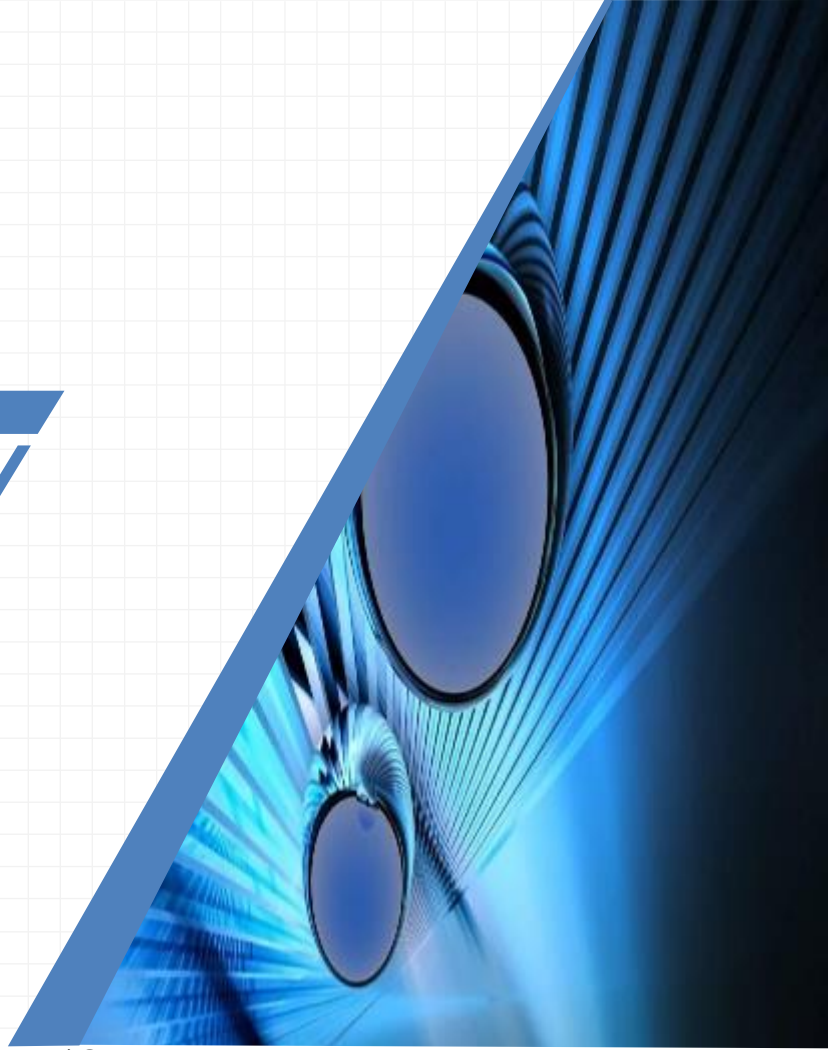
Autonomous Drive

L&T Technology Services



WE COME FROM A LINEAGE OF INNOVATION & GROWTH

Larsen & Toubro

founded in 1938 by Danish engineers

L&T is a major technology, engineering, construction, manufacturing and financial services conglomerate, with global operations.

Services


L&T Technology Services


L&T Infotech

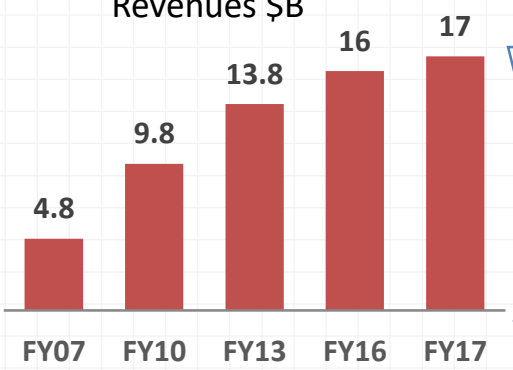

L&T Finance

Products


Heavy Engineering & Systems


Machinery & Industrial Products


Electrical & Automation



Projects


Buildings & Factories


Infrastructure


Power


Industrial Projects & Water


Hydrocarbon

CNBC- AWAZ, 2016: Construction Company of the Decade

Business World, 2016: Most Respected Companies

NewsAsia's Sustainability Ranking, 2015: Asia's 100 'Most Sustainable Companies'

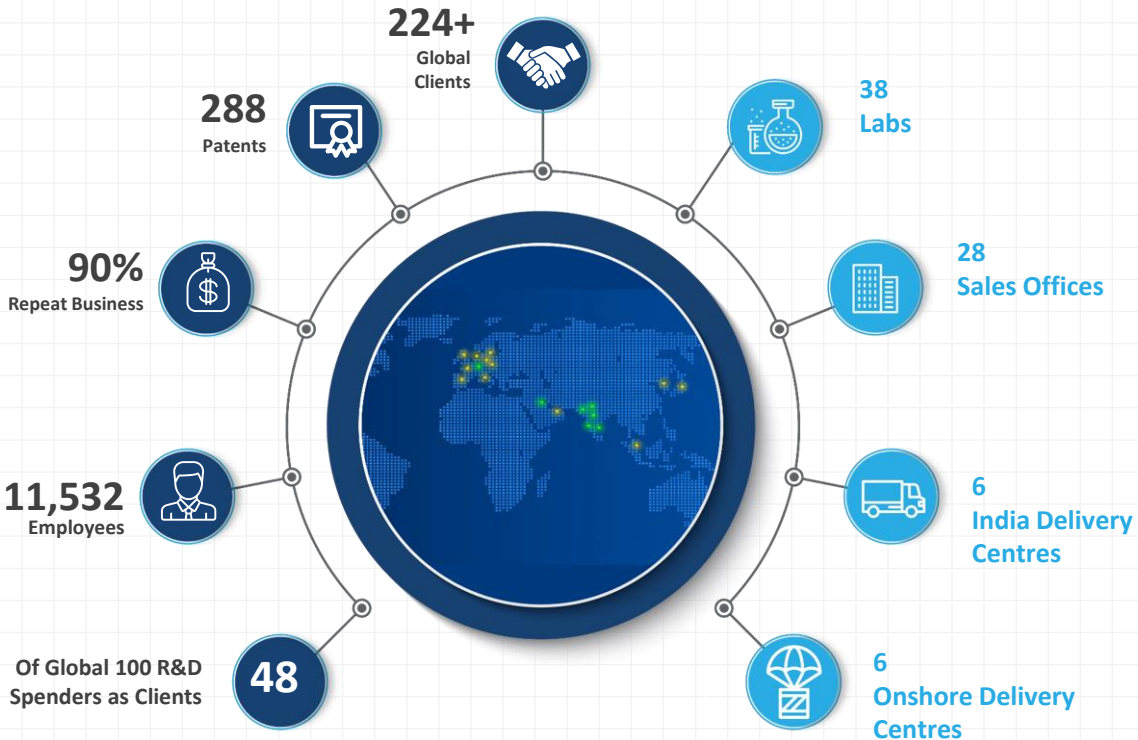
The Economic Times, 2014: L&T Ranked at No. 12 (ET 500)

