Virtual Validation of Warning-Based ADAS Features

75 YEARS
KOI MANZIL DOOR NAHIN

ASHOK LEYLAND
Koi Manzil Door Nahin
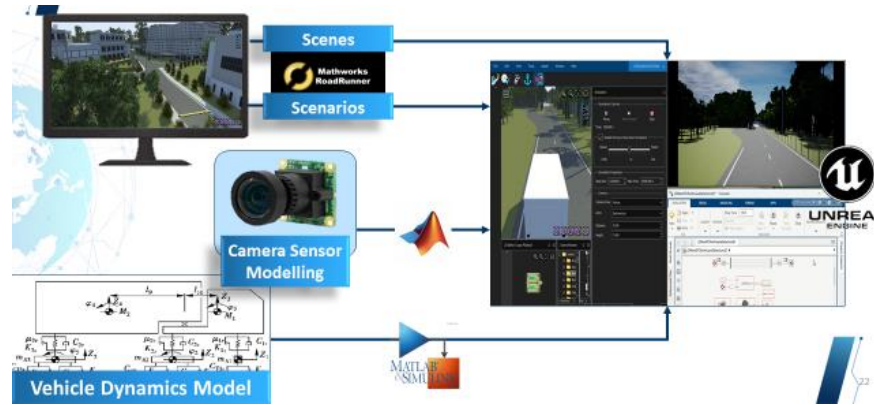
Gururaaj P
ADAS Simulation Engineer
Ashok Leyland

Divya T
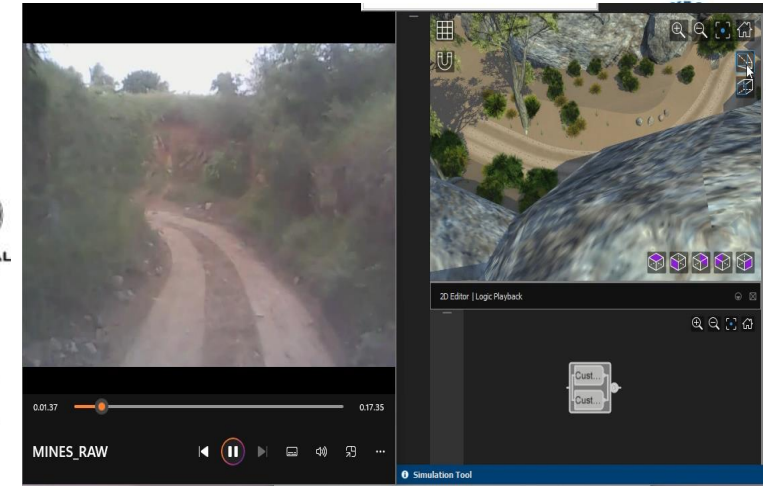Software Developer
Ashok Leyland

Agenda

- **Software-Defined-Vehicle**
- **Levels of ADAS features**
- **Software development process**
- **ADAS Simulation & Validation**
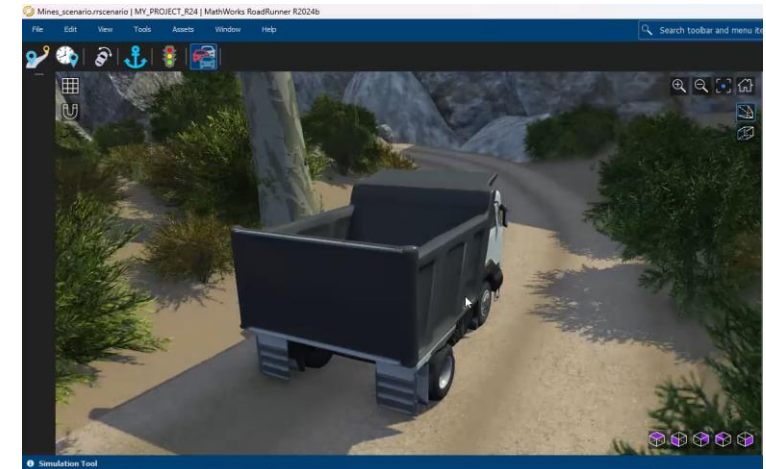- **Software in loop testing**
- **Co-simulation platforms**

Co-Simulation

Real World Comparison

Realistic 3D Assets for Perception Validation

Custom 3D Scenes

Software-Defined-vehicle

DATA Integration

Optimization

Safety

Enhanced Connectivity

Continuous Improvement

Key Benefits:

1. **Enhanced Safety by react faster in critical situations**
2. **Enhanced performance and efficiency of optimized vehicle dynamics**
3. **Personalized driving experience and Predictive maintenance.**

ADAS

Advanced Driver Assistance System

| Regulations by 2028 | Indian Environment Adaptation | Critical Scenarios | Safety Features |

ADAS Levels

Full Automation — **Driverless** — **Level 5**

Conditional Automation — **Vehicle can operate under limited conditions** — **Level 4**

Partial Automation — **Driver does not need to observe but must be ready to resume** — **Level 3**

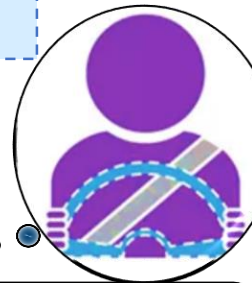**Driver Assistance** — **Driver must observe the drive and be ready to take control** — **Level 2**

No Automation — **The driver always controls all driving functions** — **Level 1**
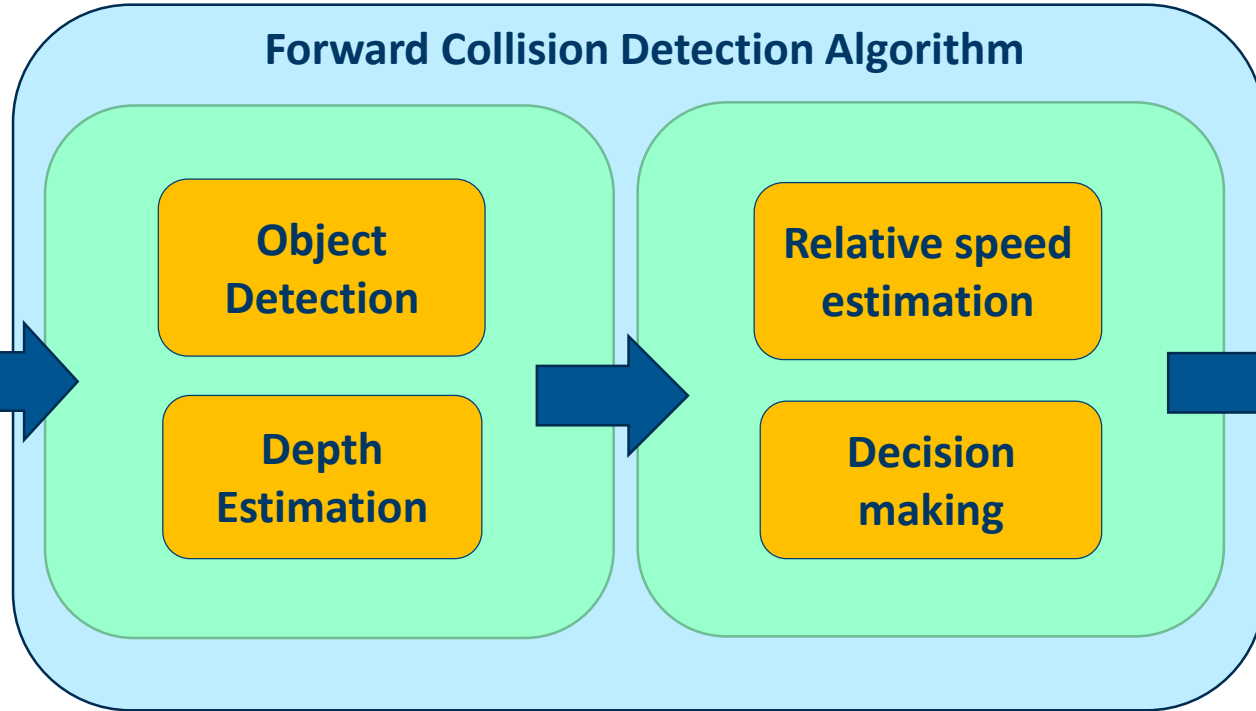
Level 0

