

Introduction

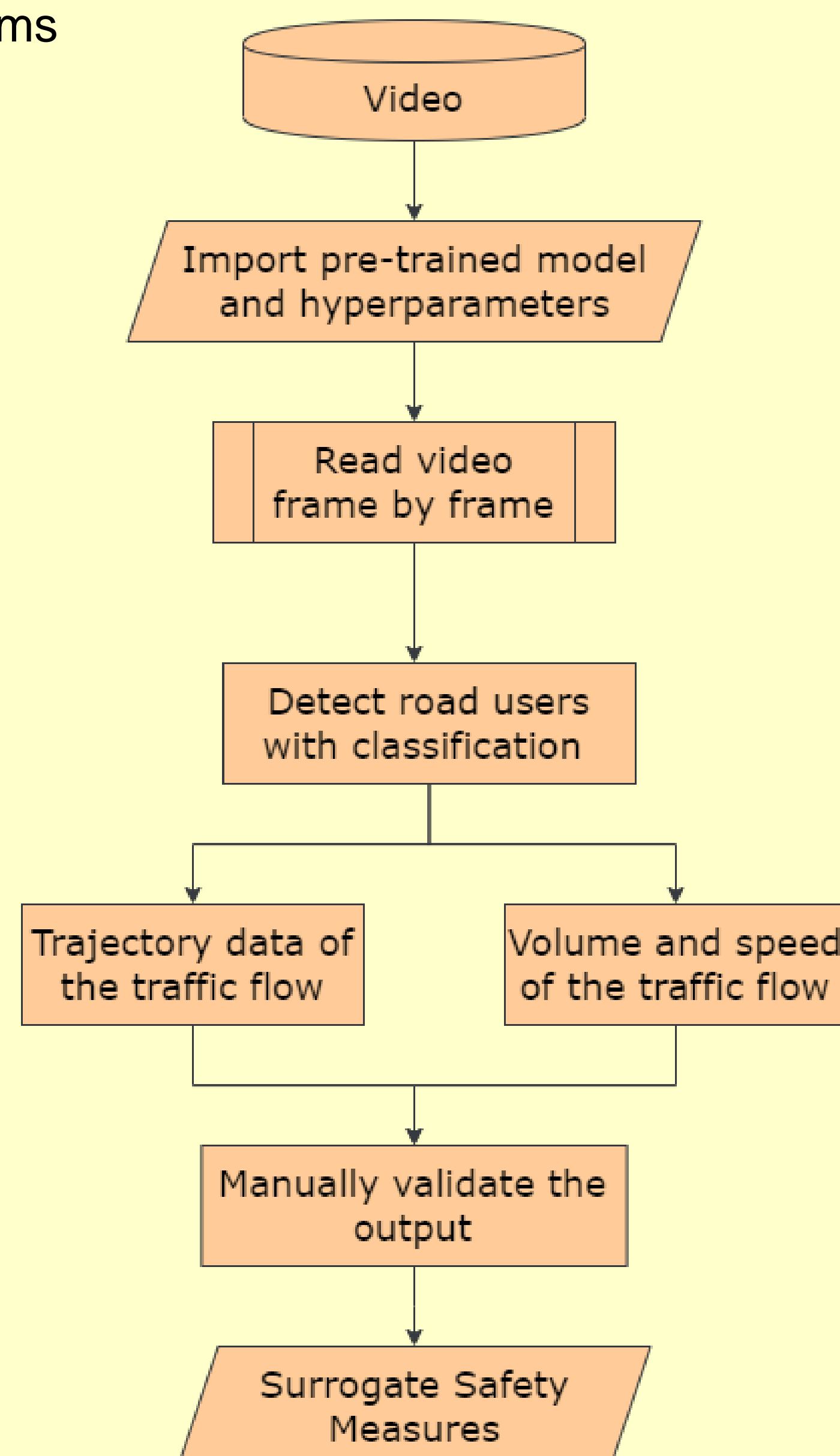
- According to the Federal Highway Administration (FHWA), more than 50 percent of combined fatal and injury crashes occur at or near the intersection
- According to New Jersey State Police, a total of 146 fatal crashes occurred at intersections in New Jersey in 2019, indicating a 39 percent increase compared to the 105 fatal crashes in 2015
- There are millions of minor crashes and conflicts that are not reported every year. In recent years, analyzing conflicts and near-miss events as a proactive approach has widely been implemented

Objective

- Developing an innovative artificial intelligence (AI)-based video analytic tool to assess intersection safety using surrogate safety measures and identify non-compliance behavior of road users'