Forbes 'Global 2000' List: World's Most Powerful Companies

65,000+ employees across the globe

Overview of L&T Technology Services

Global Leader: #1 Indian Pure Play Engineering Services Company



Industry Verticals

Transportation

Medical Devices

Telecom,
Consumer Electronics,
Semiconductors,
Media & Entertainment

Industrial Products

Process Industry

AUTOMOTIVE OVERVIEW

Focused Areas of Automotive Product Development & Validation Services

Infotainment & Driver Information Systems

Head unit | Instrument Clusters| Headup Displays | Mobility | Rear Seat Entertainment | Carplay | Android Auto

AD & Active Safety Systems

Vision based Algorithms | Radar/ Lidar| Sensor Fusion| Groundtruthing | ABS | Steering | Vehicle Dynamics | Testing

Connected Cars

V2X | Telematics | Remote Monitoring | Gateways | Cyber Security | OTA

Body Electronics & Comfort Systems

Body Control Module| Occupant Detection Systems | Seat Controls| RKE/ PKE | Comfort System | Lighting

Powertrain & Alternate Propulsion Systems

BMS| Converters/ Inverters| Transmission Systems | Engine Management

Body Engineering & Safety Restraints

Interiors | Exteriors| Chassis & Suspension| Lighting | Sunroof | Airbags | Seatbelts | Brakes

2250+ Engineers & Specialists

50+ Global Customers

6 State of the Art Labs

17+ Years of Experience

Our Clientele

BMW, Volvo, Ford, FCA Fiat Chrysler Automobiles, Mercedes-Benz, Honda, Renault, PSA Peugeot Citroen, Zoox, Continental, Calsonic Kansei, Aptiv, Delphi Technologies, Visteon, Magna, Panasonic, Bose, Lear Corporation

** Logos are properties of respective owners and are used for representative purpose*

AD Offerings

Integration Services

- ✓ Algorithm Development
- ✓ Algorithm Porting
- ✓ Algorithm Optimization
- ✓ Application Development
- ✓ Compliance to Safety Standards ISO26262

Sensing Feature Development

- ✓ Customizable Vision Based Libraries
- ✓ Sensor Fusion
- ✓ Multi Sensor Capability

Testing and Validation of ADAS

- ✓ Automated Functional Test Framework
- ✓ Automated/semi-Automated Data Labelling Tool
- ✓ ADAS-Evaluation Tool
- ✓ Build to Report Framework

