ITS SEMINAR AND EXHIBITION 2017

DRIVING ITS TO A NEW NORMAL

ITS MALAYSIA
INTELLIGENT TRANSPORT SYSTEM ASSOCIATION OF MALAYSIA

MONASH University MALAYSIA

Alternative sensor based system to augment camera-based Vehicle Detection And Classification (VDAC) – Experiments and results

- *Dr Madhavan Shanmugavel, Wong Joon Keet[a] , Choy Kok Hong[a]*
- *Alvin Siah[b], Chua kah Keong[b]*

[a] – Mechatronics students, Monash University Malaysia, [b] - M/s Recogine Technology

Outline

- Intelligent Traffic monitoring
- Image Classification with Deep Learning
- Model Training and Selection
- Model Integration and Program Packaging
- Experimental setup
- Image Classification
- Height Profiles from sound sensor
- Data analytics
- Training Results
- Conclusion

Intelligent Traffic monitoring

Vehicle classification
- Traffic monitoring
- Traffic violations
- Vehicle counting

Camera
- Lighting
- Occlusion
- Dust, Rain, haze

Sound sensor
- Non-visual
- Immune to lighting/occlusion
- Classify by height/length

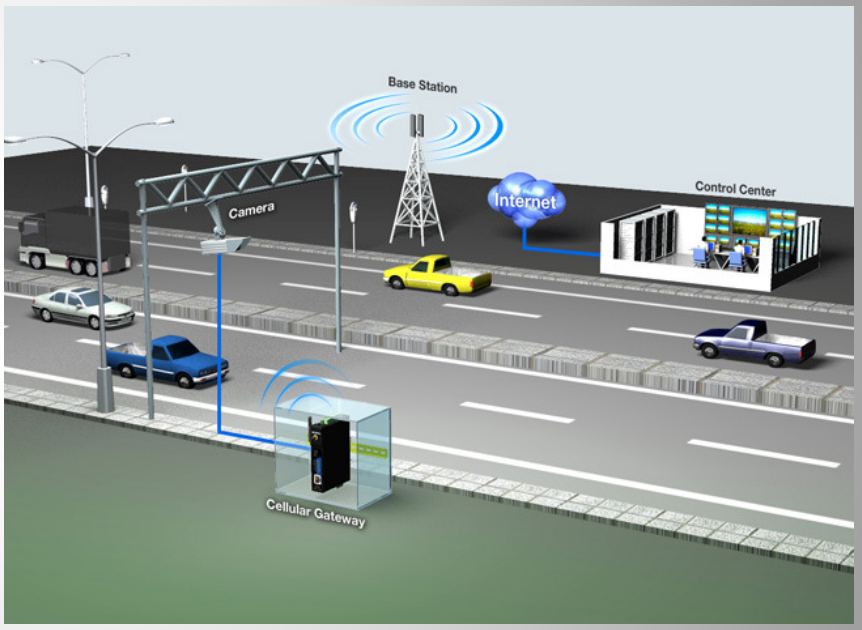
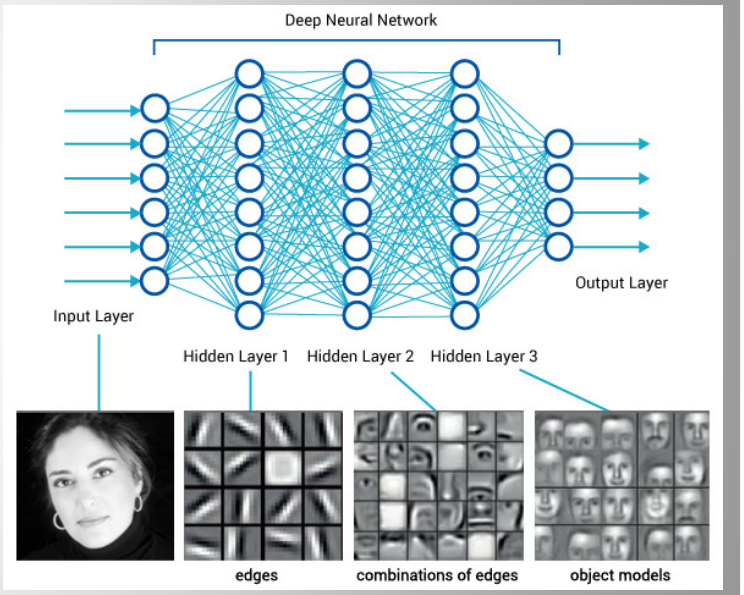


