Project Title: Event Analysis

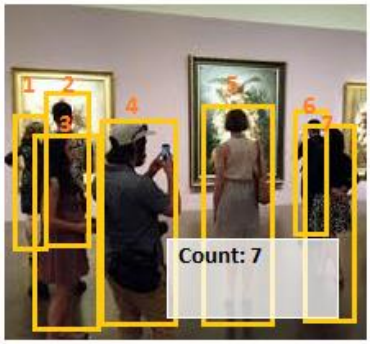
Applications of computer vision and AI in smart tourism industry

Background :

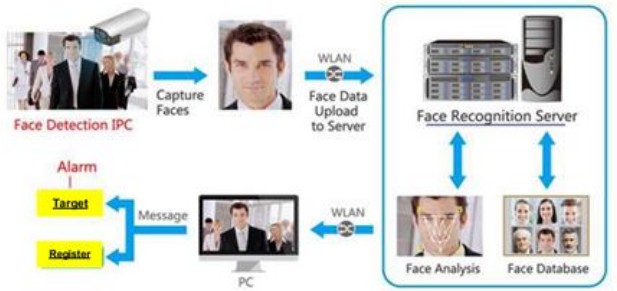
In summary, 'event analysis' is leveraged on two main technologies: HpVT provides the communication backbone and AI provides intelligent computing backbone. The goal of this project is to research and develop a cost-effective system that is capable of performing a smart visual analysis in the smart tourism domain in real-time or near real-time mode. The aim of this monitoring is to enhance safety and security. Participating countries will work on the same technological targets but may have different local applications. In this proposal, the event analysis will be employed in the following applications in the Smart Tourism area: (i) smart museums, (ii) smart surveillance and (iii) smart pedestrian and traffic monitoring.

Targets:

Smart museums



Smart surveillance



Smart pedestrian safety monitoring

Speaker:

Somnuk Phon-Amnuaisuk, Project leader, Universiti Teknologi Brunei

Project Title: **Event Analysis**

Project Members (contact points of each institution) :

Name	Position/Degree	Department, Institution, Country	Email Address
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Surachai Ongkittikul	Lecturer/Ph.D	Mahanakorn University of Technology, Thailand	surachai@mut.ac.th; s.ongkittikul@hotmail.com
Somsanouk Pathoumvanh	Deputy head/Ph.D	Lao-Japan Technical Training Center, Faculty of Engineering, National University of Laos, Lao PDR.	somsanouk@fe-nuol.edu.la
Myint-Myint Sein	Professor/Ph.D	University of Computer Studies, Yangon, Myanmar	myint@ucsy.edu.mm
Chin-Kuan Ho	Professor/Ph.D	Faculty of Computing & Informatics, Multimedia University, Malaysia	ckho@mmu.edu.my

Project Duration : 24 month, 1 September 2018 to 31 August 2020 (original plan)
The Project is extended to August 2021 (new project completion date)

Project Budget: 80,000 US$

Project Activities: **Bird's Eye View**

Concepts

Main Activities:

- Logistics
- Installation & Data collection
- Use cases development

2018

- September : kick off meeting
- November : 1st progress report

2019

- April - July : acquire cameras
- November : 2nd progress report
- Publications
  - ✓ Exploring the Applications of Faster R-CNN and Single-Shot Multi-box Detection in a Smart Nursery Domain
  - ✓ Children Activity Descriptions from Visual and Textual Associations
  - ✓ Edge Computing for Road Safety Applications

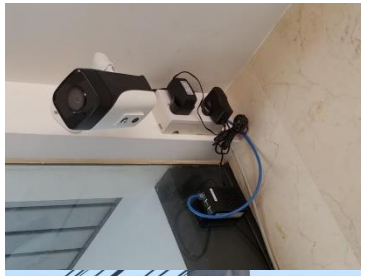
2020

- June - September: acquire hardware
- Publications
  - ✓ Object Detection, Classification and Counting for Analysis of Visual Event
  - ✓ Visual-based Positioning and Pose Estimation
  - ✓ Improved Parking Space Recognition via Grassmannian Deep Stacking Network with Illumination Correction

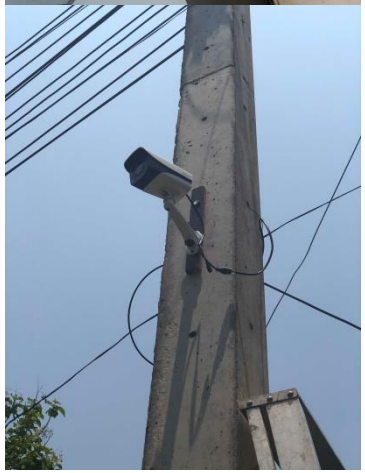
Project Activities: **Setup Camera Network (2018-2019)**