4 Tier -1's on Image Processing

20+ Engineers in ADAS

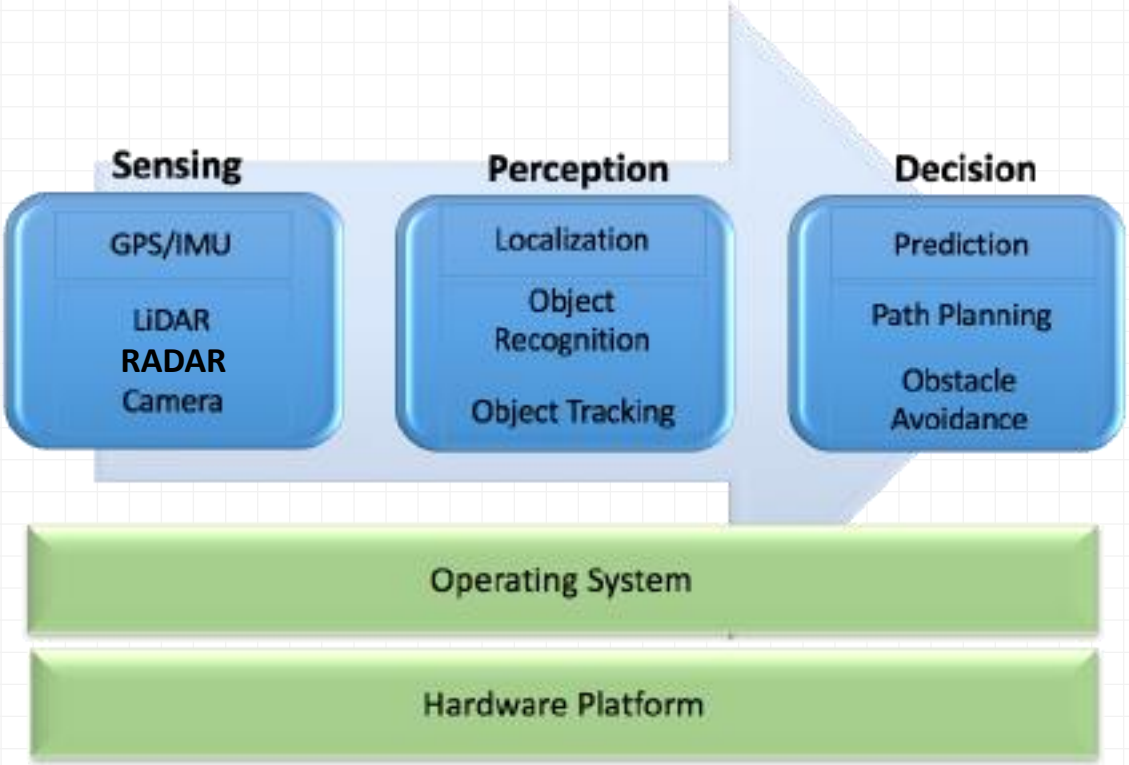
L&T TS Proprietary Tools

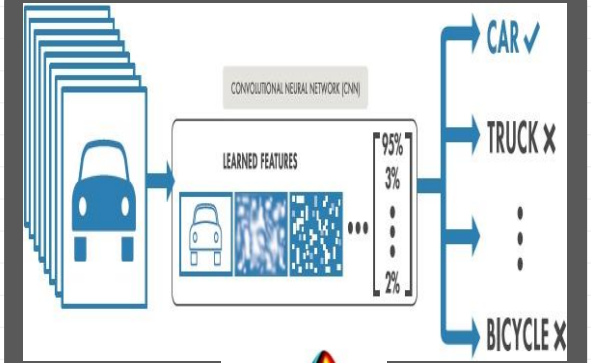
VANGEN® Tool for Data Labelling

ADAS-EVAL™ Tool for Performance Report Generation

MaLT Tool for Machine Learning Algorithm

Overview

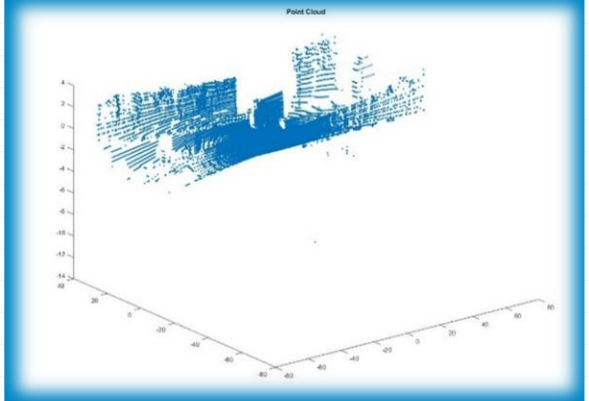




MATLAB

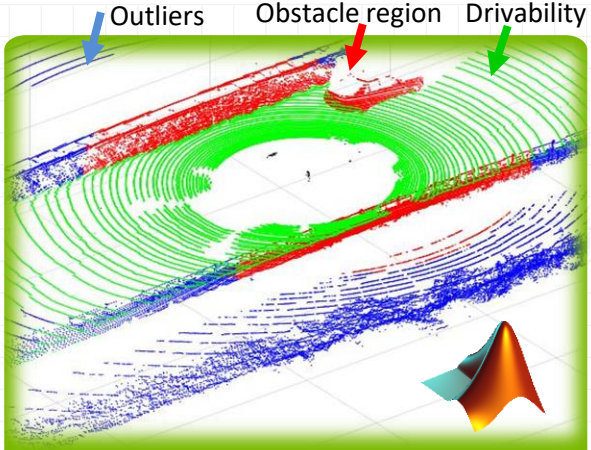
- Accelerated Training, Pretrained Models, and Visualization – TRANSFER LEARNING
- Classification, Regression, and Clustering of Shallow Networks
- Automatic Lighting Control
- Sensor fusion
- Path planning
- MIL – Simulation
- Code Generation and Deployment

Guidance Systems



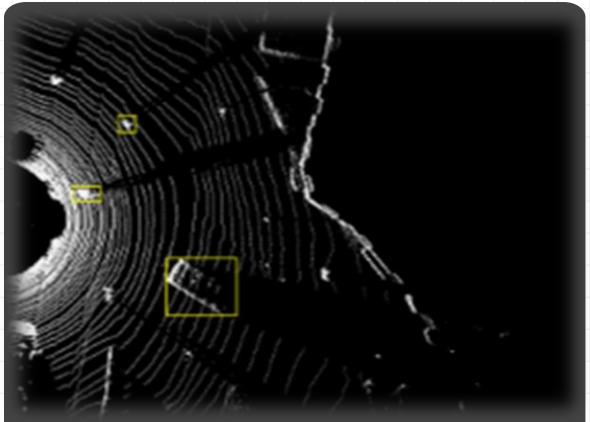
Data Acquisition – LIDAR Input Point Cloud Data

- Data acquisition using the Point cloud data generation
- Multi Sensor Capability with data synchronization and Sensor Fusion
- Sensors – LIDAR and Camera
- De-noising and Enhancements



Segmentation - Detect obstacles and the outliers

- Classifications using Advanced Machine Learning Algorithm
- Feature extraction and matching
- False removal & Tracker with validation techniques

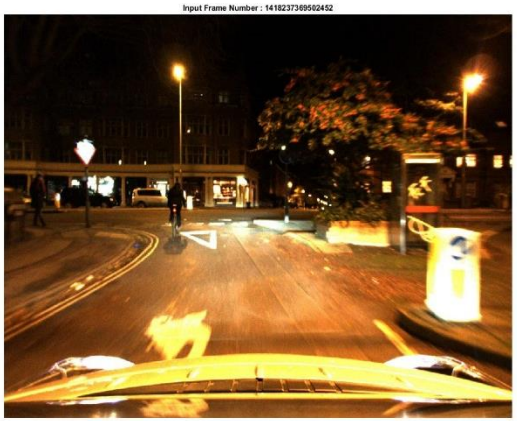


Clustering Algorithms – Detect Objects in LIDAR point cloud

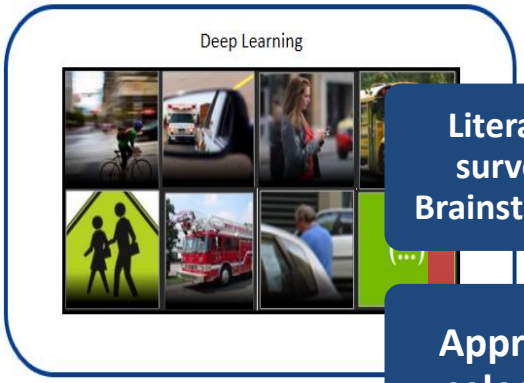
- Object Detection Algorithm
- Parameter generation and estimation - Distance Estimation
- Optimization for real time performance for accuracy, precision and execution time

LiDAR and Camera Synchronization

- Image on left, indicates night time camera data
- Image on right, represents the LiDAR point cloud (blue color) is overlaid on the respective camera frame by mapping the LiDAR and camera co-ordinates.
- The difference in coordinate system is synchronized with intrinsic and extrinsic calibration.
- The obstacles classified and distance is estimated with both camera and LIDAR that makes the system robust.



Workflow



Literature survey & Brainstorming

Approach selection

Architecture / Design

MATLAB / SIMULINK

PoC Development

Validation & Refinement

Concept finalization & generation

Integration & Porting

Optimization

System V & V

1. MATLAB toolboxes supported in quickly develop LIDAR obstacle detection.
2. Deep learning algorithms transfer learning
3. Simulation and control development

Components
▪ Software
▪ Toolbox
▪ Sensors &
▪ Systems

MATLAB is key tool that provides significant toolboxes that enable us to move faster and precise in proving the concepts