Forward collision warning system
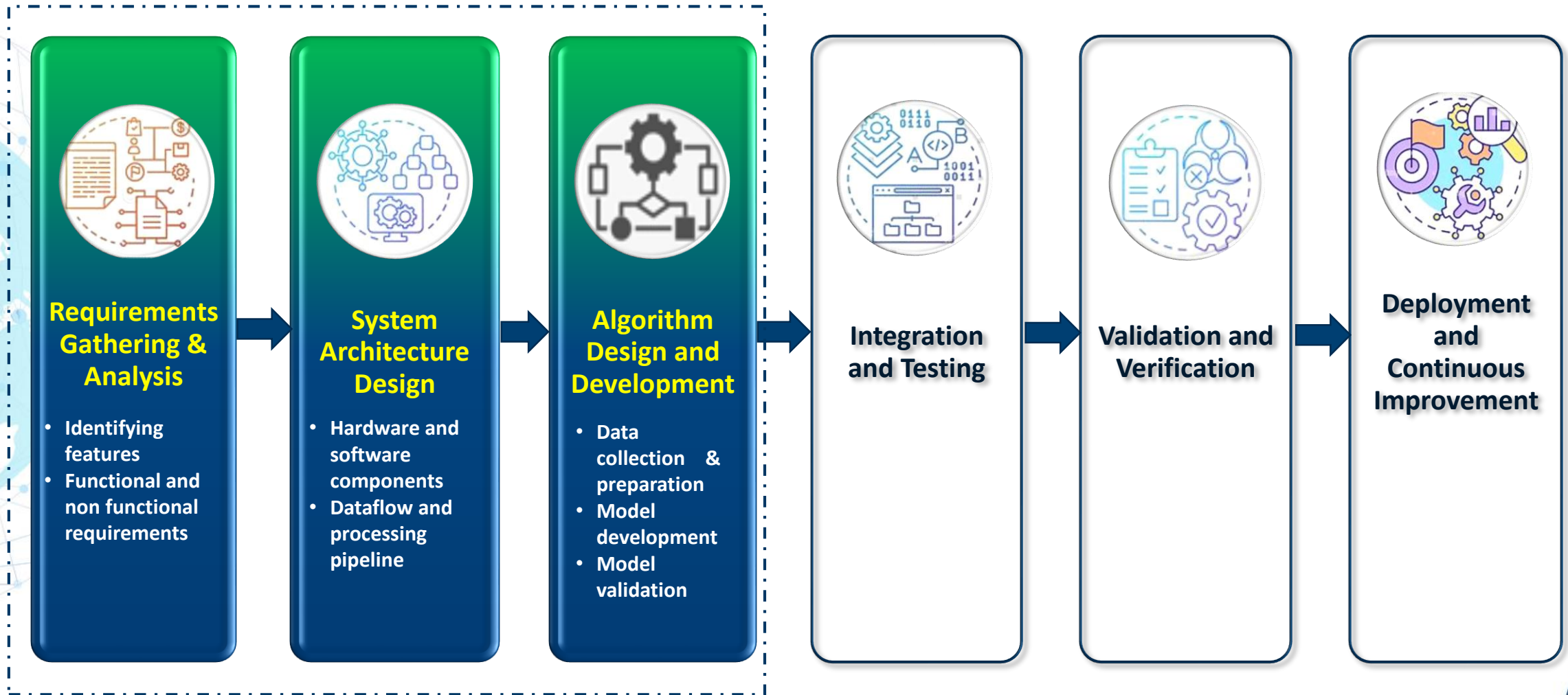

Input image from camera

Forward Collision Detection Algorithm

Object Detection

Depth Estimation

Relative speed estimation

Decision making

Collision Warning

Vehicle speed

Software Development Process

Requirements Gathering & Analysis	System Architecture Design	Algorithm Design and Development	Integration and Testing	Validation and Verification	Deployment and Continuous Improvement
• Identifying features • Functional and non functional requirements	• Hardware and software components • Dataflow and processing pipeline	• Data collection & preparation • Model development • Model validation			

