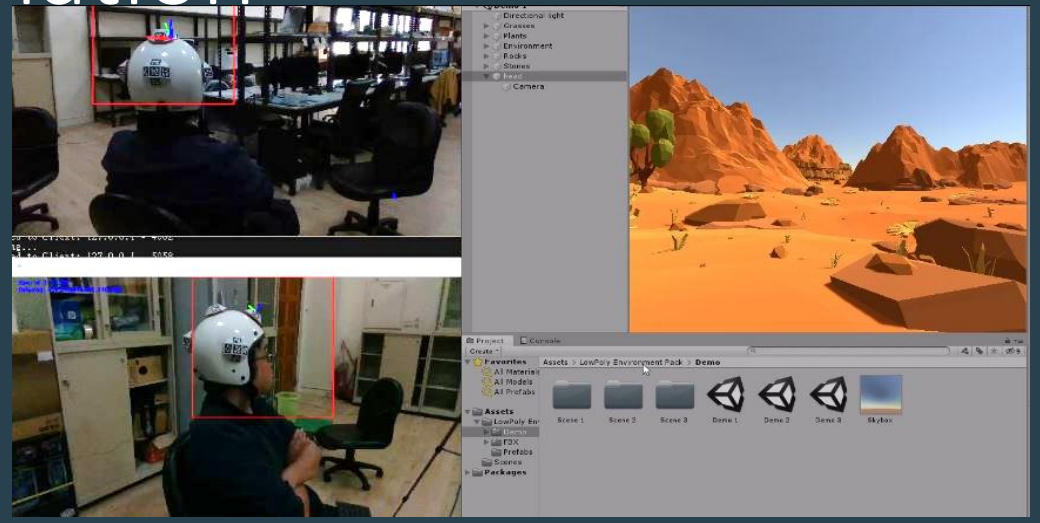
TSMC Smart Office 2018 ~2021



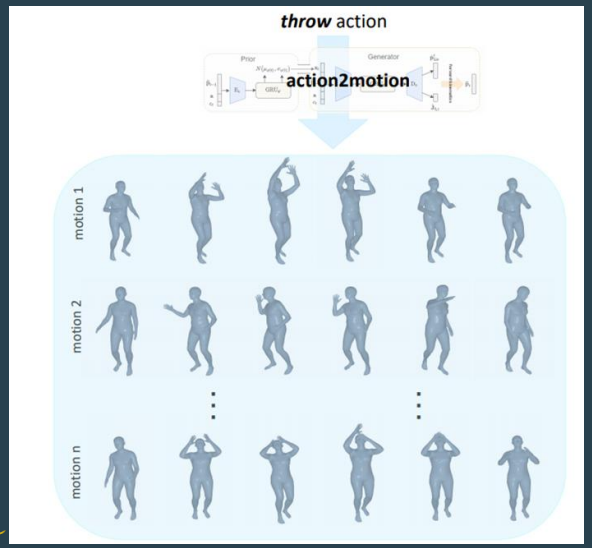
Research Topics – 3D Pose Estimation



Skeleton-based Human-Computer Interaction
2018 ~2019



Pilot Training System
2018 ~2020



Action to Motion
2021~2022

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- Introduction of ACM Lab
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計畫名稱	執行時間	職務	補助機關
基於移動攝影機之交通場景理解	2021/1/9~2022/1/8	主持人	中華電信研究 院(交安所)
109年度工研院環境建構總計畫-深度學習端到端文字偵測與辨識技術	2020/8/20~2020/12/31	主持人	財團法人工業技術研究院
辦公室感測數據預測模型分析與驗證	2020/6/18~2020/12/31	主持人	漢威聯合股份有限公司
無監督自主學習、少資料原型學習、與仿真資料生成於泛用型辨識應用系統之研究	2020/08/01~2023/07/31	主持人	行政院科技部
基於深度學習、異質資訊整合、與轉換學習之通用型停車場管理系統	2019/8/1~2020/7/31	主持人	行政院科技部
智慧創新跨域人才培育聯盟計畫-大數據分析跨校聯盟推動計畫 (B類計畫：加值創作分項4, 應用多樣性環境感測大數據於智慧建築管理)	2019/3/1~2022/1/31	分項主持人	行政院教育部
基於影像辨識之三維立體空間動態行為追蹤技術開發	2019/11/16~2020/5/13	主持人	中山科學研究院
機器學習於建築溫度環境感測大數據分析應用之研究	2019/01/01 ~ 2019/12/31	主持人	內政部建築研究所、台灣積體電路製造股份有限公司
自駕車之深度學習智能感知與情境理解系統技術	2018/12/01 ~ 2021/07/31	共同主持人	行政院科技部
探討基於RGBD攝影機之機器人場景影像切割與深度圖修復多功能網路	2018/11/1~2019/10/30	主持人	行政院科技部
機器手臂之Eye-in-hand 智慧視覺技術開發與應用	2018/03/01 ~ 2018/10/31	共同主持人	中部科學工業區
基於深度學習之物聯網大數據分析	2018/01/01 ~ 2018/12/31	主持人	台灣積體電路製造股份有限公司
智慧制空飛行無人機:基地台通訊計網路技術	2018/01/01 ~ 2018/12/31	共同主持人	行政院科技部
建立仿真實紋理的肝臟三維模型並實現網路架構下的擴增實境應用	2018/01/01 ~ 2018/08/31	主持人	行政院科技部
複雜背景下融合多深度攝影機的士兵骨架辨識系統	2017/01/01 ~ 2017/08/31	技術開發	中山科學研究院
基於深度學習、異質資訊整合、與轉換學習之通用型停車場管理系統	2017/08/01 ~ 2020/07/31	主持人	行政院科技部
自動駕駛車輛之深度學習行駛系統	2016/08/01 ~ 2017/10/31	共同主持人	行政院科技部、清華大學
影像式戶外停車空位在席偵測系統	2016/11/01 ~ 2017/10/31	主持人	行政院科技部、歐特儀股份有限公司
標記式內視鏡微創手術器械三維姿態定位研究	2016/08/01 ~ 2017/07/31	主持人	行政院科技部

計畫名稱	執行時間	職務	補助機關
大腸鏡影像之三維腫瘤重建技術	2015/08/01 ~ 2017/07/31	主持人	行政院科技部
應用無線訊號於健康照護之室內人物追蹤研究	2015/08/01 ~ 2017/07/31	主持人	行政院科技部
具互動功能之穿戴式行動學習系統(1/2~2/2) (群體型)	2015/08/01 ~ 2017/07/31	共同主持人	行政院科技部
探討全景攝影機於掃地機器人自主同時定位與圖資建立之研究	2015/11/01 ~ 2016/10/31	主持人	行政院科技部、恆準定位股份有限公司
考量裝置差異性下提升無線訊號室內定位準確度之研究	2014/11/01 ~ 2015/10/31	主持人	行政院科技部、恆準定位股份有限公司
停車場空位管理系統	2013/01/01 ~ 2013/06/30	技術委託	台彩科技
適應性壓縮式感測取樣於感知無線電網路之研究	2012/08/01 ~ 2013/7/31	主持人	行政院科技部
應用於無人飛行監控器之影像式定位技術	2011/09/01 ~ 2011/12/15	主持人	工業技術研究院

Smart Traffic – Parking Lot

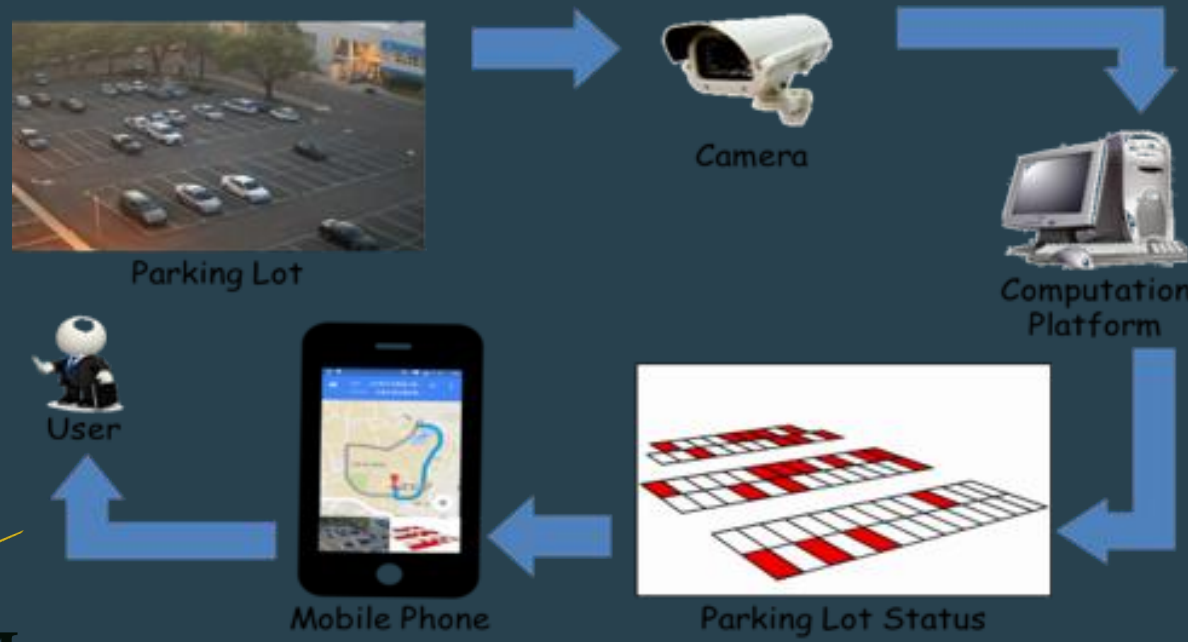
"Parking Lot Management System"
"LoRa based Parking Lot Management System"
"Domain Adaptation Management System"
"Task Consistency Management System"

Projects

- Project Name: 基於深度學習、異質資訊整合、與轉換學習之通用型停車場管理系統
  - Project Period : 2019/8/1~2020/7/31
  - Cooperation Vendors : 行政院科技部
- Project Name: 應用深度學習、地磁感測網路、與LoRa物聯網通訊實現路邊停車格自動化管理技術
  - Project Period : 2017/11/01~2018/10/31
  - Cooperation Vendors : 行政院科技部、歐特儀股份有限公司
- Project Name : 影像式戶外停車空位在席偵測
  - Project Period : 2016/11/01 ~ 2017/10/31
  - Cooperation Vendors : 行政院科技部、歐特儀股份有限公司
- “科技部工程司「產學合作計畫成果發表暨績效考評會」” 特優獎 2017、2018、2019

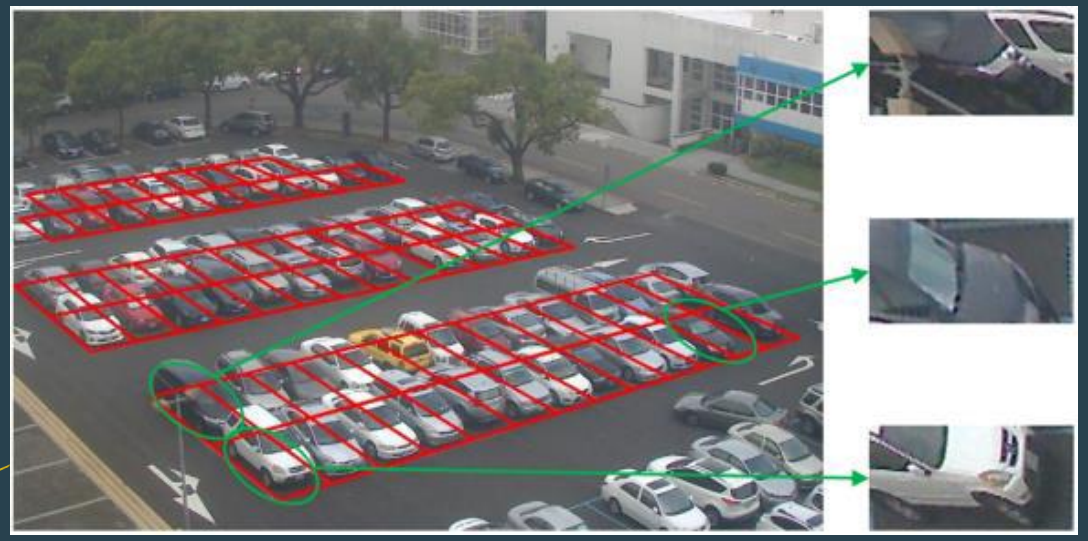
Parking Lot Management System

- Goal:
  - Use a camera (or multi-camera) to detect the entire parking space with deep learning method.

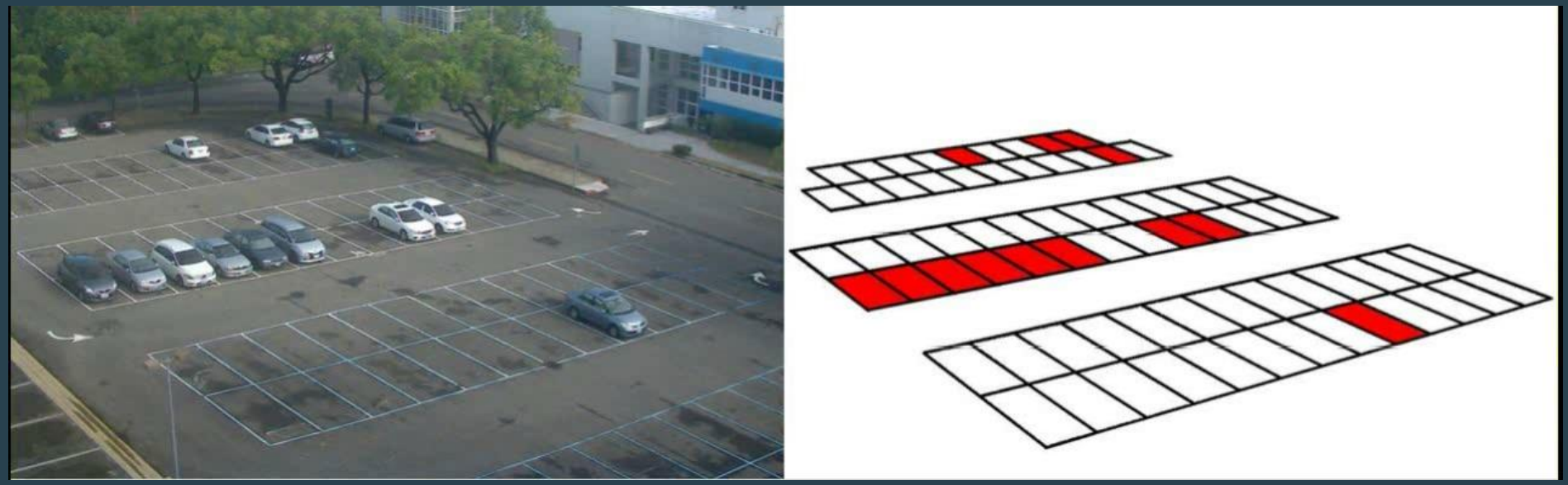


Parking Lot Management System

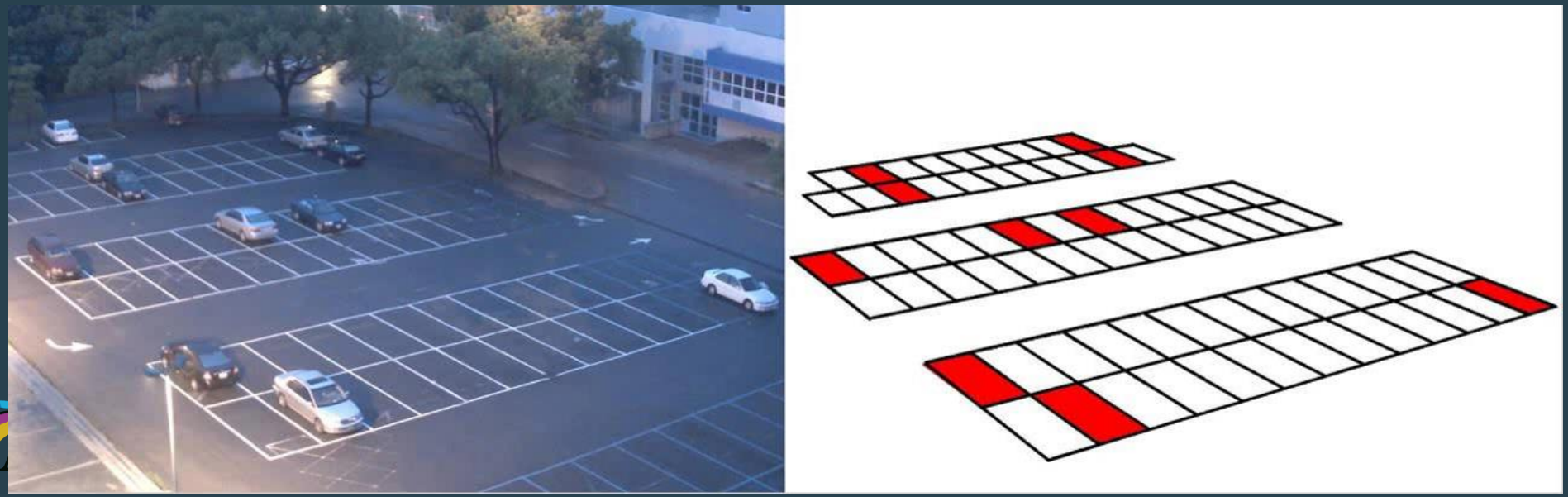
- Challenges :
  - Outdoor lighting variation, inter-object occlusion and perspective distortion.
  - Non-unified vehicle size and uncontrollable parking displacement.



- Result:



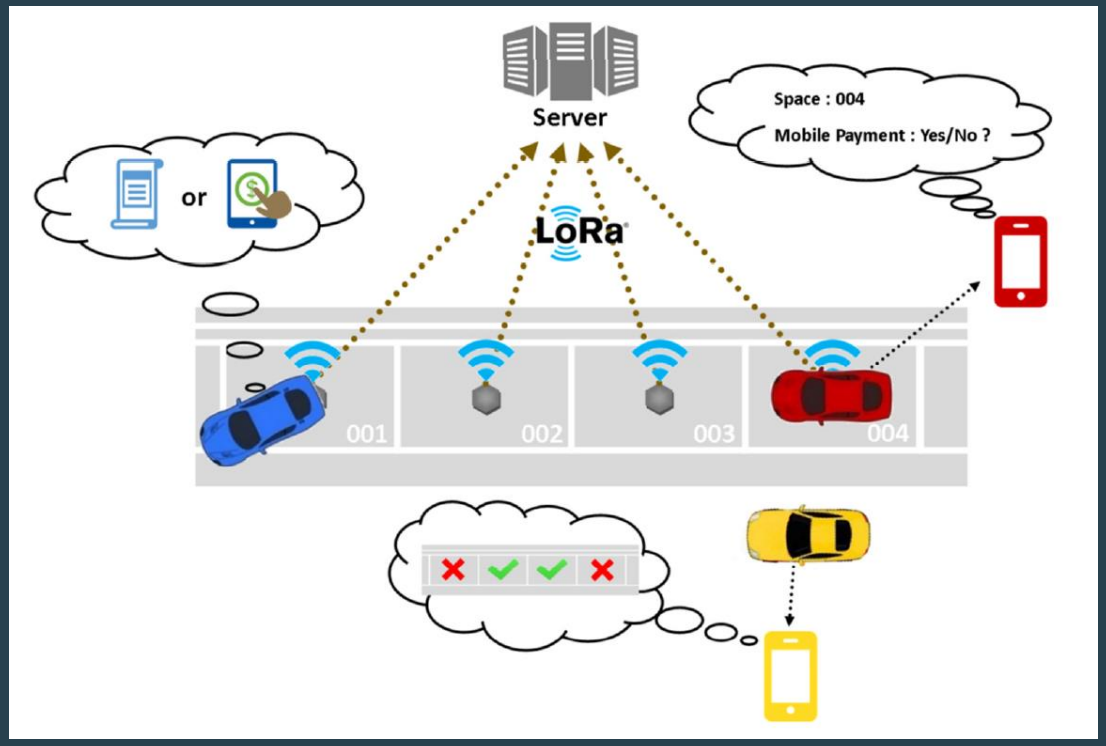
Parking lot system demo : Sunny



Parking lot system demo : Rain

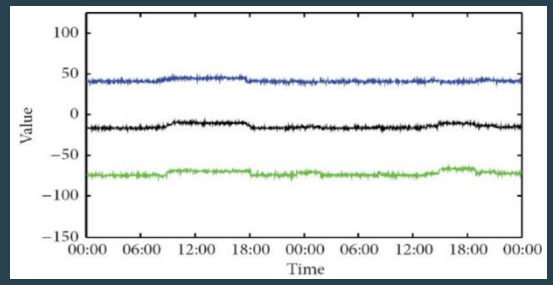
LoRa Based Parking Lot Management System

- Goal :
  - We are going to propose well-designed deep learning networks for recognizing the sequential patterns of magnetic signals.

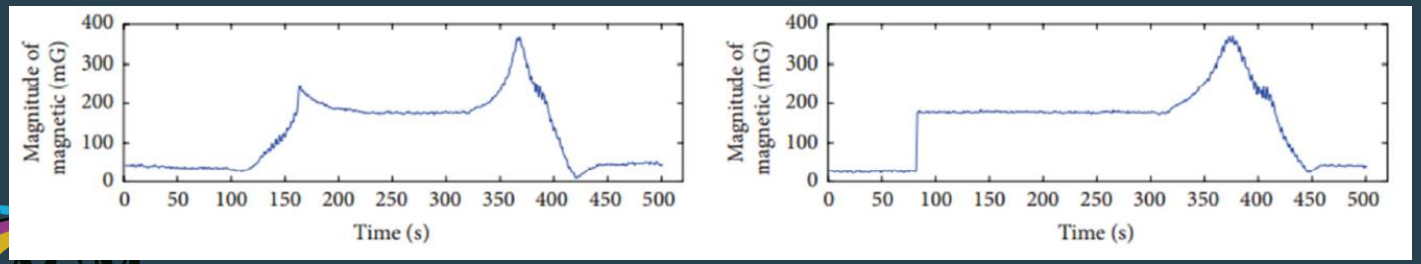


LoRa Based Parking Lot Management System

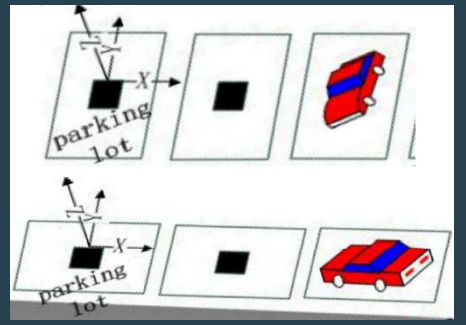
- Challenges :
  - The interruption from environment magnetic fields and environment noise.--(a)
  - The variety of magnetic signals due to vehicle types. --(b)
  - The interruption by moving vehicles.
  - The non-unified coordination of magnetic sensors. --(c)
  - The annoying magnetic responses caused by the status changing of neighboring spaces.--(d).



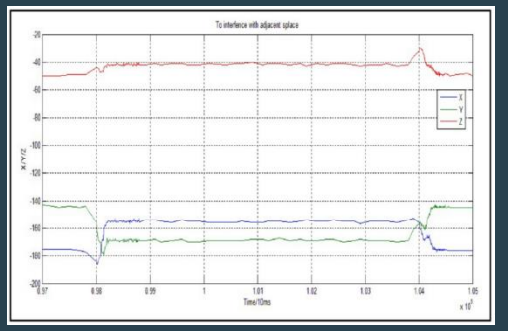
(a)



(b)

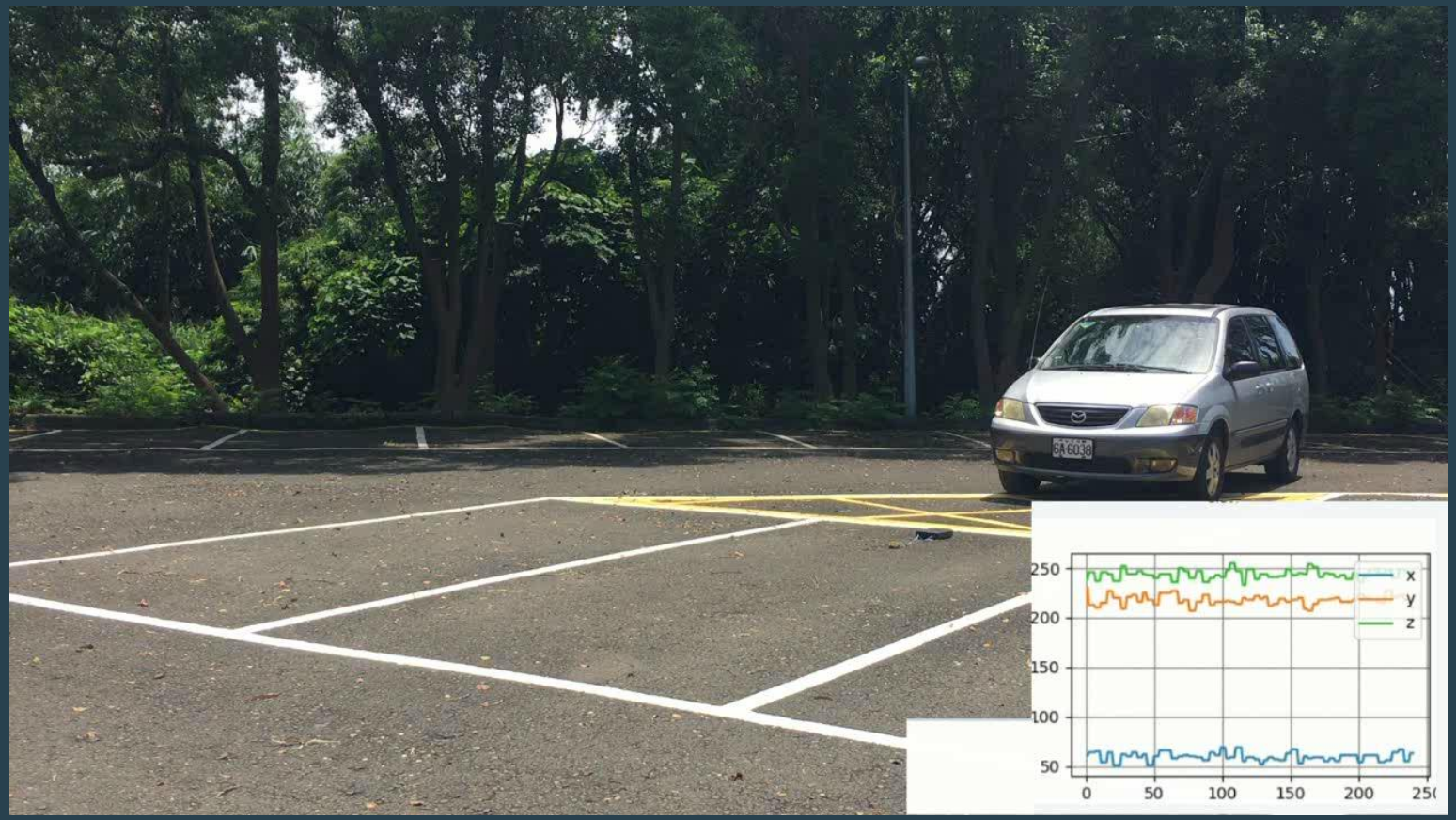


(c)



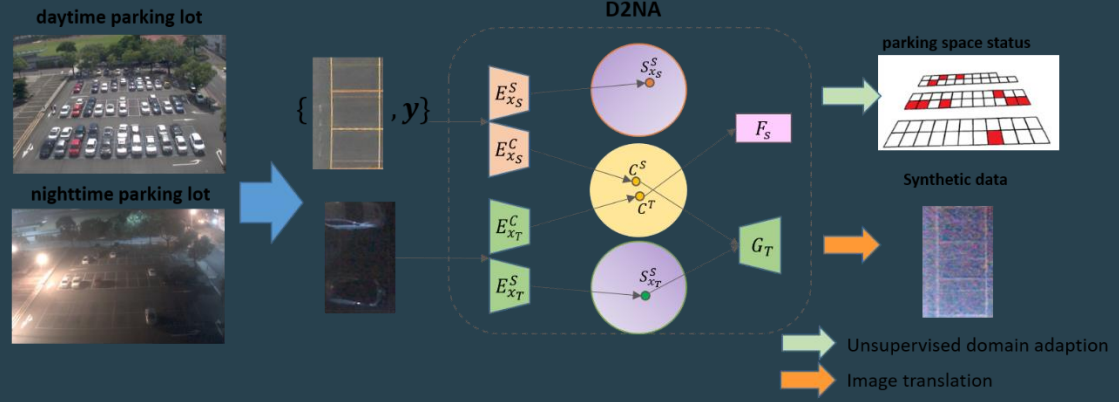
(d)

- Result



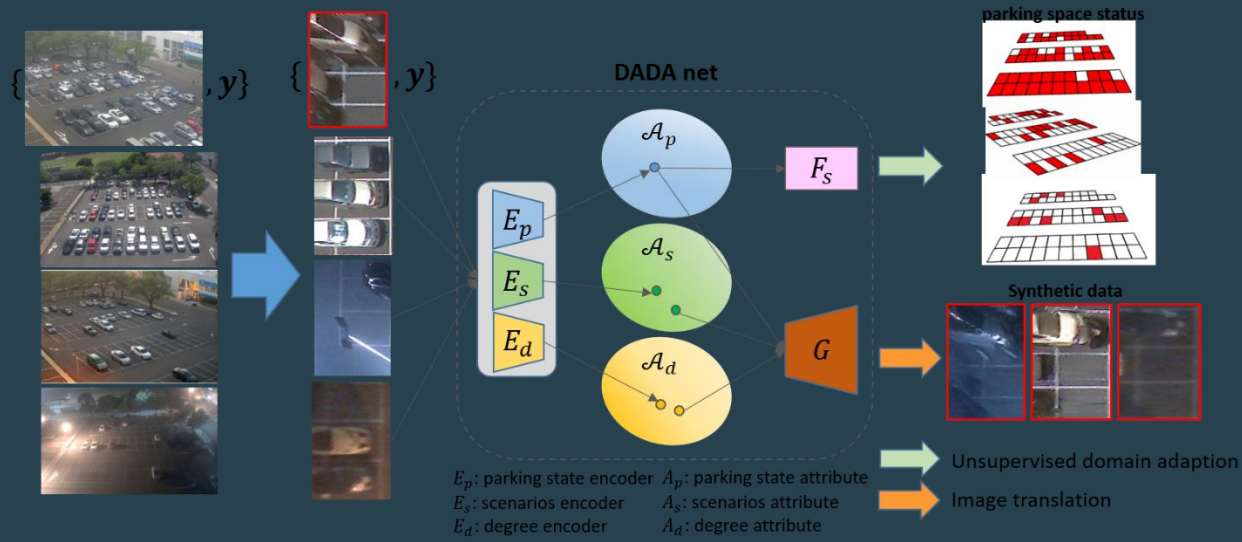
Domain Adaptation Management System

- Goal:
  - Develop a parking lot inference system across different domains through unsupervised learning without paying extra labor-intensive efforts



