Autonomous Drive
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.

We come from a lineage of innovation & growth

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

Revenues $B

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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

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OVERVIEW OF L&T TECHNOLOGY SERVICES

Global Leader: #1 Indian Pure Play Engineering Services Company

- 224+ Global Clients
- 288 Patents
- 38 Labs
- 28 Sales Offices
- 6 India Delivery Centres
- 6 Onshore Delivery Centres
- 90% Repeat Business
- 11,532 Employees
- Of Global 100 R&D Spenders as Clients
- 48

Industry Verticals

- Transportation
- Medical Devices
- Telecom, Consumer Electronics, Semiconductors, Media & Entertainment
- Industrial Products
- Process Industry

Of Global 100 R&D Spenders as Clients

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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**

**Powertrain & Alternate Propulsion Systems**
- BMS, Converters/Inverters, Transmission Systems, Engine Management

**Body Electronics & Comfort Systems**
- Body Control Module, Occupant Detection Systems, Seat Controls, RKE/PKE, Comfort System, Lighting

**Body Engineering & Safety Restraints**
- Interiors, Exteriors, Chassis & Suspension, Lighting, Sunroof, Airbags, Seatbelts, Brakes

**Connected Cars**
- V2X, Telematics, Remote Monitoring, Gateways, Cyber Security, OTA

2250+ Engineers & Specialists
50+ Global Customers
6 State of the Art Labs
17+ Years of Experience

Our Clientele

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

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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

L&T TS Proprietary Tools
- VANGEN® Tool for Data Labelling
- ADAS-EVAL™ Tool for Performance Report Generation
- MaLT Tool for Machine Learning Algorithm

4 Tier-1’s on Image Processing
20+ Engineers in ADAS

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Overview

- 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 coordinates.
- 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

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

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 / SIMULINK
- PoC Development
- Validation & Refinement
- Concept finalization & generation
- Integration & Porting
- Optimization
- System V & V

Deep Learning

Components
- Software
- Toolbox
- Sensors & Systems

MATLAB toolboxes supported in quickly develop LIDAR obstacle detection.

Deep learning algorithms transfer learning.

Simulation and control development.

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
Right Head light status: ON, ON, OFF
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
✓ 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.
✓ 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.
Test case outputs

- **Target Detection Flag**
- **Brake Force Calculation**
- **Vehicle Speed**
- **g Force**
- **Distance After Brake**
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
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

- Artificial Intelligence
- Machine Learning
- Deep Learning

Deep Learning
- Object Detection
- Instance Segmentation
- Object Classification
- Localization
- Instance Segmentation

Tools & Libraries used
- OpenCV
- Caffe
- TensorFlow
- NVIDIA
- cuDNN

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

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ASTF – ADAS Automated System Test Frame work

**Automated Frame work**

Monitor 1
- Recorded video playing on the screen

Monitor 2
- Algorithm output from 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™
**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

L&T TS Tools

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

Patent Proposed

- 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

Highly efficient & cost effective ADAS solution for AEB and ACC using monocular camera & FPGA

AEB and ACC using Monocular Cam

WHITE PAPER

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Forward Collision Warning with AEB

The Challenge

- To detect pedestrians in a video and apply an 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 sent to the ECU and controls the speed of the vehicle and applies the brake.
- Based on the object distance the vehicle will automatically apply the brake.

Business Value Delivered

- Building the Autonomous Vehicle using ADAS Features.
THANK YOU