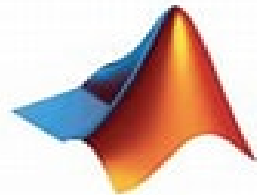# Data collection and Preparation

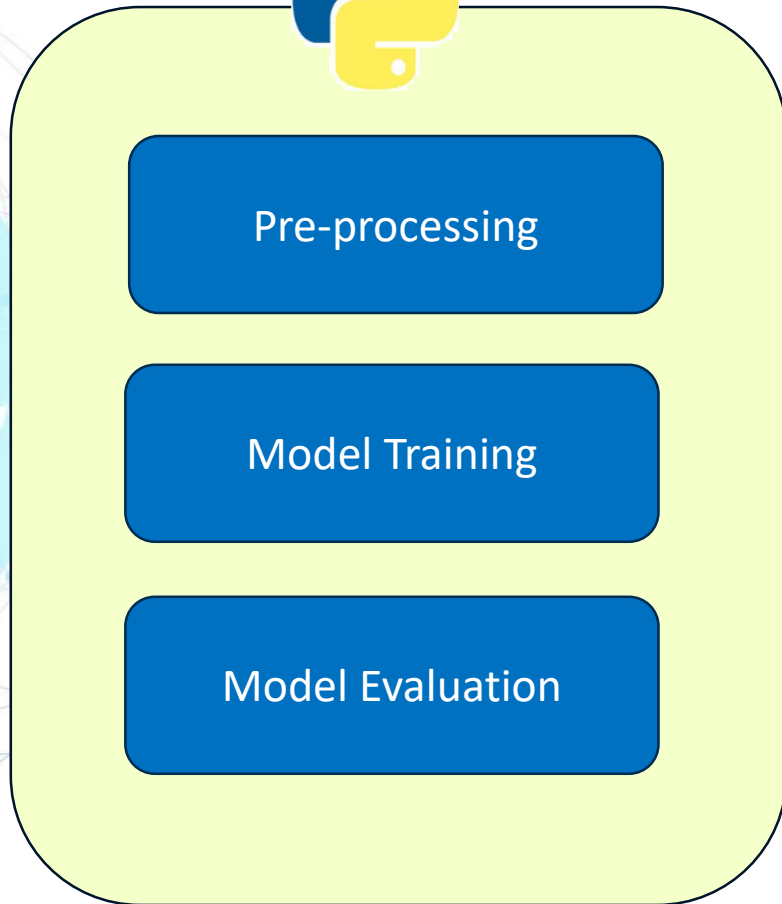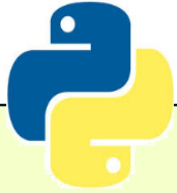**Data collection**
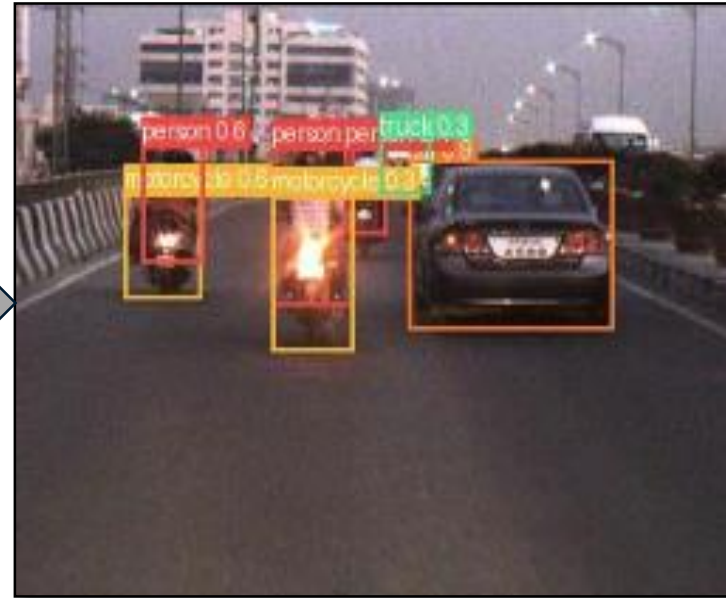
Data annotation

Challenges in Real time data collection:

- High data volume

- Hardware limitations

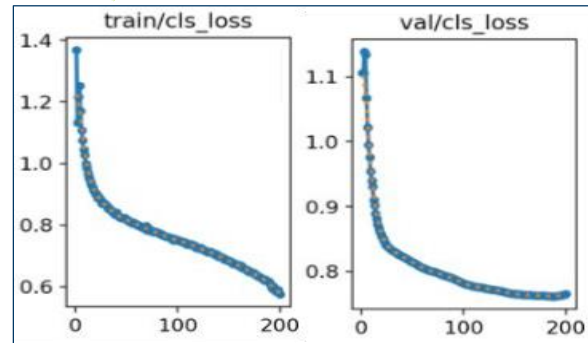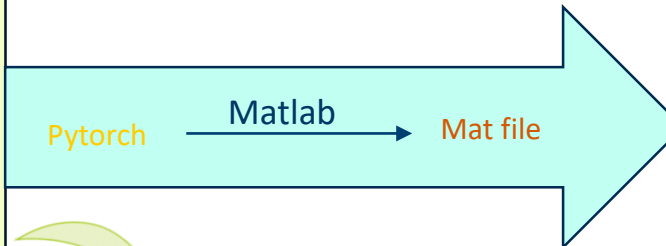- Scenario limitations

- Changing Environments

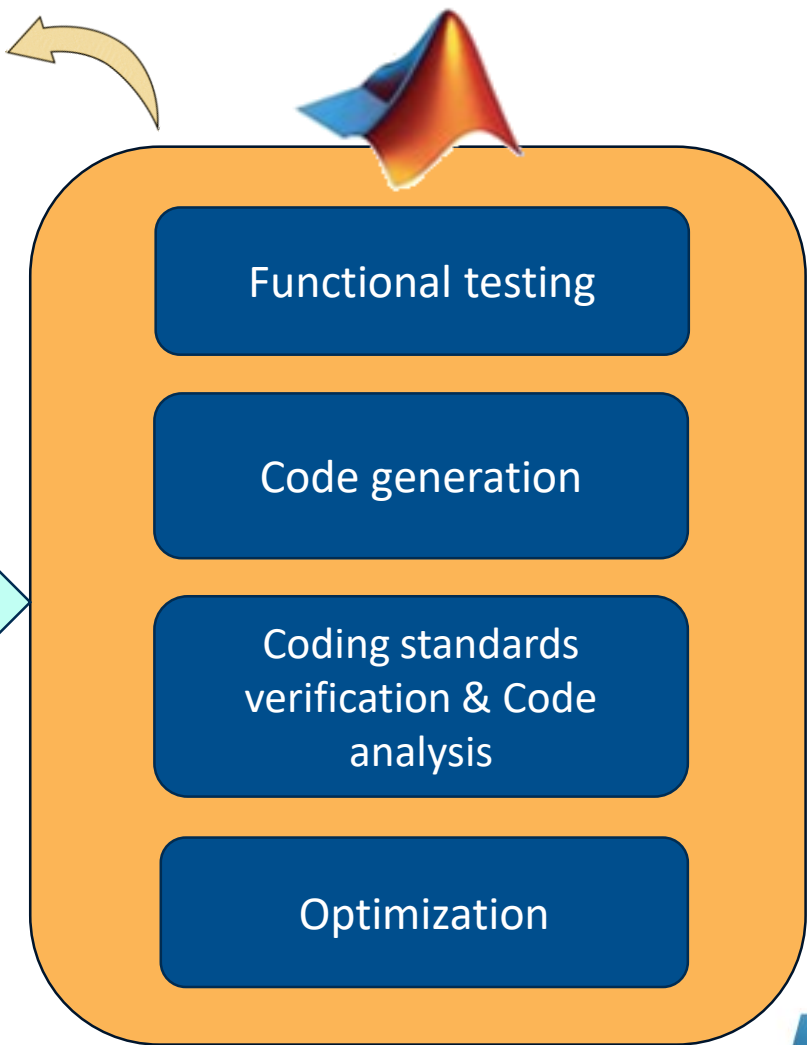- Synthetic data generation
- Automatic annotation