Image Classification with Deep Learning

- Video capture
- Image extraction
- Model training
- Model selection
- Model integration
- Program packaging

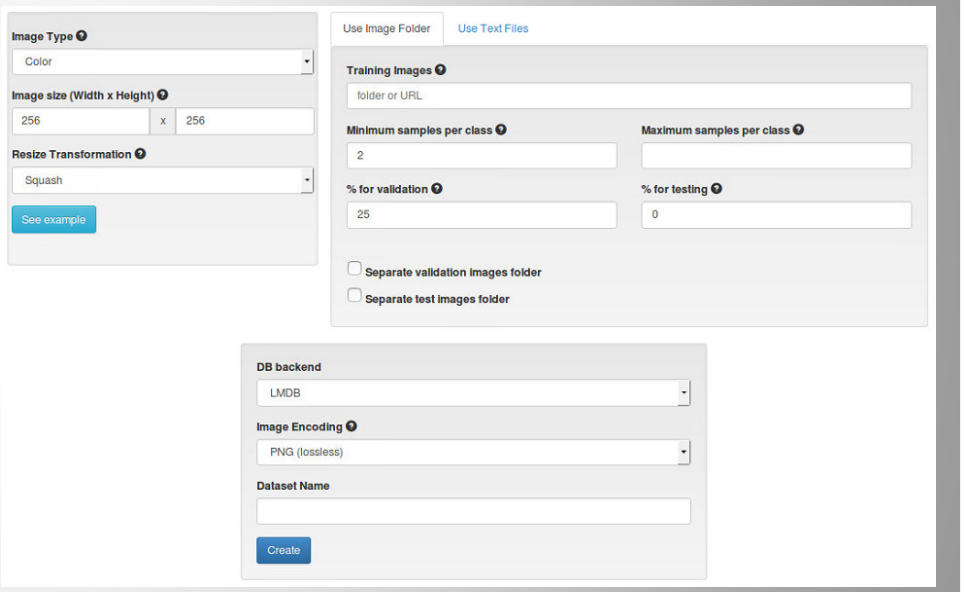
- Branch of machine learning
  - Recognise patterns
  - Many hidden layers
  - Large-scale input data
- Has 2 stages
  - Training
  - Inference



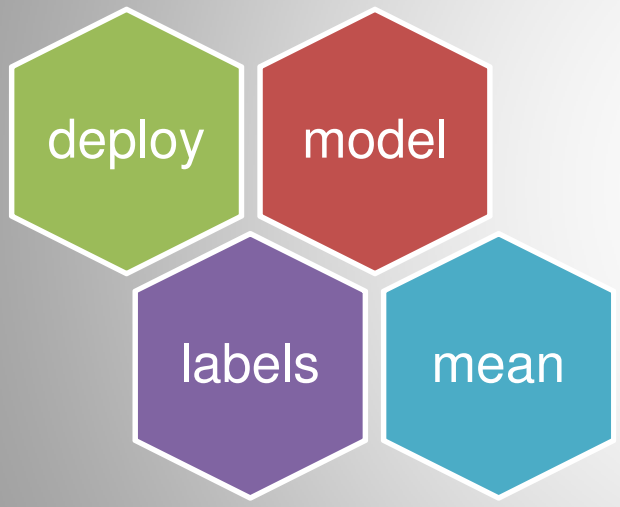
Model Training and Selection

- Create dataset
- Set parameters
- Run training
- Evaluate model

Parameter	Description
Training epochs	Total number of back-propagations
Validation interval	How often the network architecture is modified
Solver type	Back-propagation algorithm
Base learning rate	Learning rate at first epoch
Policy	Changing of learning rate
Mean subtraction	Option to subtract mean image
Network	Network architecture