Data Acquisition:
Thailand: MUT, NECTEC ← Museum
Laos: NUoL ← Pedestrian, cars
Myanmar: UCSY ← Tourist spots
Brunei: UTB ← Library

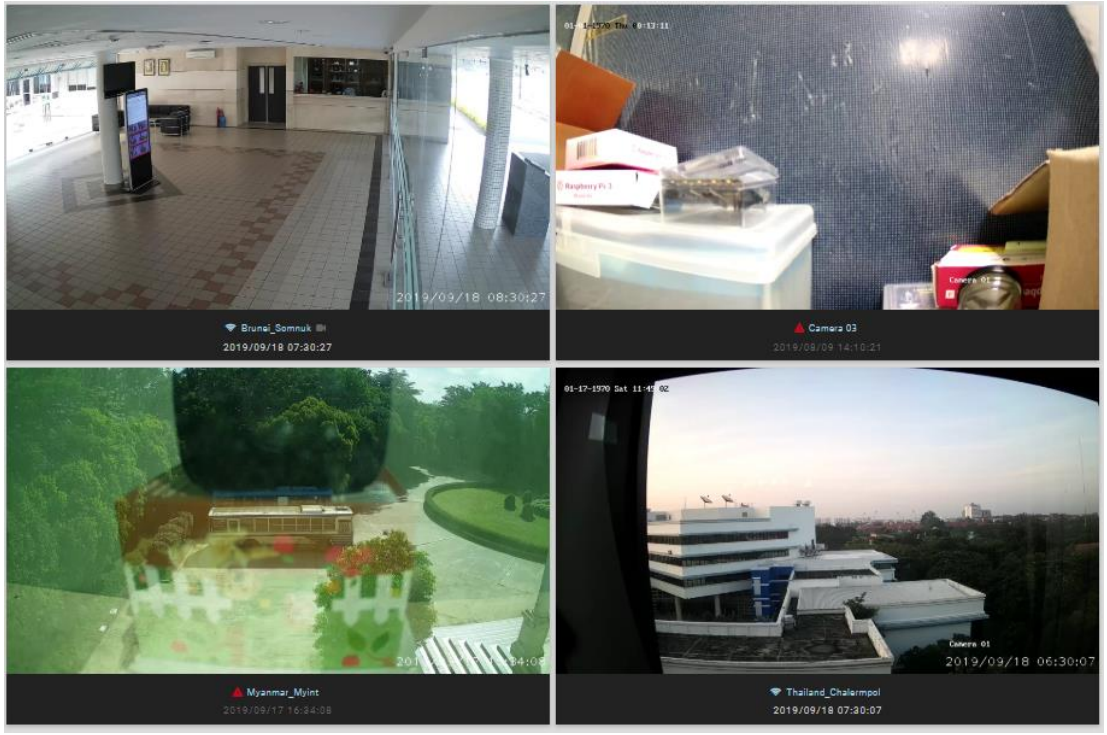
Algorithm Development:
UTB: Detection, Tracking, Counting
MUT: Face recognition
NUoL: Pedestrian, Car detection
NTU: Activity recognition



Indoor



Outdoor



Project Activities: **Develop Use Cases (2020-2021)**

Challenges:

- Installed cameras at MUT and NUoL are not detected at NICT science cloud. Under investigation.
- Confusion in regulations regarding privacy issues, non-existent or unclear local regulations on privacy issues.
- COVID 19 pandemic

Achievements:

- Installation of camera and testing communications on the following sites: UTB, NECTEC, MUT, NUoL, and UCSY.
- Developing use cases for tasks relevant to the project:
  1. UTB, UCSY, Science Cloud: Object detection, image captioning, pose estimation, position tracking.
  2. MMU, UTB, Science Cloud: Parking space analysis.
  3. UTB, NECTEC, Science Cloud: Sport scene analysis