AI-Framework

- YOLO V5 (You Only Look Once) is used for the detection and classification of road users
- Tracking and trajectory data are extracted and smoothen with the combinations of several machine learning algorithms



(Flowchart 1: Breakdown structure of the video analysis)

Methodology

Traffic Count

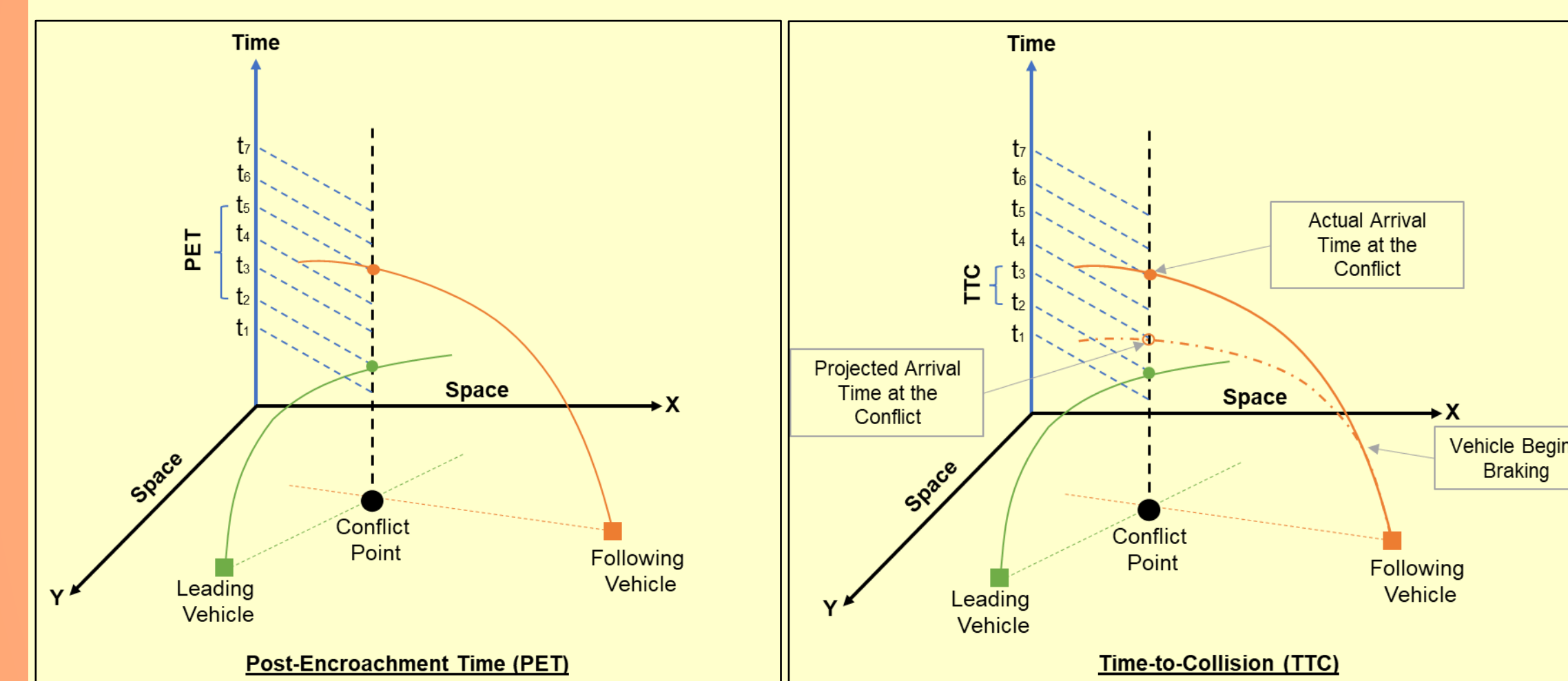
- Total number of vehicles entering the intersection
- Total number of pedestrian crossing at or near the intersection