Model Integration and Program Packaging



OpenCV

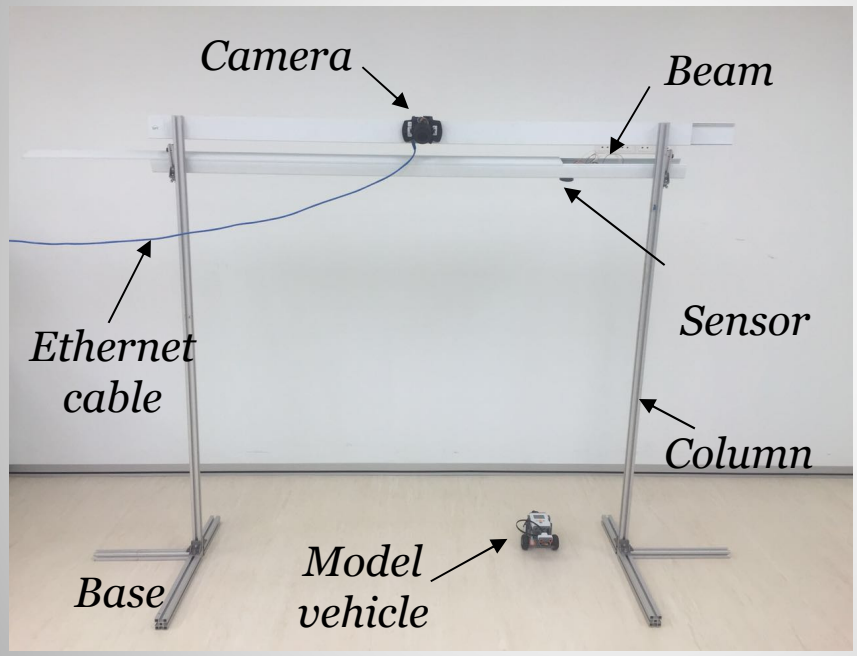
- DNN module
- Short run time
- Fails with mean-subtracted models

Caffe

- Python library
- Works with any model
- Long run time

Experimental setup

- Raspberry Pi 3: 3.3 V, 900 MHz, Wifi, microSD, Ethernet, network capable, non-volatile storage, Serial IO, GNU Linux OS



- *Adjust zoom level and focus*
- *Capture video using OpenCV*
- *Extract images with vehicle*

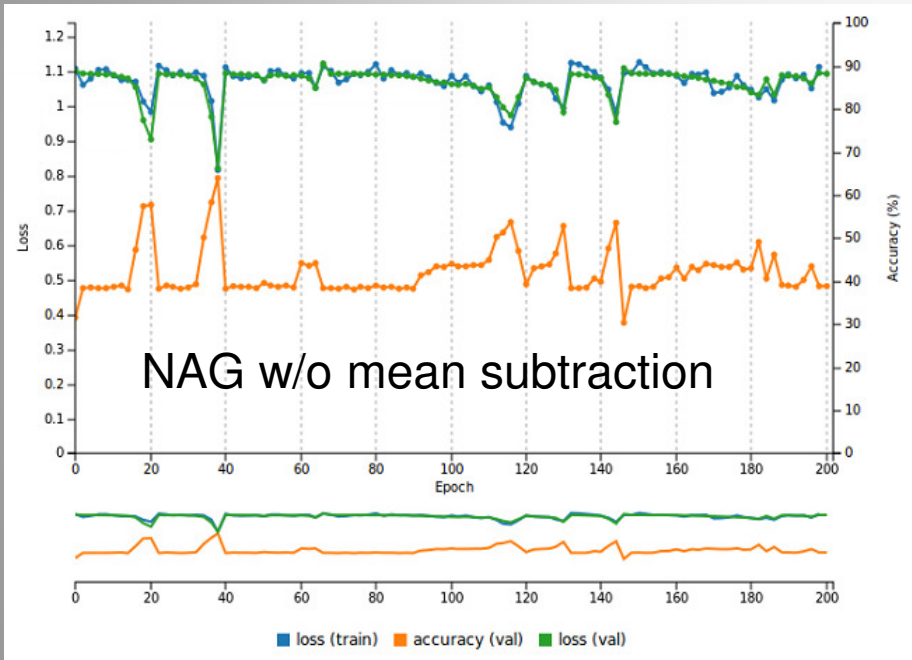
- AXIS P3384-V Fixed Dome Network Camera
  - Ethernet
  - Web interface, and Hardware reset