Project Activities: Budget Plan

September 2018 – December 2019

No.	title	items	Yen		US$
1	Payment of travel expenses for project meeting	Flight &Accomodation fee UTB 1, NTU 1, NUOL 1, UCSY 1, MMU 1, Total 5 participants	¥360,000		$3,172.64
			¥360,000		$3,172.64
2	Payment of experimental equipment	* IP Camera Systems (2 units for inside) * IP Camera Systems (2 units for outside)	¥484,000		$4,282.81
			¥484,000		$4,282.81
3	Courier fee (Yamato *takkyubin*)	sending back experimental equipment after inspection, payed by Dr. emoto	¥1,922		$17.04
			¥1,922		$17.04
			¥845,922		$7,472.49

January 2020 – December 2020

1. **Meetings**: Due to COVID pandemic the following planned meetings were cancelled: UTB, tentative schedule early January 2020; NTU, tentative schedule March/April 2020; and MMU, tentative schedule June/July 2020

2. **Hardware**: Computing expenses such as computers

3. **Conferences**: UCSY: IEEE GCCE 2020; UTB: ICONIP 2020; MMU: CIIS 2020

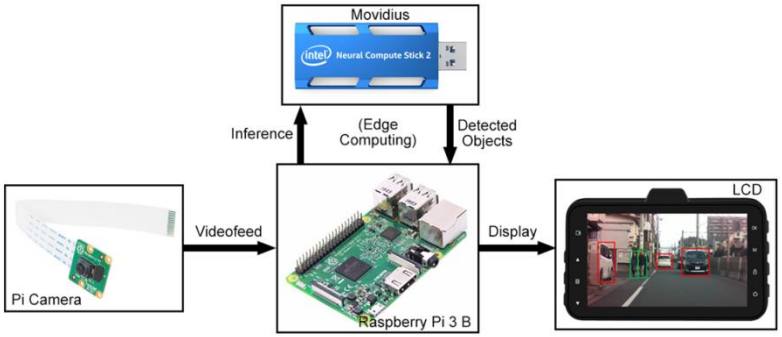
R&D results: Detection, Tracking & Counting (UTB, UCSY, SC-NICT)

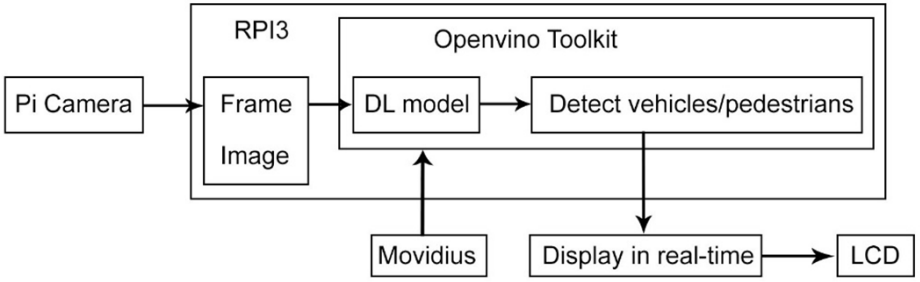
Table 1. Summary of sensitivity, specificity and average accuracy of the Faster R-CNN and the SSD detectors. Microsoft COCO is the training dataset for all models except the SSD VGG model which uses the VOC dataset.

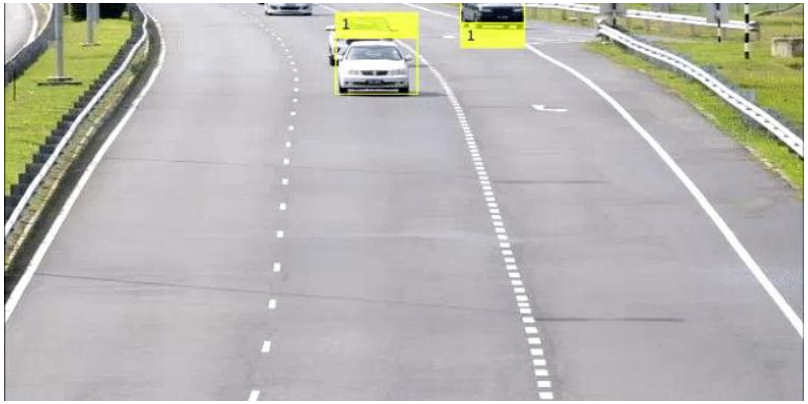
Model	Footage 1 Sens	Footage 1 Spec	Footage 2 Sens	Footage 2 Spec	Footage 3 Sens	Footage 3 Spec	Footage 4 Sens	Footage 4 Spec	Footage 5 Sens	Footage 5 Spec	Acc (%)
Faster R-CNN											
Inception model (COCO)	0.98	1.00	0.94	1.00	1.00	0.84	0.96	0.96	0.98	0.80	**95.5**
ResNet model (COCO)	0.98	1.00	0.96	1.00	1.00	0.98	0.99	0.86	0.98	0.96	**97.5**
SSD											
MobileNet model (COCO)	0.80	1.00	0.70	0.80	0.84	1.00	0.87	1.00	0.79	1.00	**85.3**
VGG model (VOC)	0.88	1.00	0.70	0.56	0.99	0.92	0.90	0.86	0.86	0.92	**86.1**