Model Development and Validation

Validation result of object detection and depth estimation models

Pre-processing

Model Training

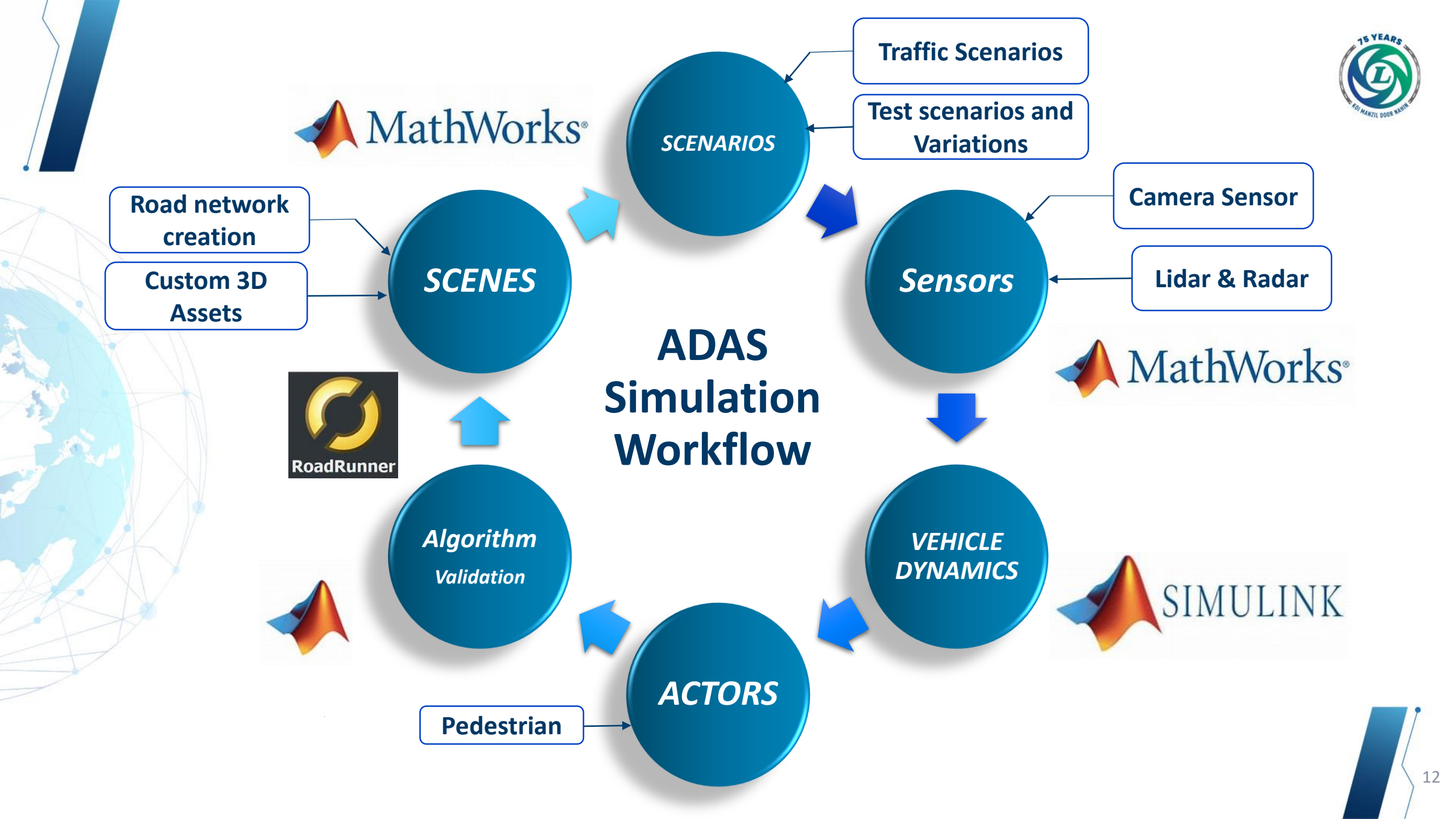Model Evaluation

Pytorch   Matlab   Mat file

Functional testing

Code generation

Coding standards verification & Code analysis

Optimization

train/cls_loss   val/cls_loss

Training process of deep learning model

Software Development Process

Requirements Gathering & Analysis

System Architecture Design

Algorithm Design and Development

Integration and Testing
- Integration
- System level testing

Validation and Verification
- Virtual validation
- Real world testing

Deployment and Continuous Improvement
- Continuous monitoring
- Feature enhancement
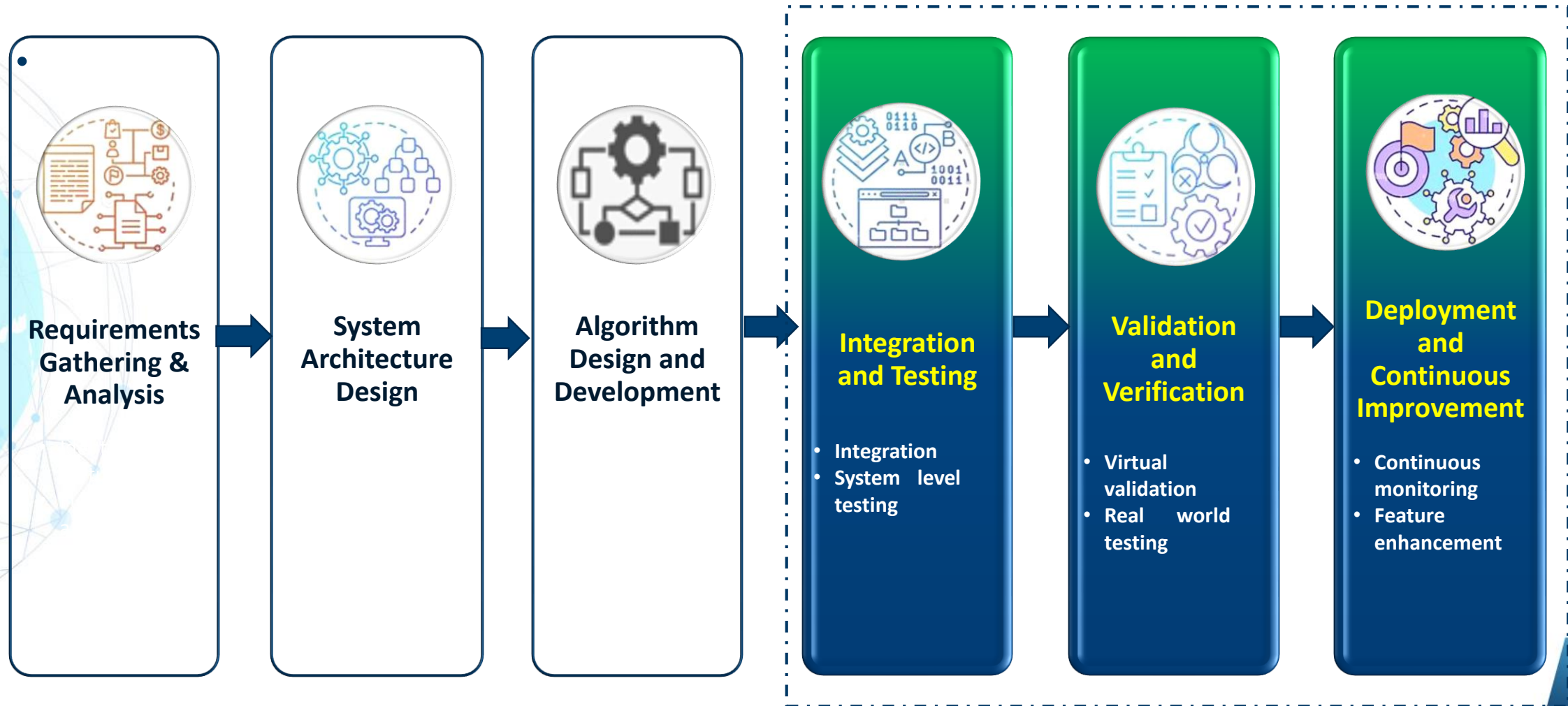
Challenges in Indian Scenarios