Automatic Lighting Control

ALC – Automatic Light Control

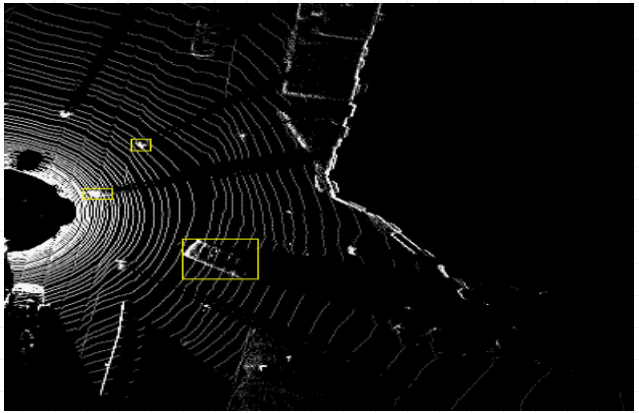
Dimming for overtaking vehicle

Dim for oncoming vehicle

Dim for leading vehicle

Camera based night vision

LIDAR based night detection



Left Head light status

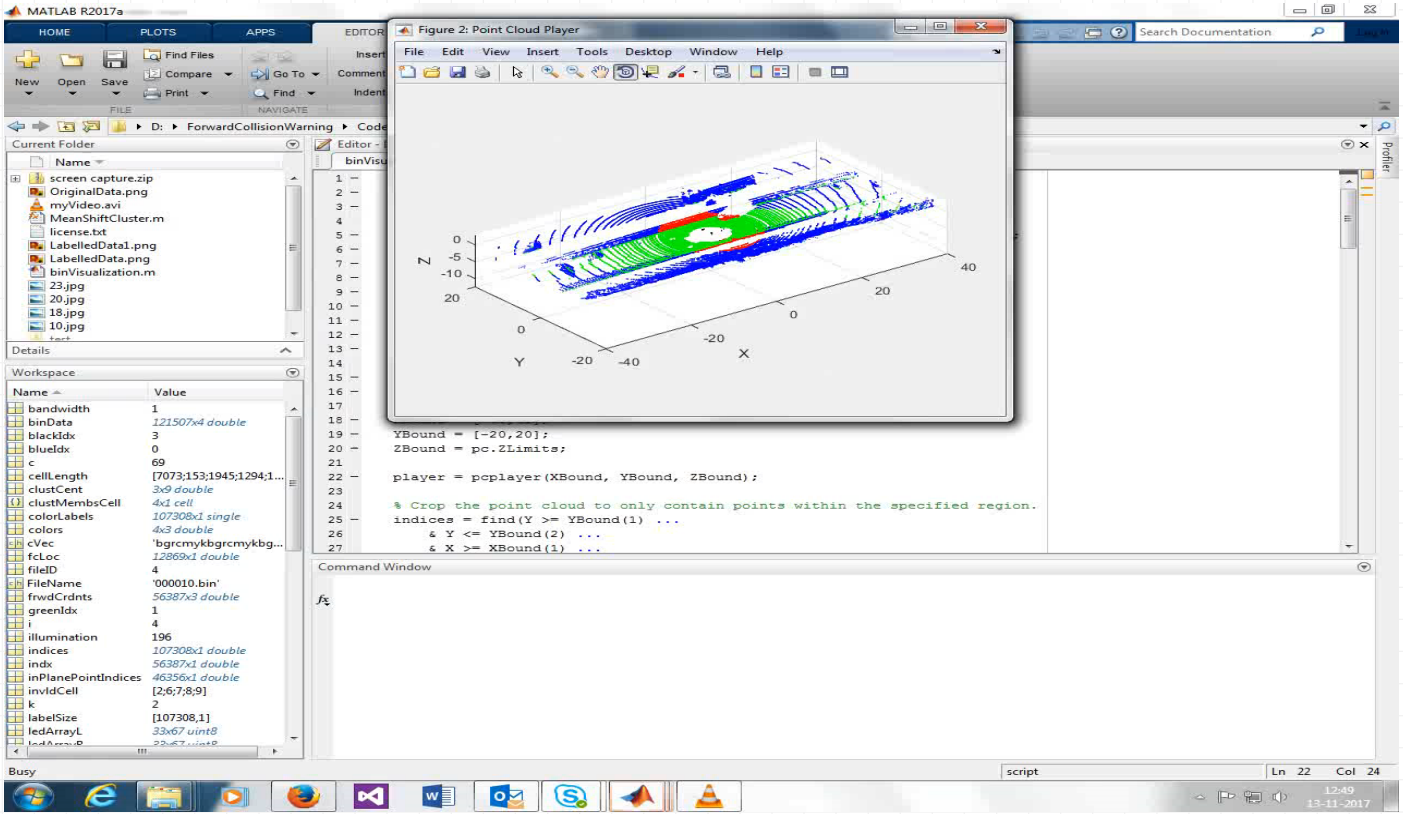
ON	OFF	ON

ON	ON	OFF

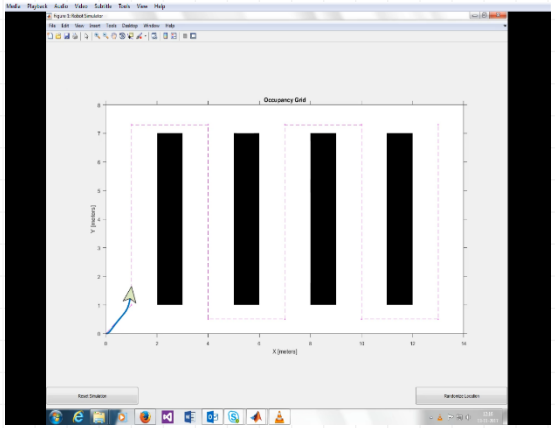
Right Head light status

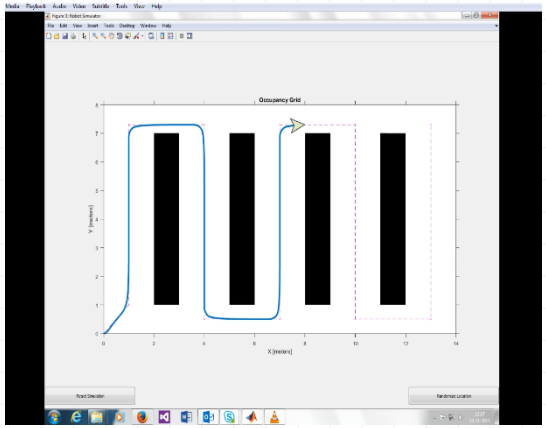
LIDAR Object Detection

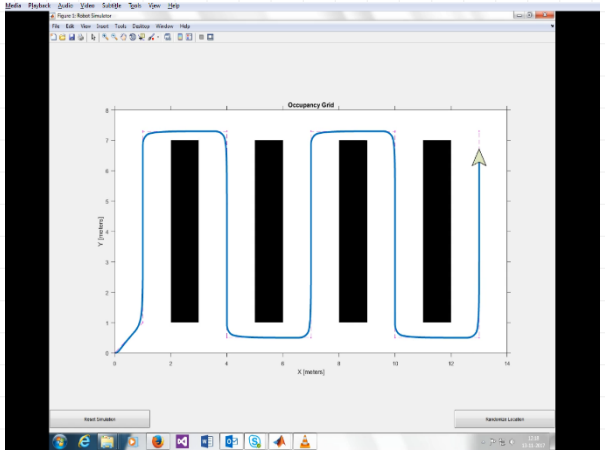
MATHWORKS - MATLAB



Path Planning for Autonomous Drive



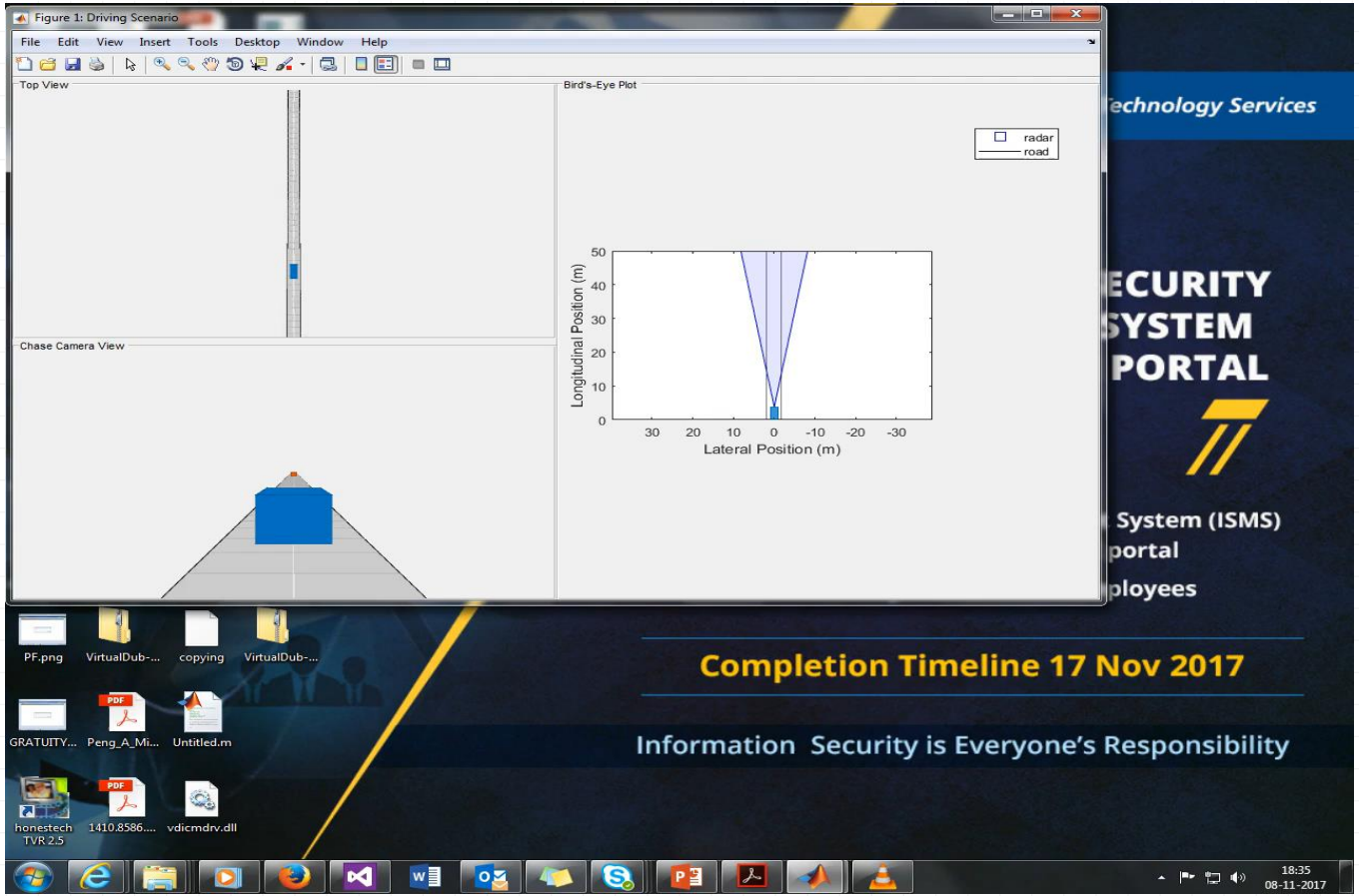




MATHWORKS - MATLAB

- Path Planning for Autonomous vehicle
- Point A to Point B
- Motion Controls

RADAR Detection



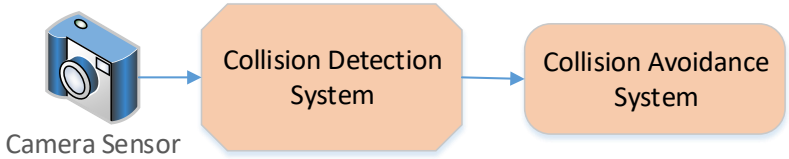
AEB Usecase

Problem Statement