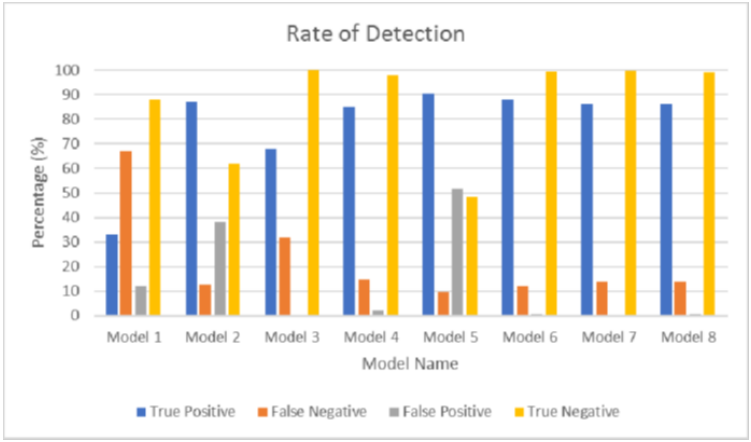
Types	**Average Accuracy (%)**
	classification
Saloon	89.7%
Van	77.3%
Truck	95.6%
Bus	98.5%
Motorbikes	76.4%
cycle	78.3%
Person/pedestrain	75.0%

R&D results: Edge Computing (UTB & Science Cloud Lab)