- **Unpredictable road conditions**

- **Variable lane widths**

- **Poor road markings**

- **Pedestrian**

- **Non- motorized vehicles**

- **Erratic Driving behavior**

- **Chaotic traffic conditions**

ADAS Simulation Workflow

- SCENARIOS
  - Traffic Scenarios
  - Test scenarios and Variations
- Sensors
  - Camera Sensor
  - Lidar & Radar
- VEHICLE DYNAMICS
- ACTORS
  - Pedestrian
- Algorithm Validation
- SCENES
  - Road network creation
  - Custom 3D Assets

MathWorks

MathWorks

SIMULINK

RoadRunner

Scene creation

Customized Environment creation for Indian roads

Ease to create complicated road networks
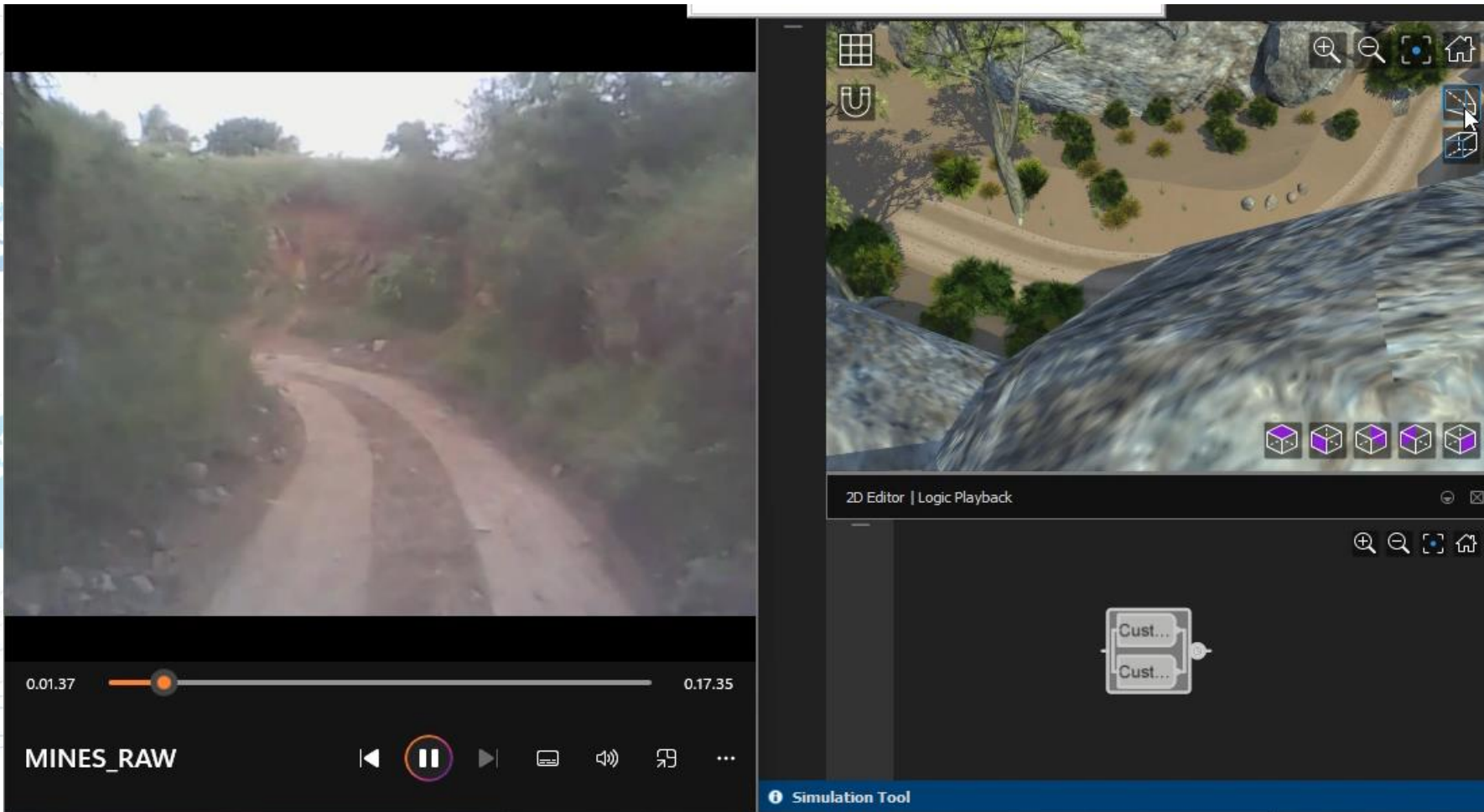
Traffic sign boards