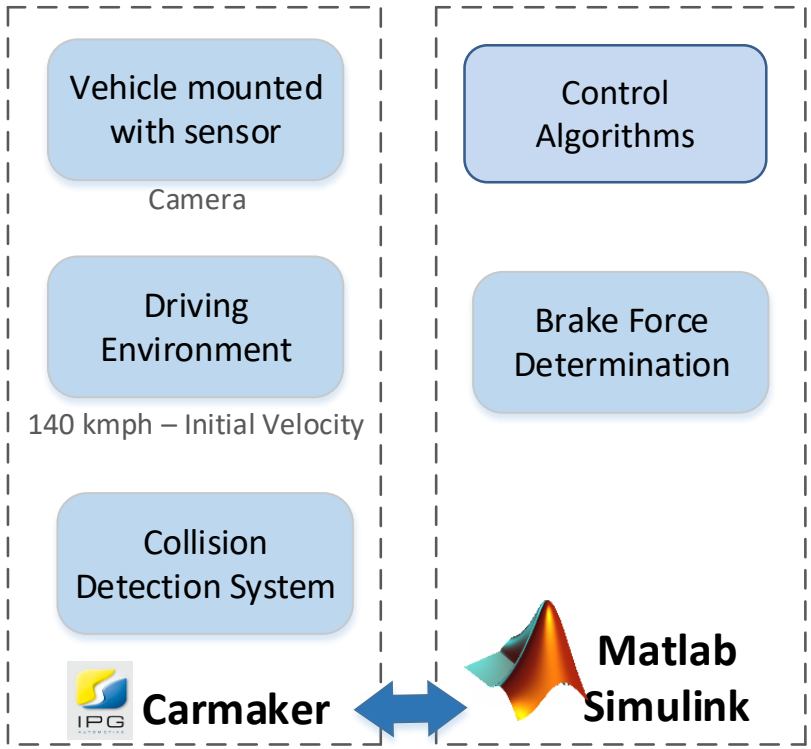
- ✓ To model an AEB scenario in Carmaker where the vehicle's initial velocity is 140kmph and decelerates after detecting a static object with resulting g force less than 0.9.
- ✓ Integrate Simulink with carmaker and compare the performance of the scenario with standalone carmaker model.
- ✓ Integrate the Simulink model with Polarion.

AEB using Carmaker and Simulink

- ✓ A scenario is modeled in Carmaker where the initial velocity of car would be 140 kmph.
- ✓ The object sensor in carmaker would detect the static object in the path.
- ✓ This detection is used as a trigger signal in Simulink for g force calculation.
- ✓ The calculated g is fed into PI controller for determining brake percent.
- ✓ This percent is sent as a brake pressure signal to Carmaker to stop the car.