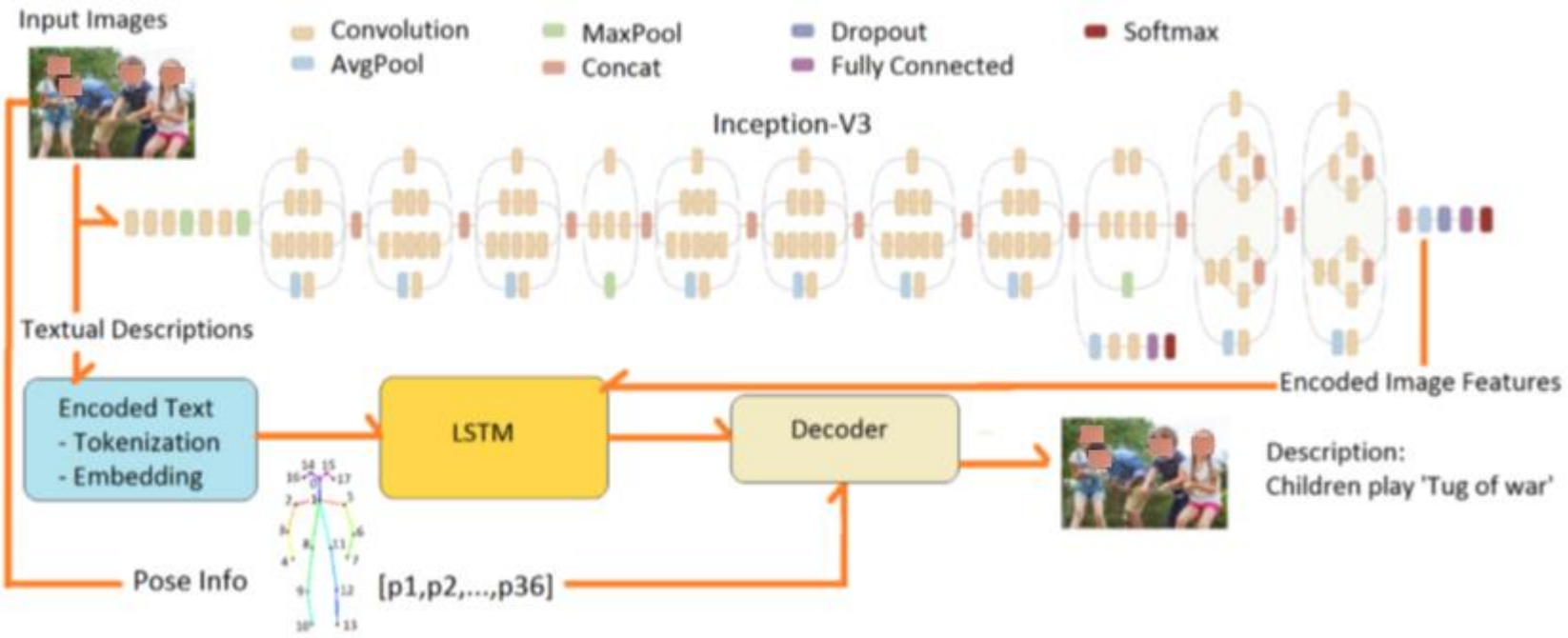






No	Models	Inference Time	Precision	Recall	F Score
	Intel Open Model Zoo				
1	person-vehicle-bike-detection-crossroad-0078	11.8 FPS	0.832	0.331	0.474
2	pedestrian-and-vehicle-detector-adas-0001	12.6 FPS	0.807	0.871	0.838
3	pedestrian-detection-adas-0002	13.4 FPS	1	0.68	0.810
4	person-detection-retail-0013	7.3 FPS	0.961	0.85	0.902
5	vehicle-detection-adas-0002	13.4 FPS	0.736	0.906	0.812
	TensorFlow Detection Model Zoo				
6	ssd_mobilenet_v1_coco	10.6 FPS	0.997	0.881	0.935
7	ssd_mobilenet_v2_coco	8.7 FPS	0.998	0.861	0.924
8	ssd_inception_v2_coco	7.6 FPS	0.995	0.862	0.924

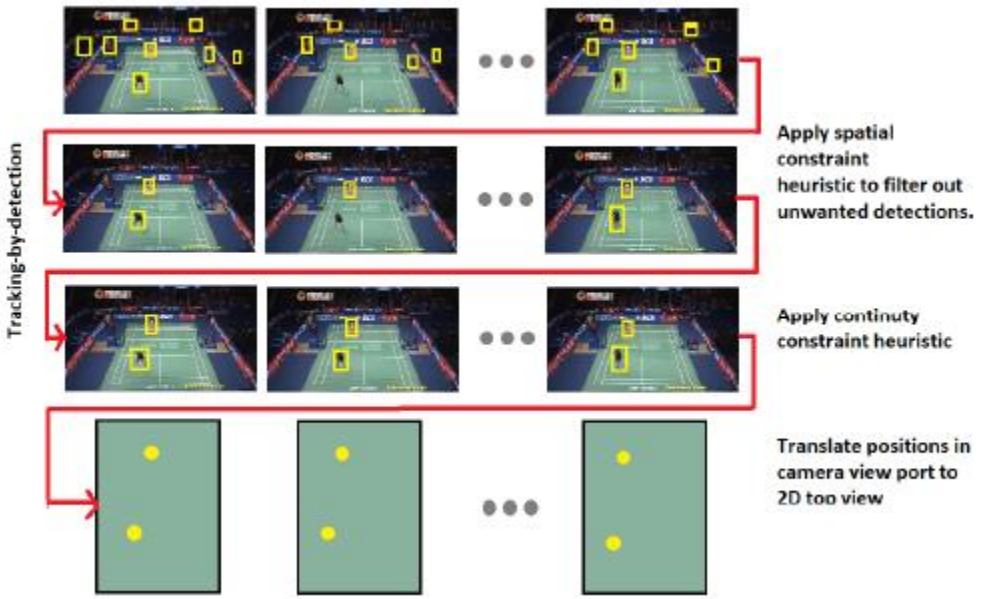
R&D results: Visual and Textual Associations (UTB, Science cloud)