Climatic Conditions

Ashok Leyland Technical Centre Infrastructure

Mathworks
RoadRunner

Environment creation

Scene creation using Roadrunner

Highway Environment
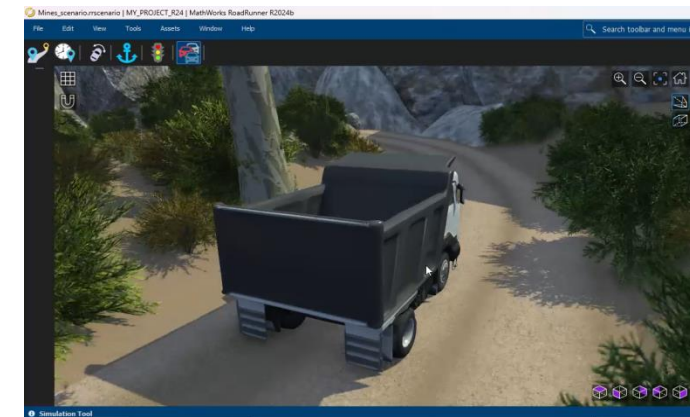
Mines muddy Road

Gen-AI 3D Assets

Image to 3d Asset Generation

Image Input

↓

Processed using Matlab and python

↓

Output as Obj

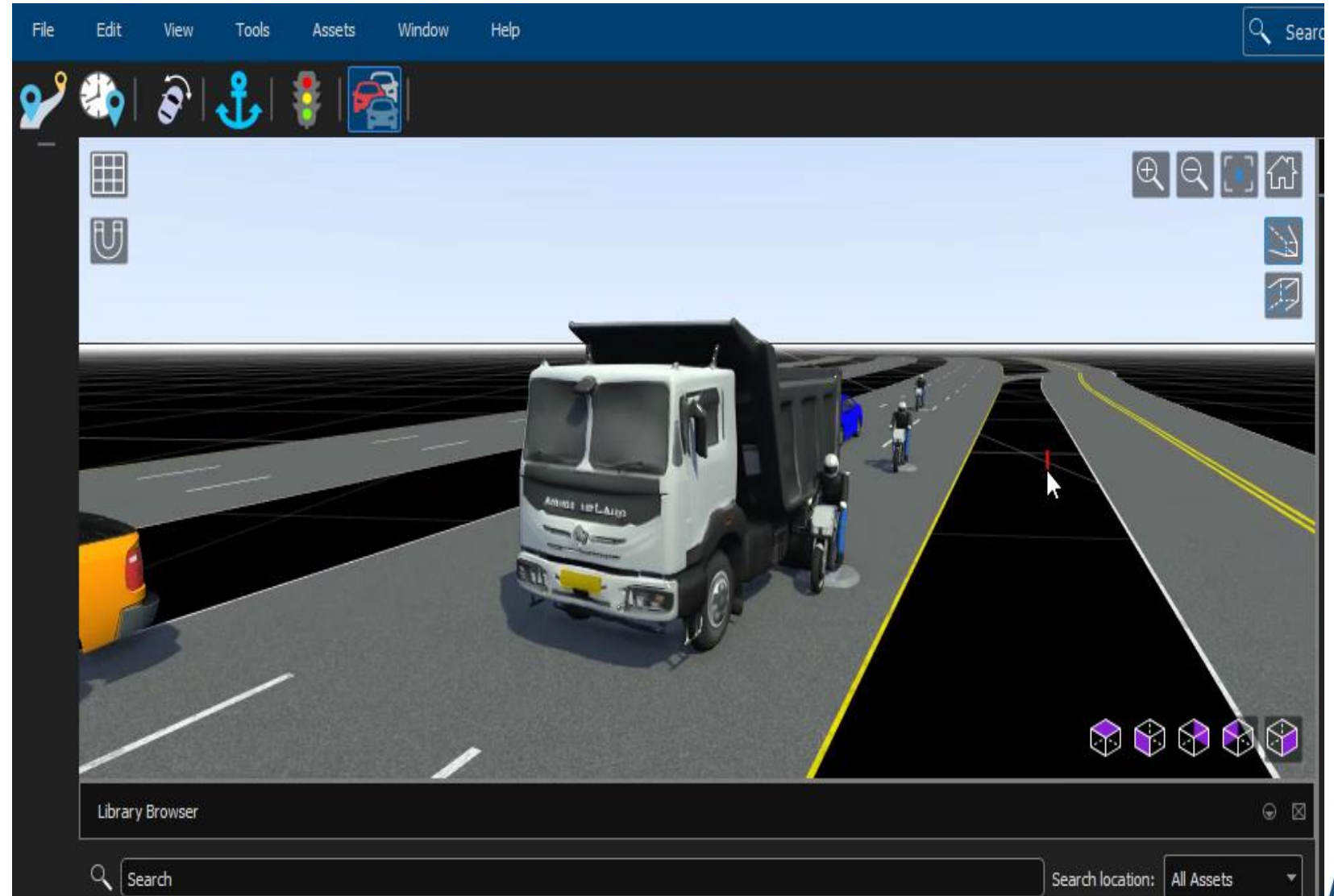Exported .Fbx file can be used in Roadrunner for customized Assets and scenarios.

Scenario creation

Scenarios with Custom Assets

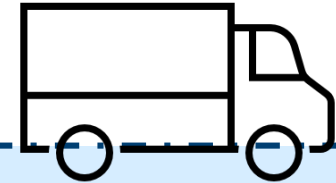**Indian Scenarios**

Euro NCAP Test Scenarios

Test Automation
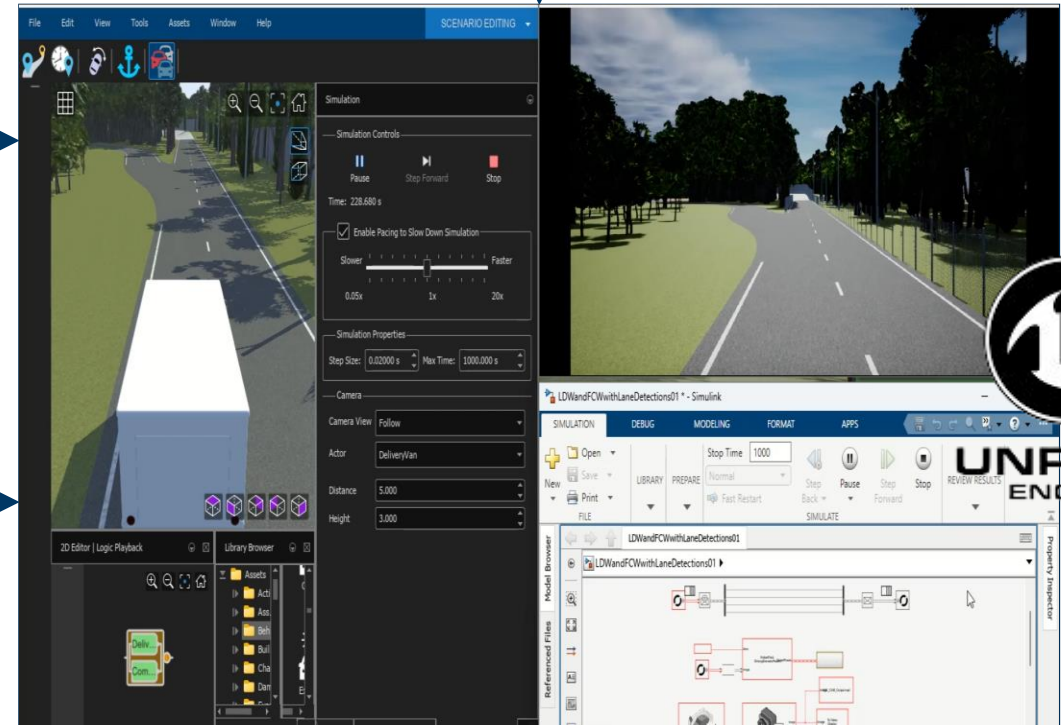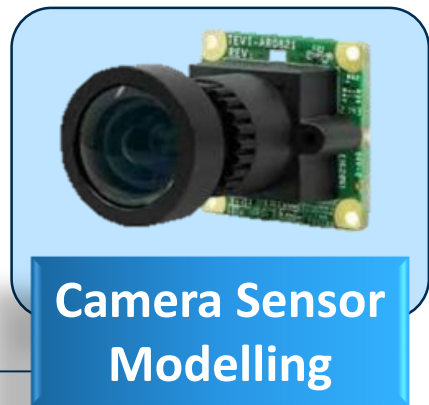
Vehicle Dynamics Modelling

