CYIENT

HD MAPS FOR OBJECT DETECTION IN AUTONOMOUS DRIVING

Cyient's 3D LiDAR Technology Enables HD Maps for Autonomous Vehicles

CONTENTS

ABSTRACT

The automotive industry is undergoing a transformation driven by disruptive technologies propelling the rapid advancement of autonomous vehicles and advanced driver assistance systems (ADAS). Data annotation and object detection are at the heart of this evolution, crucial for enabling self-driving capabilities in ADAS. Pioneering technologies like vehicle-to-everything (V2X) communication, environmental mapping and localization, and high-definition maps are fundamental. They empower vehicles to seamlessly interact with their surroundings, generate precise, detailed maps, and accurately determine their position and orientation, setting the stage for a new era of intelligent, connected driving.

Cyient offers comprehensive solutions that empower autonomous vehicles with end-to-end automating object detection with high-definition (HD) maps, improving blind spot awareness, and leveraging deep learning for point cloud (LiDAR) analysis.

INTRODUCTION

Advanced assistance systems or ADAS is the driving force in autonomous vehicle development, tasked with the safety of drivers/passengers, pedestrians, and other vehicles plying on the road. ADAS comprises a set of technology features installed in vehicles to assist drivers, which are critical for autonomous vehicles. Navigating traffic, as well as avoiding obstructions requires accurate real-time mapping of the surroundings while the vehicle is in motion. The technology applies real-world computer vision (CV) concepts to identify objects in the ADAS input system onboard the autonomous vehicle. Input data can be images from an optical camera (360-degree image) or point cloud data from a LiDAR sensor.

Data annotation, or the accurate labeling and classification of the input data, is a key step in integrating spatial intelligence with the ADAS.

Over the last 30 years, Cyient has built a strong reputation for geospatial and engineering services and solutions. Cyient has rich experience in data annotation and creating HD maps and roadside infrastructure for autonomous vehicles with precise road and position information in real time. Cyient's solutions empower autonomous vehicles by automating object detection, improving blind spot awareness, and leveraging deep learning for point cloud (LiDAR) analysis.

3. DATA ANNOTATION FOR AUTONOMOUS VEHICLES

Data annotation is the process of tagging or classifying objects captured in a frame, and it is foremost among the critical steps involved in integrating spatial data with the ADAS system.

Data annotation labels and categorizes data, such as images or video, to train machine learning algorithms. The higher the quality of annotated datasets, the better the machine-learning models are likely to perform.

Data annotation/image and video annotation is essential to autonomous driving. The autonomous car must be able to localize in an environment as the vehicle is in motion. Also, it needs to identify and keep track of moving and stationary objects to ensure safe navigation of self-driving vehicles. Autonomous cars require neural networks to train and learn through data input (supervised learning).

The images/LiDAR data are used as an initial step to train, validate, and test the computer vision algorithms.

Image and video annotation serve as a keystone in computer vision applications. The annotation scope for autonomous driving covers several types of labels, including 2D/3D bounding boxes, sensor fusion annotation, polygons, polylines, lane changes, and semantic segmentation.

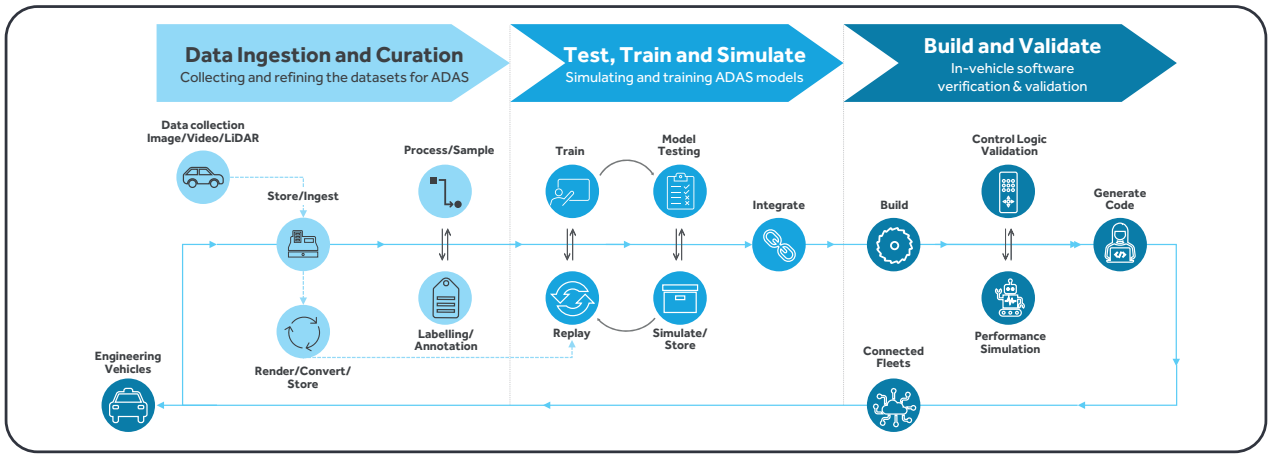
ADAS typically uses LiDAR and several cameras installed on the vehicle to collect perception data. These data streams are analyzed, and the collected visual data is localized to locate objects such as lanes, vehicles, and pedestrians with respect to the vehicle's position in the dynamic local environment.