Task1: two-domain adaption

D2NA: DAY-TO-NIGHT ADAPTATION FOR VISION BASED PARKING MANAGEMENT SYSTEM

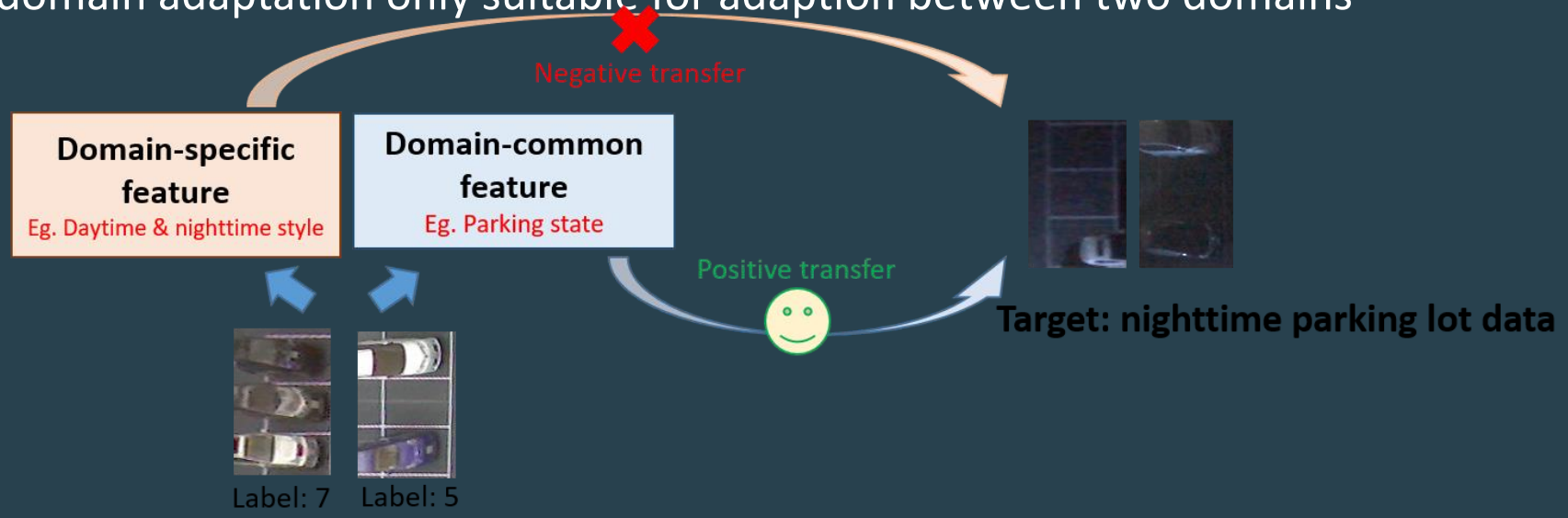


Task2: multi-domain adaption

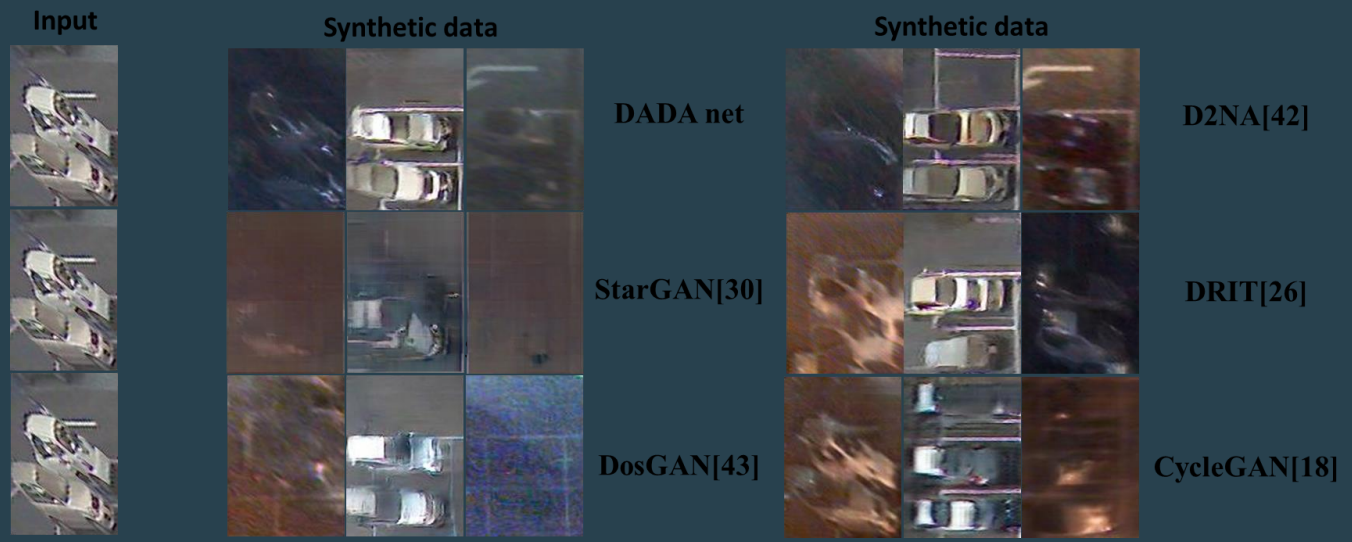
DADA net: Multi-Domain Attribute Disentanglement and Adaptation network for vision based parking management system

Domain Adaptation Management System

- Challenge
  - Lack of labeling data for new domain
  - The negative transfer problem
  - Low-transferability of high-level feature
  - How to translate the correct synthetic image
  - Traditional domain adaptation only suitable for adaption between two domains



- Result:



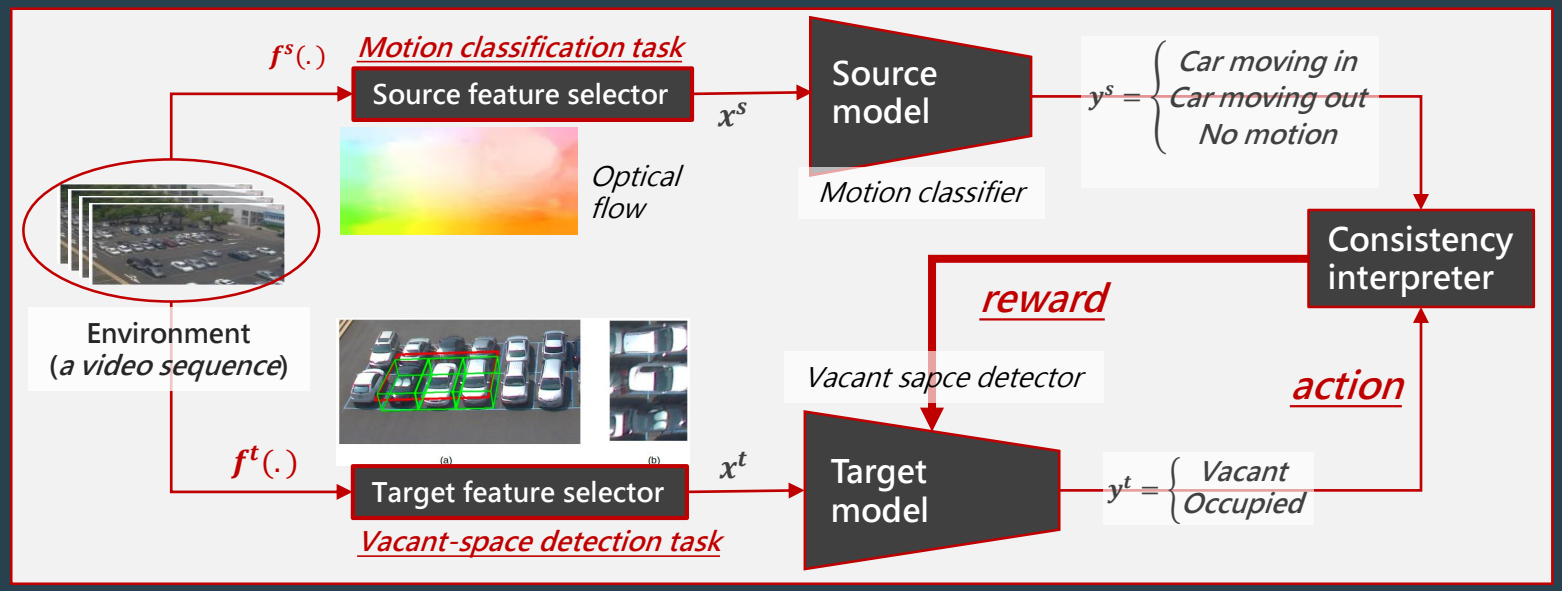
Inception score compare with other methods

Inception Score ↑	Mean	Stddev
DADA net	**4.023**	**0.367**
DADA net without Unet	3.789	0.076
DADA net without domain code	3.652	0.334
D2NA[42]	3.847	0.380
DosGAN[43]	3.528	0.174
StarGAN[30]	3.355	0.203
DRIT[26]	3.773	0.244
CycleGAN[18]	3.452	0.146

[18] J. -Y. Zhu, T. Park, P. Isola and A. A. Efros, "Unpaired Image-to-Image Translation Using Cycle-Consistent Adversarial Networks," in *IEEE International Conference on Computer Vision (ICCV)*, 2017.
[24] M. Y. Liu, T. Breuel, and J. Kautz, "Unsupervised image-to-image translation networks," *arXiv preprint arXiv:1703.00848*, 2017.
[25] X. Huang, M. Y. Liu, S. Belongie, and J. Kautz, "Multimodal Unsupervised Image-to-Image Translation," In *Proceedings of the European Conference on Computer Vision (ECCV)*, 2018

Task Consistency Management System

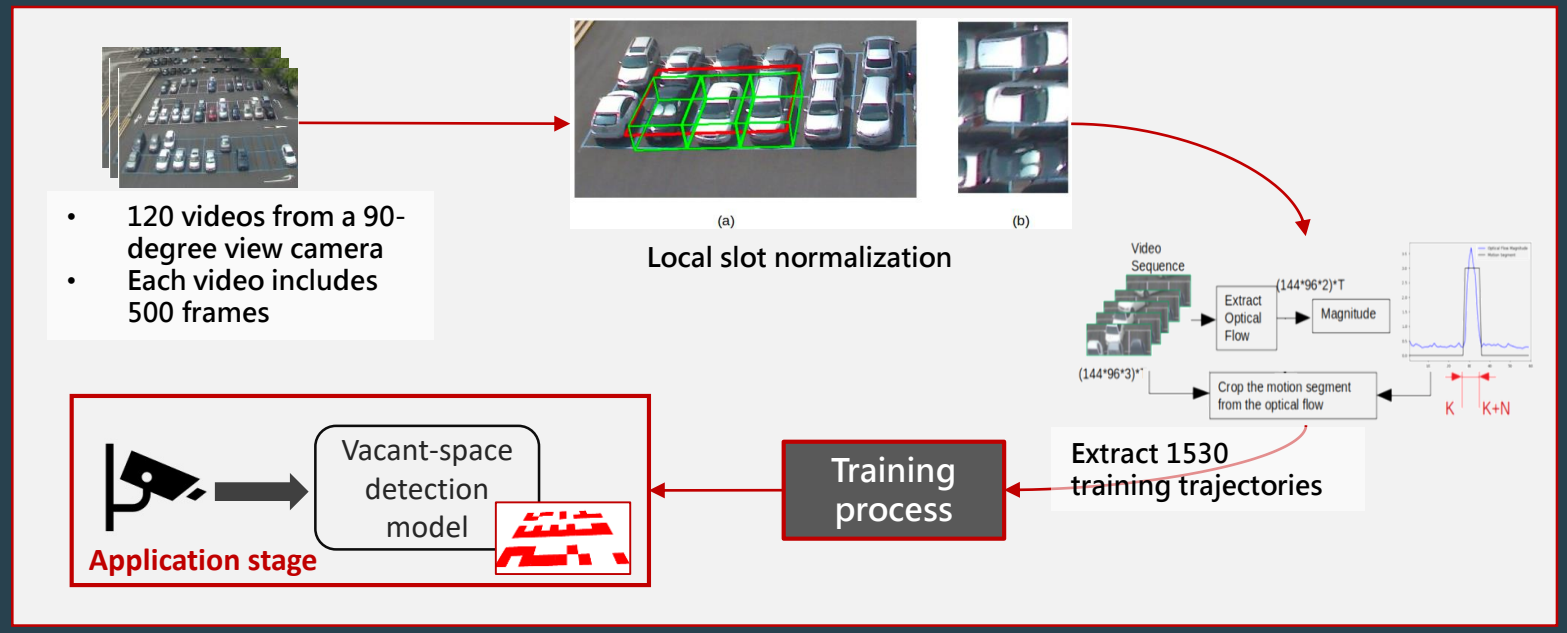
- Goal:
  - a novel framework that allows the system to train a target model (e.g., a vacant-space detector) via the task consistency with a source model (e.g., a car motion classifier).



Task Consistency Management System

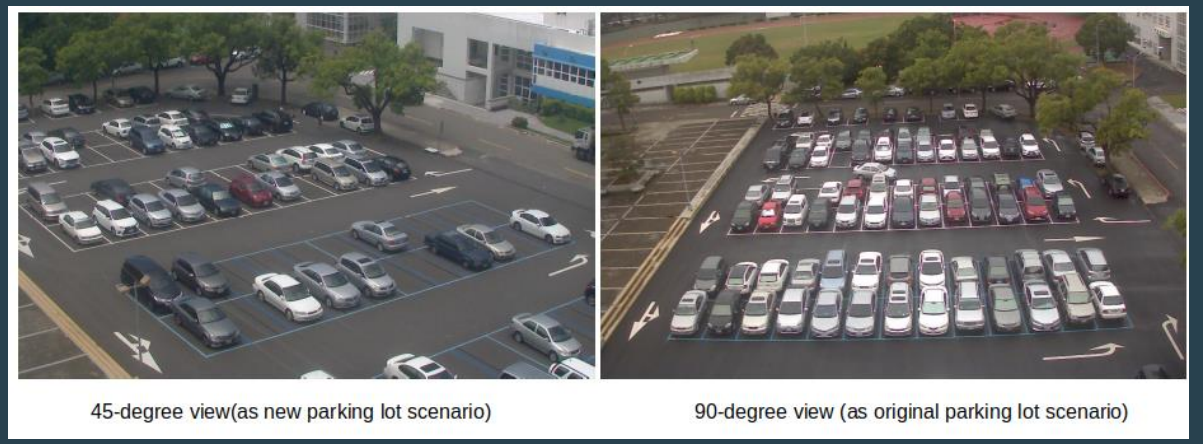
- Challenge:
  - the source task could make false detections during the learning process
  - Heavy human loads: it still requires enough new labeled samples to finetune the target network, given a powerful pre-trained model

- Result



Supervised learning (Fine tune)	97.93 (M=600*)	98.18 (M=1000*)	98.57 (M=1400*)	98.76 (M=1700*)	99.21 (M=2000*)
Task Consistency learning (Fine tune)	98.84 (N=300)	99.15 (N=500)	99.37 (N=700)	99.57 (N=850)	99.69 (N=1000)
Task consistency learning (Train from scratch)	98.15 (N=300)	98.38 (N=500)	98.45 (N=700)	99.48 (N=850)	99.54 (N=1000)

· M means the number of training samples for supervised learning.
· N means the number of training trajectories for task consistency learning.



- Publication:
  - Manh Hung Nguyen, Tzu-Yin Chao and Ching-Chun Huang, "Vacant Parking Space Detection based on Task Consistency and Reinforcement Learning", International Conference on Pattern Recognition(ICPR), Jan., 2021.
  - Wei-Zhong Zheng, Vu-Hoang Tran and Ching-Chun Huang, "D2NA: DAY-TO-NIGHT ADAPTATION FOR VISION BASED PARKING MANAGEMENT SYSTEM", IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP), May., 2020.
  - You-Feng Wu, Hoang Tran Vu, Ching-Chun Huang, "Semi-supervised and multi-task learning for on-street parking space status inference", Multimedia Analysis and Pattern Recognition (MAPR), May, 2019 (Best Paper Award)
  - Hoang Tran Vu , and Ching-Chun Huang, "Parking Space Status Inference upon a Deep CNN and Multi-task Contrastive Network with Spatial Transform", Submitted to IEEE Transactions on Circuits and Systems for Video Technology. Accepted (April 2018)
  - Hoang Tran Vu, and Ching-Chun Huang, “A Multi-Task Convolutional Neural Network With Spatial Transform For Parking Space Detection”, *IEEE International Conference on Image Processing (ICIP)*, Sep, 2017.
  - Ching-Chun Huang, and Hoang Tran Vu, “Parking Space Detection Based on a Multi-task Deep Convolutional Network with Spatial Transform ", *Computer Vision, Graphic and Image Processing (CVGIP)*, Aug, 2017.

- Publication:
  - Chingchun Huang and Hoang Tran Vu, “Vacant Parking Space Detection based on a Multi-layer Inference Framework,” *IEEE Transactions on Circuits and Systems for Video Technology*, May, 2016.
  - Ching-Chun Huang, Yi-Ren Chen, and Hoang Tran Vu, “Vacant Parking Space Detection Based On A Hierarchical and Semantic Classifier”, *Computer Vision, Graphic and Image Processing (CVGIP)*, Aug, 2015.
  - Ching-Chun Huang and Hoang Tran, “A Multi-layer Discriminative Framework for Parking Space Detection”, *IEEE International Workshop on Machine Learning for Signal Processing*, Boston, USA, Sep, 2017.
  - Ching-Chun Huang, Hoang Tran Vu, and Yi-Ren Chen, “A multiclass boosting approach for integrating weak classifiers in parking space detection,” *IEEE International Conference on Consumer Electronics - Taiwan,* Taipei, Taiwan. Jun, 2015.
  - Ching-Chun Huang, Yu-Shu Tai, and Sheng-Jyh Wang, “Vacant Parking Space Detection Based on Plane-based Bayesian Hierarchical Framework,” *IEEE Transactions on Circuits and Systems for Video Technology*. 2013.
  - Ching-chun Huang, Yu-Shu Dai and Sheng-Jyh Wang, "A Surface-based Vacant Space Detection for an Intelligent Parking Lot", *IEEE International Conference on ITS Telecommunications (ITST)*, Taipei, Taiwan, Nov. 5-8, 2012. (EI)

Smart Traffic– Autonomous Vehicle

“Depth Completion”
“Lidar Completion”
“Vehicle Detection”
“Traffic Sign Detection”
“Car Distance Estimation”
“Lane Detection”
“Crowd Counting”

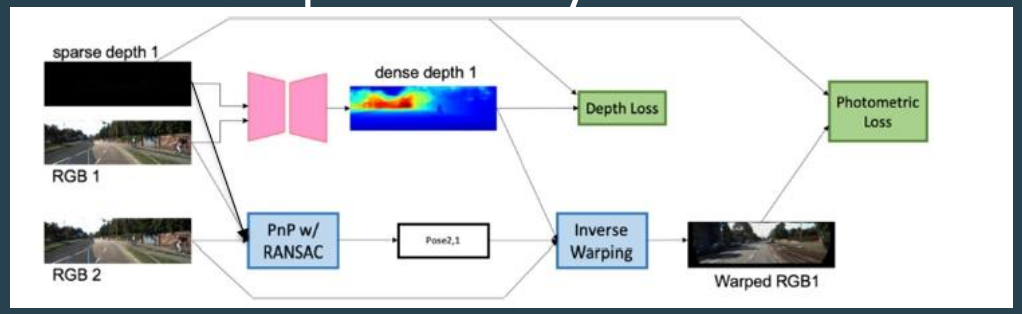
Projects

- Project Name :基於移動攝影機之交通場景理解
  - Project Period : 2021/1/9~2022/1/8
  - Cooperation Vendors ：中華電信研究 院(交安所)
- Project Name :自駕車之深度學習智能感知與情境理解系統技術
  - Project Period : 2018/12/01 ~ 2021/07/31
  - Cooperation Vendors ：行政院科技部
- Project Name :探討基於RGBD攝影機之機器人場景影像切割與深度圖修復多功能網路
  - Project Period : 2018/11/01~2019/10/31
  - Cooperation Vendors ：行政院科技部、萬潤科技
- 展示於台北車用電子展(2020、2021)

Depth Completion

- Goal :
  - Depth completion
    - Borrowing useful information from RGB image to complete the sparse depth image

- A self supervised system that can be trained without the ground truth



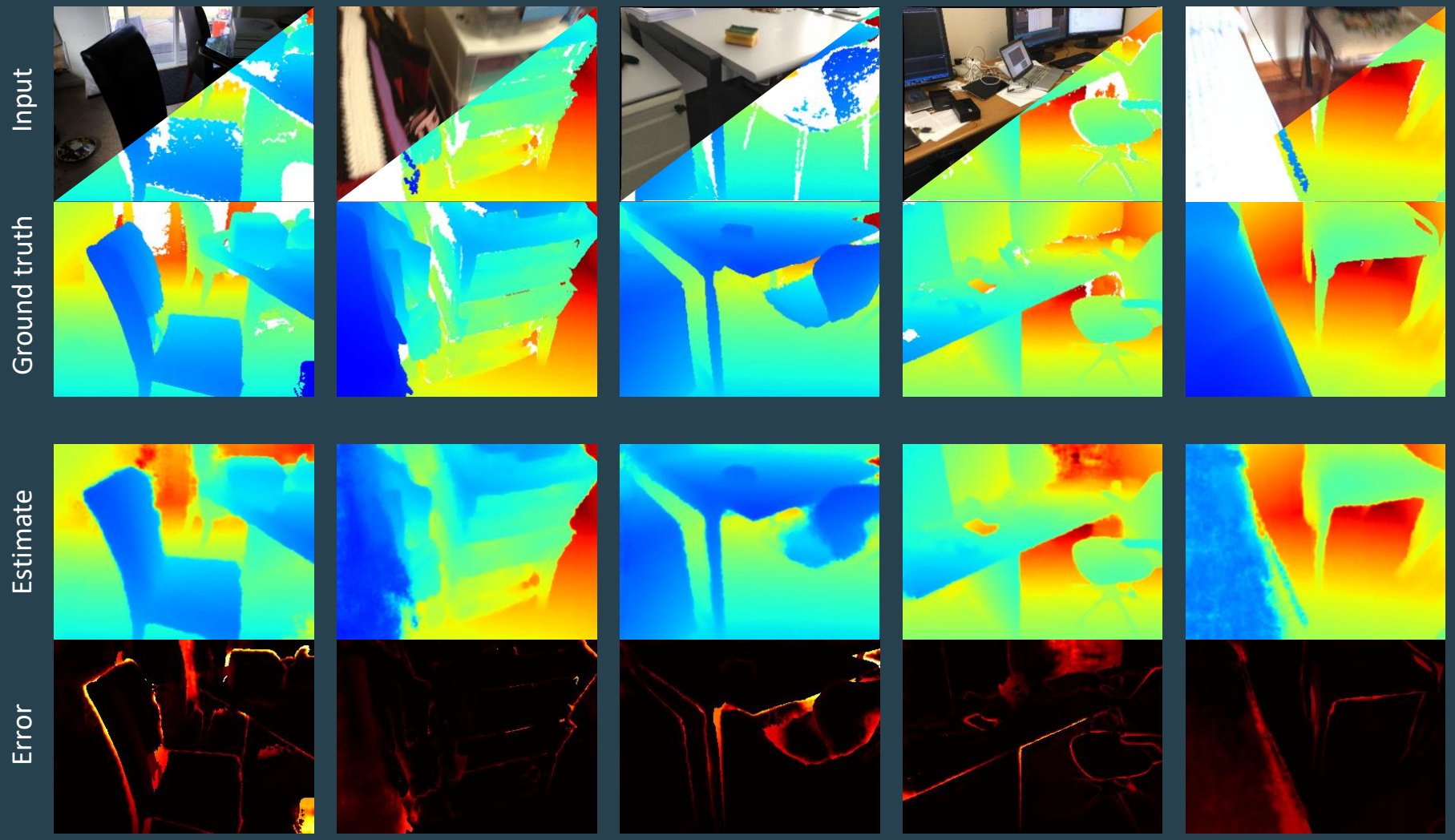
Proposed self-supervised depth completion system

Depth Completion

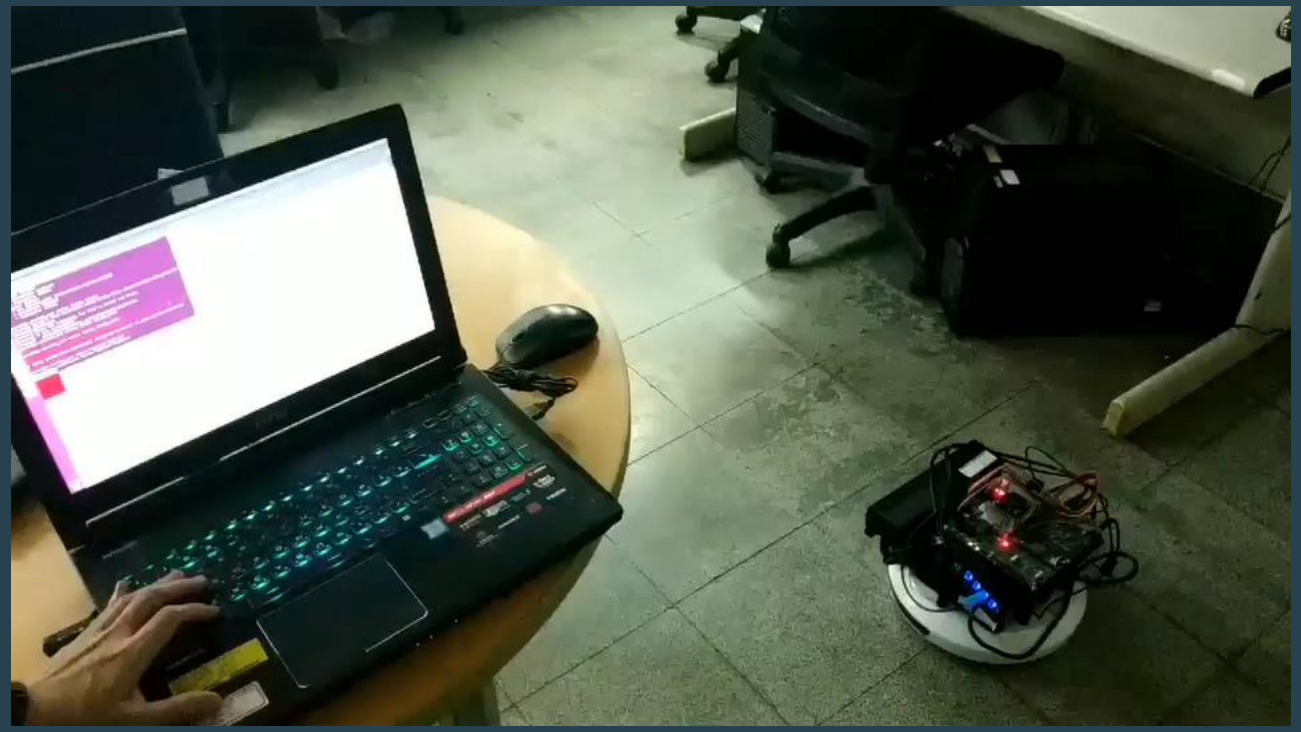
- Challenge:
  - Mixed depth pixels
    - Distorted and blurry edges emerge in the depth maps
    - Solution: new depth representation, classification problem, cross entropy loss
  - Excessively rich texture details on color images
    - Undesired depth estimation results
    - Solution: disentangle only useful information from RGB image to complete depth
  - Spatial-scale offset
    - Solution: use both color image and sparse depth image

- Result :

Example depth completion results on ScanNet test set.

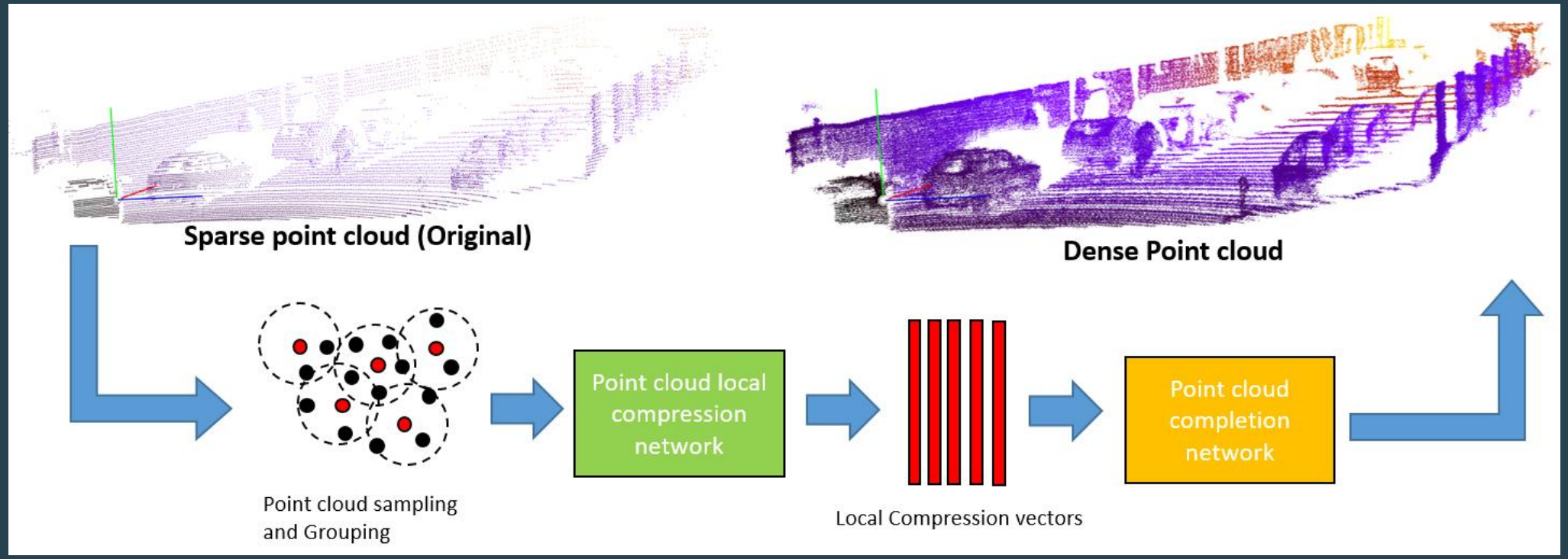


- Result



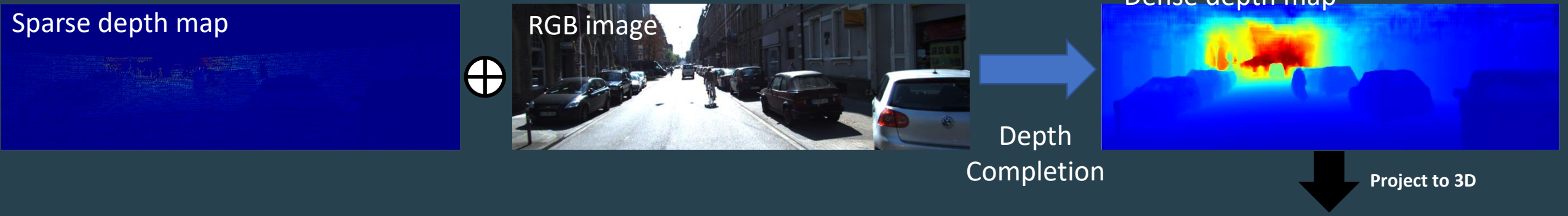
Lidar Completion

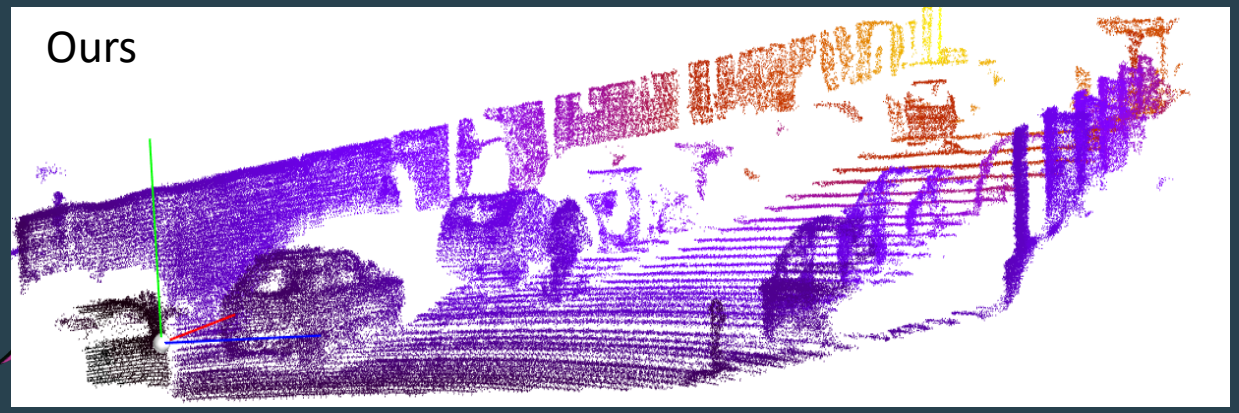
- Goal :
  - Increase the number of point cloud from the raw LiDAR data in 3D

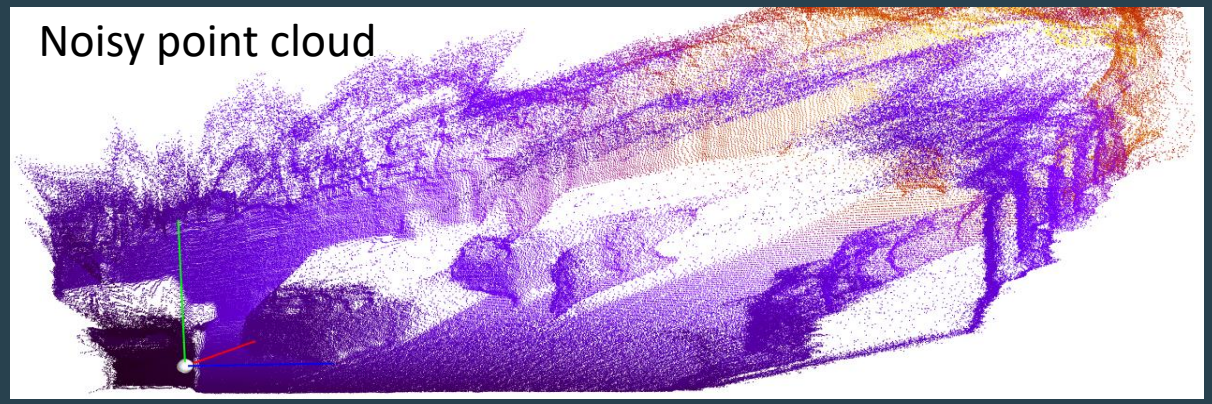


Lidar Completion

- Challenges :
  - Most of the depth completion methods suffer from the edge-blurry problem.
  - We use a more geometric way to solve the problem.
    - Our method up-samples the point cloud in the 3D coordinate directly.