AEB Flow

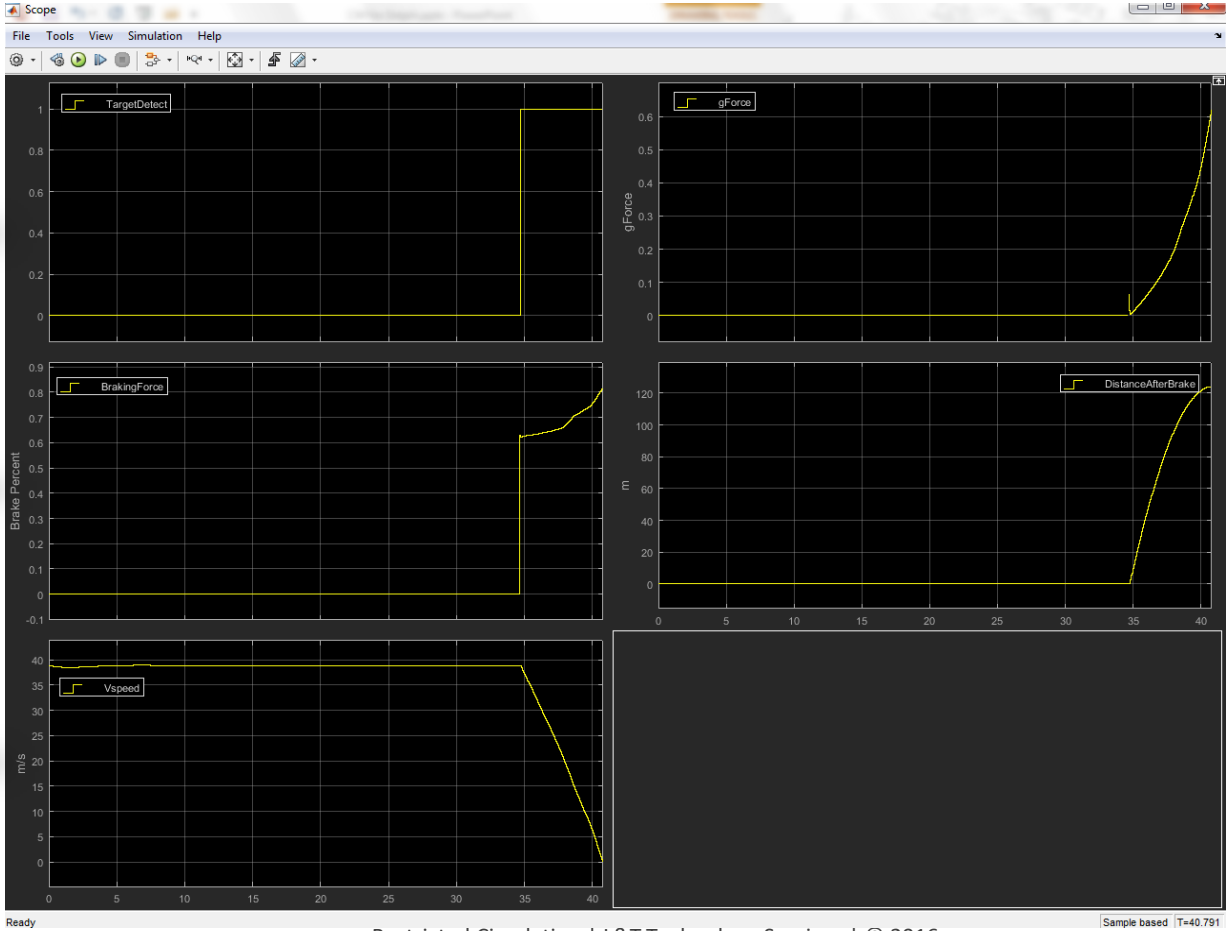


Test case outputs

Target Detection Flag

Brake Force Calculation

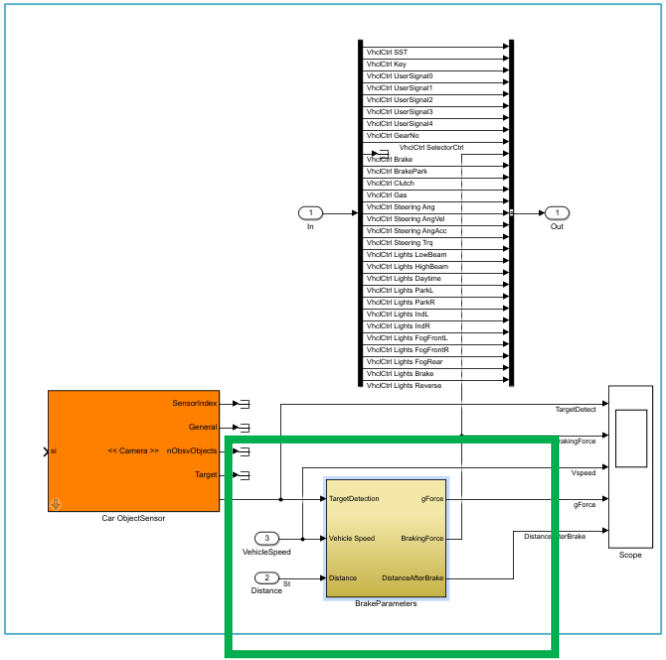
Vehicle Speed

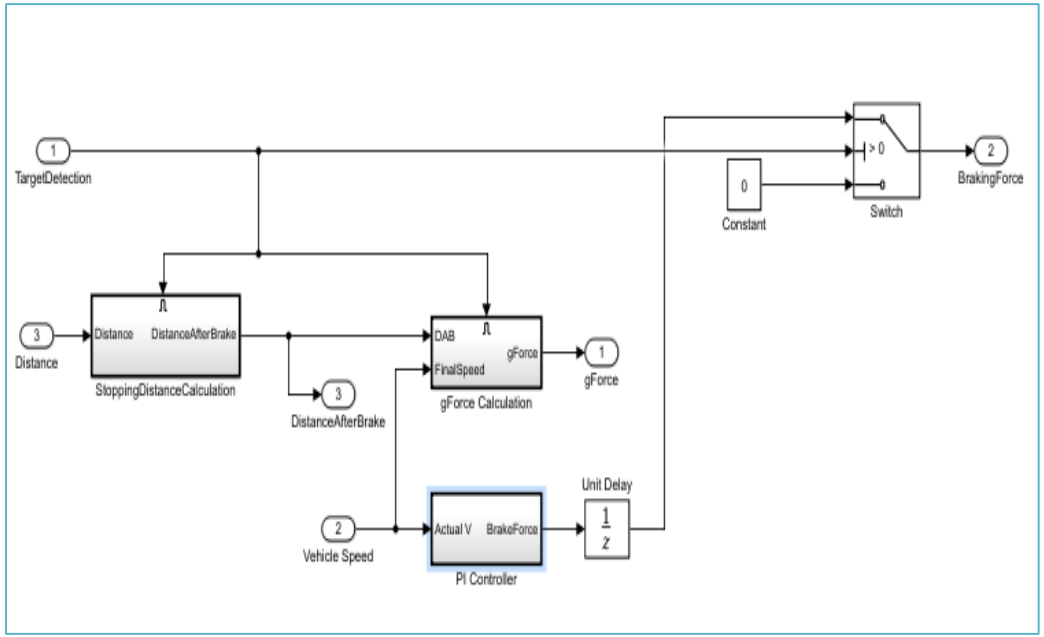


g Force

Distance After Brake

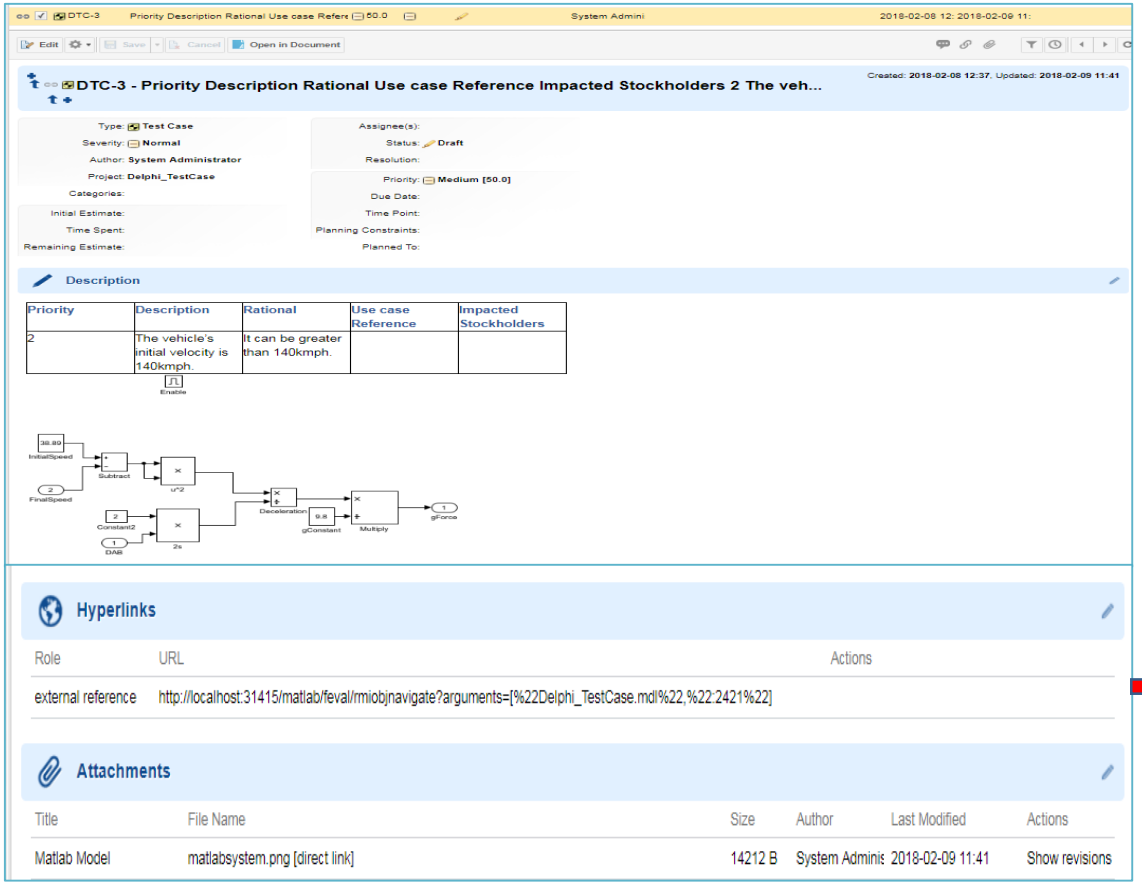
Simulink Modules





1. SIMULINK model for Braking.
2. Simulink block linked to requirements, design and test case in Polarion.

Linked Simulink block in Polarion



- Hyperlink will have URL of MATLAB Simulink .