i) Objective of labeling features

Computer vision allows AI models to draw meaningful data from images and videos and take necessary action using that information. Machine learning models are trained to recognize patterns and capture this information in their artificial storage to interpret real-time visual data effectively.

The model below explains the high-level modules and steps of Cyient's end-to-end computer vision program.

Cyient undertakes end-to-end activities such as data ingestion and curation, testing, training, and building models/algorithms to enable the training of datasets for ADAS.



By integrating LiDAR data with other sensors such as RADAR, Deep Learning can create more robust perception systems. For instance, autonomous driving systems can leverage LiDAR's high resolution to generate 3D maps, while RADAR can offer safety redundancy to ensure the proper functioning of LiDAR systems. Deep Learning can assist autonomous systems in benefiting from the strengths of each sensor while minimizing their constraints.

Cyient Solutions that Power the Future of the Automotive Industry:

Cyient brings the latest technologies to automotive OEMs and Tier-1s, creating a robust ecosystem (5G, CyberSecurity, IOT, Analytics, Cloud etc.) that powers autonomous and connected cars.

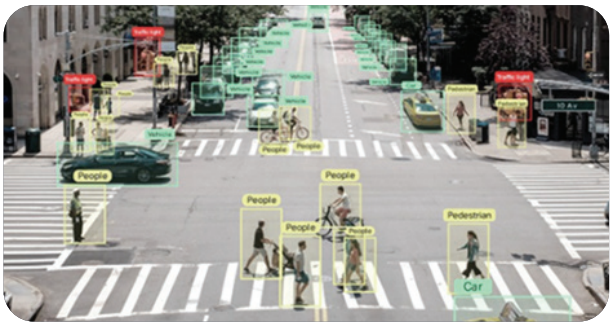
ii) Types of annotation data required for autonomous vehicles

Of the several types of data annotations, such as image, audio, video, and text, mostly image and video annotations are used for autonomous vehicles.

The input data is categorized into the following types:

Image data:

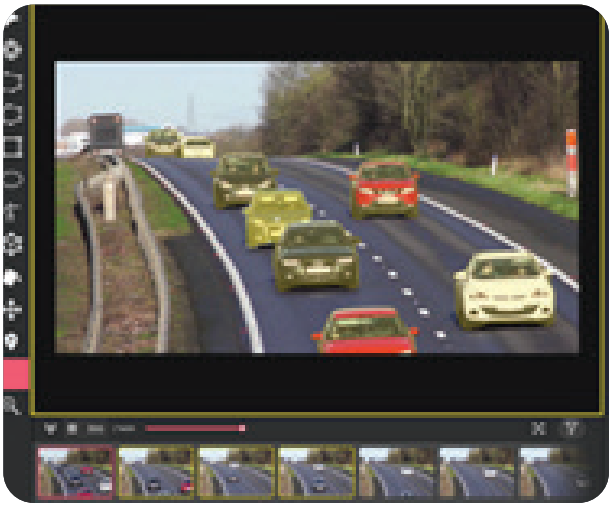
2D bounding box annotation (see Types of Data Labeling) is used as it can easily outline and capture the object of interest. These images are analyzed and annotated to identify objects. For example, cars, pedestrians, animals, traffic signs, traffic lights, etc.

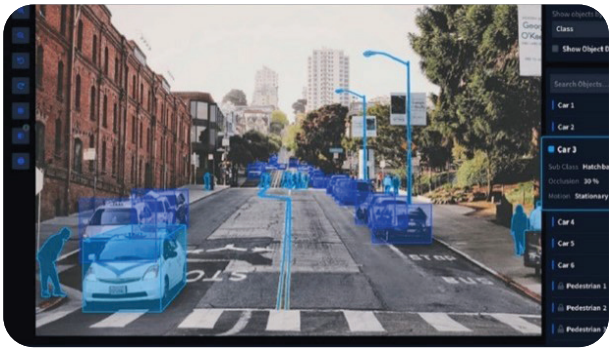


Video data:

Video annotation involves breaking the video into individual frames and classifying these frames using various methods. In this, the object of interest will be in motion. Note that even a short video of 30 seconds can have many images that need to be annotated.