- Results

Comparison with State-of-the-art Methods

Method	RMSE(均方根誤差)
DSPN [1]	766.74
MSG-CHN [2]	762.19
Ours (1st year)	814.73
Ours (2nd year)	**751.29**

[1] Z. Xu, H. Yin and J. Yao: Deformable Spatial Propagation Networks For Depth Completion. 2020 IEEE International Conference on Image Processing (ICIP) 2020.
[2] A. Li, Z. Yuan, Y. Ling, W. Chi, C. Zhang and others: A Multi-Scale Guided Cascade Hourglass Network for Depth Completion. The IEEE Winter Conference on Applications of Computer Vision 2020.

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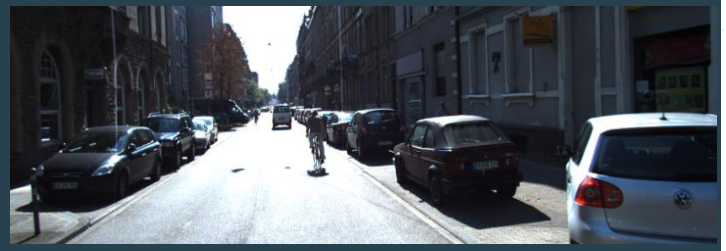
- Results

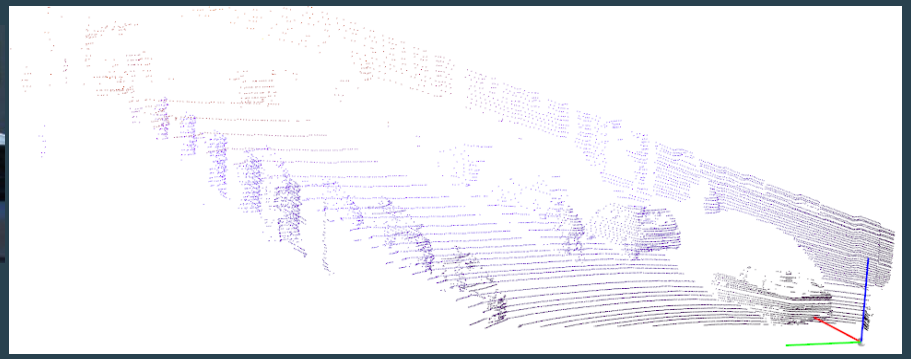
Example depth completion results on KITTI test set.

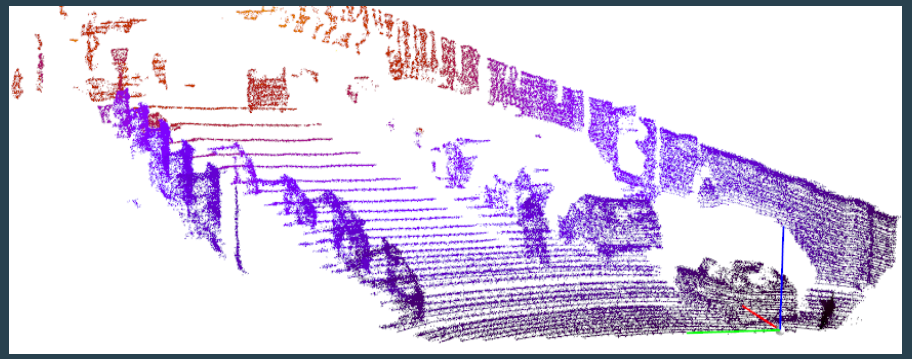
RGB

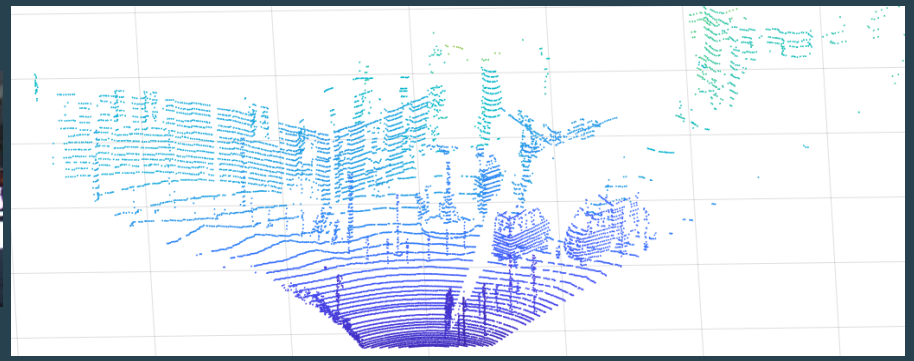
Sparse point cloud

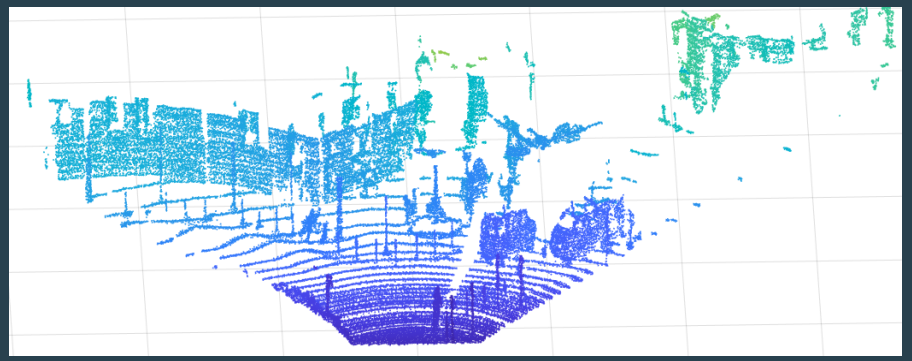
Prediction





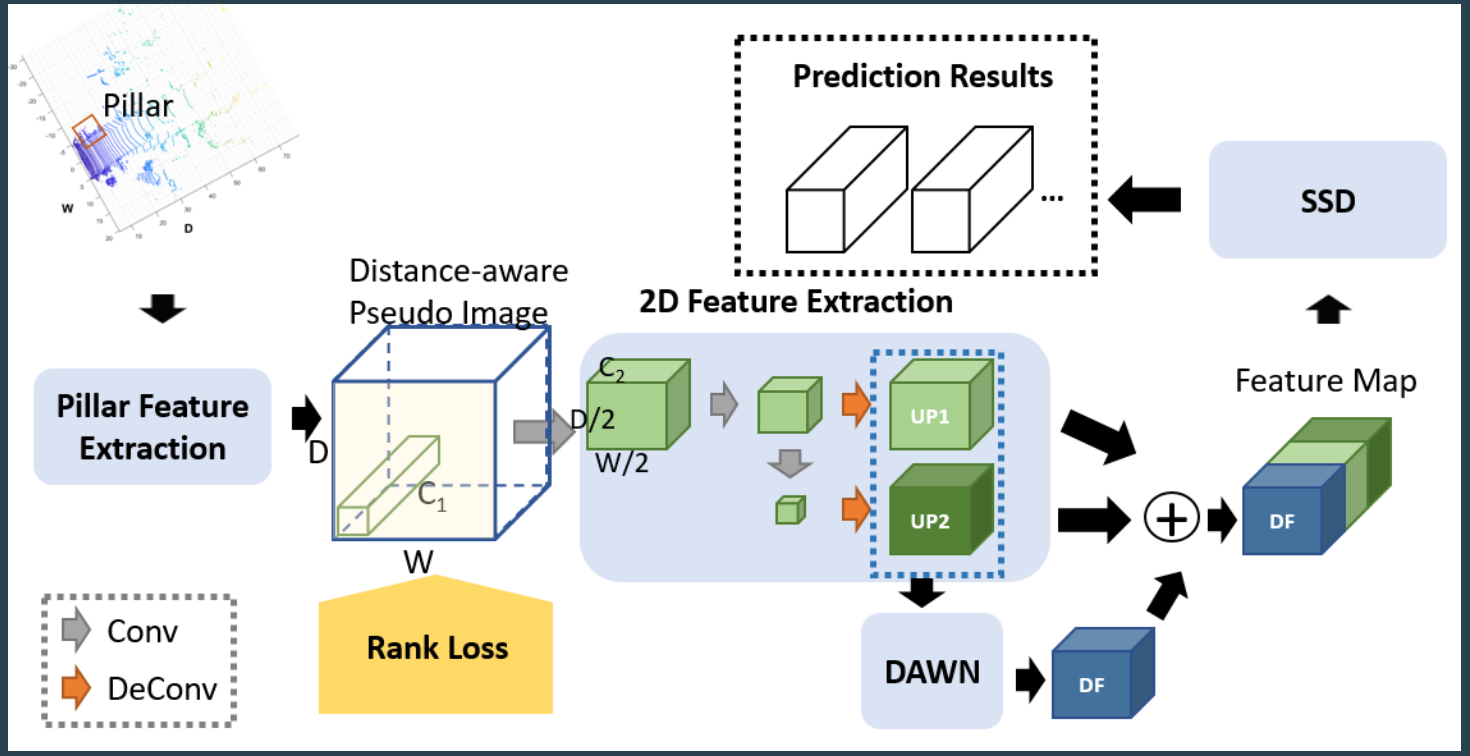






Vehicle Detection

- Goal:
  - Based on the point cloud generated by Lidar, detect objects and generate corresponding 3D bounding boxes in real time

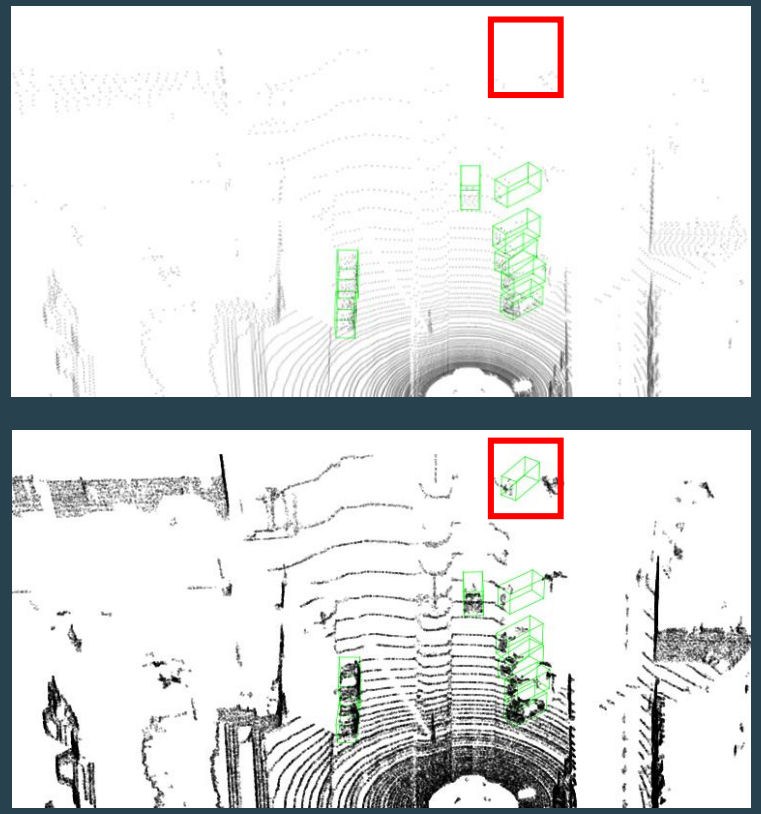


Vehicle Detection

- Challenges :
  - Large amount of computation on LiDAR-based 3D object detection
    - Solution: using pillar to be a unit in order to reduce the computation
  - Lidar is sparse and has difficulties in detecting small objects
    - Solution: using dynamic receptive field to collect more information
  - Target pillars contain some redundant points
    - Solution: using loss to constrain the distribution of the feature of target pillars

- Result :

3D Vehicle Detection Results

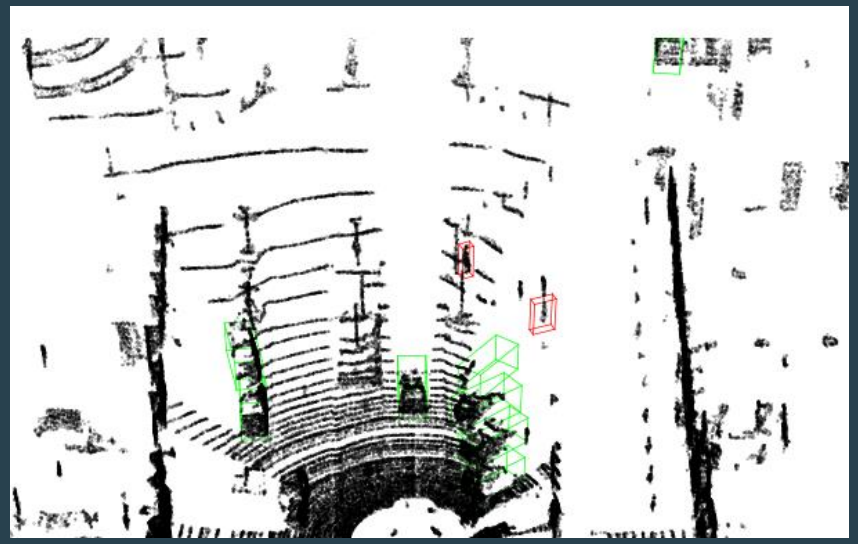


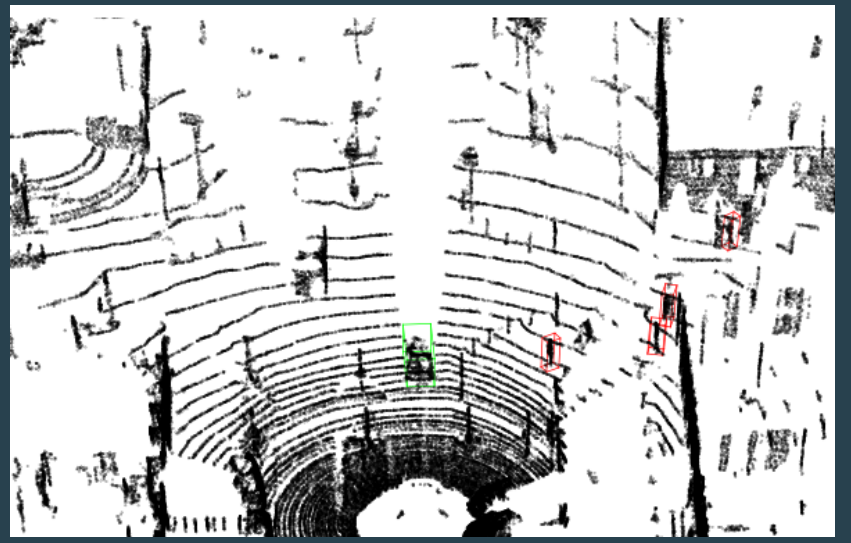
Comparison with State-of-the-art Methods

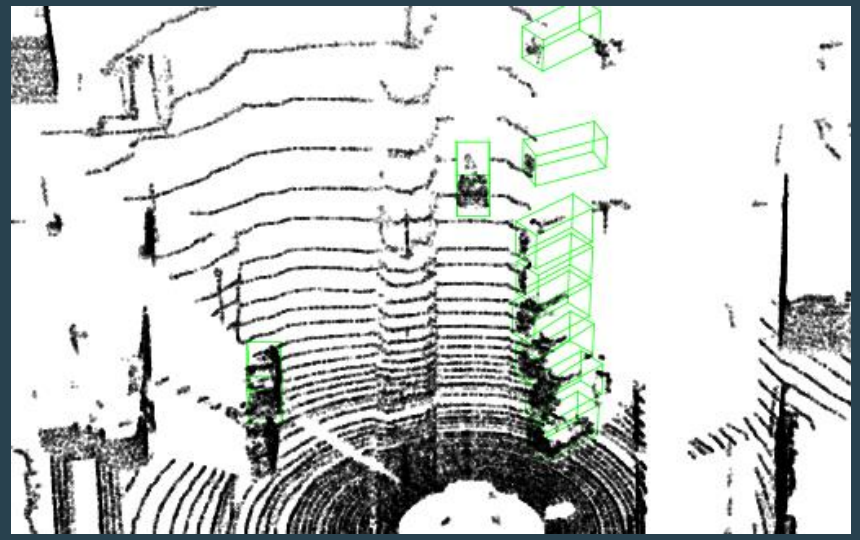
Car	準確度 (%)	Speed(FPS)
2019 Uber [1]	70.22	13
2020 CMU [2]	72.29	1.67
2020 Samsung [3]	73.34	25
Ours	**74.85 (+4.17)**	**60 (+30)**

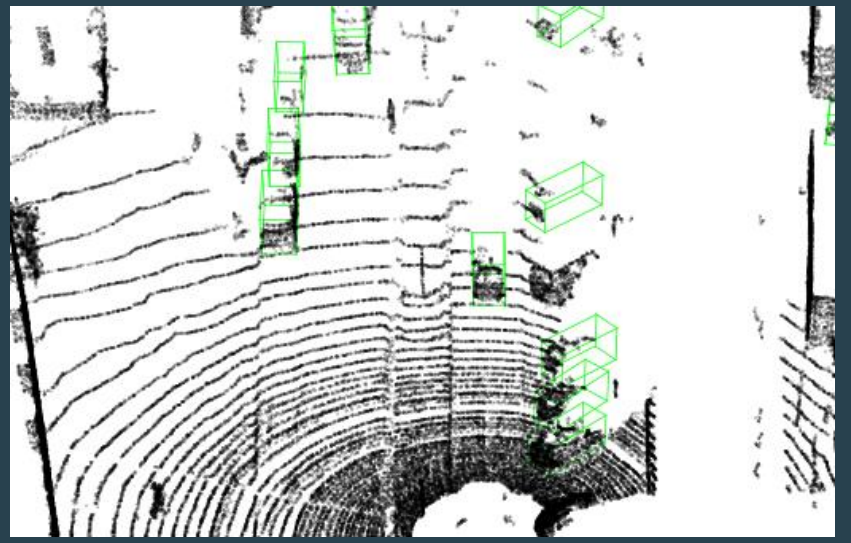
[1] Ming Liang*, Bin Yang*, Yun Chen, Rui Hu, and Raquel Urtasun. Multi-task multi-sensor fusion for 3d object detection. In CVPR, 2019.
[2] Shi, W., Rajkumar, R.: Point-GNN: graph neural network for 3D object detection in a point cloud. In: CVPR (2020)
[3] Qi Chen, Lin Sun, Zhixin Wang, Kui Jia, and Alan Yuille. Object as hotspots: An anchor-free 3d object detection approach via firing of hotspots. ECCV, 2020

- Result :







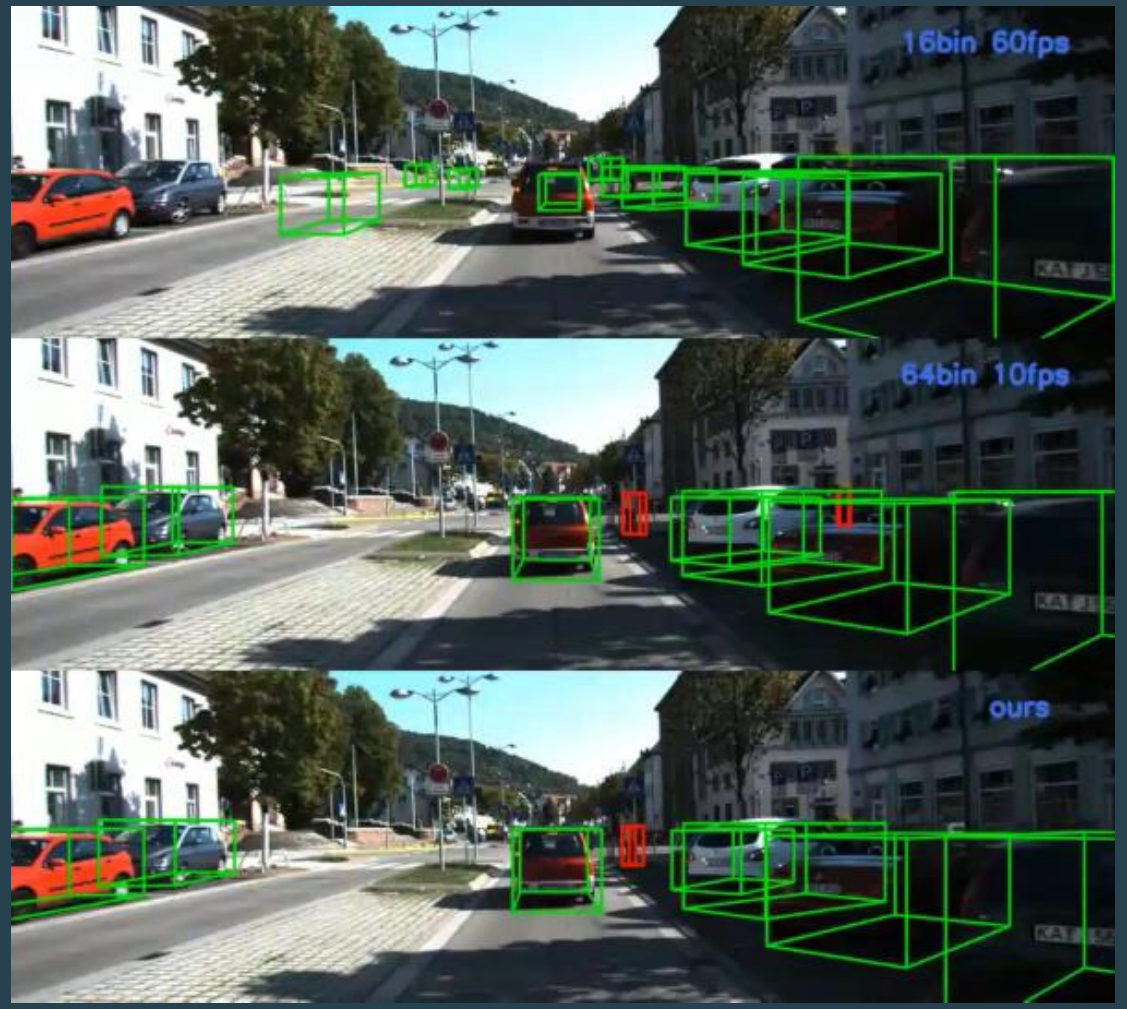


- Result

16 bin+
our vehicle detection module

64 bin+
PointRCNN

64 bin+ our Lidar completion
+our vehicle detection module

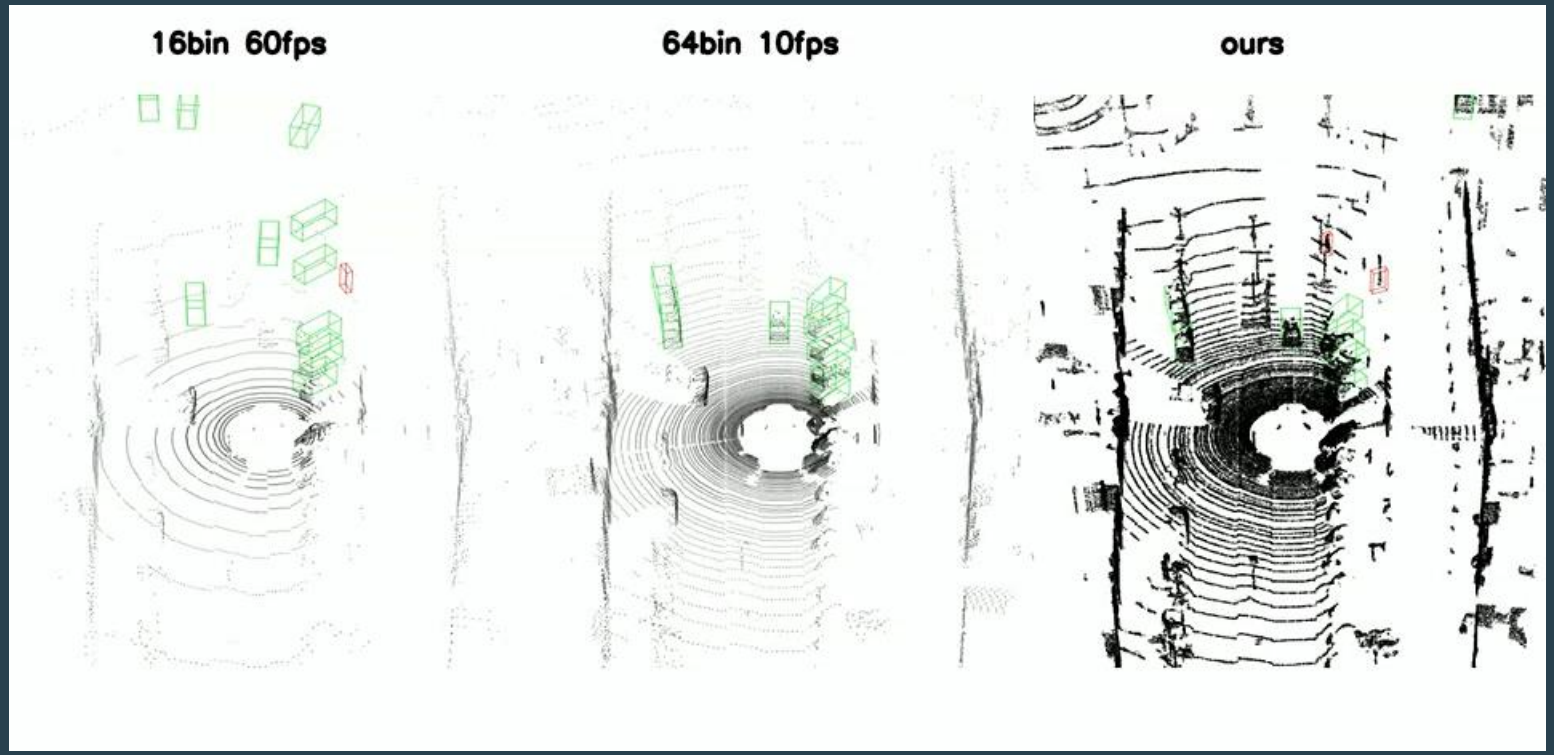


- Results

16 bin+
our vehicle detection module

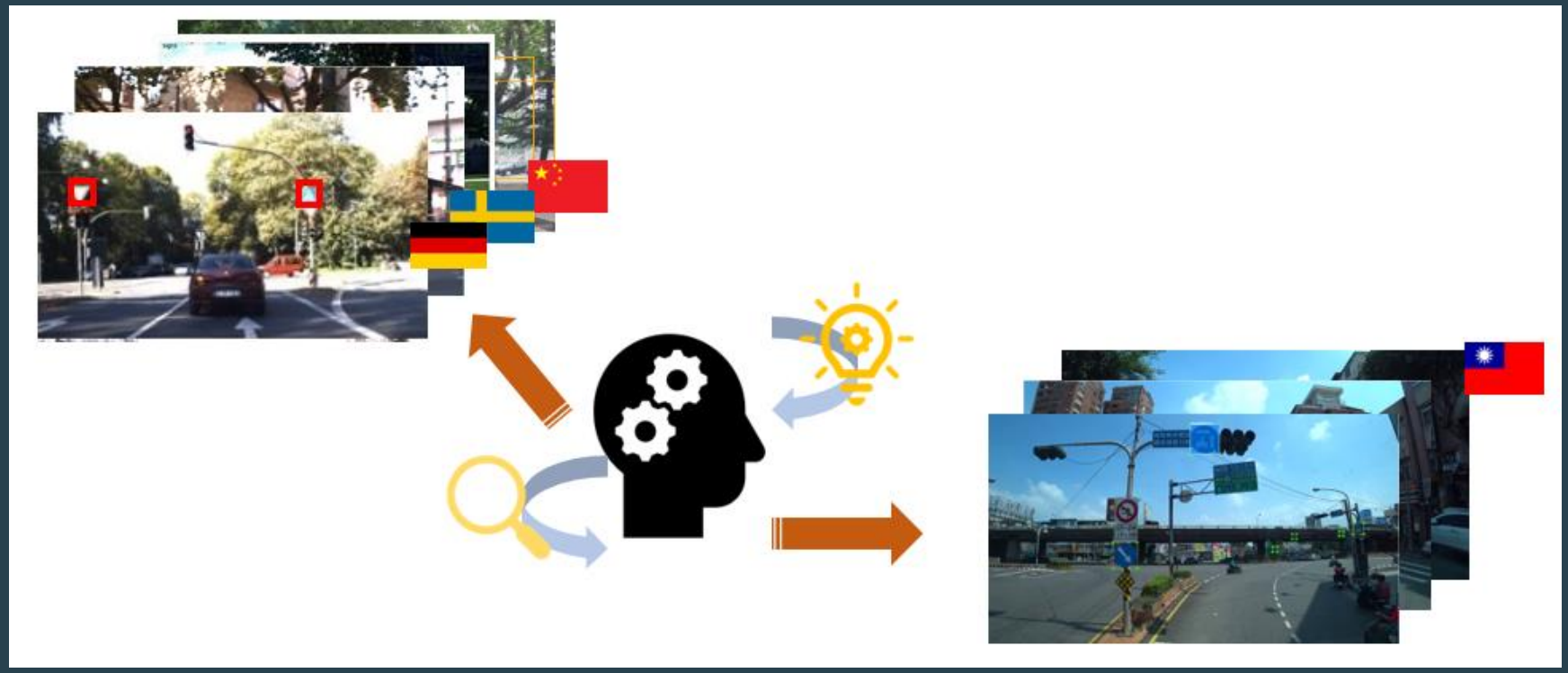
64 bin+
PointRCNN

64 bin+ our Lidar completion
+our vehicle detection module



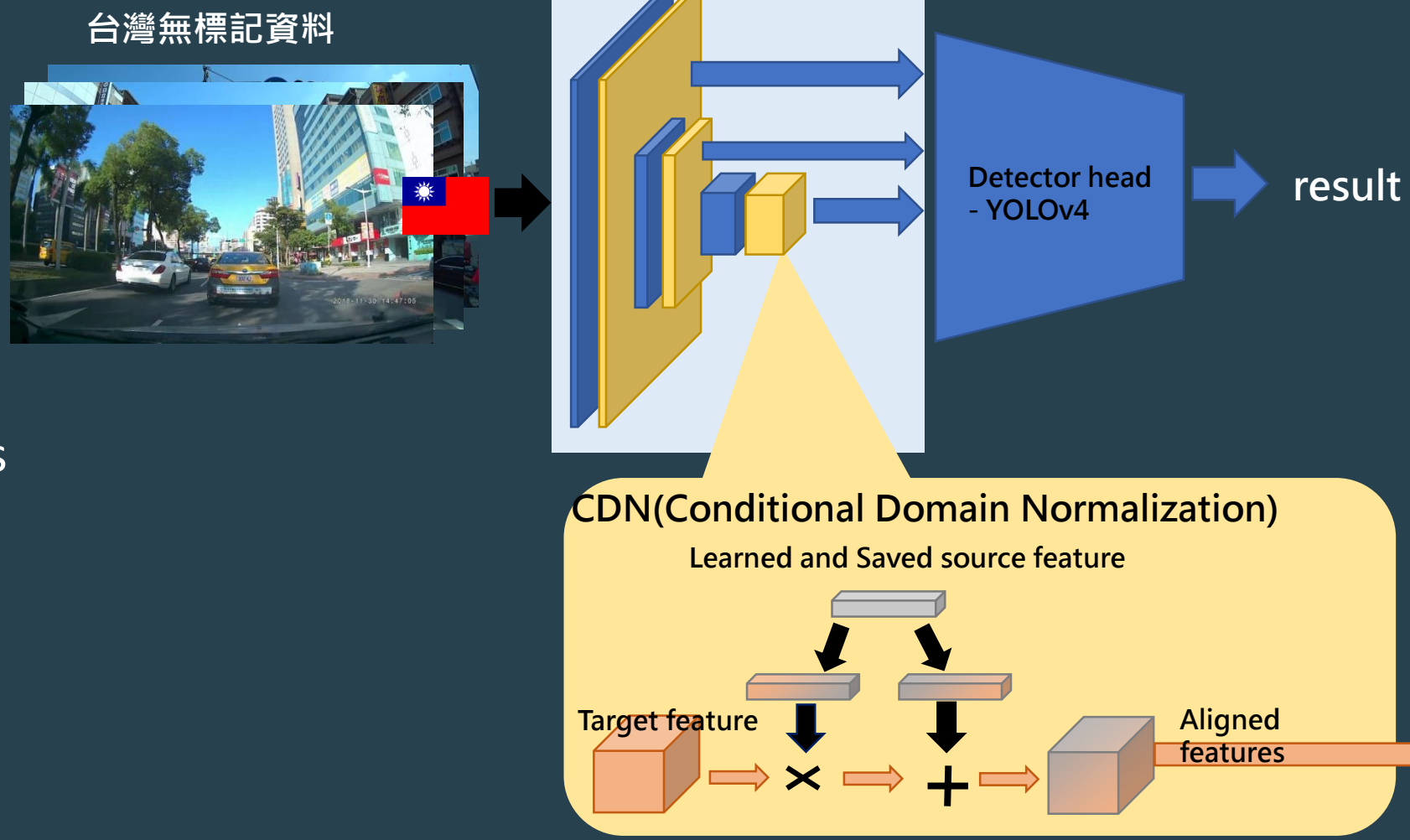
Traffic Sign Detection

- Goal:
  - Deploy a well-trained traffic sign detector into another domain (from country A to country B)

