

## LiDAR Attack Pipeline

This pipeline simulates and analyzes different types of attacks on LiDAR data. It works in two main steps:

1. **LidarOnly.py collects LiDAR Data:** A script in the CARLA simulator captures LiDAR point clouds and saves them as .npy files and .png images. The script collects 300 frames.
2. **FullLidarAttack.py creates 5 different attacks on the LiDAR cloud points:** This script takes the collected data, applies attacks, visualizes the results, and creates a combined video showing all attacks in a 3x2 grid.

### Step 1: Run LidarOnly.py - Collect LiDAR Data in CARLA

- A script runs in the CARLA simulator to capture LiDAR point cloud data.
- The data is saved as:
  - .npy files: These contain the raw 3D point cloud data.
  - .png images: These are 2D visualizations of the LiDAR data.
- **Output:**
  - A folder with .npy files (point clouds) and .png files (images).

### Step 2: Run FullLidarAttack.py - Process and Visualize Attacks

This script processes the collected LiDAR data, applies attacks, and generates videos.

#### What Does This Script Do?

##### 1. Load Data

- Reads the .npy files (LiDAR point clouds) and .png images from the folders.

##### 2. Apply Attacks

The script applies five types of attacks to the LiDAR data:

Attack Type	Attack Description
Spooing	Adds fake points to the LiDAR data, creating false obstacles.
Adversarial Noise	Adds random noise to the points, making it harder to detect real objects.

<b>Occlusion</b>	Removes points beyond a certain distance, simulating blocked or hidden objects.
<b>Misalignment</b>	Shifts the entire point cloud to the side, simulating a sensor calibration error.
<b>Scaling</b>	Shrinks the point cloud, making objects appear smaller than they really are.

### 3. Visualize Results

- For each attack, the script creates a 2D scatter plot of the LiDAR data.
- All points (original and attacked) are plotted in the same color (red) for consistency.
- The visualizations are saved as .png images in separate folders for each attack.

### 4. Generate Videos

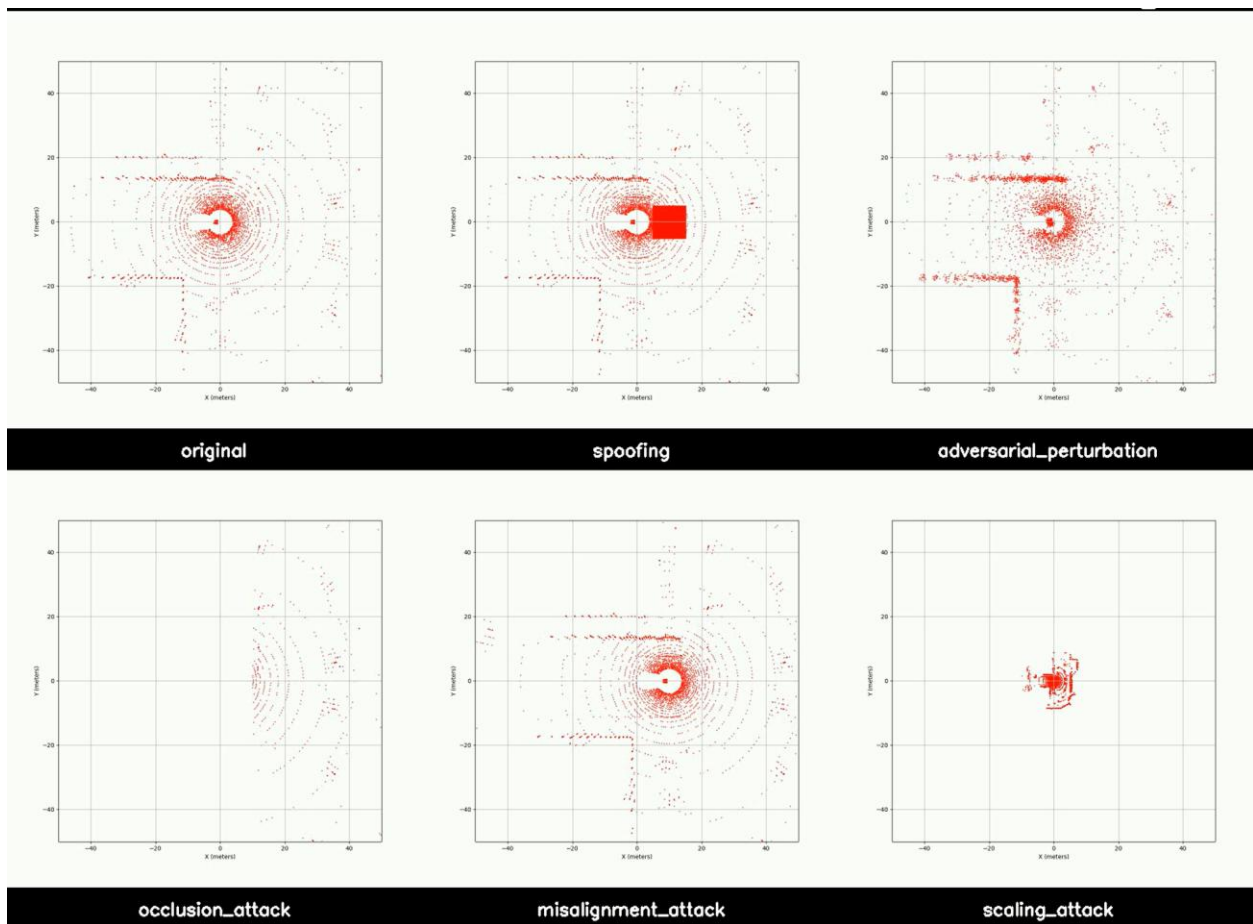
- The function creates a video for each attack and the original data:
  - It takes all the .png images in each folder and combines them into a video.
  - Example: original.mp4, spoofing.mp4, adversarial\_perturbation.mp4, etc.

### 5. Combine Videos into a 3x2 Grid

- The function combines all six videos (original + five attacks) into a single video arranged in a 3x2 grid:

**Top row:** Original    Spoofing    Adversarial Noise

**Bottom row:** Occlusion    Misalignment    Scaling



The combined video is saved as **combined\_attacks.mp4**

### Complete Pipeline Summary:

1. **Data Collection:** Captures real-world-like LiDAR data using CARLA.
2. **Attack Simulation:** Applies realistic attacks to the LiDAR data.
3. **Visualization:** Creates easy-to-understand 2D plots of the attacks.
4. **Video Generation:** Produces videos for each attack and combines them into one grid for comparison.

**Next Step:** Refine the LiDAR attacks further and integrate with Karim's camera-based pipeline.