The temporal data is crucial for understanding object movements and predicting their future behavior. This enables the model to understand the dynamics and movements in the video sequence accurately. For example, identifying vehicle number plates, toll collection, fining, congestion management, etc.

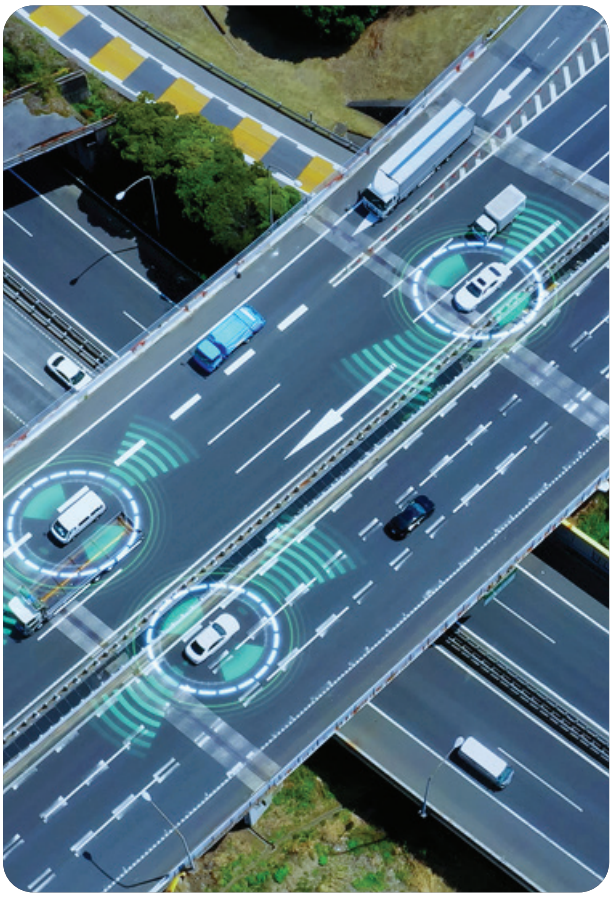


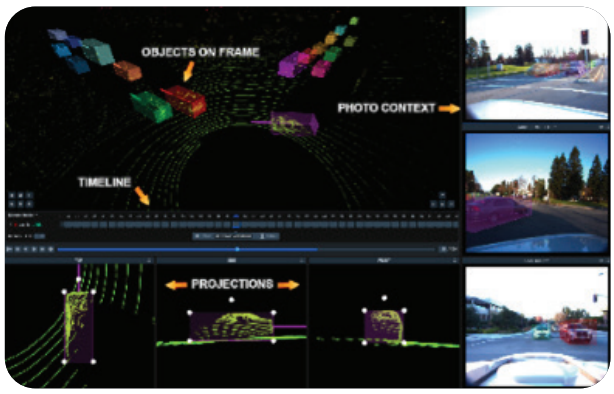


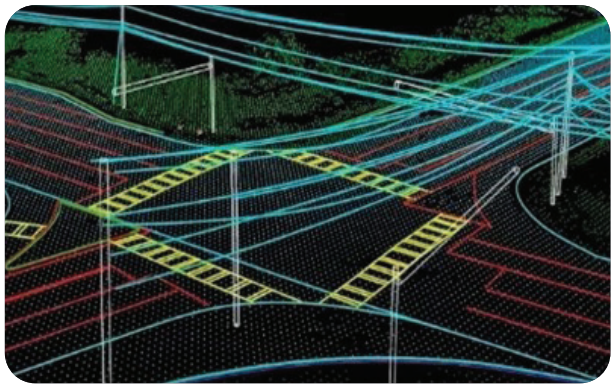
3D LiDAR data (point cloud):

LiDAR is a remote sensing method that uses light to generate precise 3D representations of the surroundings. LiDAR data is an essential sensor for geospatial technology, autonomous technology, and other industry applications.