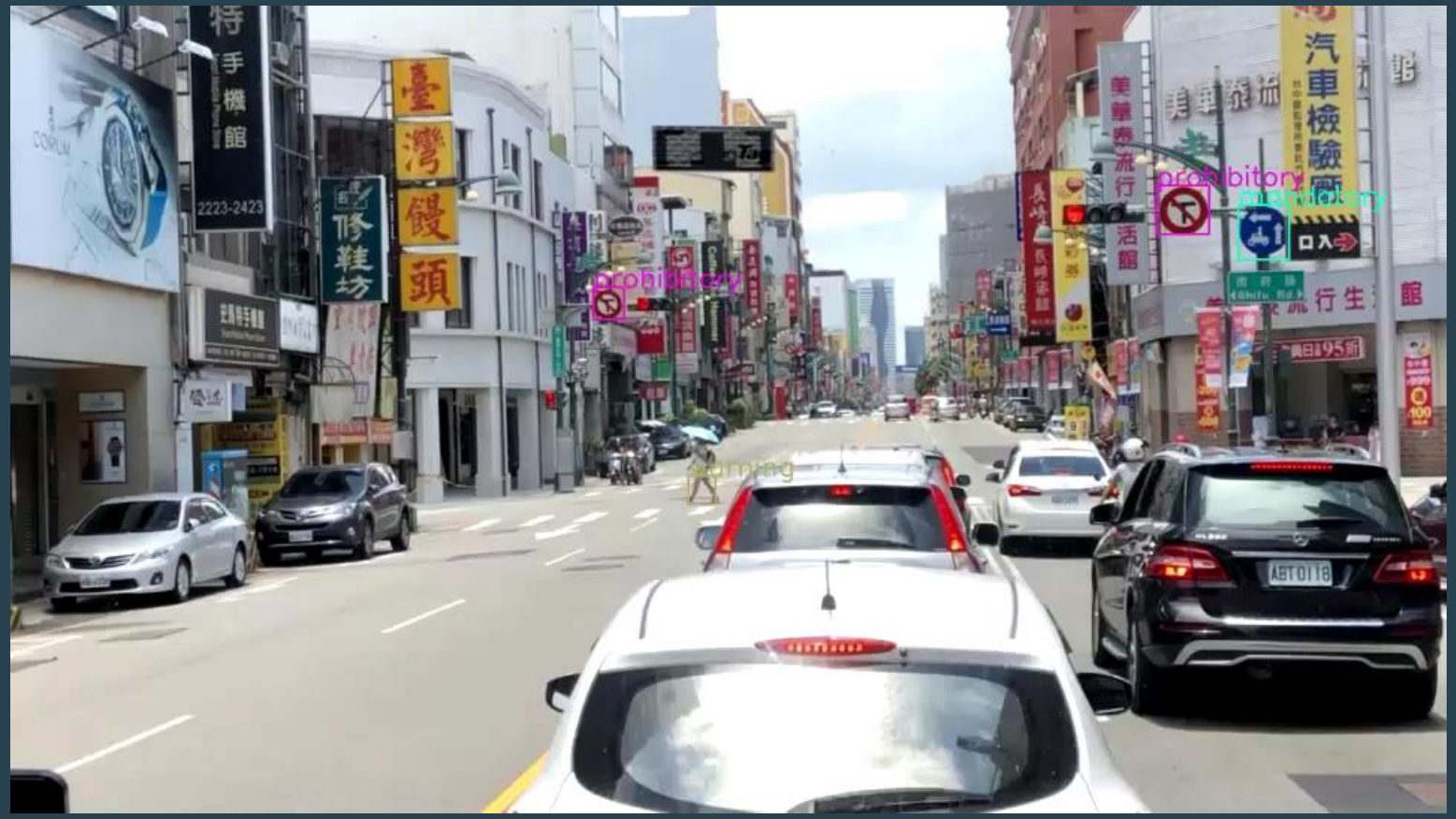


Traffic Sign Detection

- Challenge:
  - Traffic signs in different countries have diverse styles
  - Re-labeling the ground truth in a new domain is a heavy burden

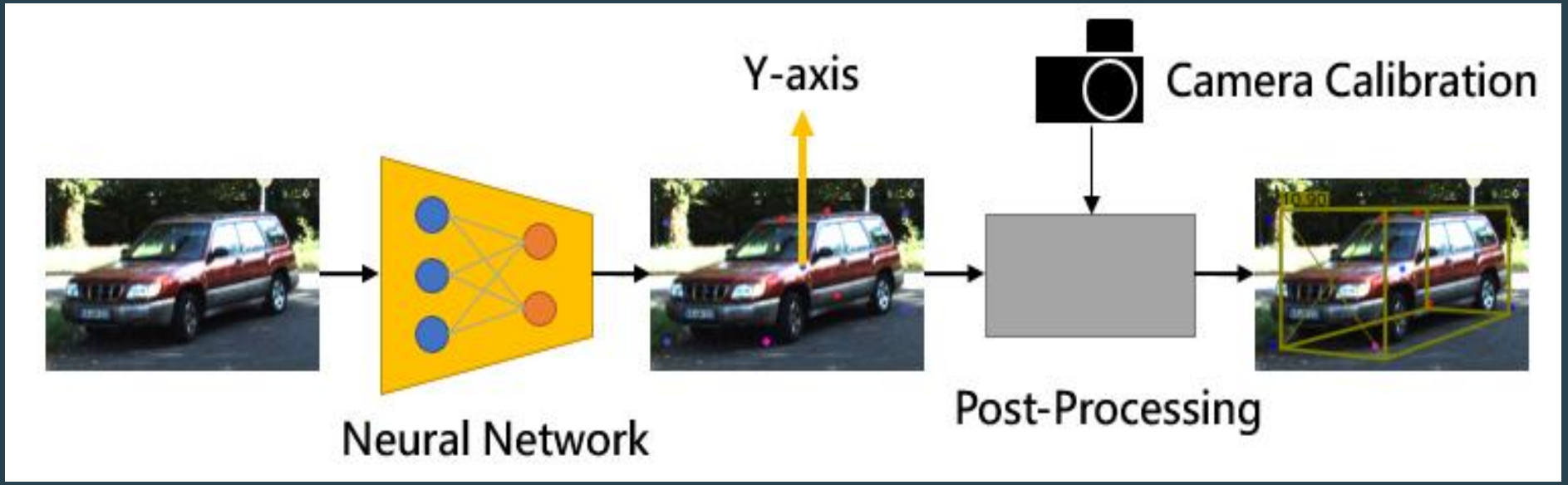


- Results



Car Distance Estimation

- Goal:
  - Estimate the car distance by single camera

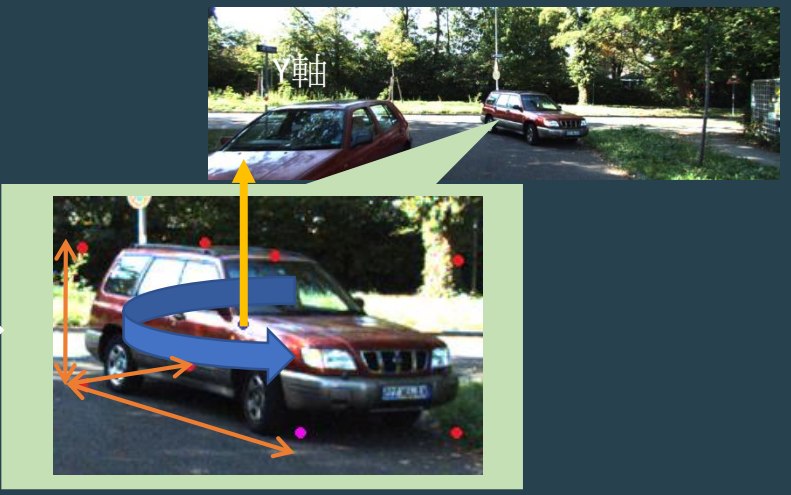


Car Distance Estimation

- Challenges:
  - Lacks of depth information
  - Conventional methods that is data-driven tend to have the issues of:
    - Overfitting
    - Hard to apply to other cameras

原始影像

神經網路
(Real Time Monocular 3D Detection)

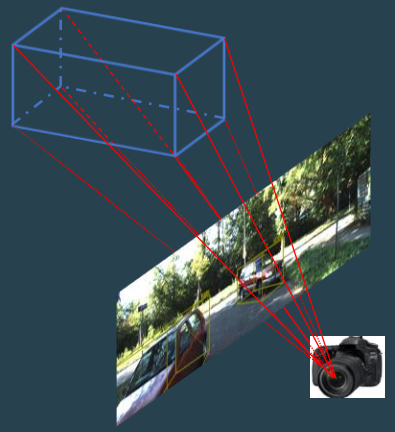


2D關鍵點(3D bounding box頂點在影像上座標)、角度、車輛大小

2D-3D
投影變換

後處理

相機參數



最終結果

- Results

Lane Detection

- Goal :
  - Create a robust vision-based lane detection and tracking in different scenarios.

Front-view image

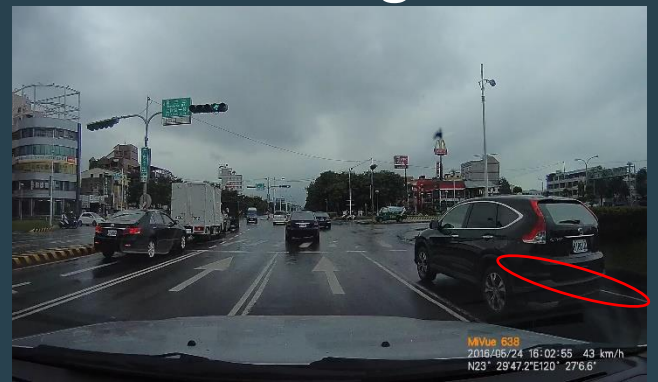
Detection and Tracking algorithm

Lane detection result

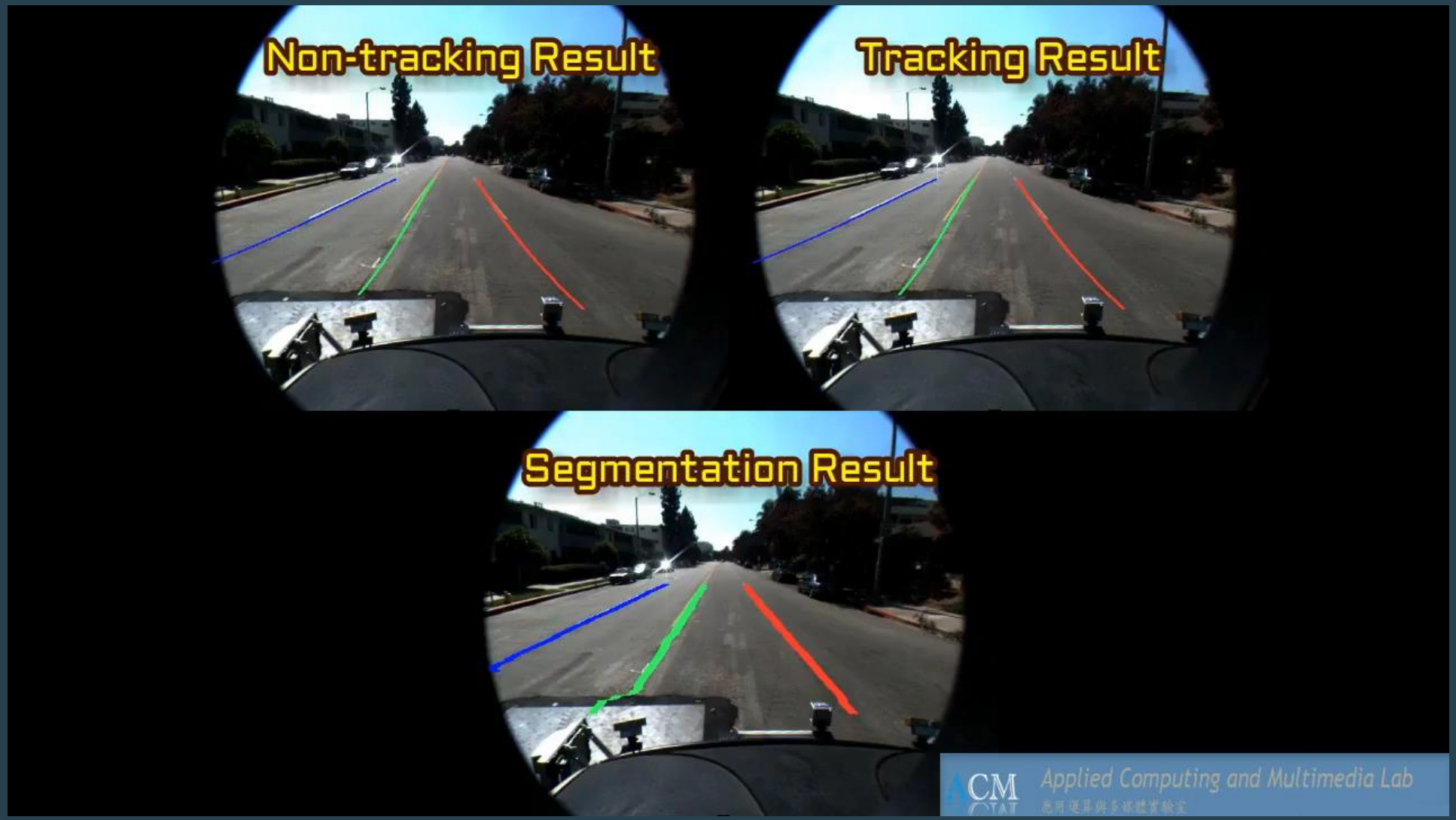
Lane Detection

- Challenges :
  - Noises from various lane marking
    - Texture marking, Zebra crossing, Crossroad signs, Intersection, Curve lane

  - Shadows cast from vehicles, trees and buildings

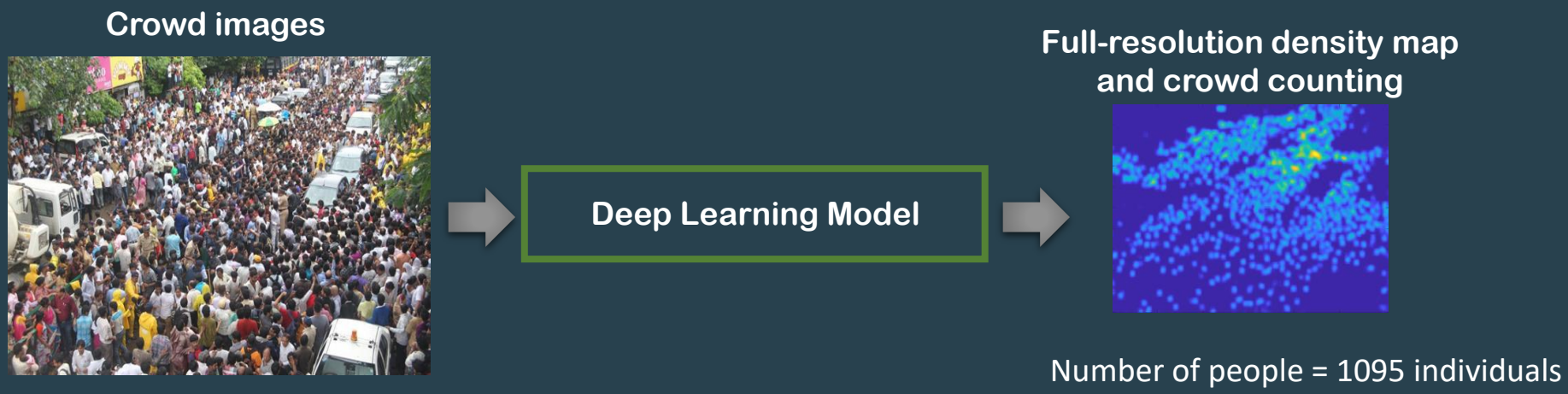


- Result :


Non-tracking Result
Tracking Result
Segmentation Result
ACM
Applied Computing and Multimedia Lab

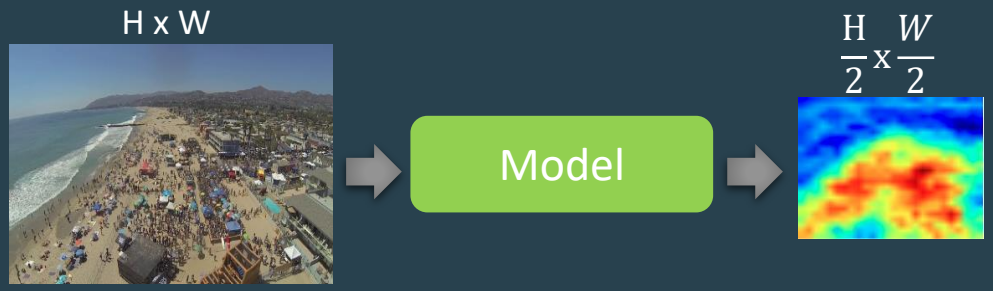
Crowd Counting

- Goal :
  - Given the crowd image, we build the Deep Learning model to estimate the crowd density map and count number of people. (UAV based)



Crowd Counting

- Challenges :
  - The significant scale variation in highly congested crowd
  - The estimated density map has low resolution

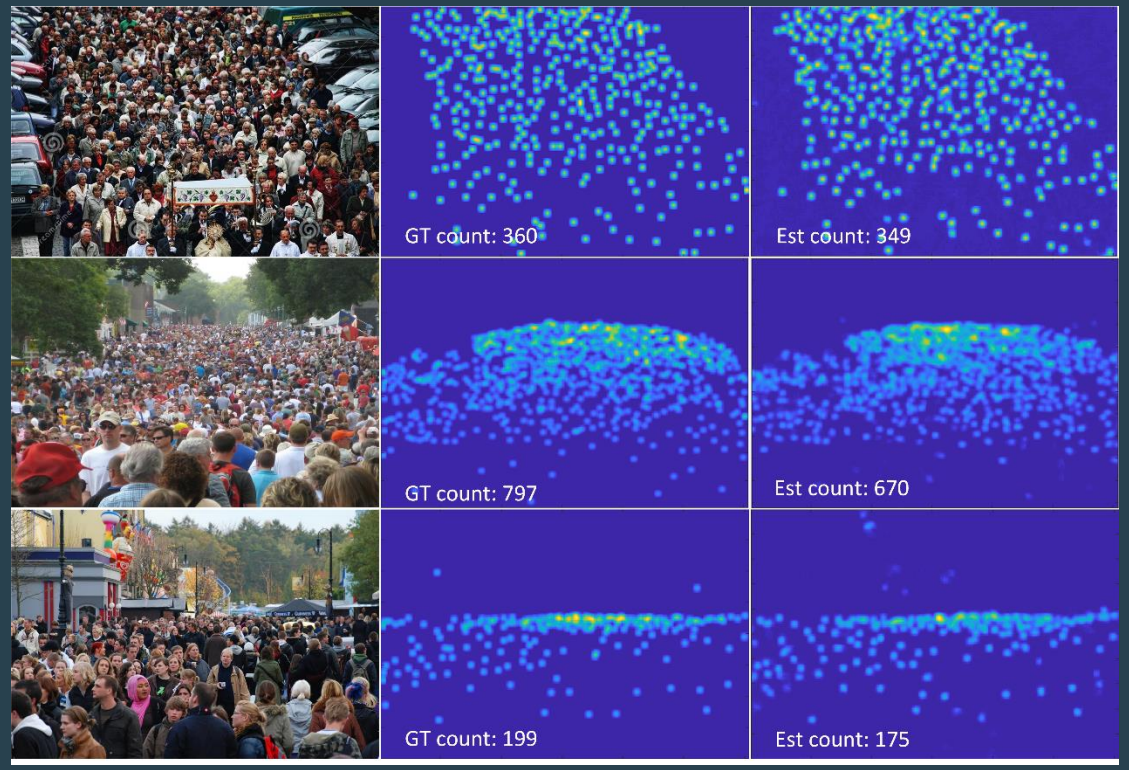


Example of low-resolution density map

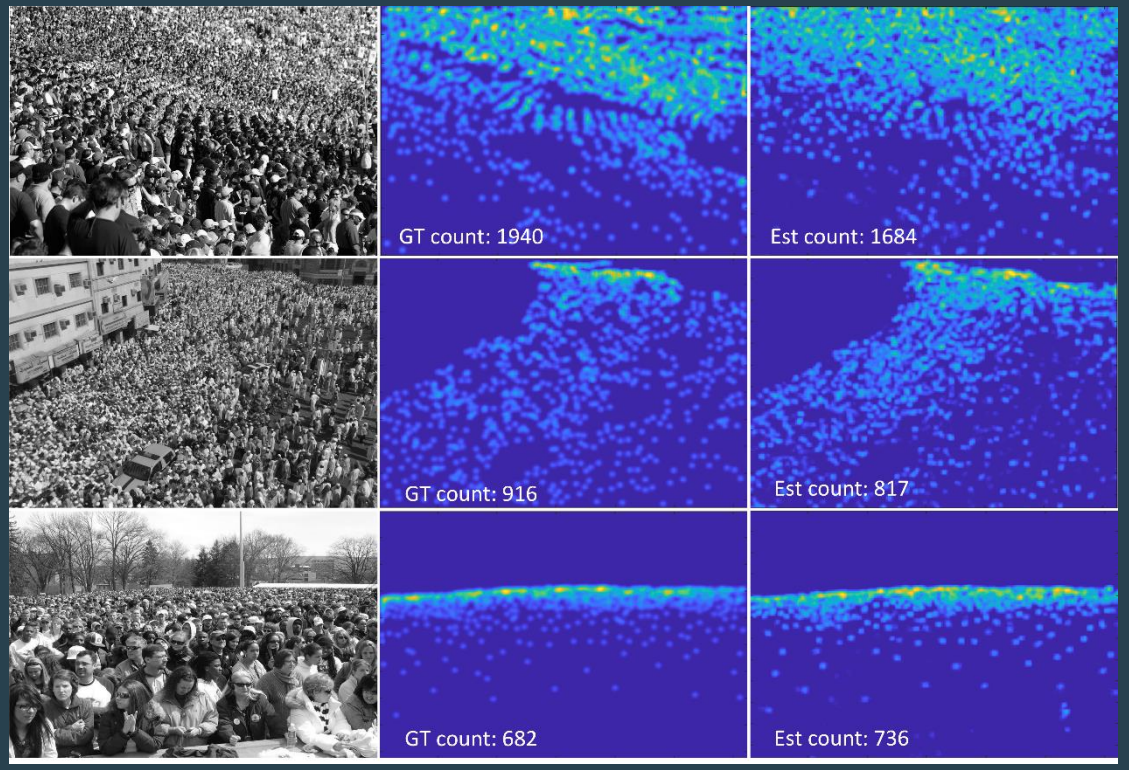
Examples of high crowd density

- Result :

The illustration on ShanghaiTech dataset



The illustration on UCF_CC_50 dataset



- Publication:
  - You-Feng Wu, Vu-Hoang Tran, Ting-Wei Chang, Wei-Chen Chiu, Ching-Chun Huang, "DEN: Disentangling and Exchanging Network for Depth Completion", International Conference on Pattern Recognition(ICPR), Jan., 2021.
  - Van-Su Huynh, Vu-Hoang Tran, and Ching-Chun Huang, "IUML: INCEPTION U-NET BASED MULTI-TASK LEARNING FOR DENSITY LEVEL CLASSIFICATION AND CROWD DENSITY ESTIMATION", IEEE International Conference on Systems, Man, and Cybernetics, 2019.
  - Van-Su Huynh, Vu-Hoang Tran and Ching-Chun Huang , "DAnet: DEPTH-AWARE NETWORK FOR CROWD COUNTING", 2019 IEEE International Conference on Image Processing(ICIP), Sept. 2019.
  - Tzung-Yan Tsai, Zhe-Yu Lu, and Ching-Chun Huang, "License Plate Recognition System Based on Deep Learning", International Conference on Consumer Electronics - Taiwan (ICCE-TW), Yilan, Taiwan, May, 2019
  - Thanh-Phat Nguyen, Hoang Tran Vu, and Ching-Chun Huang, "Lane Detection and Tracking based on Fully Convolutional Networks and Probabilistic Graphical Models", IEEE International Conference on Systems, Man, and Cybernetics, Oct., 2018.
  - Ching-Chun Huang, Hoang Tran Vu, Tsann-Tay Tang, "Inter-Vehicle Communication, License Plate Verification, and Distance Estimation for the Construction of Driving Surroundings", International Conference on Connected Vechicles & Expo, Nov., 2014.

Visual Data Analysis/Enhancement

"Image Compression"

"Medical Image Processing"

"Adaptive Image Super-resolution"

"Invertible Image Super-resolution"

"Visual Data Exposure Correction"

"Optical Character Recognition"

Projects

- Project Name :基於生成模型的視訊壓縮
  - Project Period : 2018/01/01~ 2021/12/31
  - Cooperation Vendors ：行政院科技部
- Project Name :109年度工研院環境建構總計畫-深度學習端到端文字偵測與辨識技術
  - Project Period : 2020/8/20~2020/12/31
  - Cooperation Vendors :財團法人工業技術研究院
- Project Name :建立仿真實紋理的肝臟三維模型並實現網路架構下的擴增實境應用
  - Project Period : 2018/7/1~2019/6/30
  - Cooperation Vendors ：秀傳醫院
- Project Name :融合電腦斷層與超音波診斷影像配合擴增實境應用在肝臟侵入式放射線導引針之技術開發
  - Project Period : 2017/08/01~ 2018/07/31
  - Cooperation Vendors :行政院科技部
- Project Name :大腸鏡影像之三維腫瘤重建技術
  - Project Period : 2016/08/01 ~2017/07/31
  - Cooperation Vendors :行政院科技部

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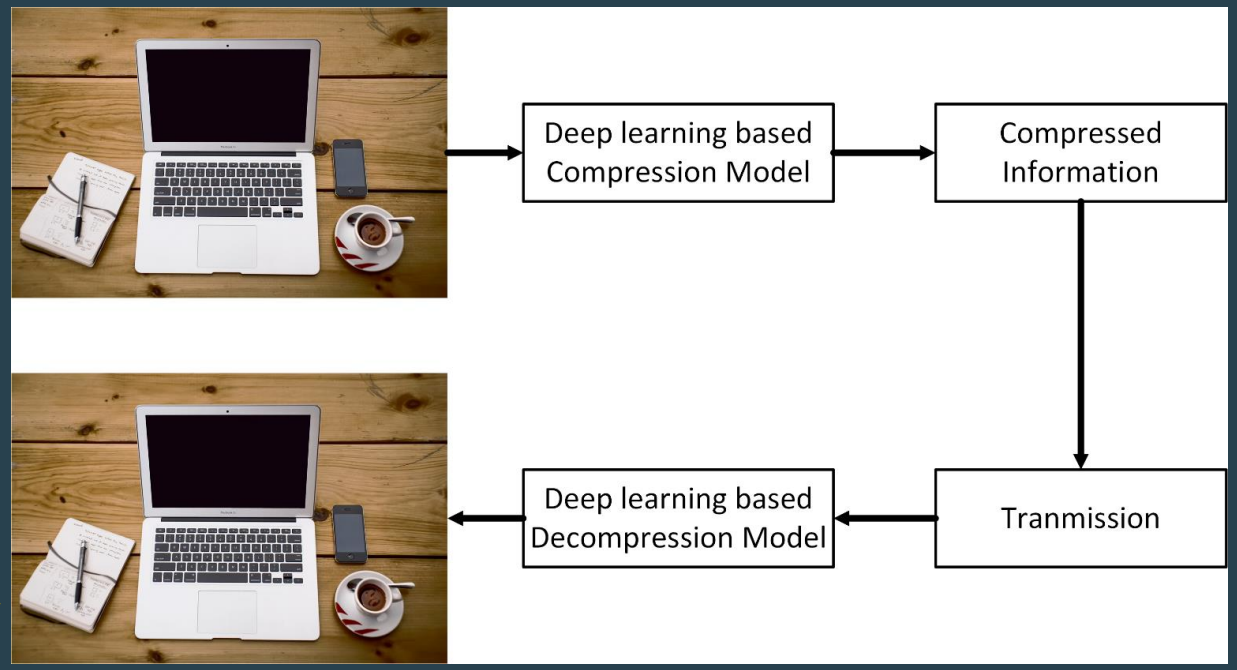
Image Compression

- Goal :
  - Learn Deep Image Structure Prior for Ultra-Low Bit Rate Image Compression.