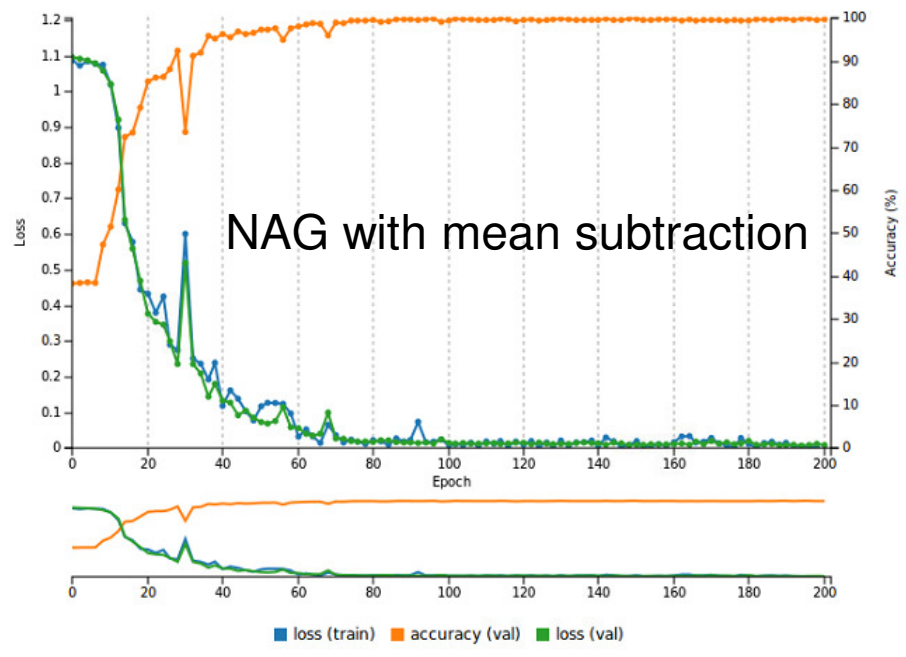
- URM06 UART sensor
  - Command frames
  - 49.5 kHz emission
  - Max range of 10m

Comparison of Image Classification

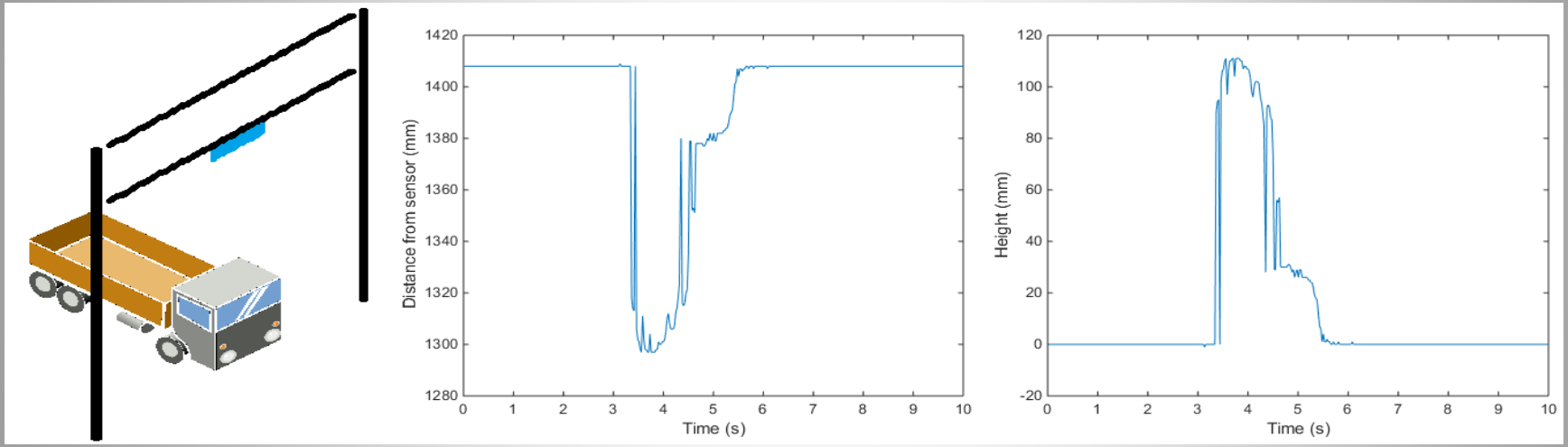
Model	1	2	3	4	5	6
Solver type	SGD		NAG		AdaGrad	
Mean subtraction	No	Yes	No	Yes	No	Yes
Network	AlexNet					
Policy	Exponential decay					
Highest accuracy (%)	89.58	99.85	63.99	99.85	97.47	99.55
Lowest loss (training)	0.2637	0.0123	0.8152	0.0040	0.0399	0.0005