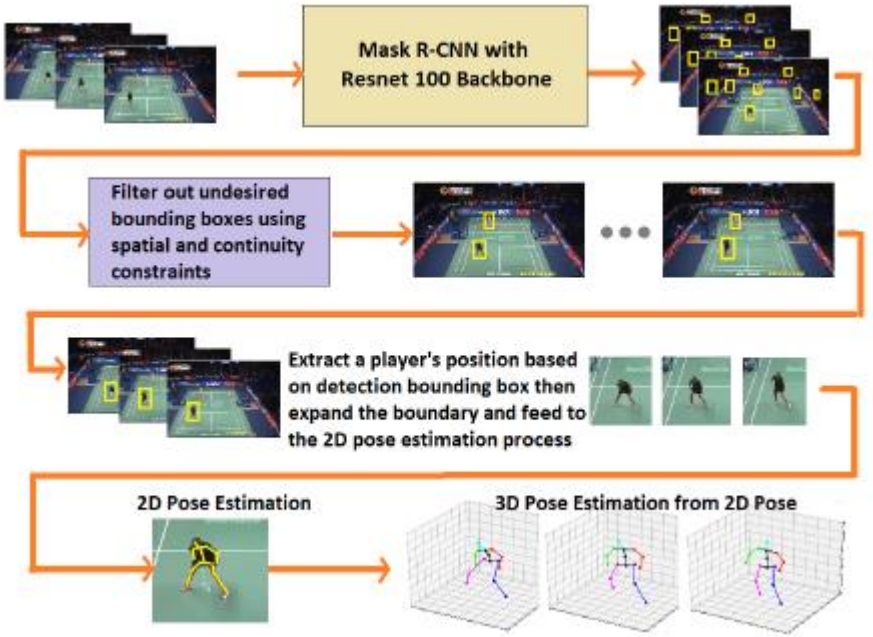


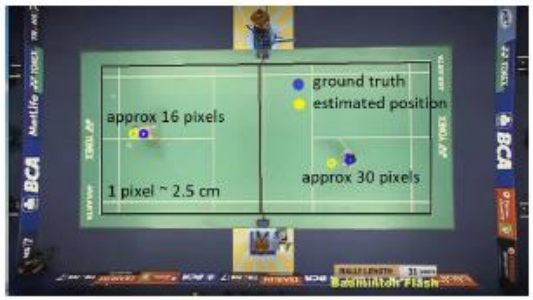
group of people are gathered around carnival game
group of kids are playing with water balloons
group of people are sitting around table with drinks

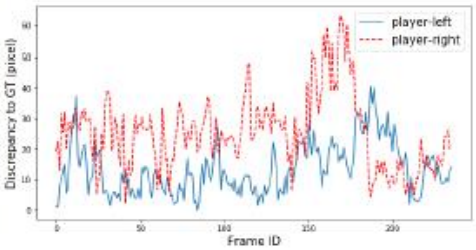
two children are playing in the grass
two boys are playing on the grass
two children are sitting on the grass

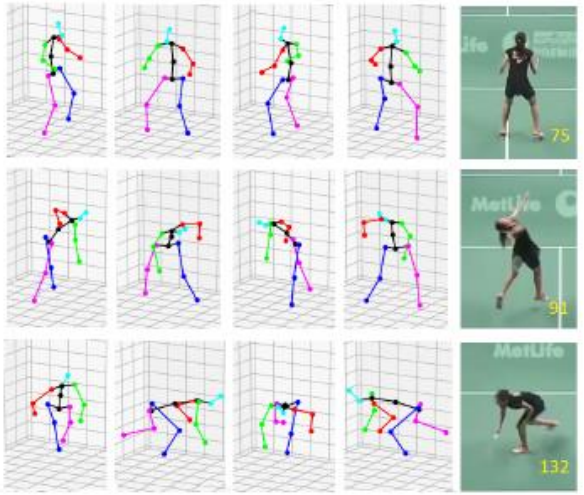
R&D results: Position and Pose Estimations (UTB, Science cloud, NECTEC)