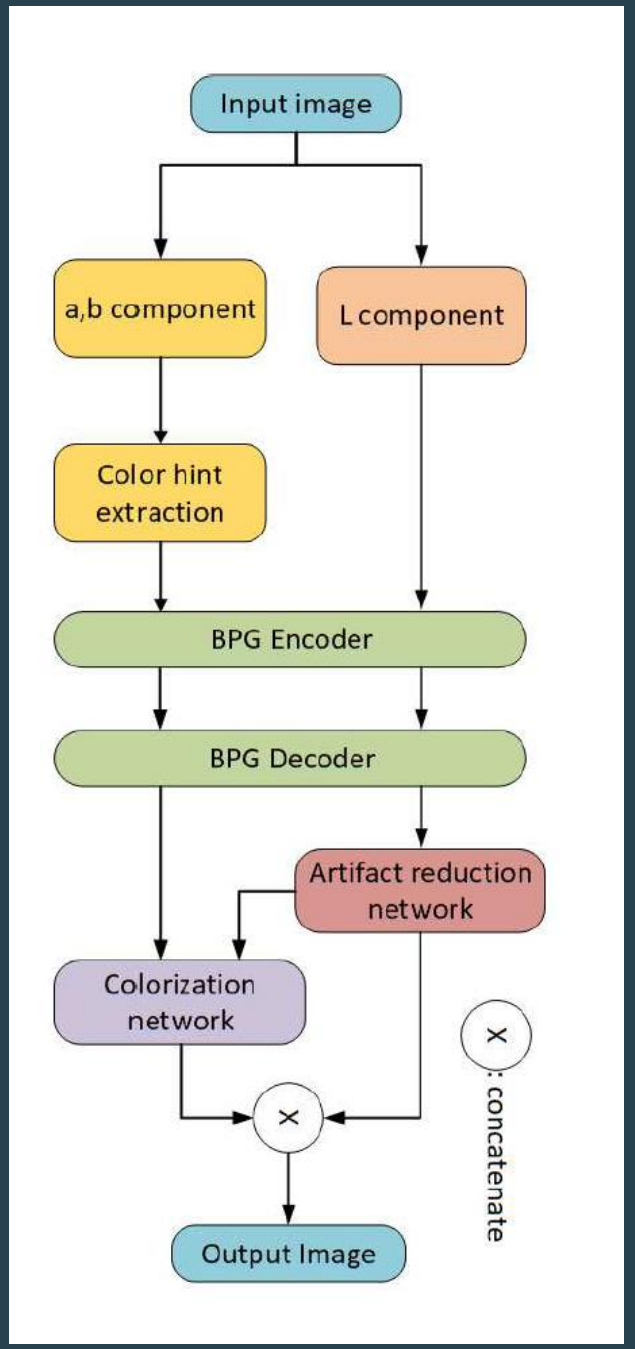
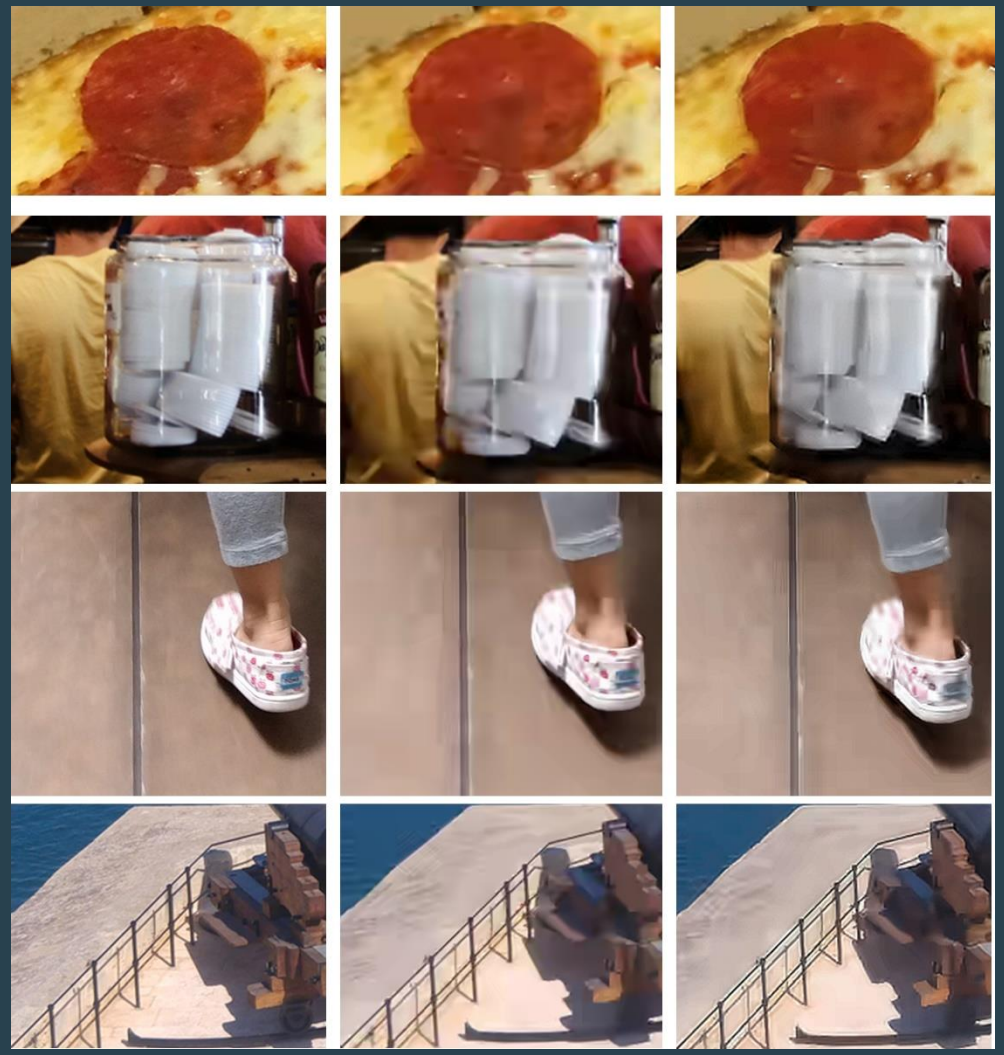


Image Compression

- Challenges :
  - The image quality is usually degraded at very low bitrate.
  - How to find out that which necessary information should be transmitted and which prior information that deep learning model provides.

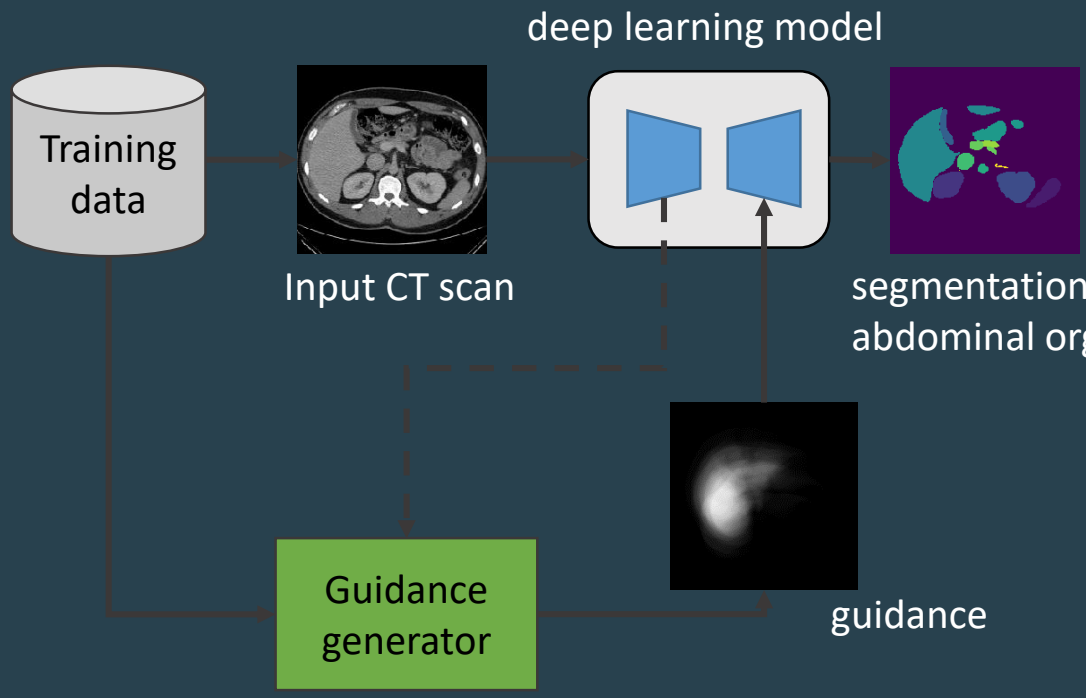
- Result:



Original Image | BPG Result | Our Result

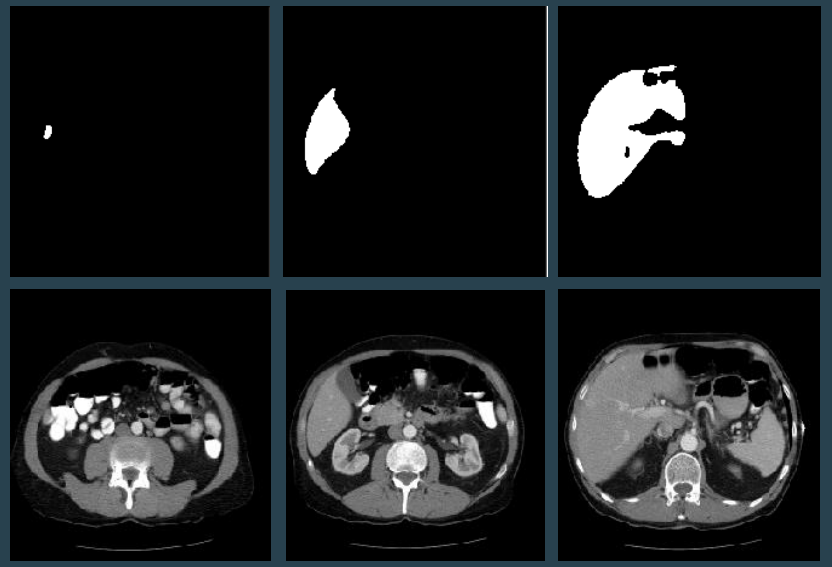
Medical Image Processing

- Goal:
  - Build up a deep learning model for accurate and robust segmentation of abdominal organs on CT scan

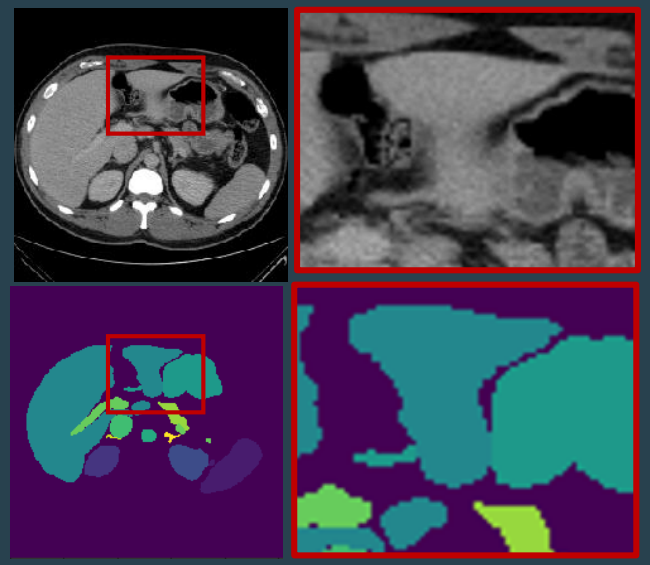


Medical Image Processing

- Challenges :
  - Segmentation difficulty in CT-scanned data
    - Weak boundaries of organs, Clustering background, High appearance similarity between organ and tissue and Appearance variation caused by external factors
  - Large variation of organ
    - Large variation of organ size and shape through the longitudinal axis

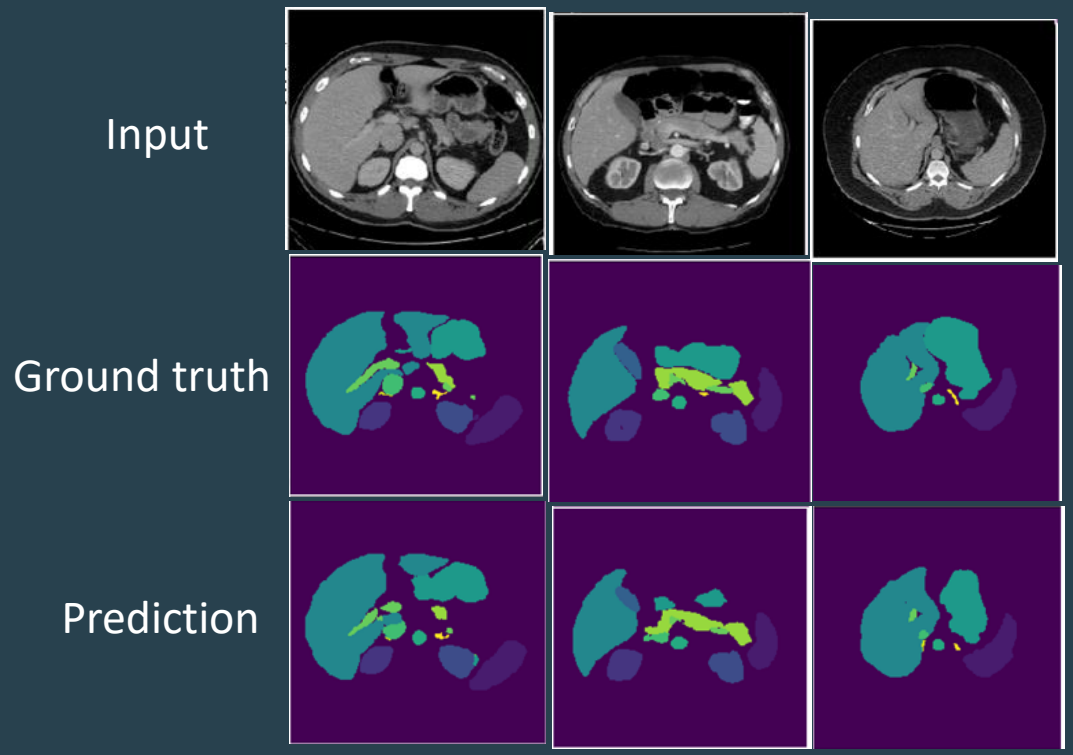


Large variation of organ



weak boundaries of organs

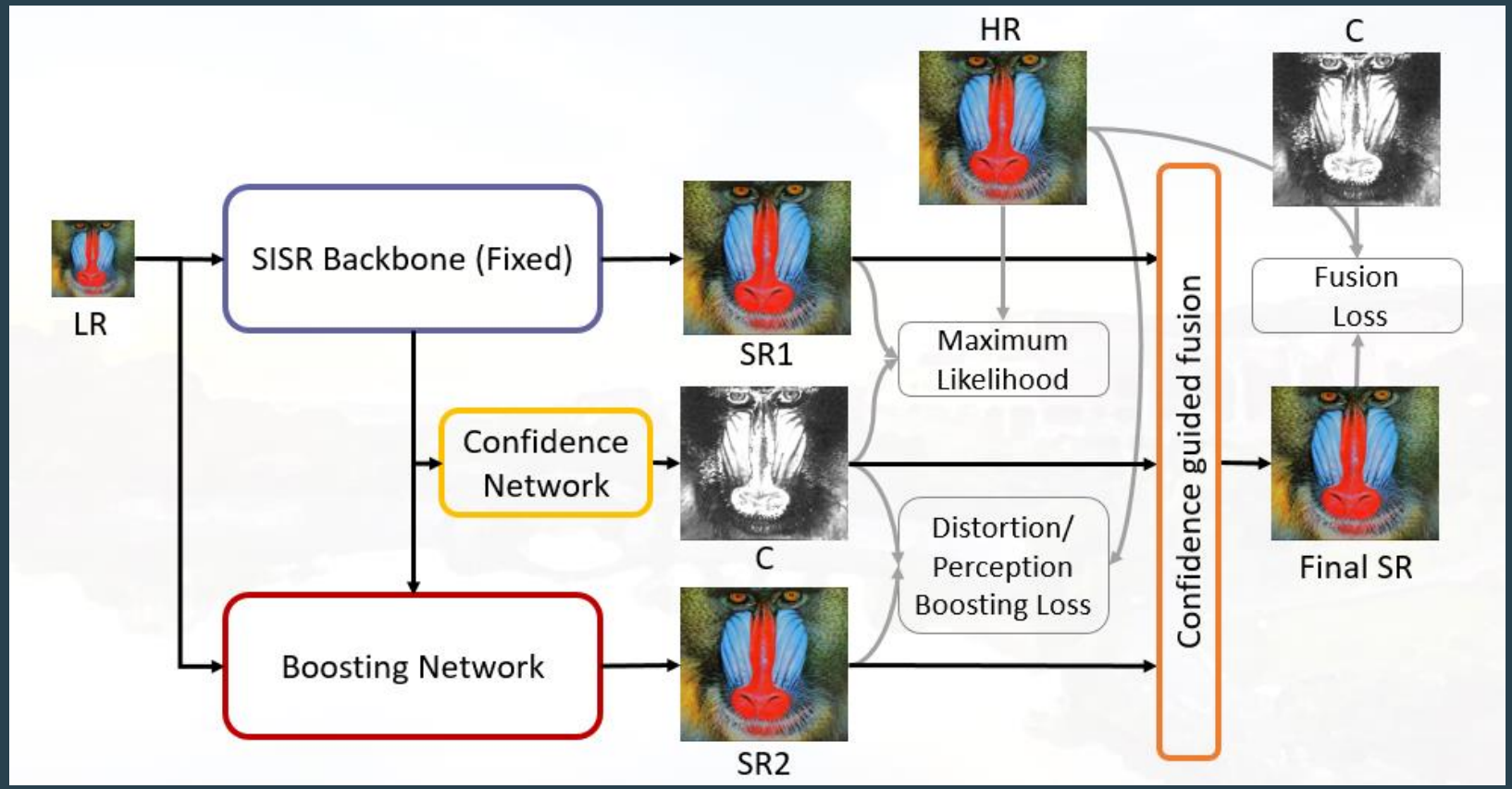
- Result :



Background	Spleen	Kidney (R)	Kidney (L)	gallbladder	esophagus
liver	stomach	aorta	IVC	PV & SV	pancreas
adrenal gland (R)	adrenal gland (L)				

Adaptive Image Super-resolution

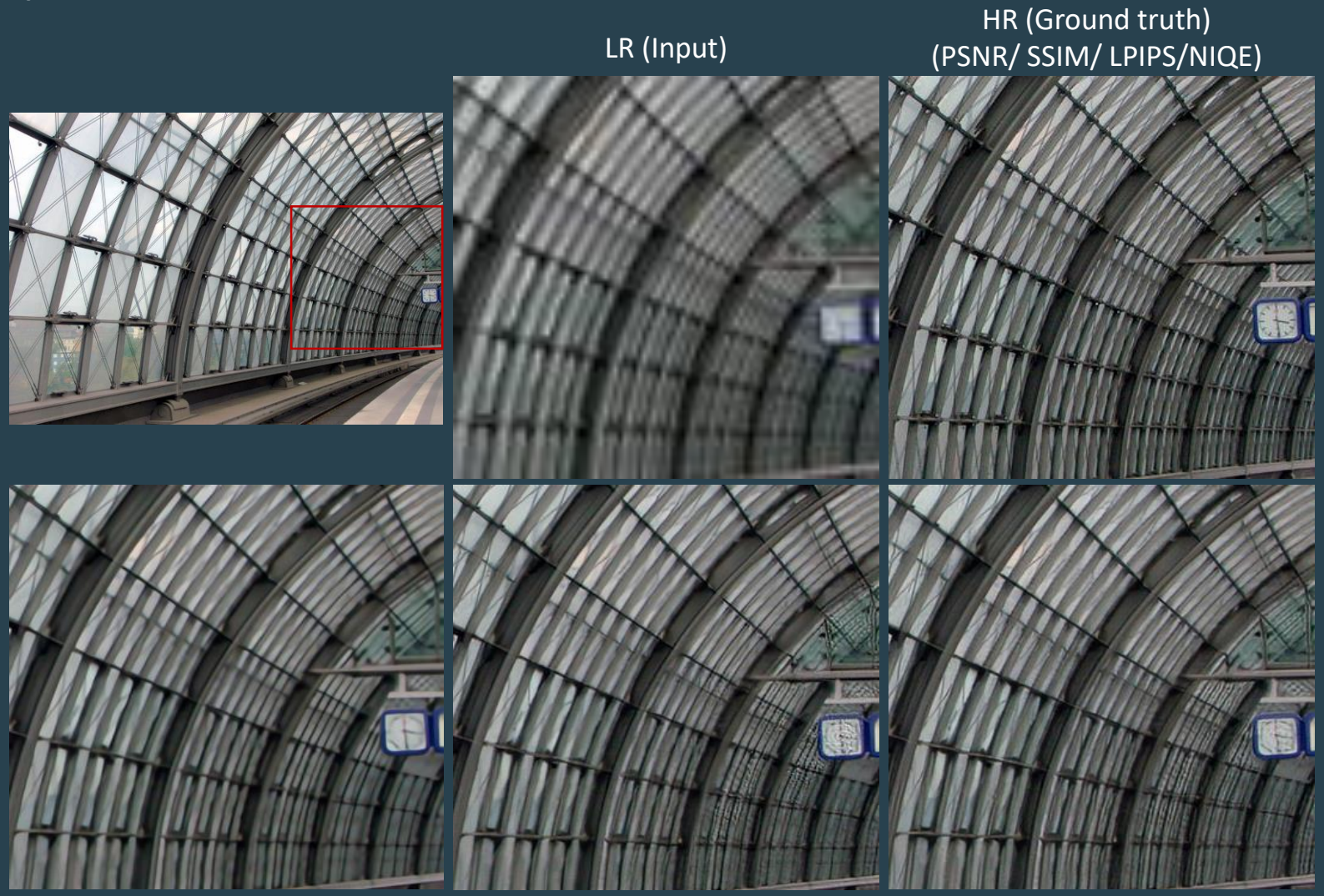
- Goal: Propose a novel and effective algorithm for learned image super-resolution.



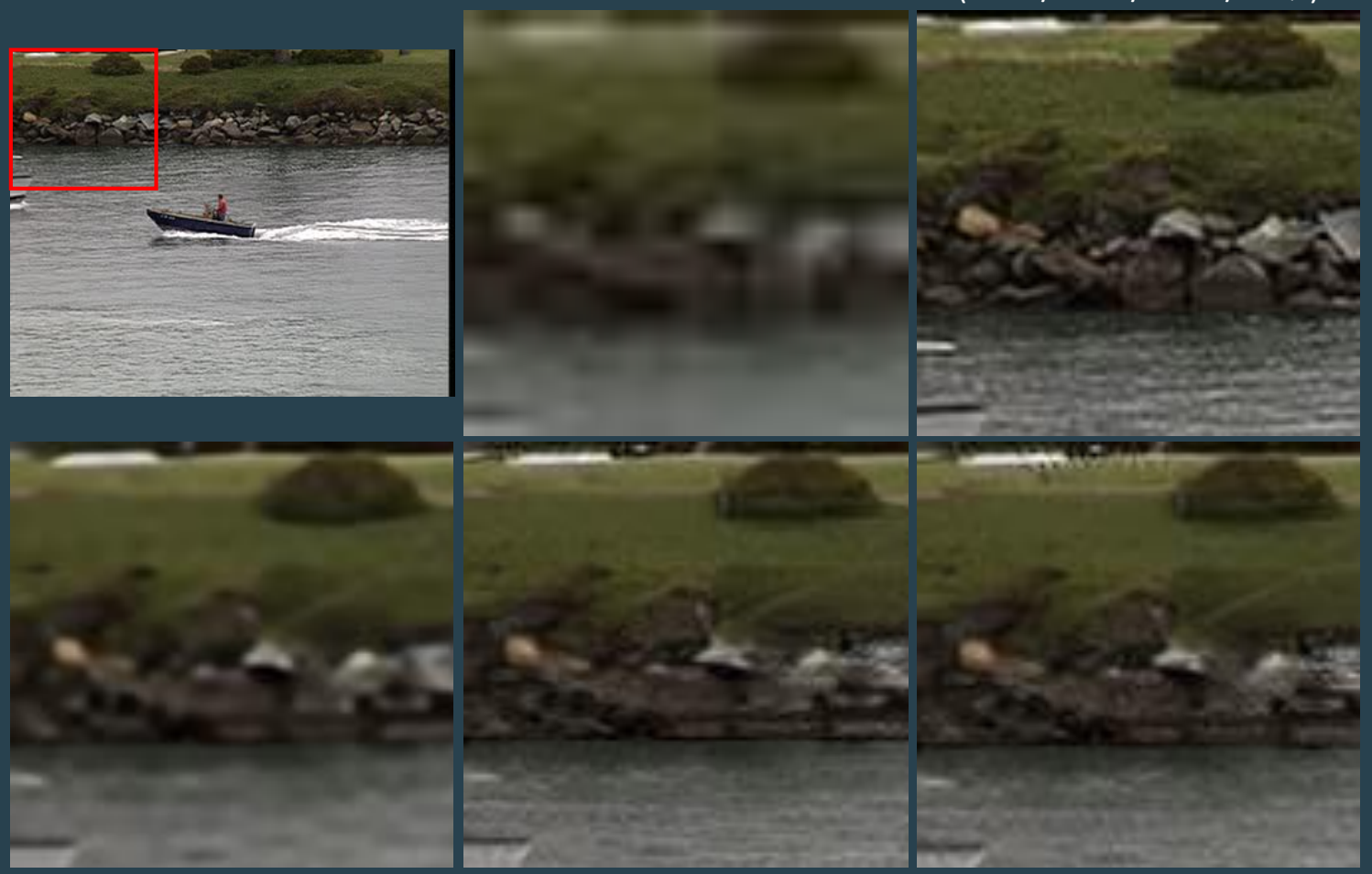
Adaptive Image Super-resolution

- Challenges :
  - Most research **only focuses on network architecture design**, and the performance improvement in such a design comes from an **increase of the parameter number** and the elaboration of neural connection
  - Most research focus on **optimization for distortion or perception separately**, but few studies focus on optimization for the tradeoff between them

- Result :

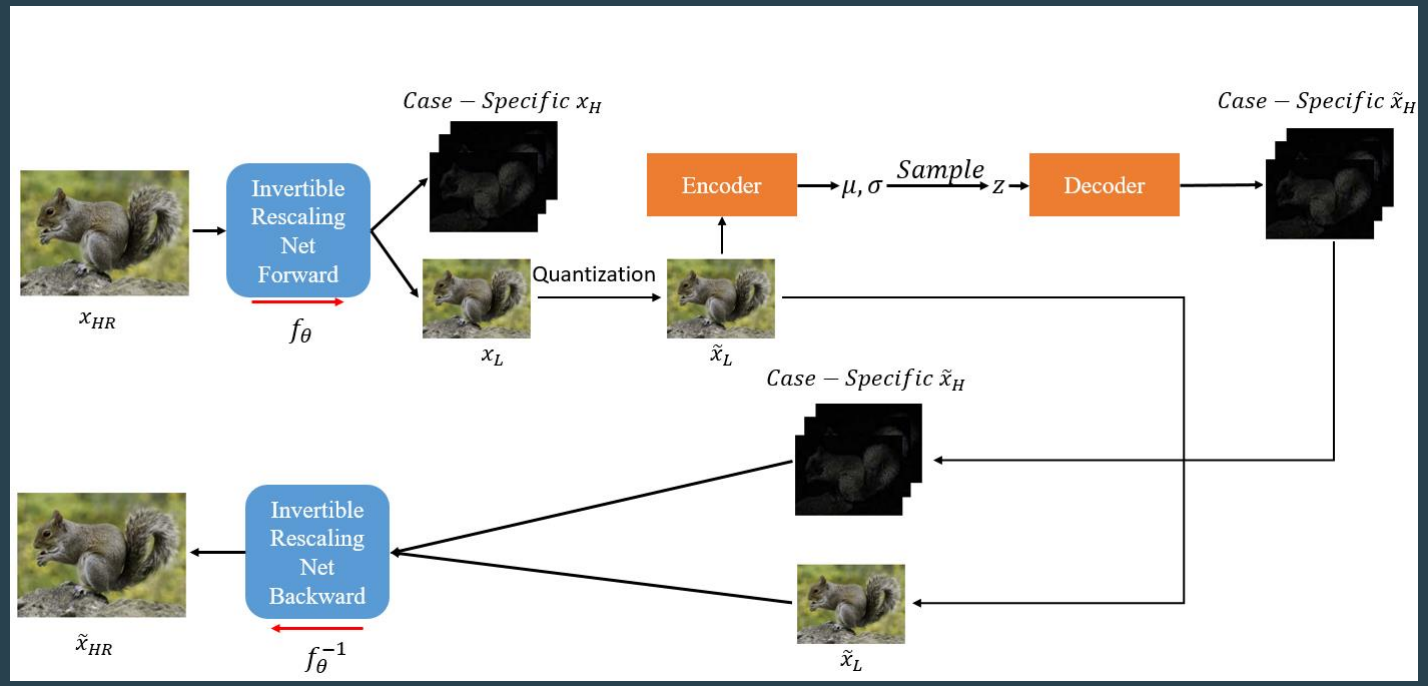

LR (Input)
HR (Ground truth)
(PSNR/ SSIM/ LPIPS/NIQE)
SR1
(**27.83**/**0.8541**/0.2312/4.7002)
SR2
(26.91/0.8083/0.2182/ 4.3194)
Fusion
(26.93/0.8159/**0.2062**/**4.2122**)

- Result :


LR (Input)
HR (Ground truth)
(PSNR/ SSIM/ LPIPS/NIQE)
SR1
(**26.39**/**0.5764**/0.3943/6.3587)
SR2
(25.37/0.5075/**0.3203**/4.4971)
Fusion
(25.37/ 0.5082/ 0.3216/**4.489**)

Invertible Image Super-resolution

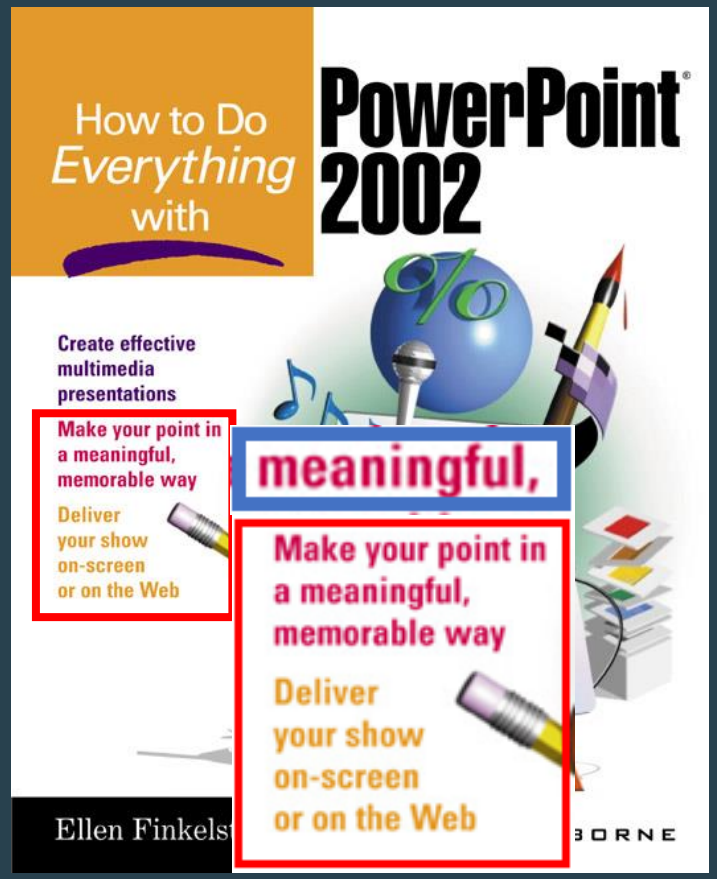
- Goal:
  - Learn conditional Image rescaling by invertible neural network
    - Address the ill-posed problem of image super-resolution



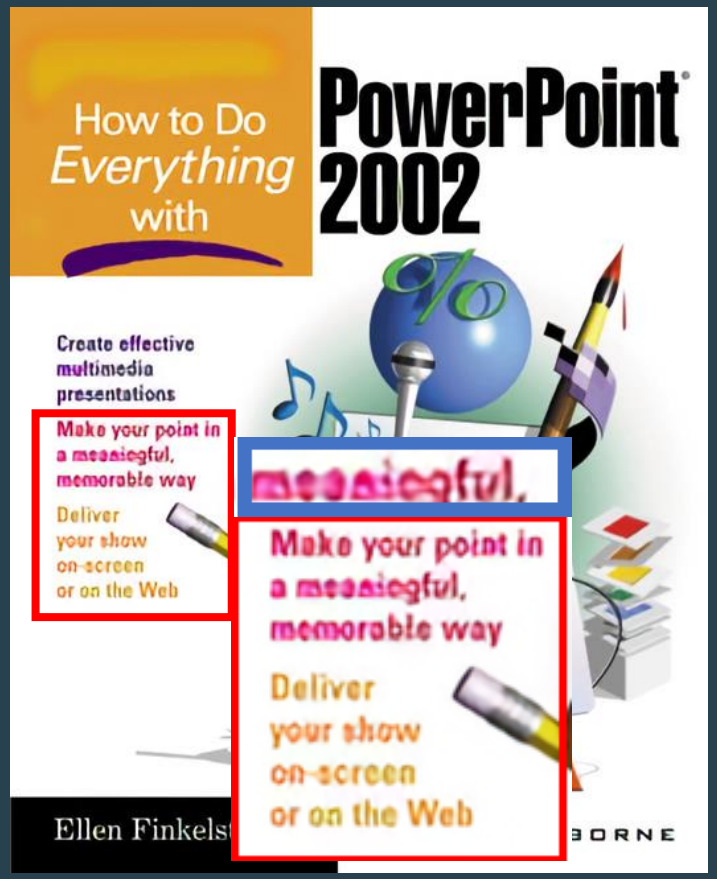
- Challenges :
  - Current method sample high-frequency information independent of low resolution image
    - Solution: Sample accurate high-frequency information by exploiting low-resolution information.

