MiTra: A Drone-Based Trajectory Data for an All-Traffic-State Inclusive Freeway with Ramps

Dataset Overview:

This dataset contains original videos, tracking logs to validate the videos, and extracted trajectory data of naturalistic traffic collected using unmanned aerial vehicles (drones) over a 900 m section of the A50 urban freeway in Milan, Italy. Nine flight campaigns, totaling 135 min, were conducted using six drones flying in a line to capture comprehensive coverage across all traffic states, from free flow to congested conditions.

The dataset offers detailed trajectory data extracted from single drone videos (54 datasets from nine flight campaigns of six drones) and nine datasets of stitched footage from all six drones. With a granularity of 30 frames per second, we extracted 124,641 vehicle trajectories from single drone videos and 24,161 trajectories from stitched footage. This enables complete vehicle tracking across five distinct categories: Cars (73.0%), Medium Vehicles (13.4%), Heavy Vehicles (11.3%), Motorcycles (2.1%), and Buses (0.2%).

Of the total vehicles, 76.9% traveled straight on the freeway, while 13% merged and 10.1% diverged using on-ramps and off-ramps, respectively, in both directions. Regarding lane changes, 51.9% of the vehicles in the dataset executed at least one. Among these, 24.8% performed a single lane change, while 27.1% changed lanes multiple times.

In addition to trajectory data, this dataset includes the original videos and tracking files, which show the recorded traffic scenes, provide visual context, and enhance the usability and interpretability of the trajectory data. The tracking files can be used to map vehicle IDs in the video, enabling various analyses as detailed in the user guide.

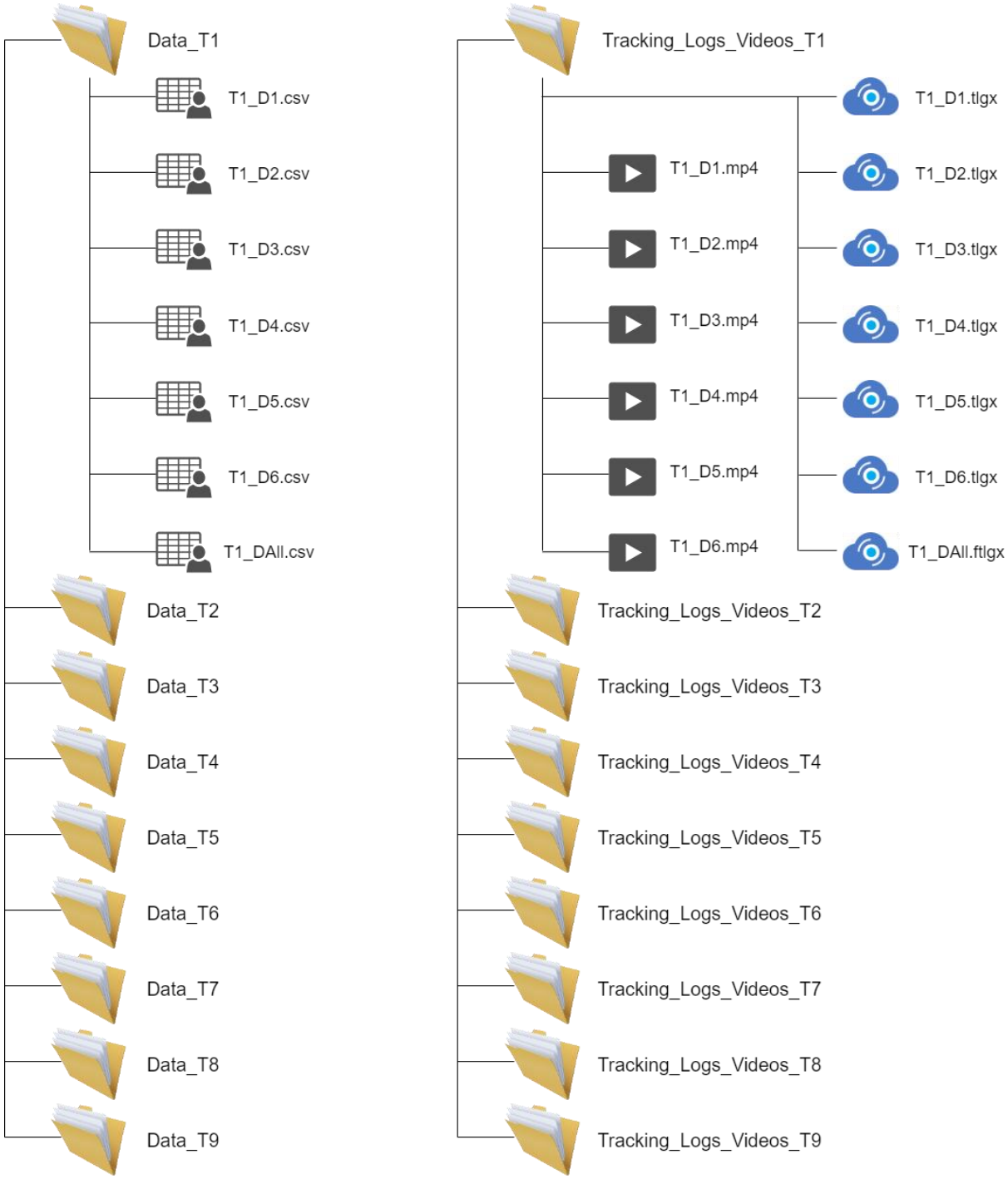
This dataset facilitates the analysis of driving behavior, traffic dynamics, and vehicle interactions, offering valuable insights for research, planning, and policymaking in transportation and urban mobility.