LiDAR data is stored as point clouds in raw format. Cuboid-annotated objects help depict the length, width, and approximate depth of target objects, such as road edges, signage, pedestrian crossings, traffic lights/signs, barriers, etc. LiDAR data allows the creation of HD maps, which are very precise for displaying location data.







iii) Types of data labeling

The most relevant types of data labeling used for computer vision are:

- Bounding box: The most used and simplest of data labels, bounding boxes are rectangular boxes that identify the position of an object in an image or video. This box defines the object's X and Y coordinates.
- Cuboids: Cuboids are three-dimensional labels that identify an object's width, height, and depth, as well as its location. The tool extracts a cuboid over the object of interest, such as a building, car, or household object, which defines the object's X, Y, and Z coordinates.

iv) Data annotation types:

The types of data annotations used for autonomous vehicles are:

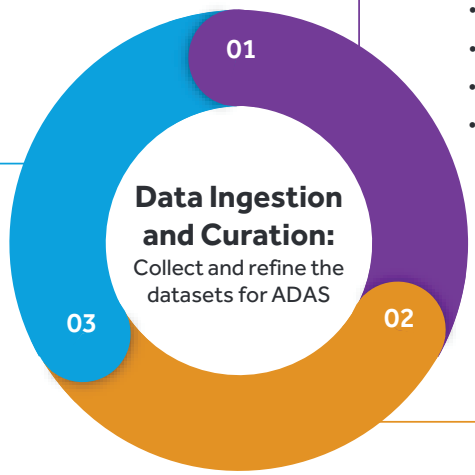
2D Bounding Box Annotation	Identifies the position and location of the target object. of an object in an image. This box defines the object's X and Y co-ordinates.
Semantic Segmentation	Objects shown in an image are grouped based on defined categories. It involves classifying each pixel in an image with a corresponding class.
3D Cuboid Image Annotation	A 3-D bounding box is also called a cuboid. Draws a cube over an object/ 2D images to obtain 3D perspectives on height, width, and depth.
Polygon Annotation	Annotating an object's exact edges, regardless of shape. Utilizes multiple vertices and x and y coordinates for making polygonal-shaped objects.
Polyline Annotation	Draw lines in the image by Defining the directions, divergences, and sidewalks for making roads and streets etc., for road recognition.
Instance Segmentation	Detects the instances of each category. It distinguishes between different instances of the same class.
3D Point Cloud Annotation (LiDAR)	Annotating the point clouds to support LiDAR data using the 3D cuboids. Identify and track objects over a collection of frames.

4. CYIENT'S ANNOTATION SERVICES AND TOOLS

Cyient offers LiDAR data acquisition, mapping, processing, and feature extraction services with proven methodologies and deep expertise in working with high-resolution imagery and LiDAR datasets. The scope of detection tools has increased with 3D object detection. In this case, 3D object detection provides details such as location, direction, and size.

Some key components of data annotation for ADAS are:

- Finding objects, marking lanes, estimating depth, planning paths, recognizing traffic signs, predicting behavior, map and localization data, and machine learning feedback loop.
- Labeled data, such as marked objects and road signs, enable autonomous vehicles to recognize their surroundings and choose the best actions for secure driving.



Raw Data Capture and Monitor

- Annotation case logic & Ground truth
- Sequence of Annotation steps
- Datasets contain action sequence
- Data visualisation and analysis

Services

- Cyient Leverages cloud-based infrastructure and digital connectivity
- Training Datasets/Model for ADAS
- Model and algorithm development
- Simulation and validation

Cloud-based Annotation Viewer

- Automatic Annotation
- 2D/3D object detection
- Static and Dynamic object tagging/labeling
- Annotator reviews post auto-annotation

5. ENABLING TECHNOLOGIES FOR ADAS

- **Supplying vehicle-to-vehicle/everything communications connectivity services using 5G V2X:**

  Vehicle-to-everything facilitates communication among vehicles, infrastructure, and pedestrians, offering vital data for informed decision-making. Geolocation technology is pivotal in V2X systems, ensuring precise location exchange and seamless interaction between road entities. It empowers 5G autonomous vehicles (AVs) to share crucial information such as weather updates and road conditions. This enables other vehicles to proactively respond to hazards like debris, floods, and accidents.

- **Environmental mapping and localization:**

  LiDAR's 3D mapping capabilities, fused with camera data, enable the vehicle to create detailed maps of the surroundings. These maps assist in localization, helping the vehicle accurately determine its position and orientation within the mapped environment.

- **High-definition maps for precise vehicle positioning and localization:**

  The HD maps provide an accurate and comprehensive representation of the road network, including the geometry and characteristics of each lane, intersection layouts, and landmark locations. They also provide detailed lane-level information, including lane widths, curvature, and boundaries.