Training Results





Height Profiles from sound sensor



Sensor “sees” passing vehicle

Distance from sensor plot

Invert to get height plot

Data Analysis

Extract signal

- 100 data points
- Compare known signal with input

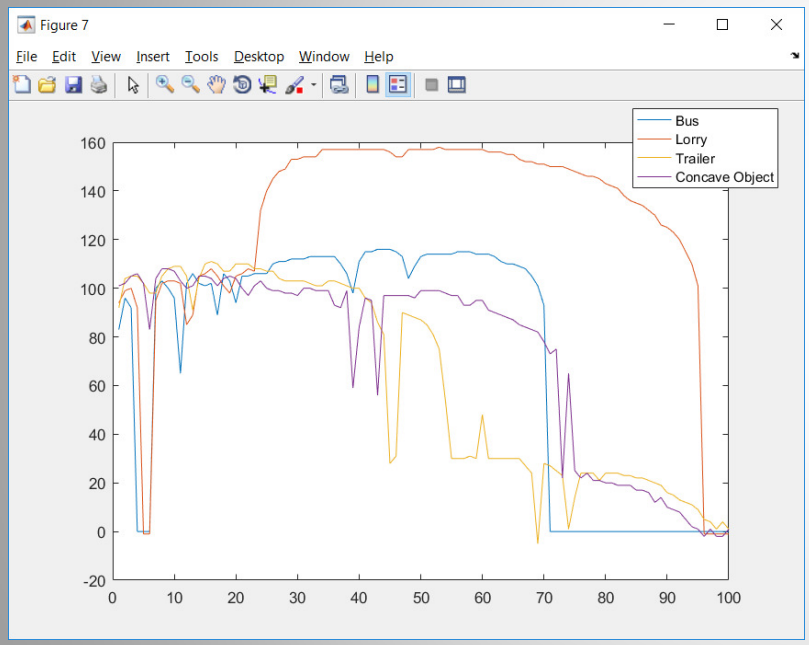
Eliminate outliers

- Calculate normal range
- $(m - 1.5IQR, M + 1.5IQR)$

Calculate index

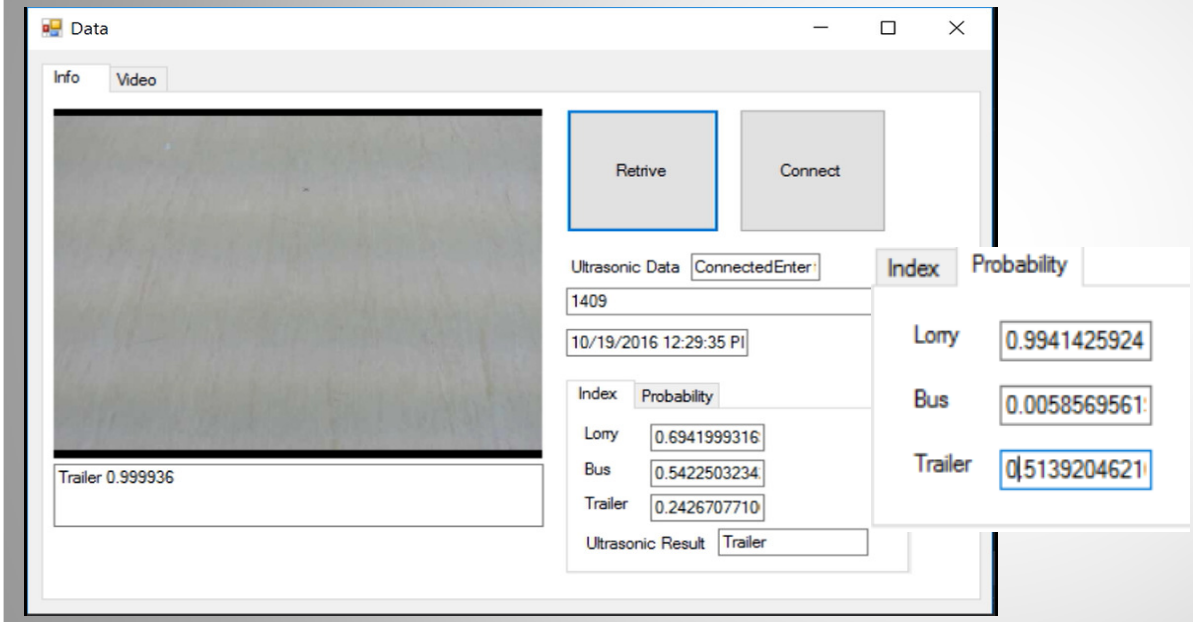
- Gauge correlation with NRMSD
- $X = \frac{\sqrt{MSE(\boldsymbol{G}, \boldsymbol{T})}}{mean(\boldsymbol{T})}$
- $MSE(\boldsymbol{G}, \boldsymbol{T}) = \frac{1}{n}\sum_{k=1}^{n}(\boldsymbol{G}_k - \boldsymbol{T}_k)^2$