- Result :

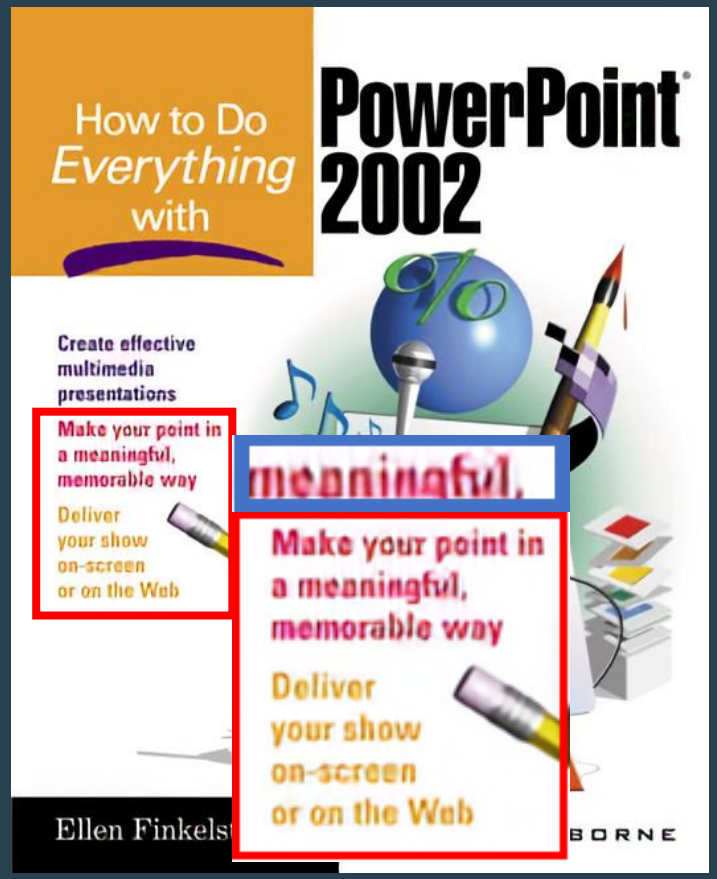
Ground-truth



IRN[1]



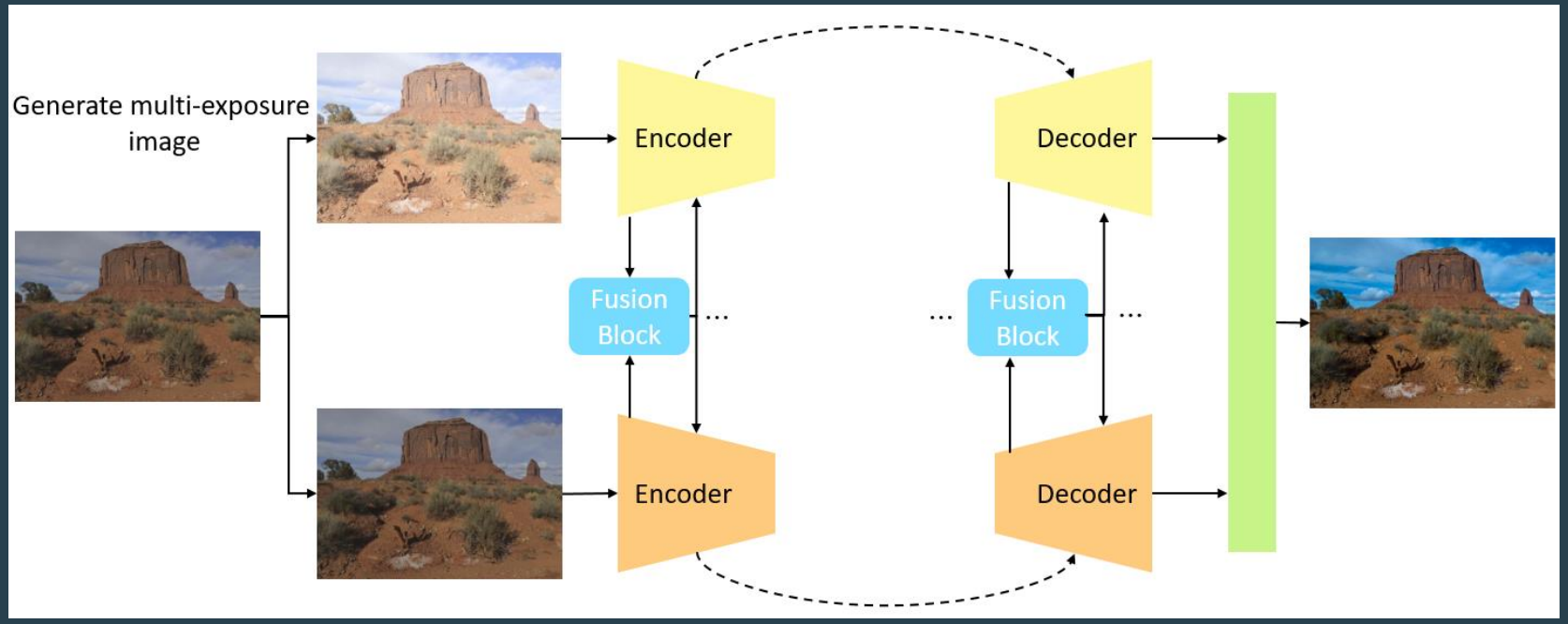
Ours



[1] Mingqing Xiao et al. , Invertible image rescaling , ECCV2020

Visual Data Exposure Correction

- Goal :
  - Low-light Image Enhancement on Mobile Phone
    - Improve image brightness and reveal hidden information in darken areas.



Visual Data Exposure Correction

- Challenges :
  - Conventional methods fail to recover image detail in extremely dark or bright areas
    - Solution: Generate multi-exposure image and fusion them.
  - Model may over enhance normal images
    - Solution: Using multi-exposure dataset to train a model for multi-exposure correction.

- Result :

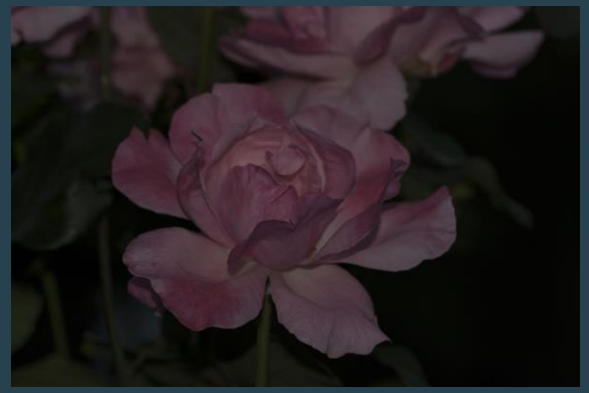
Comparison with State-of-the-art Methods

Dataset：FiveK	PSNR(↑)	SSIM(↑)	NIMA(↑)
UEGAN [1]	21.28	0.87	4.76
Zero-DCE [2]	13.45	0.74	4.07
DeepLPF [3]	23.908	0.910	4.56

[1] Zhangkai Ni, Wenhan Yang, Shiqi Wang, Lin Ma, Sam Kwong. Towards Unsupervised Deep Image Enhancement with Generative Adversarial Network. In TIP 2020.
[2] Chunle Guo, Chongy Li, Jichang Guo, Chen Change Loy, Junhui Hou, Sam Kwong, Runmin Cong. Zero-Reference Deep Curve Estimation for Low-Light Image Enhancement. In CVPR 2020.
[3] Sean Moran, Pierre Marza, Steven McDonagh, Sarah Parisot, Gregory Slabaugh. DeepLPF Deep Local Parametric Filters for Image Enhancement. In CVPR 2020.

- Result :

Input



Output

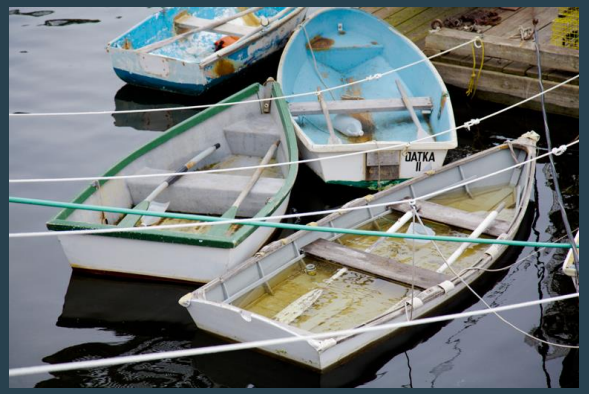
Ground Truth

- Result： Reduce the color deviation of other method

Input

DeepLPF [1]

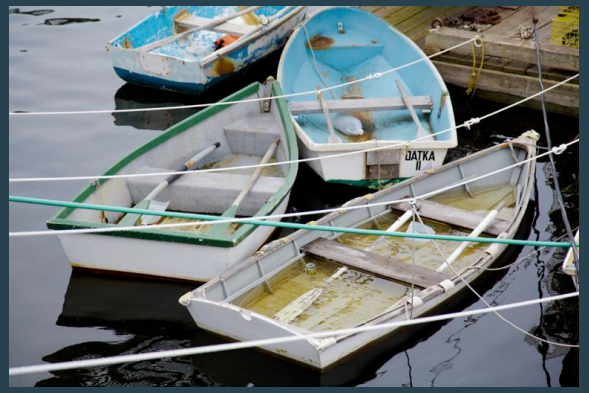
Ground Truth



Input

Our

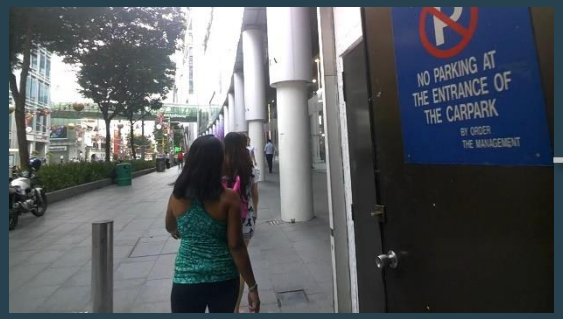
Ground Truth



[1] Sean Moran, Pierre Marza, Steven McDonagh, Sarah Parisot, Gregory Slabaugh. DeepLPF Deep Local Parametric Filters for Image Enhancement. In CVPR 2020.

Optical Character Recognition

- Goal :
  - Detecting and recognizing scene texts or documents.



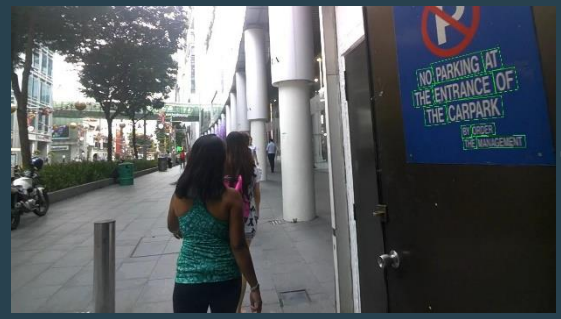
Input scene image

CNN

Feature extractor

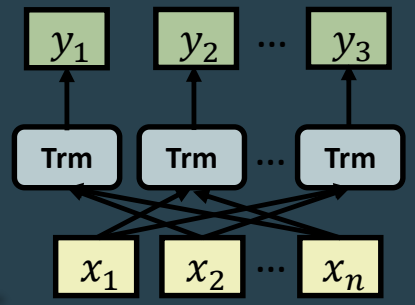
Predict bounding boxes

Text/non-Text Head



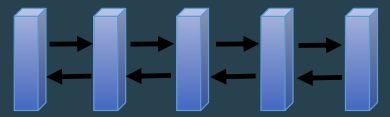
Text Proposal Feature

(a) Transformer



or

(b) Bidirectional LSTM



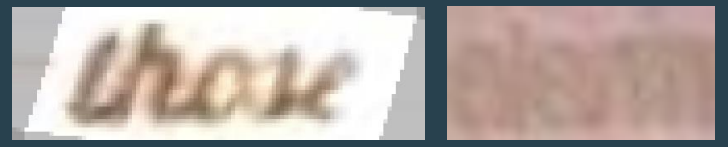
Text decode

NO PARKING AT THE ENTRANCE ....

Output text on the image

Optical Character Recognition

incomplete text

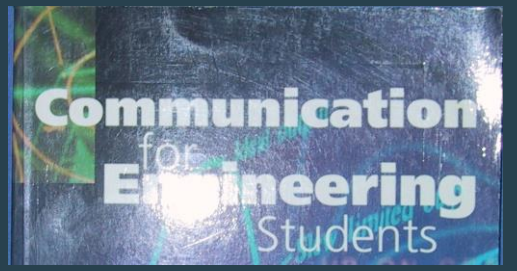


blur text

- Challenges :
  - Text Detection :
    a) Curved Text : It's hard to frame up curve text with rectangle box
    b) Perspective Text
    c) Complicated Background : Model usually consider line-shaped object as text
  - Text Recognition :
    a) Incomplete Text : The missing character is hard to be recognition by model without Language Model.
    b) Illumination Text
    c) Blur Text

perspective text

curved text



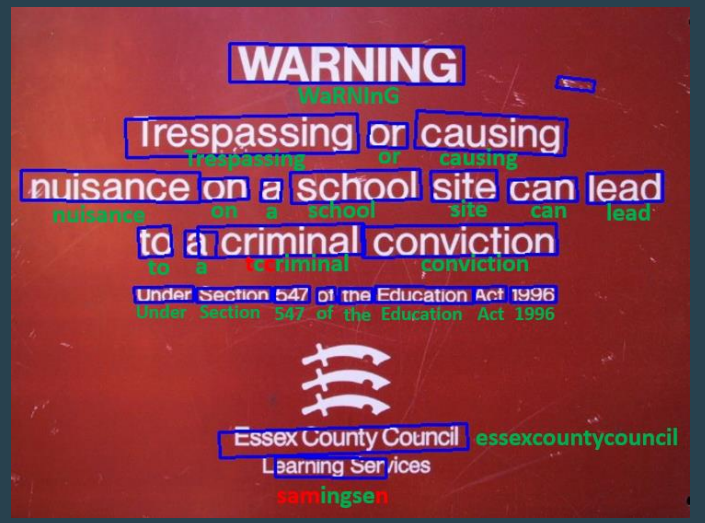
illumination text

- Result :

Name	NAME	CELL	cell phone	PHONE	Profession	PROFESSION
Joe	JOE		911222555	911222555	student	
Agatha	AGATHA		585	968445852	police officer	POLICE OFFICER
Amanda	AMANDA		365145258	365145258	teacher	TEACHER
Karen	KAREN		968524156	968524156	professior	PROFESSIOR
Daisy	DAISY		984563259	984563259	engineer	ENGINEER
Linda	LINDA		985888777	985888777	bus driver	DRIVER
Frances	FRANCES		963635295	963635285	fire fighter	FIGHTER
BONNIE	Bonnie		965412586	965412586	zoo keeper	KEEPER
Joanna	JOANNA		963415628	963415628	house wife	WIFE
Isabel	ISABEL		974785127	974785127	house keeper	KEEPER
CAROLINE	CAROLINE		963257419	963257419	chief	CHIEF
Margaret	MARGARET		963415896	963415896	flight attendant	ATTENDANT
Nicole			963485126	963485126	actor	ACTOR
Emma			965874219	965874219	singer	SINGER
Grace	GRACE		934568216	934568216	lawyer	LAWYER
Pandora	PANDORA		98463215	984632159	DOCTOR	DOCTOR
Atalanta	ATALANTA		974584126	974584126	waitress	WAITRESS
Stephanie	STEPHANIE		963254163	963254163	farmer	FARMER

(a) Document detection and recognition

(b) Scene text detection




```
1 545,418,655,421,655,446,544,443,UNIVERSITY
2 545,470,651,471,651,492,545,491,WIVENHOE
3 607,514,714,516,713,539,607,536,GREENSTEAD
4 658,471,708,471,708,492,658,491,TRAIL
5 544,443,628,445,627,470,544,469,LEADING
6 607,541,668,543,667,564,607,562,CENTRE
7 693,422,757,424,756,445,692,442,ESSEX
8 773,472,802,472,801,494,773,494,114
```

(c) Scene text recognition

- Publication :
  - Ching-Chun Huang, and Hung-Nguyen Manh, "X-ray Enhancement based on Component Attenuation, Contrast Adjustment, and Image Fusion", IEEE Transactions on Image Processing, July 2018.
  - Y. C. Huang, Y. H. Chen, C. Y. Lu, H. P. Wang, W. H. Peng, and C. C. Huang, "Video Rescaling Networks with Joint Optimization Strategies for Downscaling and Upscaling", Conference on Computer Vision and Pattern Recognition(CVPR), June, 2021.
  - Chung-Sheng Lai, Zunzhi You, Ching-Chun Huang, Yi-Hsuan Tsai, Wei-Chen Chiu, "Colorization of Depth Map via Disentanglement", European Conference on Computer Vision(ECCV), Aug., 2020.
  - Ching-Chun Huang, Nelson Chong Ngee Bow, Loh Yuen Peng, Punchok Kerdsiri, amd Vu-Hoang Tran, "DEN: Disentanglement and Enhancement Networks for Low Illumination Images", IEEE International Conference on Visual Communications and Image Processing(VCIP), Dec., 2020.

- Publication :
  - Ching-Chun Huang, Thanh-Phat Nguyen and Chen-Tung Lai, "Multi-channel Multi-loss Deep Learning Based Compression Model For Color Images", 2019 IEEE International Conference on Image Processing(ICIP), Sept. 2019.
  - Vu-Hoang Tran, and Ching-Chun Huang, "Domain Adaptation Meets Disentangled Representation Learning and Style Transfer", IEEE International Conference on Systems, Man, and Cybernetics, 2019.
  - Ching-Chun Huang, Ismail, Ming-Xun Cai, and Hoang Tran Vu, "HDR Compression based on Image Matting Laplacian", 2016 IEEE International Conference on Consumer Electronics - Taiwan (ICCE-TW).
  - Atul Kumar, Shih-Wei Huang, Yen-Yu Wang, Wan-Chi Hung, Kai-Che Liu, and Chingchun Huang, "Laparoscopic video augmentation with infrared image information", 2016 IEEE International Conference on Consumer Electronics - Taiwan (ICCE-TW).

Smart Building

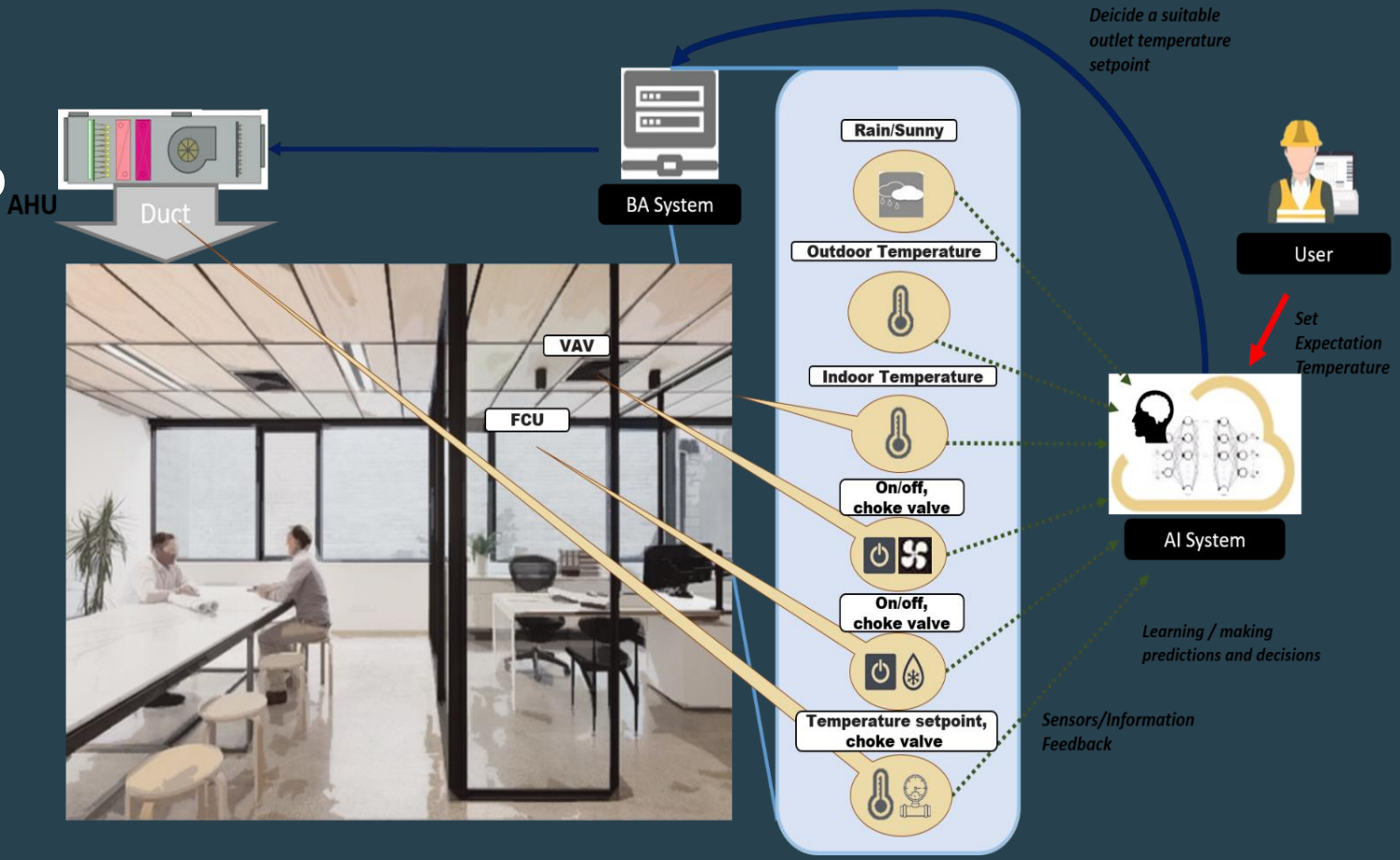
"Smart HVAC Control"
"Occupancy Estimation and Prediction"
"Indoor Positioning"

Projects

- Project Name :機器學習於建築溫度環境感測大數據分析應用之研究
  - Project Period : 2019/01/01 ~ 2019/12/31
  - Cooperation Vendors :內政部(建築研究所)、台灣積體電路製造股份有限公司
- Project Name :辦公室感測數據預測模型分析與驗證
  - Project Period : 2020/6/18~2020/12/31
  - Cooperation Vendors :漢威聯合股份有限公司
- Project Name :智慧創新跨域人才培育聯盟計畫-大數據分析跨校聯盟推動計畫 (B類計畫：加值創作分項4, 應用多樣性環境感測大數據於智慧建築管理)
  - Project Period : 2019/3/1~2022/1/31
  - Cooperation Vendors :教育部
- Project Name :應用多重感測器整合於銀髮族長期照護系統之監控技術－子計畫二：應用無線訊號於健康照護之室內人物追蹤研究
  - Project Period : 2015/08/01~2017/10/31
  - Cooperation Vendors ：行政院科技部
- Project Name :探討全景攝影機於掃地機器人自主同時定位與圖資建立之研究
  - Project Period : 2015/11/01~ 2016/10/31
  - Cooperation Vendors :行政院科技部、恆準定位有限股份公司
- Project Name :室內定位技術關鍵模組與系統
  - Project Period : 2013/02/01~ 2013/12/15
  - Cooperation Vendors :工業技術研究院
- 內政部舉辦之巢向未來競賽金獎(2020)與銀獎(2019)

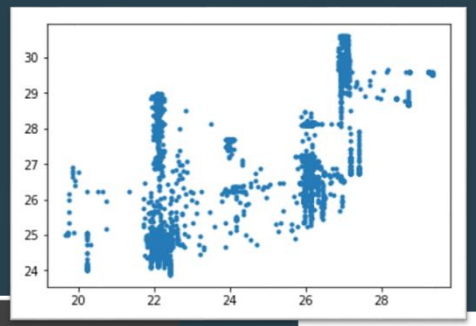
Smart HVAC Control

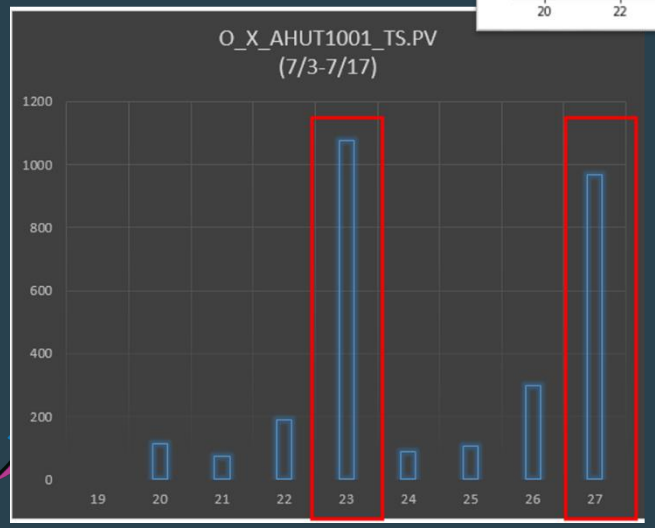
- Goal :
  - Automatically generate the parameter settings of AHU to lower the power consumption and satisfy the expected setting at the same time.
  - this system can improve itself while learning.

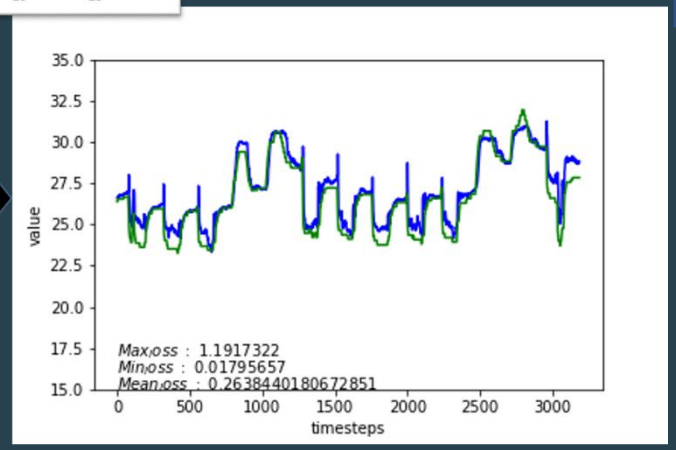


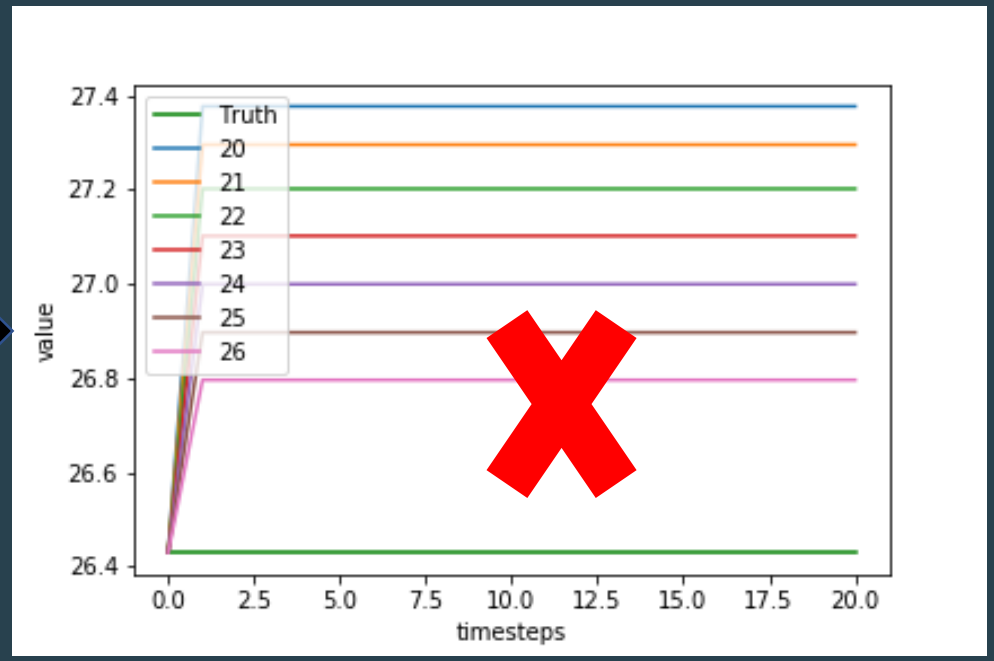
Smart HVAC Control

- Challenges :
  - The extreme and rare dataset problem
    - The network tend to fit data with wrong tendency





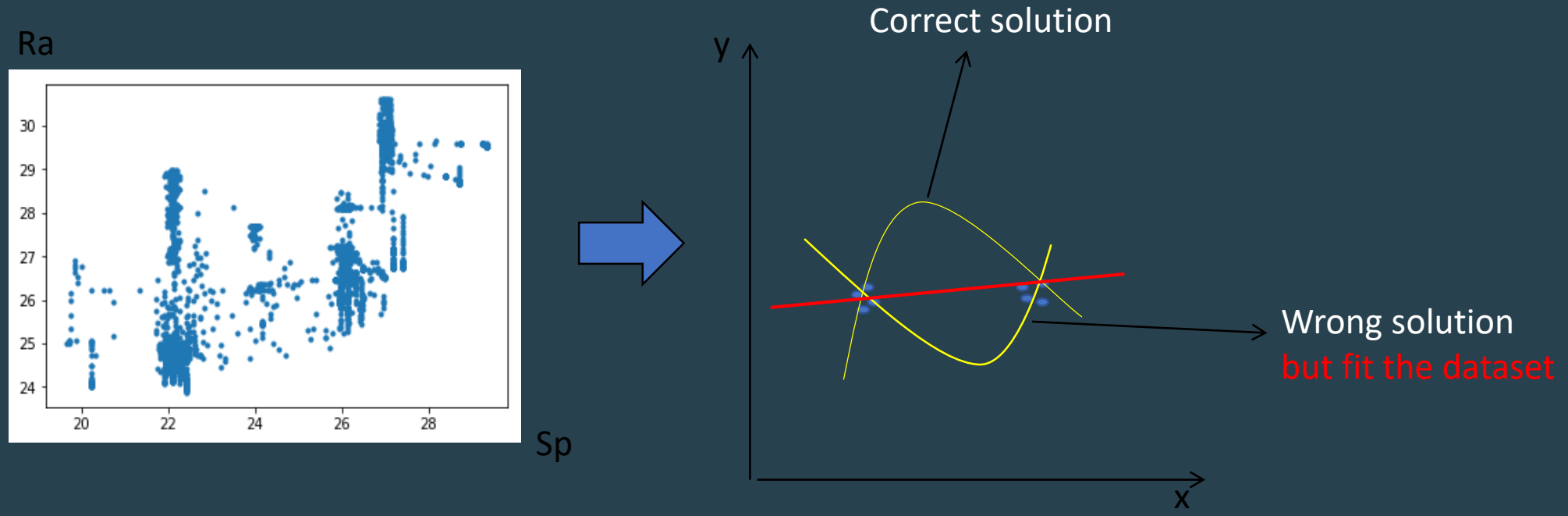




Fix environment, compare with different set points.