Folder Structure:

File Naming Convention: “T(flight campaign number)_ D(drone number).csv /.mp4 /.tlgx”

The Data folder for each flight campaign (*Data_T1, Data_T2, etc*.). Within each data folder, there are CSV files named according to the drone (*T1_D1.csv, T1_D2.csv, etc.*) and file (*T1_DAll.csv)* is for stitched data of all 6 drones for given flight campaign.

The Tracking logs and Videos folder follows a similar structure, with folders for each flight campaign (*Tracking_Logs_Videos_T1, Videos_ Tracking_Logs_T2, etc.*). Video files named accordingly (*T1_D1.mp4, T1_D2.mp4, etc.)* and tracking file of individual single drone named (T*1_D1.tlgx, T1_D2.tlgx, etc.*). The tracking file for stitched footage from all six drones is named *T1_DAll.ftlgx*. Instructions for accessing these tracking files are provided in the following section.


Data_T1
T1_D1.csv
T1_D2.csv
T1_D3.csv
T1_D4.csv
T1_D5.csv
T1_D6.csv
T1_DAll.csv
Data_T2
Data_T3
Data_T4
Data_T5
Data_T6
Data_T7
Data_T8
Data_T9
Tracking_Logs_Videos_T1
T1_D1.mp4
T1_D2.mp4
T1_D3.mp4
T1_D4.mp4
T1_D5.mp4
T1_D6.mp4
T1_D1.tlgx
T1_D2.tlgx
T1_D3.tlgx
T1_D4.tlgx
T1_D5.tlgx
T1_D6.tlgx
T1_DAll.ftlgx
Tracking_Logs_Videos_T2
Tracking_Logs_Videos_T3
Tracking_Logs_Videos_T4
Tracking_Logs_Videos_T5
Tracking_Logs_Videos_T6
Tracking_Logs_Videos_T7
Tracking_Logs_Videos_T8
Tracking_Logs_Videos_T9

Accessing Trajectory Data:

Navigate to the "Data_T*" folder of desired flight campaign e.g., ("*Data_T1*") to access the trajectory CSV files.

Each CSV file contains trajectory data for individual vehicles, including timestamps, vehicle IDs, and position coordinates. Details of all variables are provided in the following table.