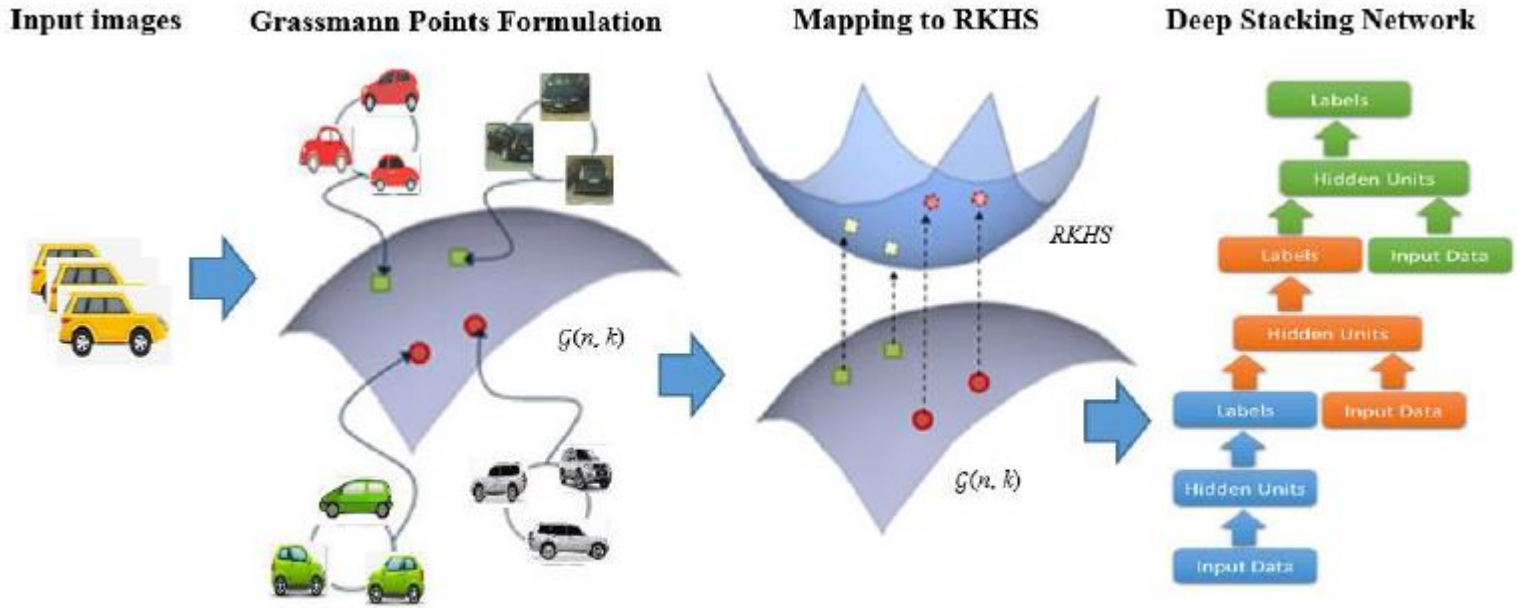




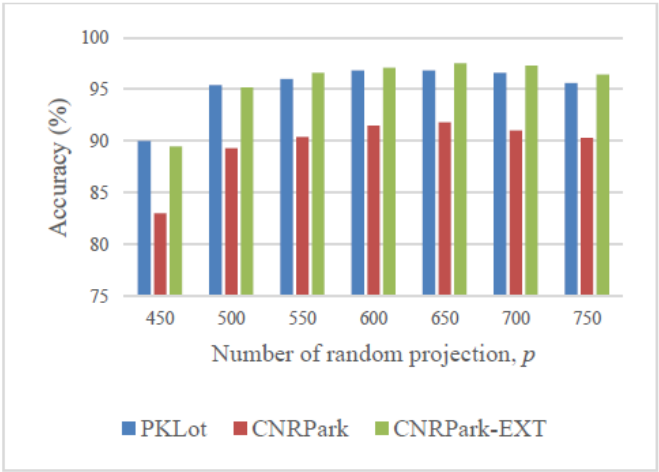


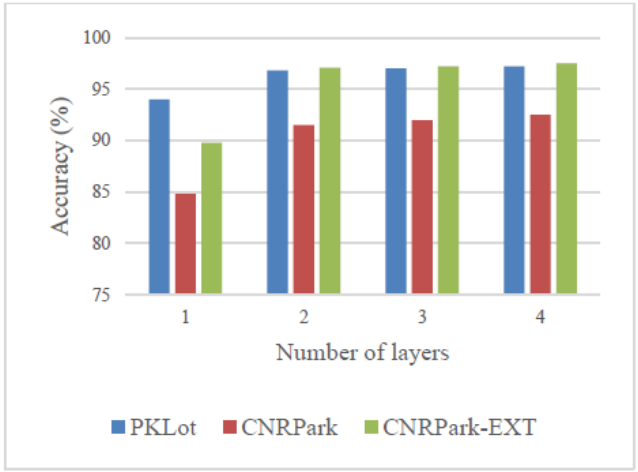


R&D results: Parking Space Analysis (MMU, UTB, Science cloud)



Overall framework of GDSN.