Smart HVAC Control

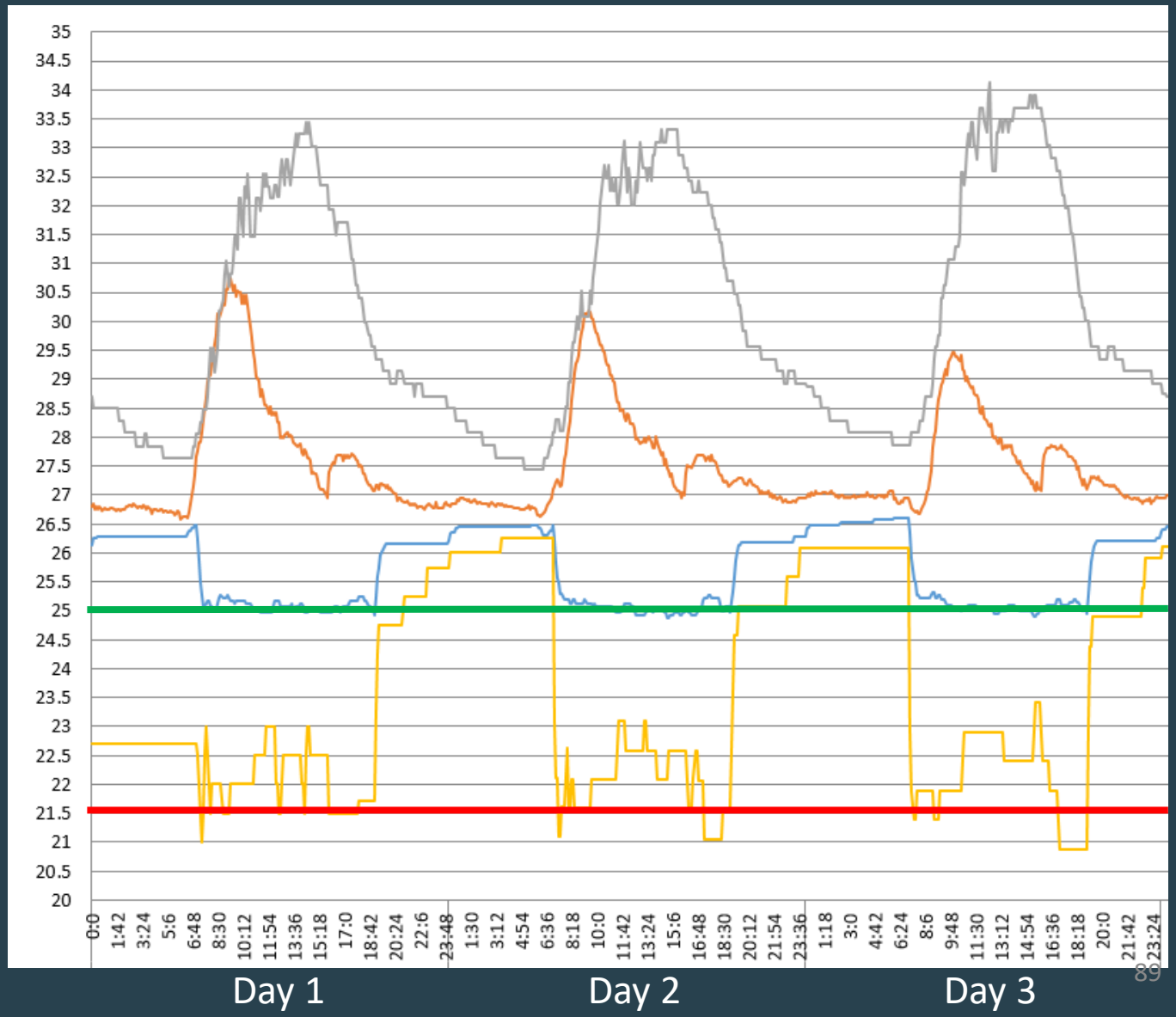
- Challenges :
  - The extreme and rare dataset problem
    - Rare and extreme data may leave too much uncertain space for the network



- Result :
  - Learning Property

Mean error: +- 0.125 degree

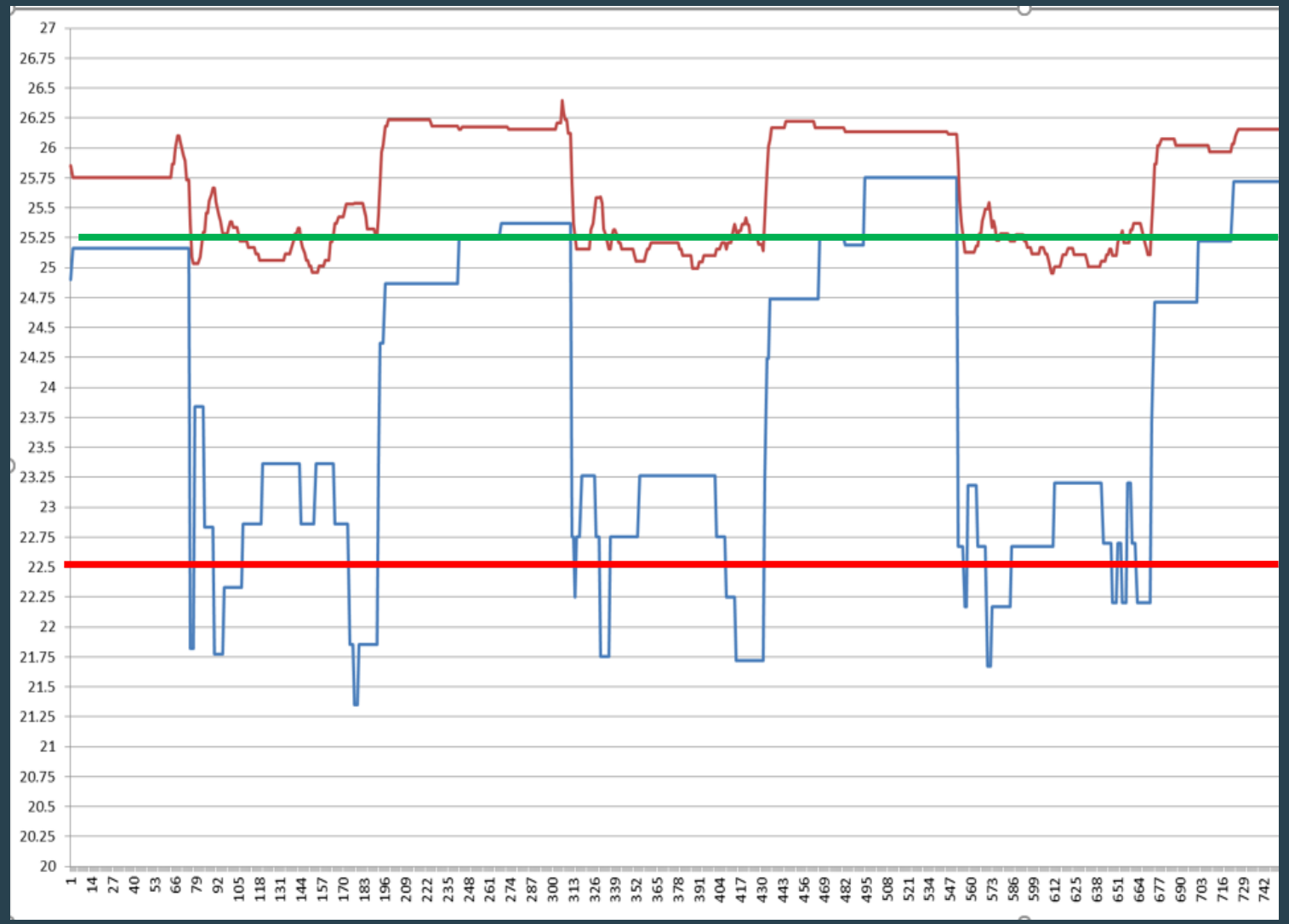
- expectation : 25
- original setpoint
- AI setpoint
- out door temperature
- temperature near by window
- indoor temperature



- Result :
  - Learning Property

We change the expectation temperature from 25 → 25.25

Mean error: +- 0.25 degree



energy saving mode expectation : 25.25 degree(C)

original energy saving mode setpoint

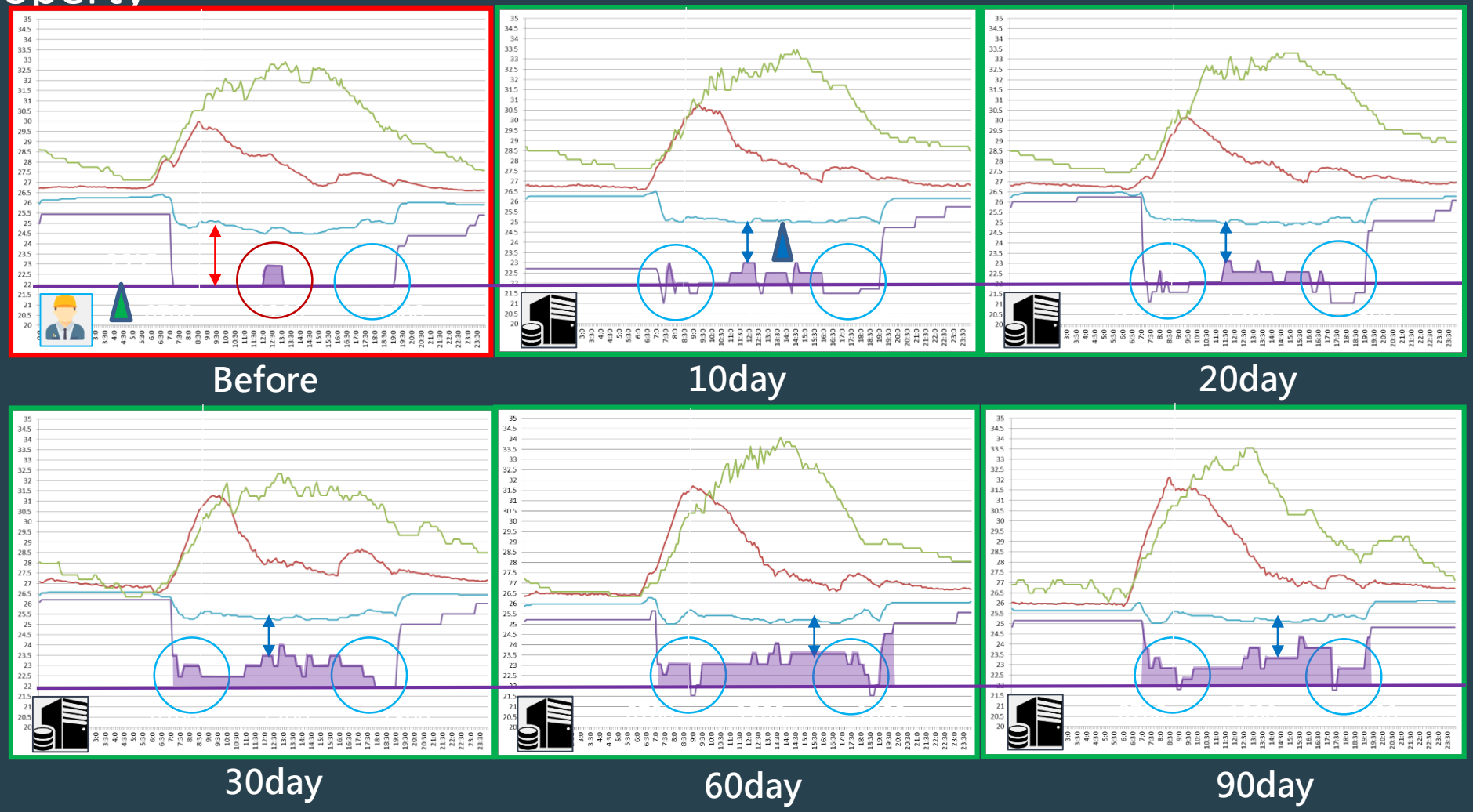
indoor temperature

simulation model based AI setpoint

- Result :
  - Learning Property

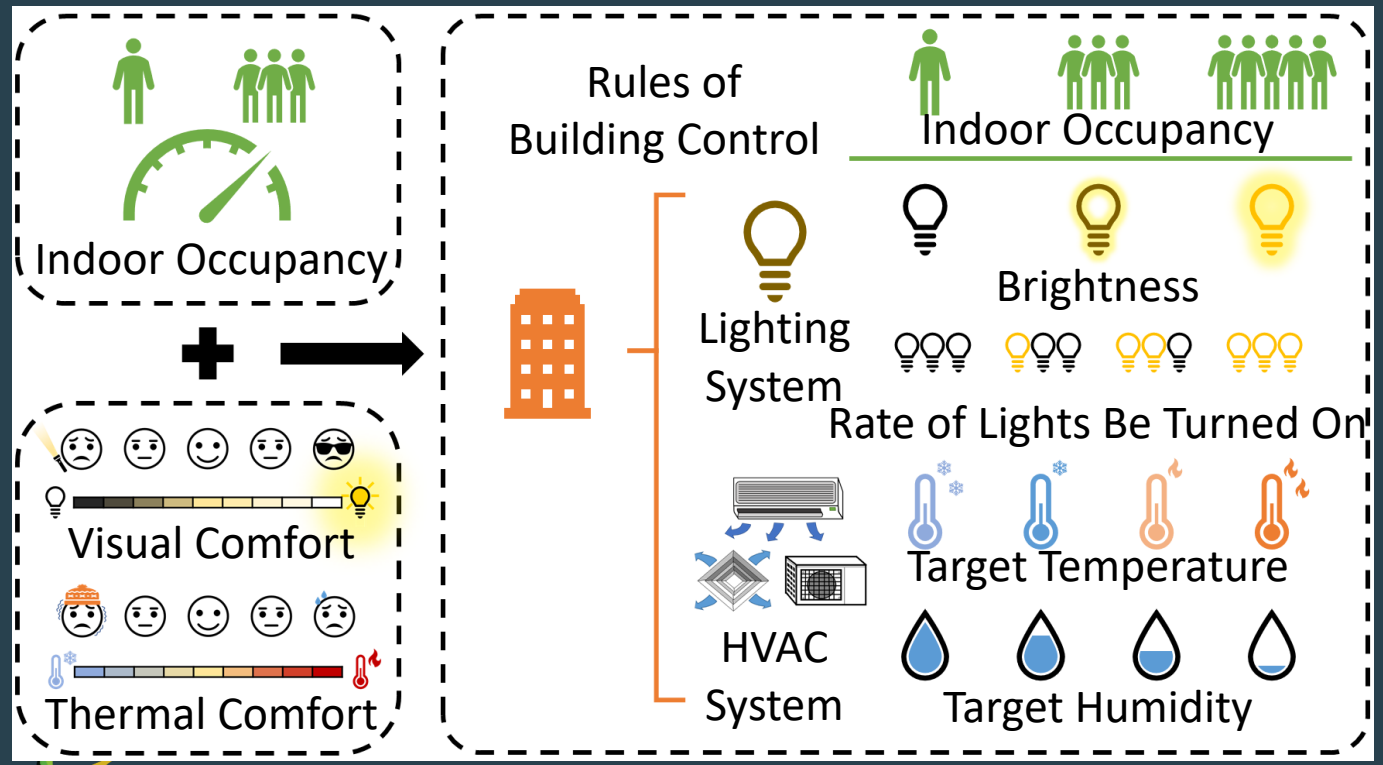
Mean error: +- 0.25 degree

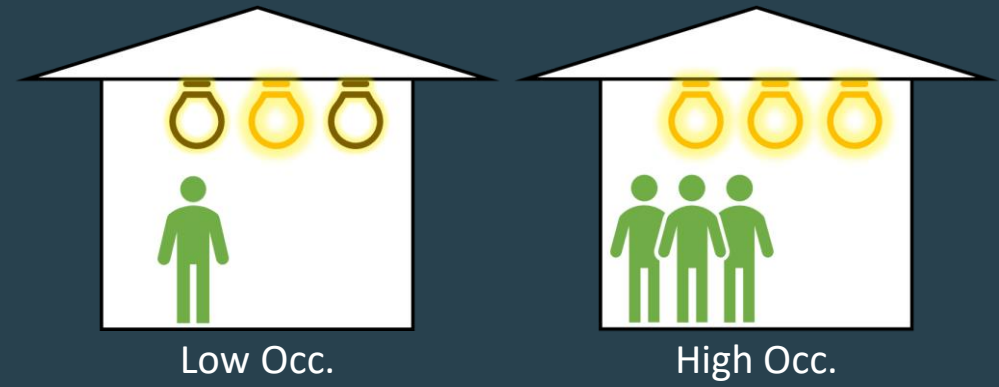
temperature setpoint
out door temperature
temperature by the window
indoor temperature
positive correlation to energy saving
expert controlling
AI controlling
The heat load increasing moment / switch to working mode



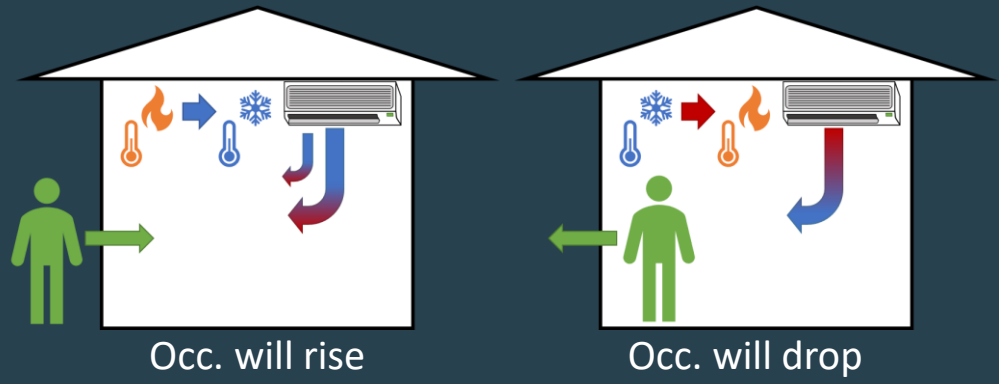
Occupancy Estimation and Prediction

- Goal :
  - Estimating indoor occupancy and forecasting future occupancy.





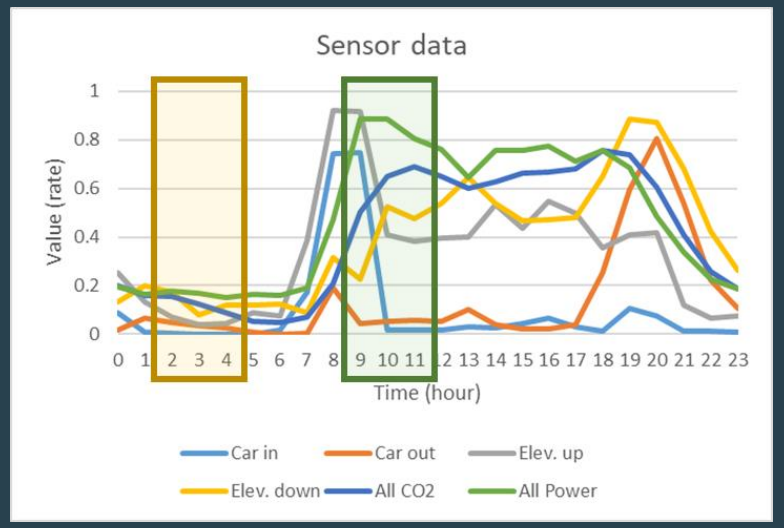
Real time indoor occupancy



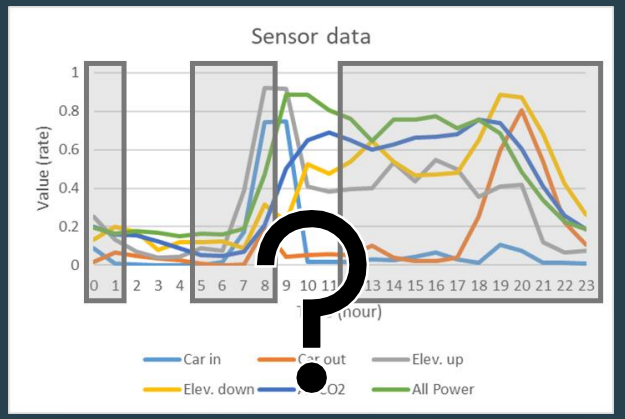
Future occupancy

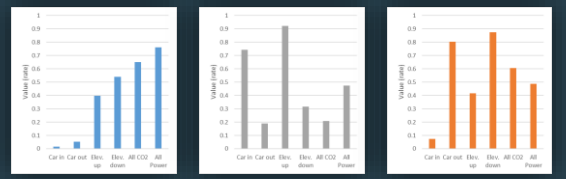
Occupancy Estimation and Prediction

- Challenges :
  - How to mix each sensor value into a clear value?
    a) We can roughly find the extreme states. (Highest occupancy & Lowest occupancy)
    b) It is difficult to define a clear value for the states between them.

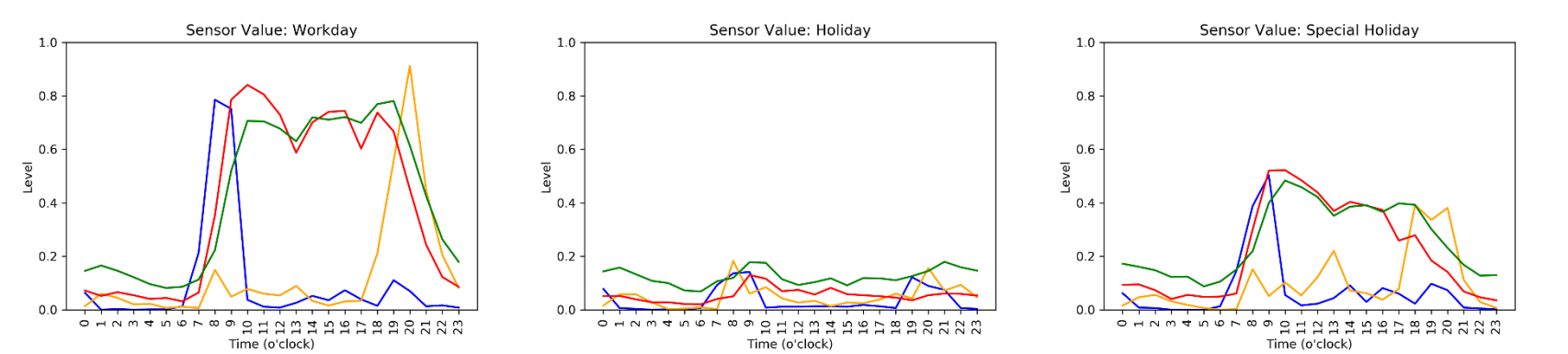


Sensor data on working day

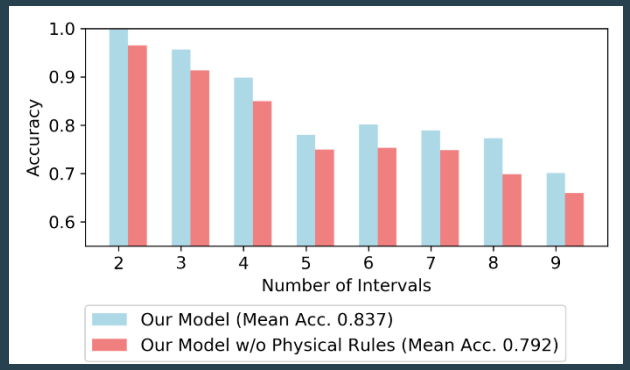




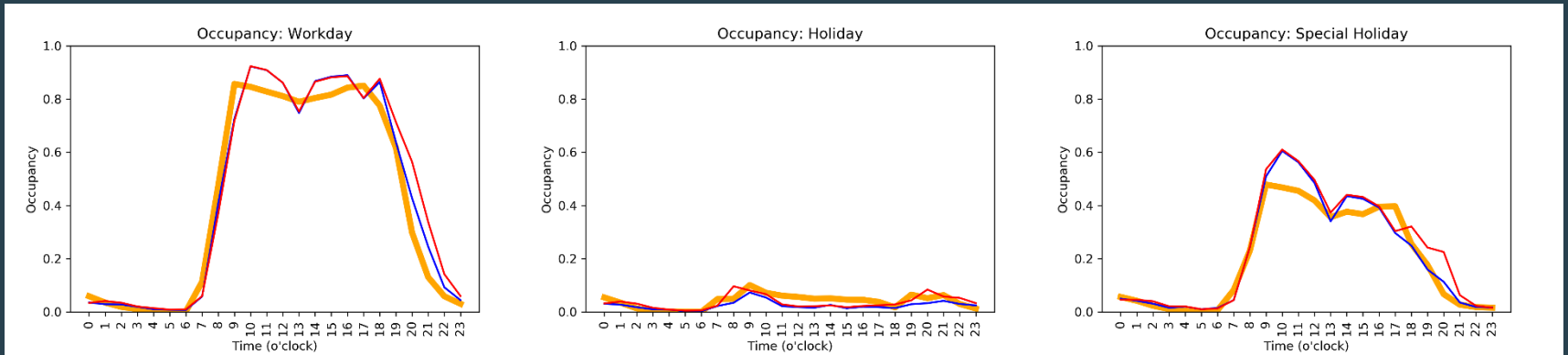
• Result :



A sample of sensor data value on (a) workday, (b) holiday and (c) special holiday.

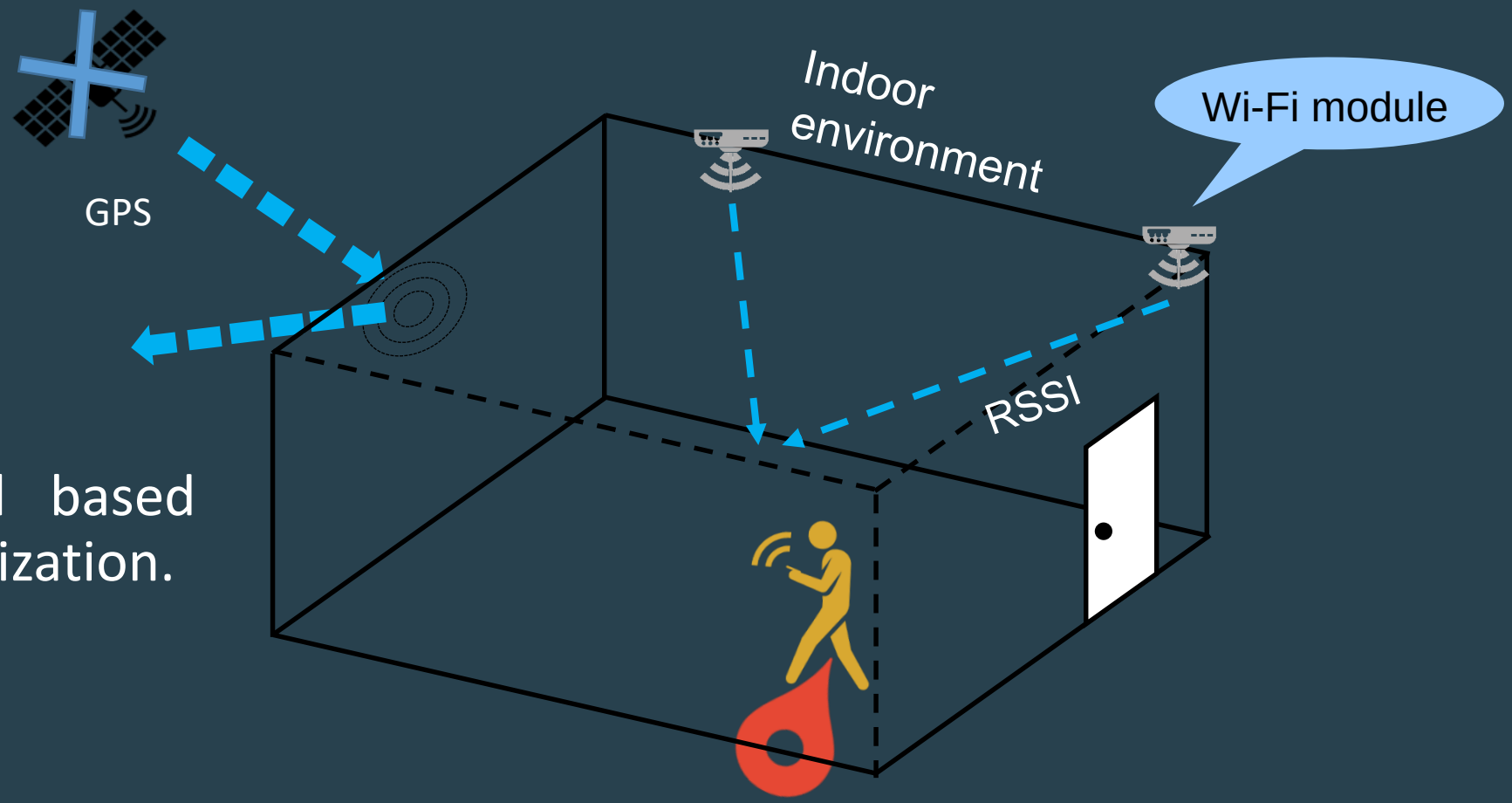


Accuracy of models in different intervals.



A sample of estimated occupancy of our work and our work without physical rules on (a) workday, (b) holiday and (c) special holiday.