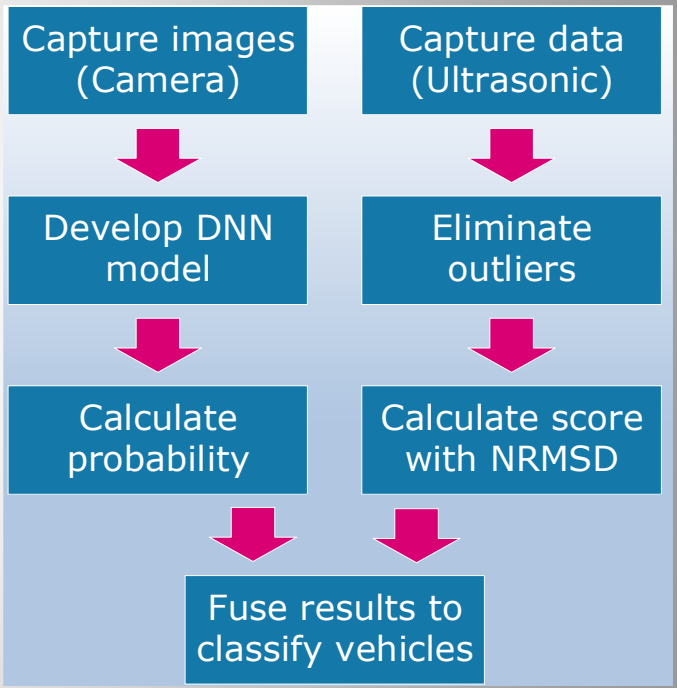
Height signatures



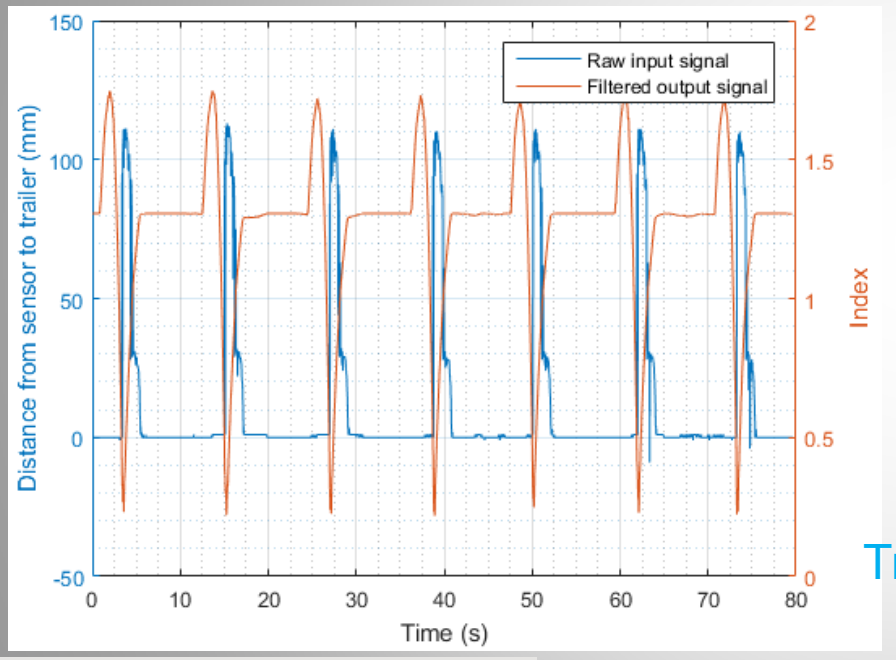
Each type of vehicle got their own signal “shapes”. Allowing the sensor to classify the vehicles based on a standard template