Scientific Contribution:

Presentations at International Conferences:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
1	Children Activity Descriptions from Visual and Textual Associations	Somnuk Phon-Amnuaisuk, Ken T. Murata, Praphan Pavarangkoon, Takamichi Mizuhara and Shiqah Hadi	Universiti Teknologi Brunei National Institute of Information and Communication Technology CLEALINK Technology Co. Ltd.	The 13th Multi-Disciplinary International Conference on Artificial Intelligence (MIWAI 2019)	17-19/11/2019	Kuala Lumpur, Malaysia
2	Edge Computing for Road Safety Applications	Shiqah Hadi, Ken T. Murata, Somnuk Phon-Amnuaisuk, Praphan Pavarangkoon, Takamichi Mizuhara and Soon-Jiann Tan	Universiti Teknologi Brunei National Institute of Information and Communication Technology CLEALINK Technology Co. Ltd.	The 23rd International Computer Science and Engineering Conference (ICSEC 2019)	30/10/2019 to 1/11/2019	Phuket, Thailand

Scientific Contribution:

Presentations at International Conferences:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
3	Object Detection, Classification and Counting for Analysis of Visual Events	Myint Myint Sein, Khaing Suu Htet, Ken T. Murat, Somnuk Phon-Amnuaisuk	University of Computer Studies Yangon, National Institute of Information and Communication Technology, Universiti Teknologi Brunei	The 9th IEEE Global Conference on Consumer Electronics (GCCE 2020)	13-16/10/2020	Online Conference, Kobe, Japan
4	Visual-based Positioning and Pose Estimation	Somnuk Phon-Amnuaisuk, , Ken T. Murata, La-Or Kovavisaruch, Tiong-Hoo Lim Praphan Pavarangkoon, Takamichi Mizuhara	Universiti Teknologi Brunei National Institute of Information & Communication Technology, National Electronics and Computer Technology Center, and CLEALINK Technology Co. Ltd.	The 27th International Conference on Neural Information Processing (ICONIP2020)	18/11/2020 to 22/11/2020	Online Conference, Bangkok, Thailand

Scientific Contribution:

Presentations at International Conferences:

No:	Paper title:	Author names	Affiliation	Conference name:	The date of the conference	The venue of the conference
5	Improved Parking Space Recognition via Grassmannian Deep Stacking Network with Illumination Correction	Tee Connie, Michael Kah Ong Goh, Koo Voon-Chet, Ken T. Murata, and Somnuk Phon-Amnuaisuk	Multimedia University, National Institute of Information and Communication Technology, Universiti Teknologi Brunei	The 4th International Conference on Computational Intelligence in Information Systems (CIIS 2020)	25-27/1/2021	Online Conference, Brunei

Societal Impact:

- Public Policy, Civil Right: This project creates a lot of discussion in terms of the privacy issues and how they should be handled.
- Social Entrepreneurship: The computer vision and AI technology provides great technological tools to SMEs.
- Environmental Sustainability: The outcome could provide a better understanding to our environment.

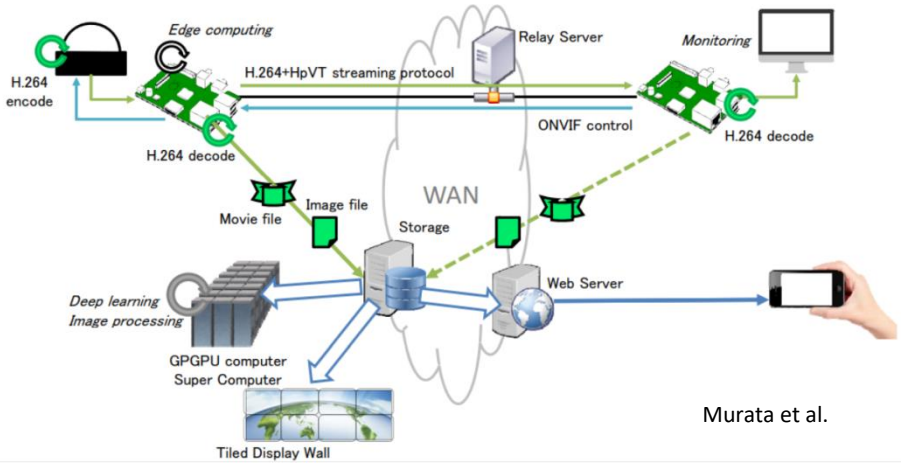
https://www.kellogg.northwestern.edu/social-impact/about.aspx

Conclusion

- **Visual sensors with AI augmentation could open a wide range of applications.**
- **We investigate the domain and successfully develop some potential use cases.**

Concepts

Big picture on visual IoT



Murata et al.

Use Cases

- UTB, UCSY, Science Cloud: Object detection, image captioning, pose estimation, position tracking.
- MMU, UTB, Science Cloud: Parking space analysis.
- UTB, NECTEC, Science Cloud: Sport scene analysis.