Indoor Positioning

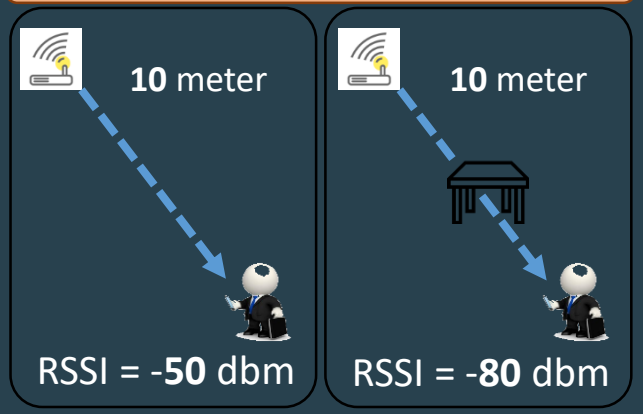


- Goal :
  - Wi-Fi signal based Indoor Localization.

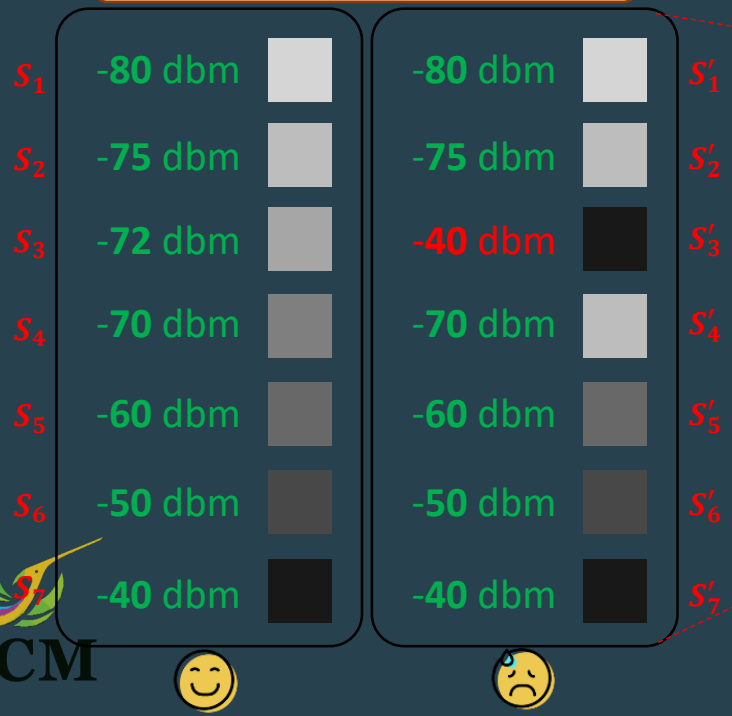
RSSI: Received Signal Strength Indicator (unit: dbm)

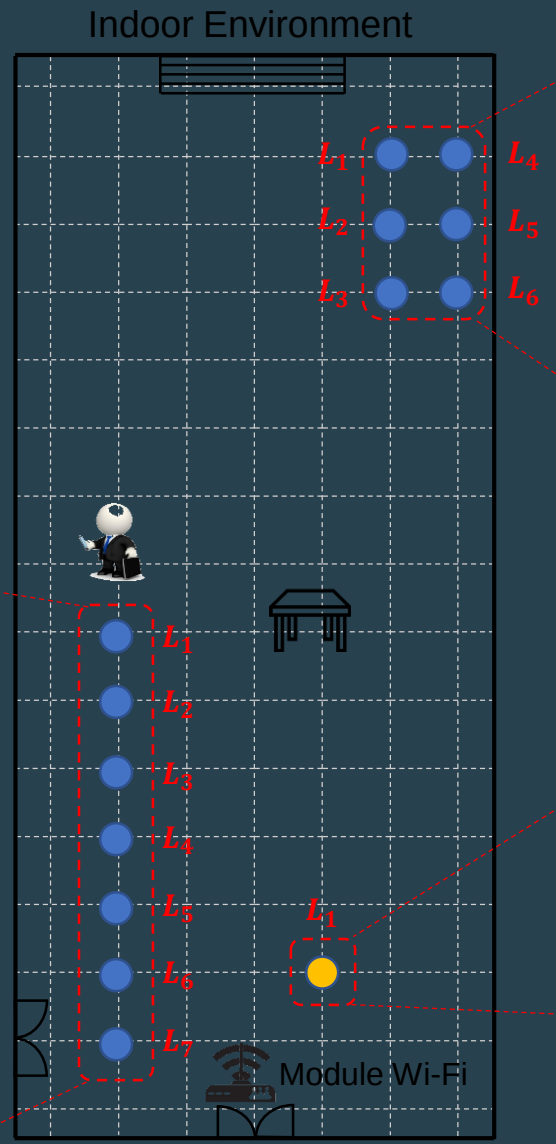
• Challenges :

Occlusion effect

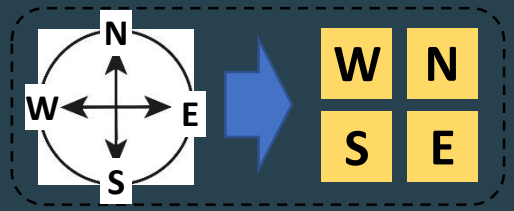


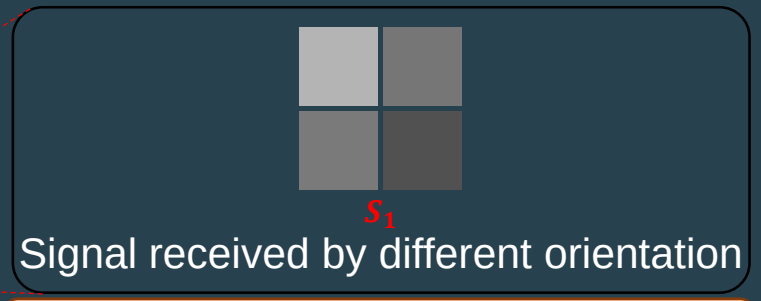
Similarity Inconsistency





Device diversity





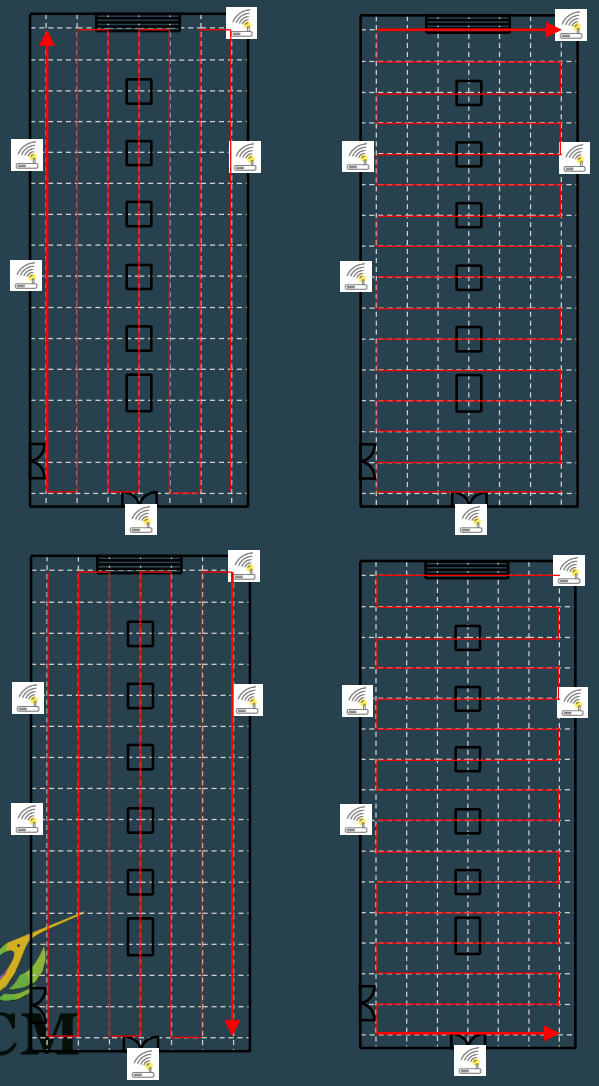
Signal variant with orientation

S Signal strength received at location L - 40 dbm - 120 dbm

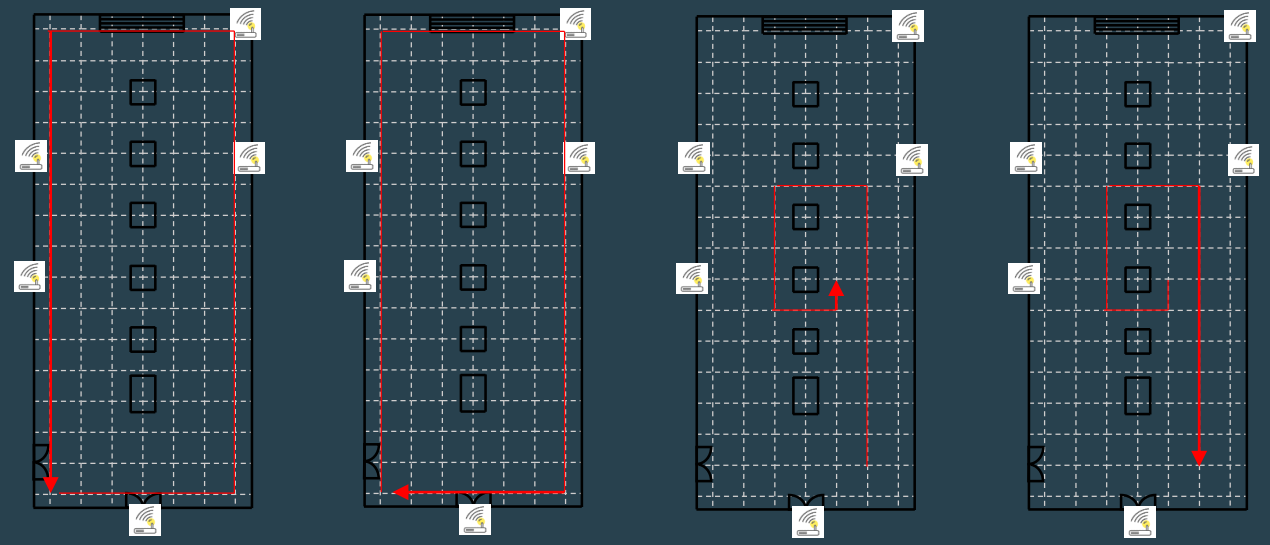
Comparisons on Multiple Devices

- **Multiple devices** (Training device: **Asus, Lenovo** – Testing device: **Asus, Lenovo, Samsung**)

Training (60 samples/location)



Testing (20 samples/location)



- Result:
  - Multiple devices (Training device: **Asus, Lenovo** – Testing device: **Asus, Lenovo, Samsung**)

Localization performance of comparison methods on testing round

Device	Evaluation (meter)	DNN	Deep-Fi	Multi-task	MGCN-LSTM
Asus	MED	3.679	4.285	2.672	**2.038**
	MaxED	16.450	18.175	7.011	**6.502**
	VED	3.535	9.106	1.742	**1.537**
Lenovo	MED	3.291	4.005	2.684	**2.334**
	MaxED	12.168	16.108	7.033	**6.945**
	VED	2.259	6.812	2.298	**1.984**
Samsung	MED	4.220	5.200	2.739	**2.278**
	MaxED	16.262	16.875	8.189	**7.304**
	VED	5.496	9.442	1.976	**1.642**

- Publication:
  - Tzu-Yin Chao, Manh Hung Nguyen, Ching-Chun Huang, CHIEN-CHENG LIANG, Chen-Wu Chung, “Online Self-Learning for Smart HVAC Control”, 2019 IEEE International Conference on Systems, Man and Cybernetics.
  - Wei-Yuan Lin, Ching-Chun Huang, Hung Nguyen Manh and Nguyen Tran Duc, "Wi-Fi Indoor Localization based on Multi-Task Deep Learning", IEEE International Conference on Digital Signal Processing, Nov., 2018.
  - Chingchun Huang, Wei-Chi Chan and Manh Hung-Nguyen, "Unsupervised Radio Map Learning for Indoor Localization", 2017 IEEE International Conference on Consumer Electronics - Taiwan (ICCE-TW).
  - Hoang Tran Vu, Hung Nguyen Manh, Wei-Chi Chang, Wei-Yuan Lin, Hung-Sheng Cheng, Yi-Ning Chuang and Ching-Chun Huang, “A Hybrid Method for Visitor Localization and Tracking in a Museum Environment,” The 9th IEEE International Conference on Ubi-Media Computing, Moscow, Russia. , Aug. 2016.
  - Chingchun Huang and Hung-Nguyen Manh, "RSS-based Indoor Positioning based on Multi-dimensional Kernel Modeling and Weighted Average Tracking", IEEE Sensors Journal, Feb., 2016.
  - Ching-Chun Huang, Hung-Nguyen Manh, Yu-Shiun Wang, "An Self-Adaptive Wireless Indoor Localization System for Device Diversity", 2016 IEEE International Conference on Consumer Electronics - Taiwan (ICCE-TW).

3D Pose Estimation

"Kinect Based Skeleton Tracking"
"Head Pose Estimation"

Projects

- Project Name :基於影像辨識之三維立體空間動態行為追蹤技術開發
  - Project Period : 2019/11/16~2020/5/13
  - Cooperation Vendors ：中山科學研究院
- Project Name :複雜背景下融合多深度攝影機的士兵骨架辨識系統
  - Project Period : 2018/03/01 ~ 2018/12/31
  - Cooperation Vendors ：中山科學研究院

Kinect Based Skeleton Tracking

- Goal :
  - Create a motion tracking system with multiple Kinects to track the user in 360 degree (marker-free system).

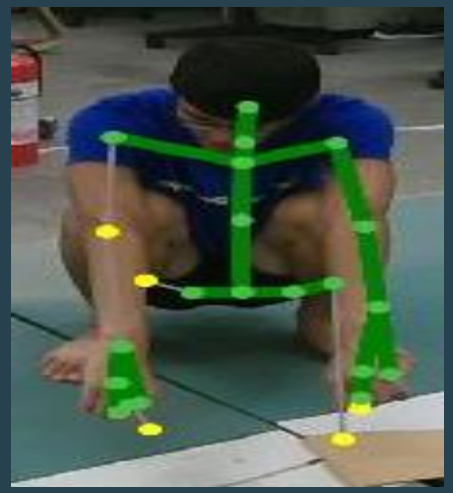
- Skeleton from each camera

- Fused the information

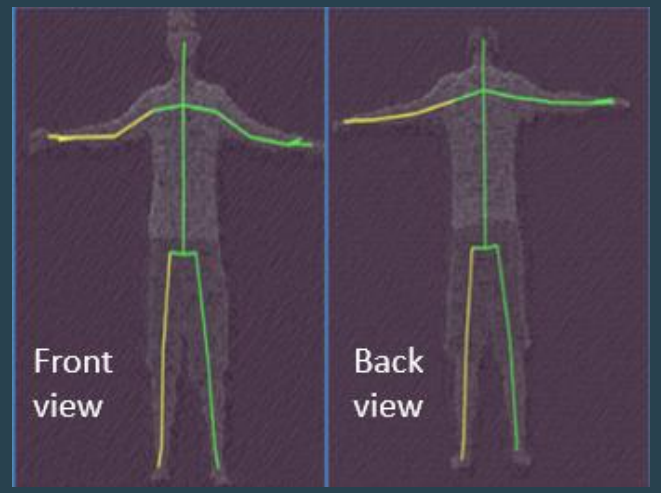
- Control the 3D model

Kinect Based Skeleton Tracking

- Challenges :
  - Solve the self-occlusion problem.
  - Solve left-right problem.

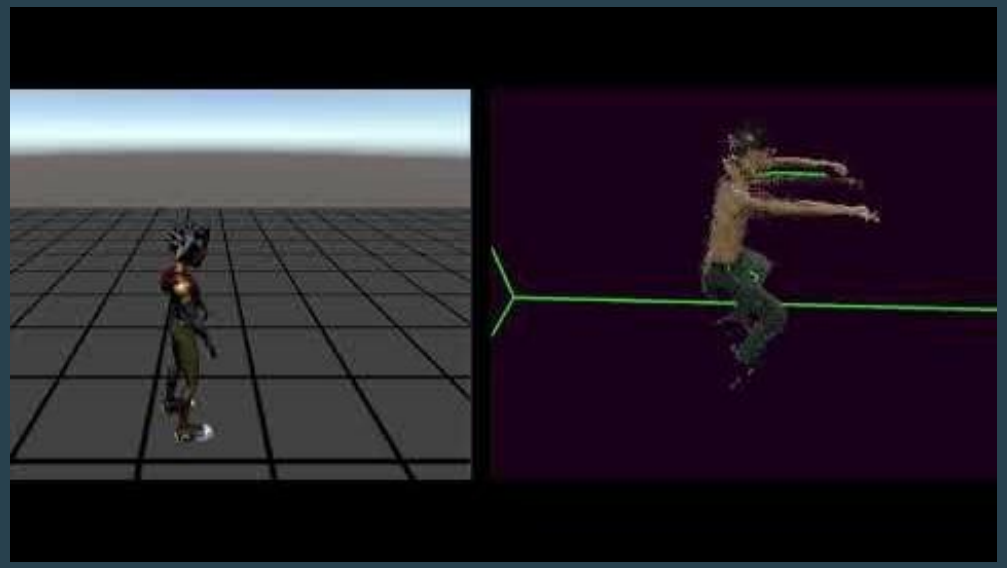


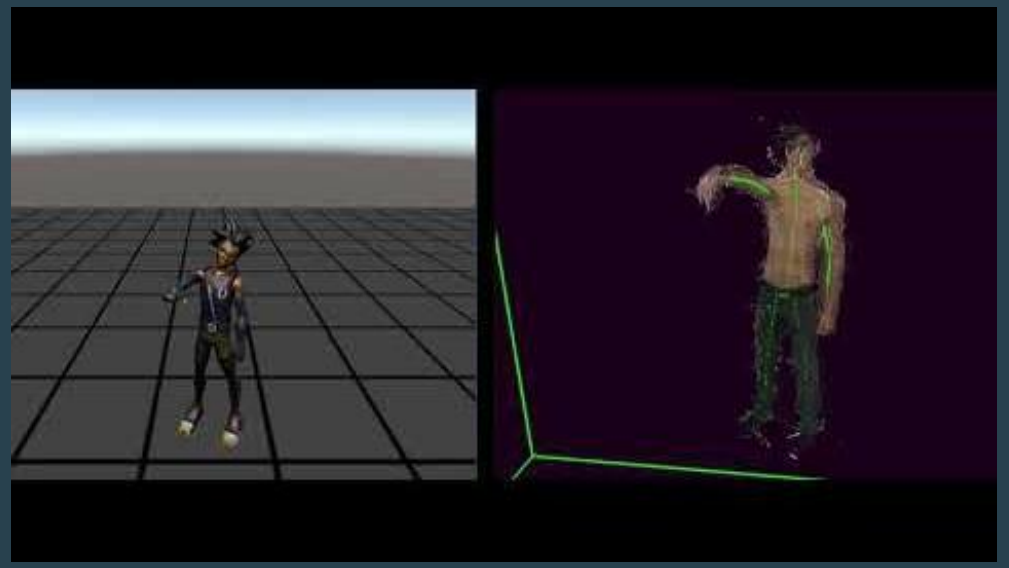
Occlusion problem

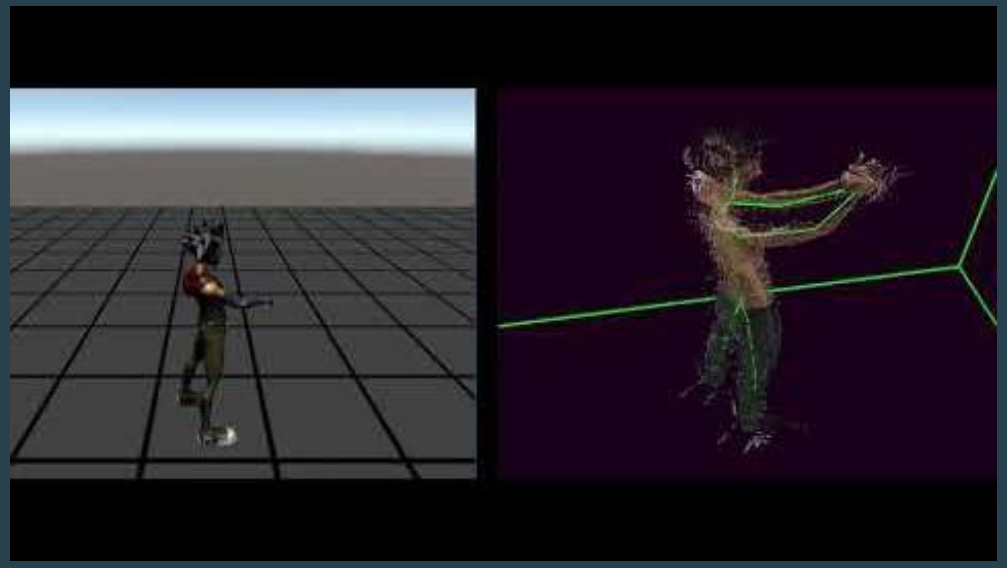


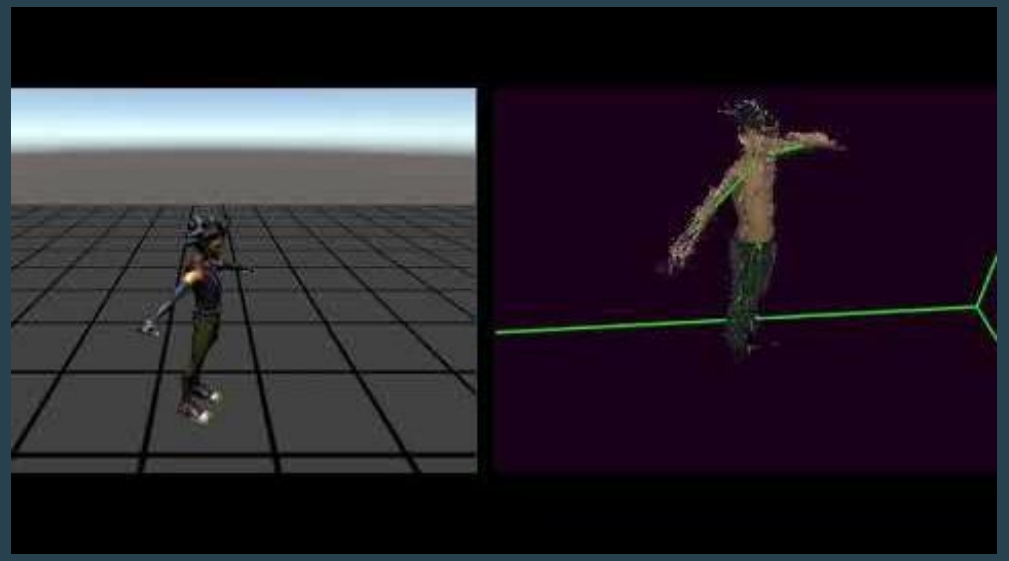
Left-right problem

- Result :



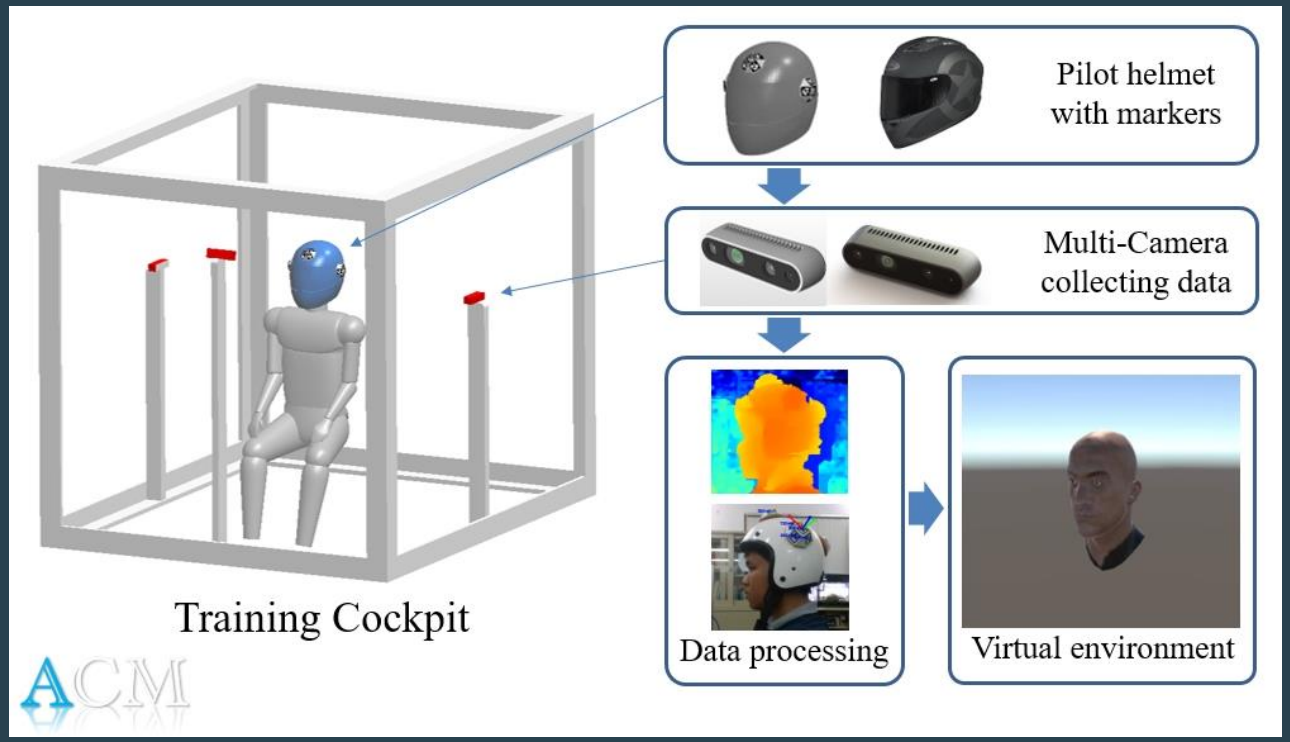






Head Pose Estimation

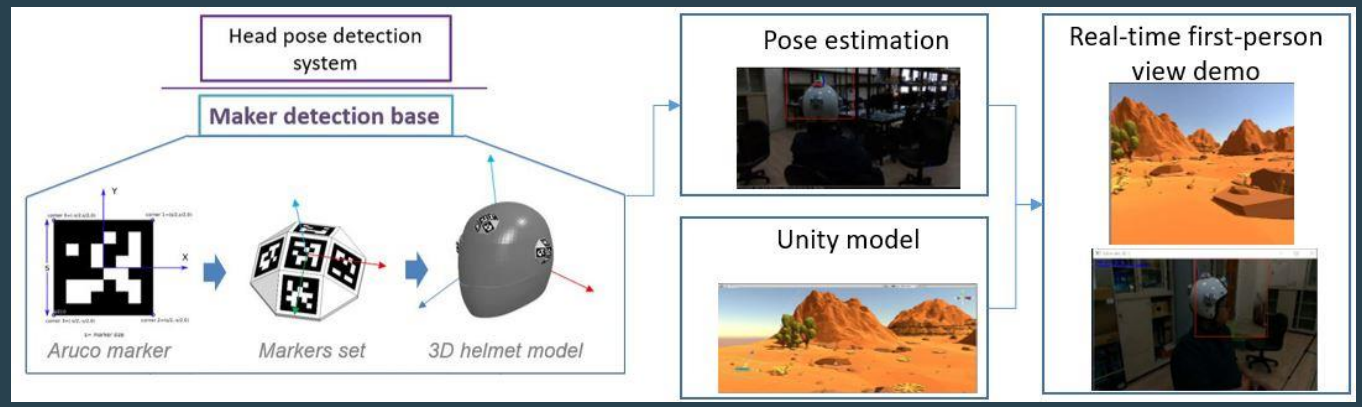
- Goal :
  - Estimate head position and rotation using code/marker based localization

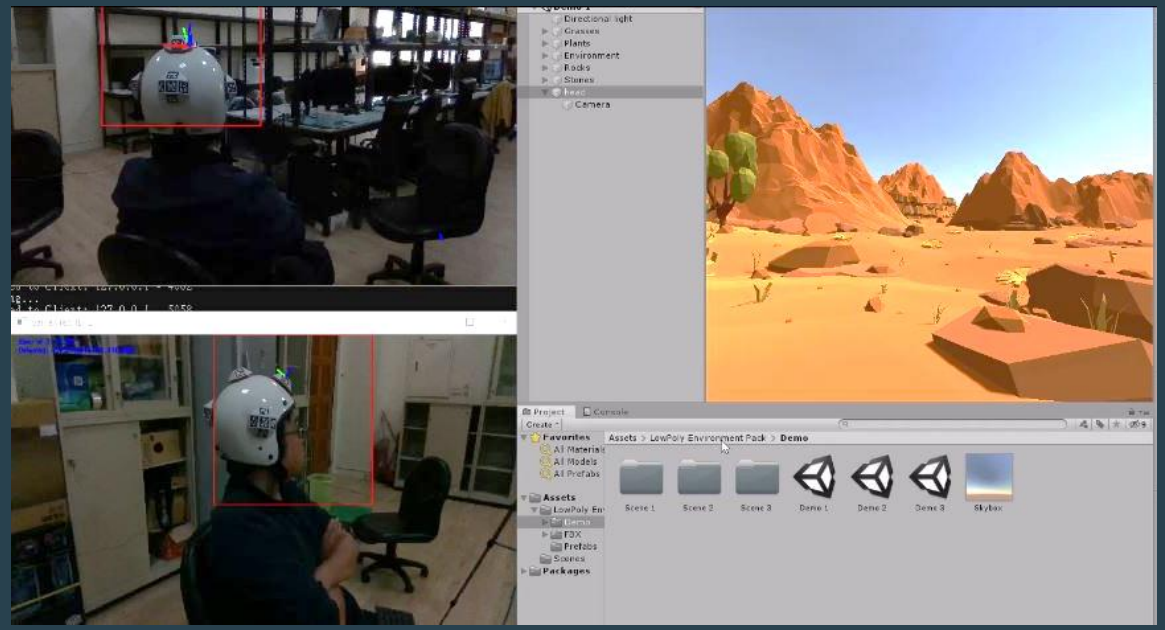


Head Pose Estimation

- Challenges :
  - High refresh rate estimation
  - Multi-cameras data fusion
  - Wide range operation of human head

- Result :


Head pose detection system
Maker detection base
Aruco marker
Markers set
3D helmet model
Pose estimation
Unity model
Real-time first-person view demo



- Publication :
  - Viet-Toan Truong, Jhih-Siang Liao, and Ching-Chun Huang, “Multi-camera Marker-based Real-time Head Pose Estimation System,” In: 2020 International Conference on Multimedia Analysis and Pattern Recognition (MAPR). IEEE, 2020. p. 1-6.
  - Ching-Chun Huang and Manh Hung Nguyen, “**Robust 3D Skeleton Tracking based on OpenPose and a Probabilistic Tracking Framework,”** IEEE International Conference on Systems, Man, and Cybernetics (SMC), 2019.
  - Po-Hsien Wang, Ting-Ying Wang, Ya-Chu Chang, and Ching-Chun Huang, "Immersive 3D Human-Computer Interaction System", International Conference on Consumer Electronics - Taiwan (ICCE-TW), Taichung, Taiwan, May, 2018.

Outline

- Introduction of ACM Lab
- Research Topics
- Introduction of Projects
- International Laboratory Co-operation

International Laboratory Co-operation

- Internship program. (Co-advising)
  - Duration : 3 – 6 months
  - Number of applicants: 2-10 persons/year
  - Participants: senior undergraduate student, master student
- Master/PhD program. (Co-advising)
  - Number of applicants: 2 – 3 persons/year
- Visiting program.
  - Duration : 3 – 6 months
  - Number of applicants: 2 – 3 persons/year
  - Participants: Lecturer

Thanks for your listening

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