Integrating data





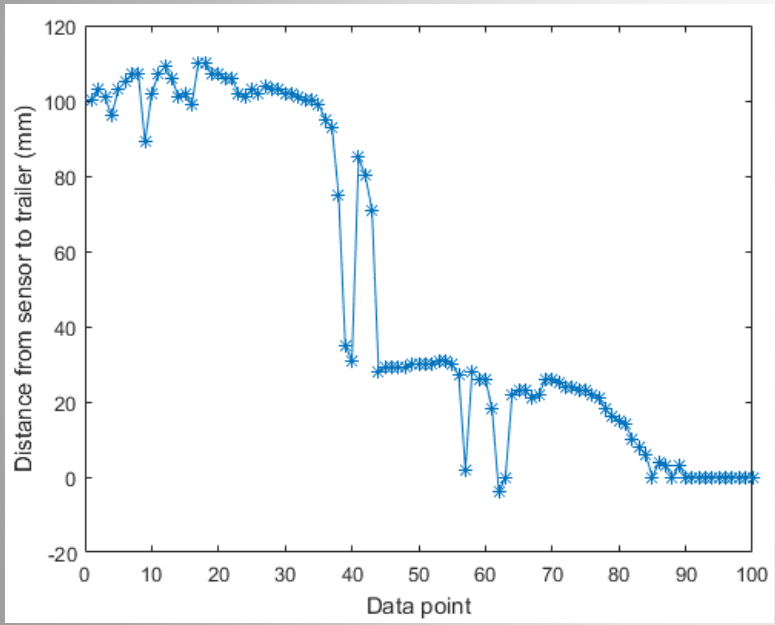
Template Matching



- Stalactite-shaped response
- Small index when trailer detected
- Good response < 0.3

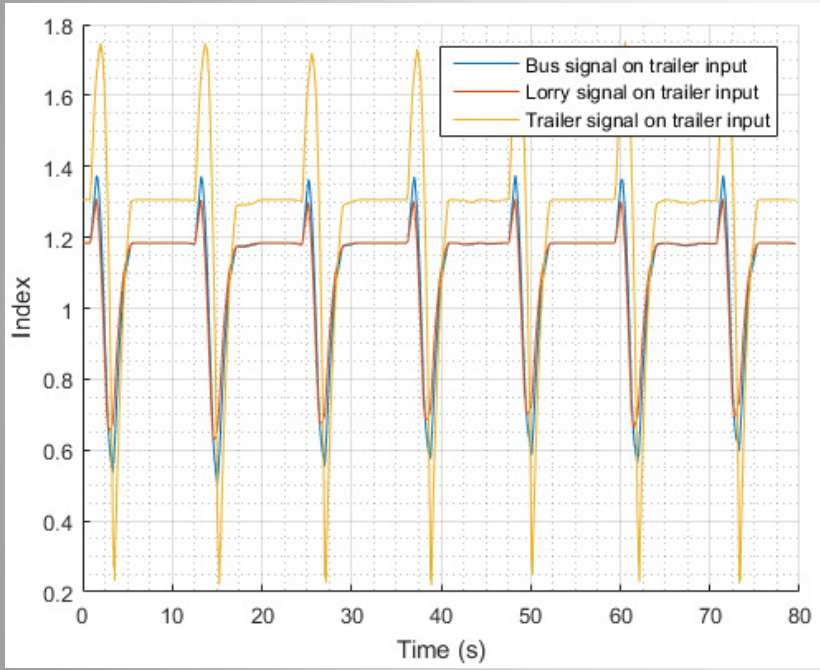
Trailer input signal & similarity index

Trailer Template Signal



- Pre-determined signal
- Signature of model vehicle
- 100 data points
  - Head
  - Tail

Similarity Index Plots on Trailer Input



- Smallest index with correct match
- Upward spike before decline
  - Possible passing object
  - Biggest mismatch (error)

Summary

- Image and sound based Vehicle Detection And Classification (VDAC) via machine learning
- Promising results
- Performance accuracy of sound sensor in VDAC is equivalent to that of camera
- Further works on sensor fusion are planned to enhance the VDAC

U O Y K N A H T

T H A N K Y O U