- We can directly use this URL to go back to Simulink block.

Environmental Generator &

Forward Collision Warning

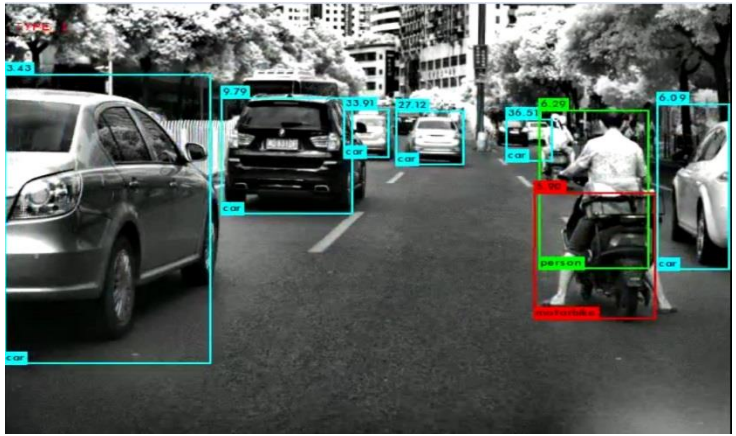
Environmental Generator

Input image

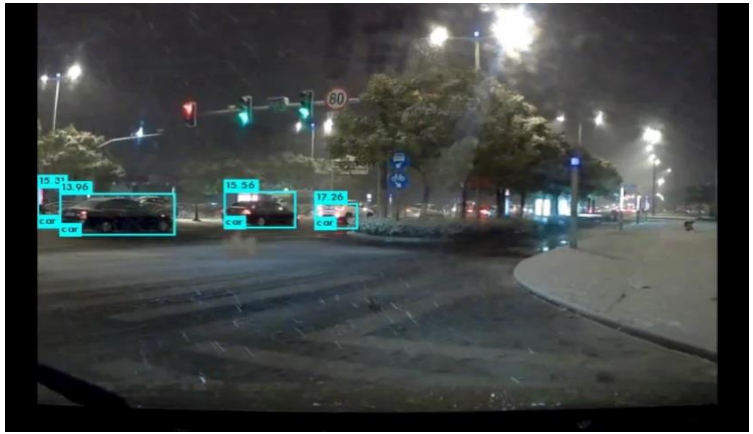
Output image

- **Deep learning by performing transfer learning with pretrained deep network models (including Inception-v3, ResNet-50, ResNet-101, GoogLeNet, AlexNet, VGG-16, and VGG-19) and models imported from TensorFlow®-Keras or Caffe.**