- ✓ **High Fidelity dynamics**
- ✓ **Customized vehicle**
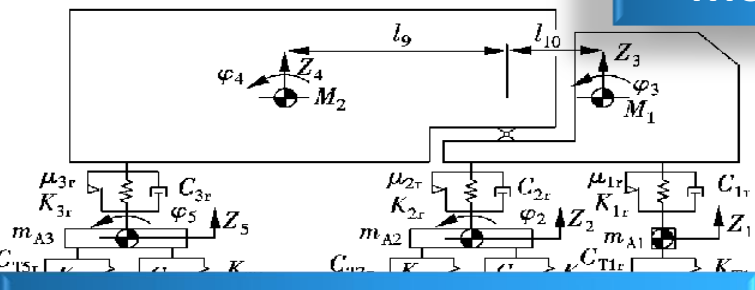- ✓ **Test Various Models**
- ✓ **Data Retrieving**
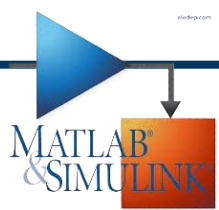
Software in the Loop Testing

ADAS Simulation

Scenes

Scenarios

Sensors and Vehicle Dynamics

Co-simulation software

To Validate the ADAS Algorithm

Forward Collision warning

✓ **Realistic 3D Simulation**

✓ **Faster Development Cycle.**

Validating Algorithm

- Validating Camera Output
- Validating ADAS Features and Warnings

Co-simulation Workflow

Scenes

Scenarios

Camera Sensor Modelling

Vehicle Dynamics Model

Co-simulation with Unreal Engine

Key Simulation Output:

✓ **Validating ADAS Algorithm with various test cases and scenarios**

✓ **Test Automation of Scenarios**

✓ **To ensure the safety and robust of the ADAS features**

FCW Validation Workflow
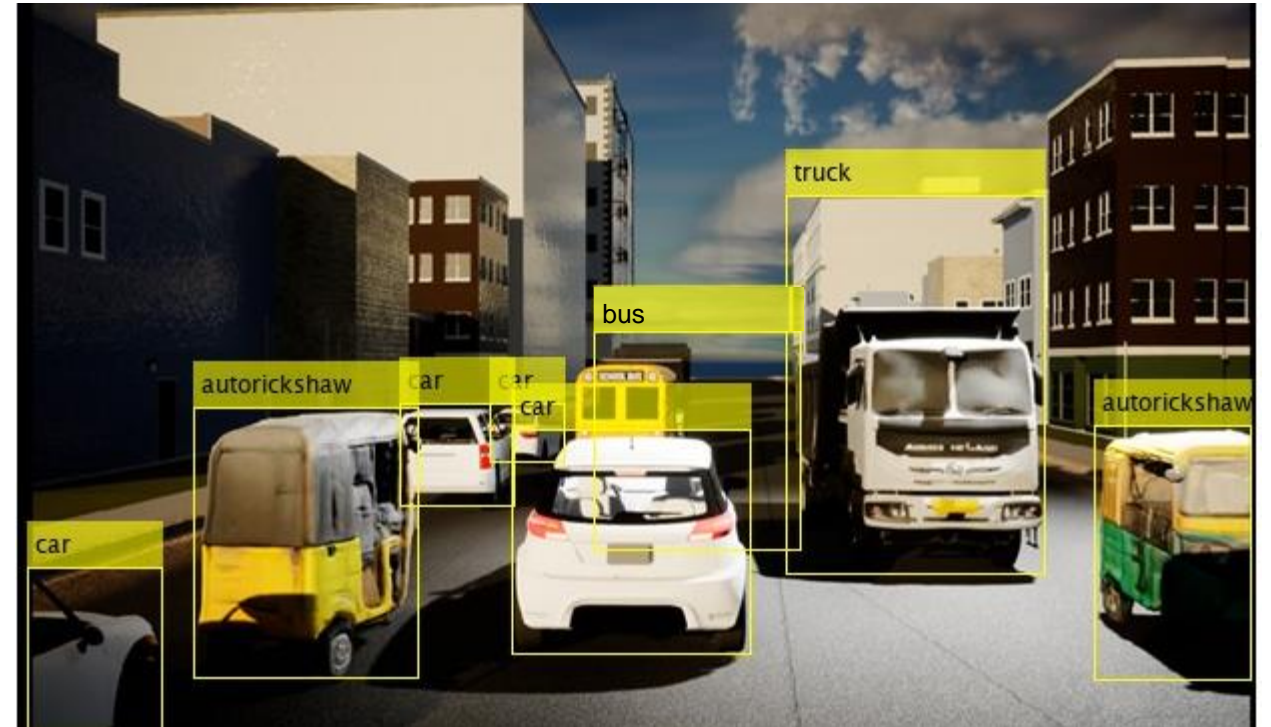
Realistic 3D Assets for Perception Validation