- **Augmented reality (AR) head-up displays (HUD):**

  By combining computer vision with AR HUDs, drivers can access critical information while keeping their eyes on the road, reducing distractions, and enhancing safety. The intuitive presentation of information on the windshield helps drivers make well-informed decisions without the need to glance at secondary displays or devices.

6. CYIENT'S GEOSPATIAL CAPABILITIES

Cyient's expertise spans LiDAR and remote sensing, photogrammetry, 2D/3D development, location-based services, GIS application customization and integration, and technology implementation. At Cyient, we are developing the HD maps that include the collection, analysis, and integration with technologies such as ADAS.

Some of the domain/service areas are:

Earth Observation:
Automated imagery processing solutions and insights

LiDAR:
Create a highly detailed digital twin enabling data acquisition, mapping, processing, and feature extraction

Geospatial Solutions:
Design, build, and integrate geospatial solutions

Open Street Map:
Employ the power of the mapping revolution

Data Acquisition and Processing:
Capture high-resolution spatial data using different platforms

7. CYIENT'S SOLUTIONS FOR THE AUTOMOTIVE INDUSTRY

Cyient brings the latest technologies to automotive OEMs and Tier-1s, creating a robust ecosystem that powers autonomous, connected cars and electric vehicles.

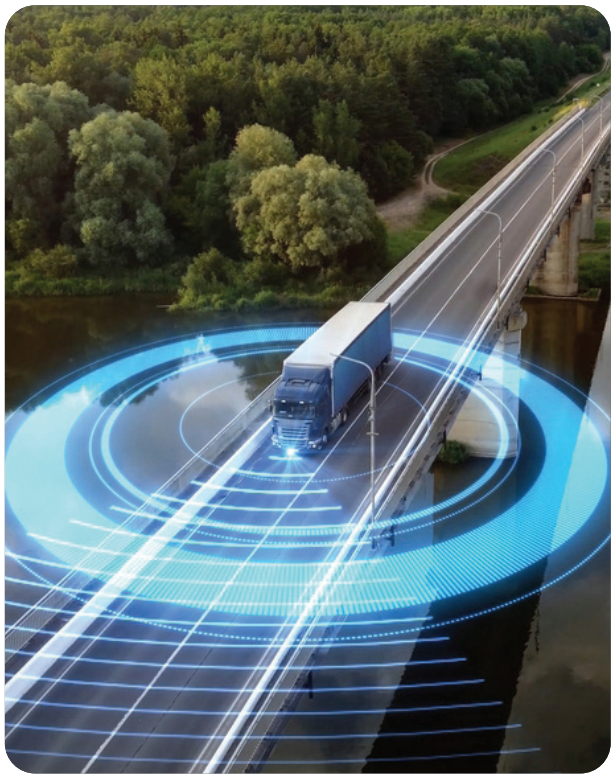
For more information, see: https://www.cyient.com/automotive

8. CONCLUSION

Cyient delivers high-quality data annotation using automation tools that conform to rigorous data security standards, accuracy, and consistency.

Our auto-labeling accelerators creates databases quickly and accurately to identify objects and road conditions. Wherever Human intervention or annotators are required, and a small team of experts can review and adjust a machine's capability as it learns to ensure high data quality .

As machine learning technology evolves, there is an ever-greater need for high-quality data and labels. Autonomous vehicles rely heavily on a diverse range of data to operate effectively and safely. As the industry continues to grow and evolve, keeping pace with the latest advances and technologies in data annotation for self-driving vehicles is critical for safer vehicles and road safety.



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Sushma is a core GIS analyst by qualification. She has 16 years of experience in GIS and remote sensing, as well as AI/ML training data applications. She has worked extensively on navigation maps, network design, process planning, and analysis, and brings diverse experience across several well-known organizations in the GIS world with clients on the Fortune 500 list.

REFER TO THE LINK BELOW TO READ FURTHER

- https://www.cyient.com/geospatial/lidar
- https://www.cyient.com/geospatial/data-acquisition
- https://www.cyient.com/blog/object-detection-and-annotation-tools.
- https://www.cyient.com/geospatial

ABOUT CYIENT

Cyient (Estd: 1991, NSE: CYIENT) partners with over 300 customers, including 40% of the top 100 global innovators of 2023, to deliver intelligent engineering and technology solutions for creating a digital, autonomous, and sustainable future. As a company, Cyient is committed to designing a culturally inclusive, socially responsible, and environmentally sustainable Tomorrow Together with our stakeholders.

For more information, please visit www.cyient.com

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