Variables details

Header	**Details**
Vehicle_ID	Unique vehicle ID for the given flight campaign (and drone in case of single drone data)
Vehicle_type	Type of vehicle
Time [s]	Current timestamp
x [m]	UTM Coordinates longitude at the current time
y [m]	UTM Coordinates latitude at the current time
Speed [km/h]	Speed at the current time
Lon. Acc. [ms-2]	Longitudinal Acceleration at current time in m/s^2 (positive value means acceleration and negative value means deceleration)
Lat. Acc. [ms-2]	Lateral Acceleration at current time in m/s^2 (positive value means acceleration to the right and negative value means acceleration to the left)
Angle [rad]	Heading angle
Vehicle_length [m]	Length of vehicle
Vehicle_width [m]	Width of vehicle
Lane	Lane number: 0–3: Mainline (left-to-right) 4–7: Mainline (right-to-left) 10–11: Inner/outer ramp (left-to-right) 20–21: Inner/outer ramp (right-to-left)
Leader_ID	ID of the leading vehicle in the same lane
Follower_ID	ID of the following vehicle in the same lane
Left_Leader_ID	ID of the leading vehicle in the left adjacent lane
Left_Follower_ID	ID of the following vehicle in the left adjacent lane
Right_Leader_ID	ID of the leading vehicle in the right adjacent lane
Right_Follower_ID	ID of the following vehicle in the right adjacent lane

Viewing Recorded Videos:

Navigate to the "*Tracking_Logs_Videos_T**" folder of the desired flight campaign (e.g., "*Tracking_Logs_Videos_T1*") to access the recorded traffic scene videos. Videos are named based on the corresponding flight campaign and drone number for easy reference (e.g., "*T1_D1.mp4*"). Use video playback software to view the recorded traffic scenes and observe vehicular movements.

Accessing Tracking Logs:

Navigate to the "*Tracking_Logs_Videos_T**" folder of the desired flight campaign (e.g., "*Tracking_Logs_Videos_T1*") to access the tracking logs. Before proceeding, ensure that you have installed the "DataFromSky Viewer" software. You can install it using https://www.datafromsky.com/download/DataFromSkyViewer.exe and the user manual (*DFS_VIEWER_user_guide.pdf*) can be access from the software help section.

Open the desired tracking log file. When prompted to select the corresponding video, choose the video file with the same name as the tracking log (e.g., if you open T1_D1.tlgx tracking log, select the video T1_D1.mp4 to upload).

After loading the video in the DFS_Viewer software, adjust the settings for optimal viewing:

Go to View -> Switch Coordinate Space -> Show in working coordinate space to obtain the best view of the tracking vehicles.

For tracking files involving all six drones (e.g., T*_DAll.ftlgx), select the videos in the following order: T*_D4, T*_D5, T*_D6, T*_D1, T*_D2, T*_D3, and following the viewing settings as described above.

Teleporting Jumps:

We performed a dedicated check for vehicle teleportation, where the continuity of each trajectory was verified to prevent any sudden, unrealistic jumps in vehicle position (especially across stitched segments) Specifically, we flagged any instance where the longitudinal displacement exceeded 2 meters in a single time step (equivalent to 60 m/s) or the lateral displacement exceeded 0.5 meters (equivalent to 15 m/s). These thresholds were selected to capture physically unrealistic jumps while allowing for normal acceleration and lane-changing behavior.
For the stitched data, this validation identified 27 longitudinal jumps involving 3 vehicles, and 253 lateral jumps involving 60 vehicles, out of a total of 24,161 vehicles and 63,780,893 time instances. This confirms that such anomalies are extremely rare and isolated.

We have included a separate file in the dataset that lists the vehicle IDs and corresponding time steps where these anomalies occurred. For single drones file name is "Teleporting_jumps.csv" and for stitched cases file name is "Teleporting_jumps_Dall.csv".