Image

Video from Unreal Engine

Simulink Environment

3D Asset Generation Pipeline using Matlab

3D Asset

Test Image → **Perception Model** → **Object Detection Result**
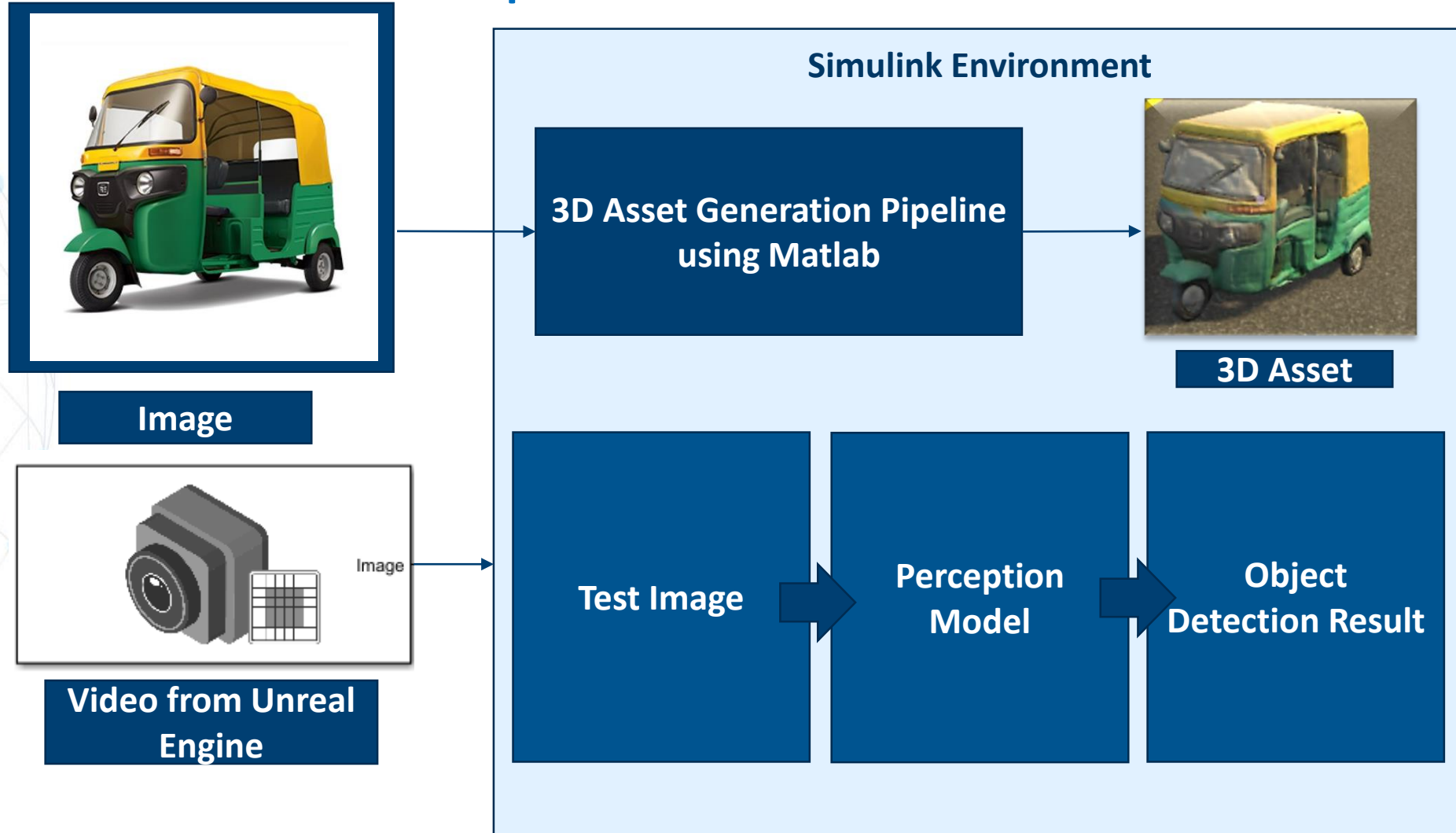
Object Detection

With realistic 3D Assets

Real World Environment

Virtual Simulation Environment

FCW validation

Forward collision warning Test Bench
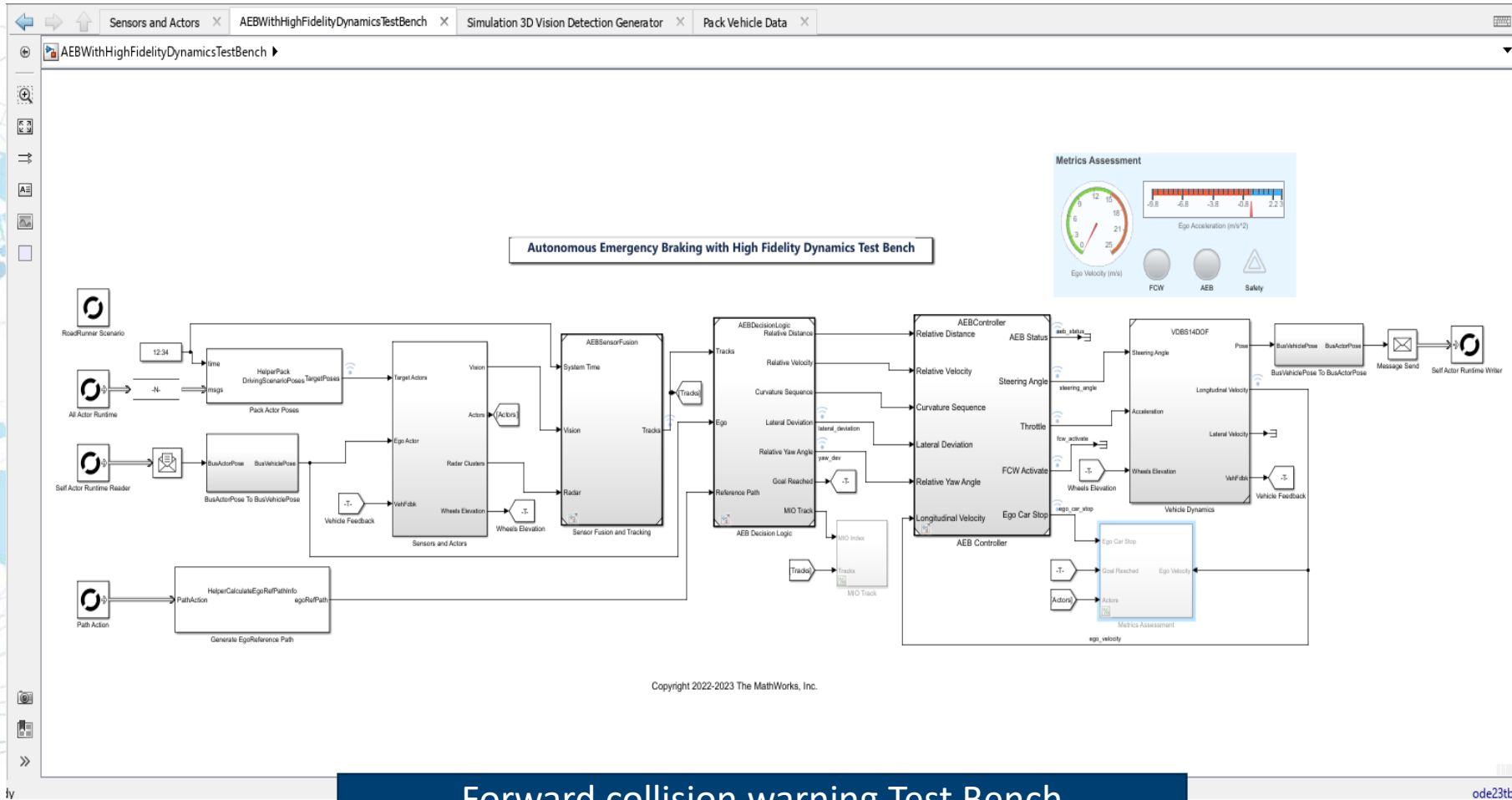
Validation Result:

✓ Depth Estimation

✓ FCW warning System

Benefits

| | Time Reduction | Train critical scenarios | Cost Reduction |

Thank you

Koi Manzil Door Nahin!