Object Detection with 1.3mp Camera up to 50 meters



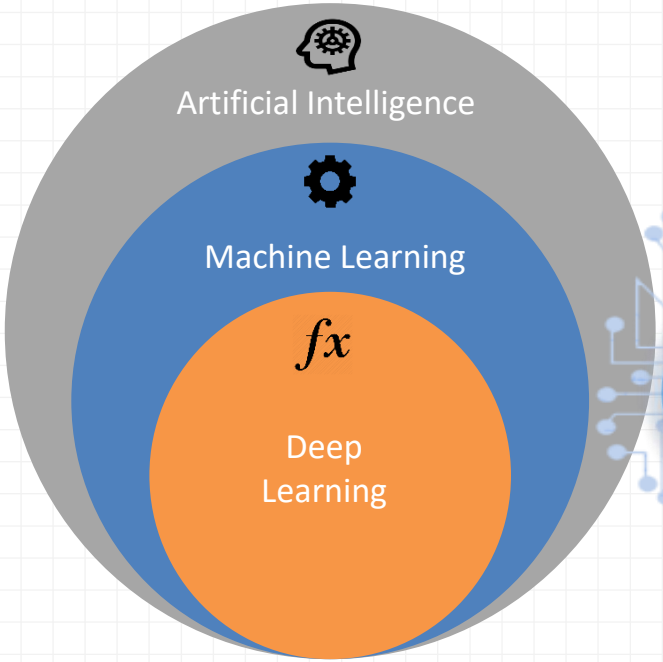
Day condition

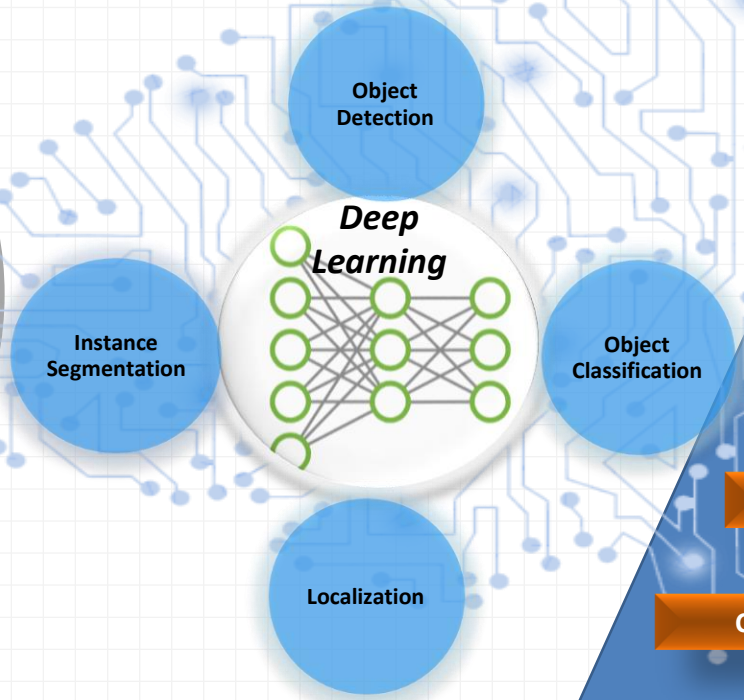


Night in snowing condition

- Deep learning Framework
- Object Detection and classification at day and Night Time
- Distance Estimation
- TTC Estimation
- Warning

Machine Learning & Deep Learning Frameworks





Our Services

- Surveillance & Security
- Autonomous Navigation
- Medical & Life science
- Consumer Electronics

Tools & Libraries used

L&T Testing and Validation Tools

ASTF – ADAS Automated System Test Frame work

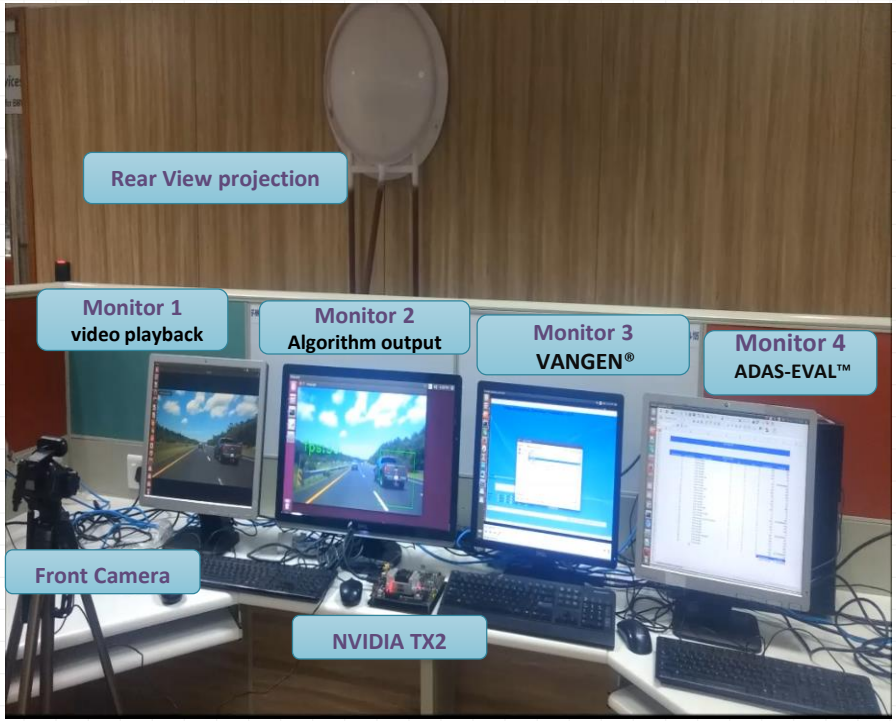
Automated Frame work

Monitor 1
Recorded video playing on the screen

Monitor 2
Algorithm output form NVIDIA TX2

Monitor 3
Automated Data labelling from VANGEN®

Monitor 4
Automated Report Generation from ADAS-EVAL™



Highlights

- Rear view projection – Distortion correction for larger FOV camera (+180)
- Front camera – capture and streams the video to NVIDIA TX2 board
- Monitor 1 - Recorded video displayed on the screen.
- Monitor 2 - Object detection algorithm output form NVIDIA TX2
- Monitor 3- Automated data labelling Generation from VANGEN®
- Monitor 4 –Automated report Generation from ADAS-EVAL™

LTTS VANGEN™ v2.0

Data Annotation and Labelling activity

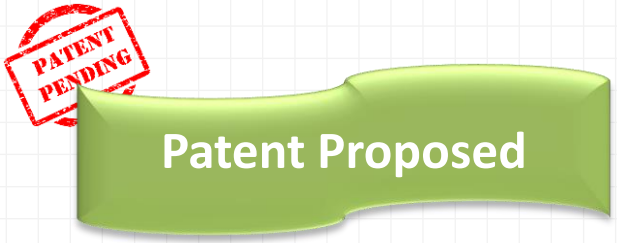
- VANGEN is Video Annotation Generator tool meant for ground truth generation that supports continuous annotation, re/de-annotation

Differentiators:

- Semi-automated with statistical view of objects and distance estimation
- Data annotation for LIDAR and mapping with vehicle dynamics
- Parallel execution for performance improvement

L&T TS Intellectual Property

- VANGEN – ADAS ground truth application
- ADAS-EVAL - ADAS Algorithm Performance Evaluation



- Projection based distortion correction
- Environmental – Image generator for ADAS validation
- Deep learning for Unconstrained Self Driving Car
- Safety Alert of ADAS by Integrating Android and Linux
- Testing Simulator for Vision Based ADAS

Forward Collision Warning with AEB

The Challenge

- To detect pedestrians in a video and apply a adaptive brake

Solution Highlights

- Captured video frames, which are processed through pedestrian detection algorithms to extract the features of each frame
- Detected objects information has been send to the ECU and controls the speed of the vehicle and apply the brake.
- Based on the object distance the vehicle will automatically applies the brake.

Business Value Delivered

- Building the Autonomous Vehicle using ADAS Features.

THANK YOU

L&T Technology Services