Violation or Non-Compliance Events

- Vehicle: Red light running
- Pedestrian: Crossing outside the crosswalks

Surrogate Safety Measure

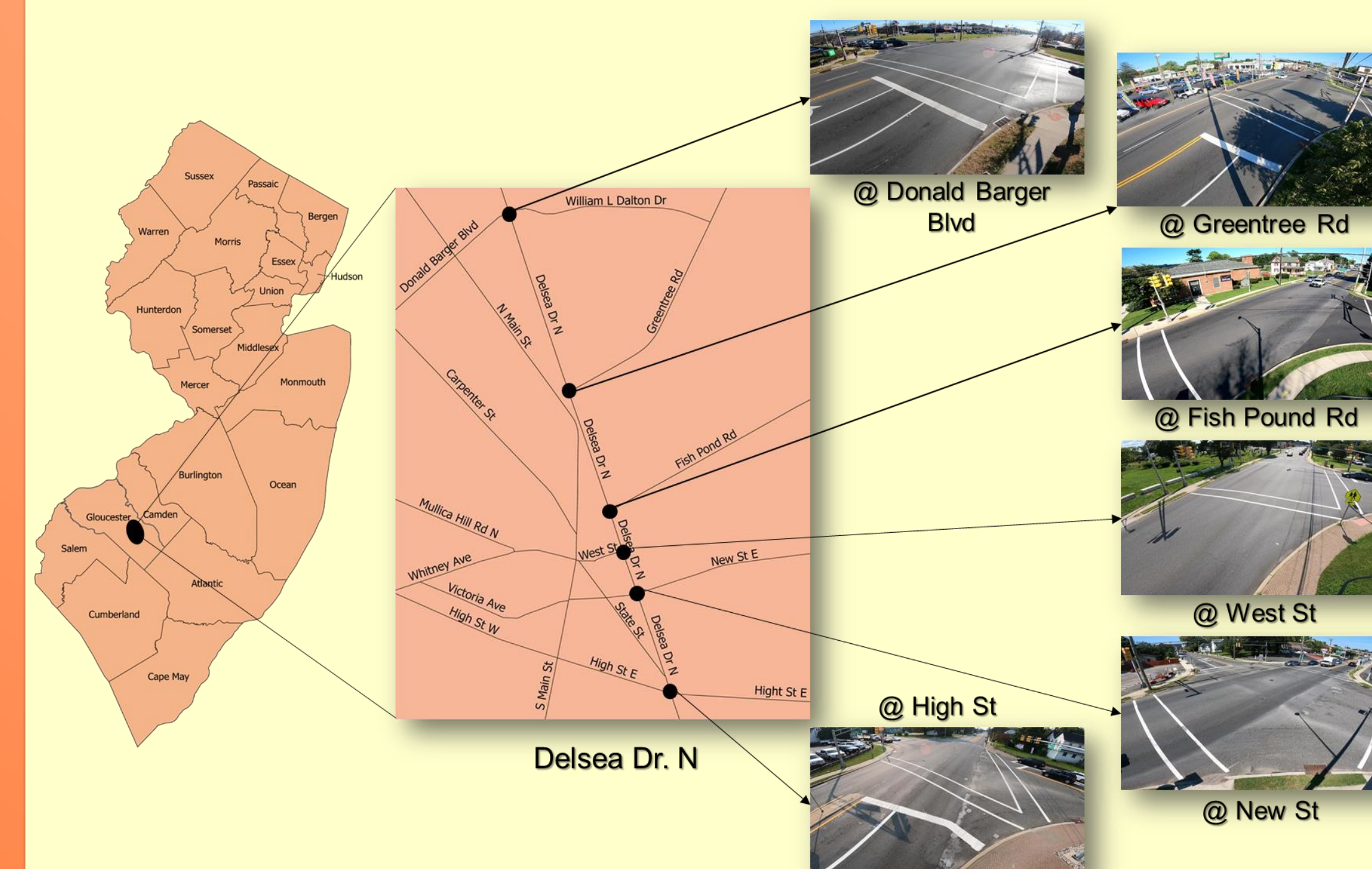
- Post-Encroachment Time (PET) : A time between the leaving of the encroaching vehicle from the conflict point and the entering of the vehicle with an appropriate way at a conflict point.
- Time-to-Collision (TTC): TTC is defined as the time that remains before two road users collide unless one of them takes an avoiding manipulation such as braking or changing lanes



(Figure 1: Time-space diagram to identify the Post-Encroachment Time (PET) and Time-to-Collision (TTC))

Study Locations

- Nine hours (9:00 AM – 6:00 PM) of continuous video data were collected at six different signalized intersections on Delsea Dr., Glassboro, New Jersey.



(Figure 2. Study intersections)

Results and Discussion

Detection and Tracking Accuracy

Table 1. Detection and tracking accuracy

Delsea Dr. N and Donald Barger Blvd.					Delsea Dr. N and Fishpond Rd.					Delsea Dr. N and West St.				
Start Direction	Detection Counts	Manual Count	Accuracy	Error	Start Direction	Detection Counts	Manual Count	Accuracy	Error	Start Direction	Detection Counts	Manual Count	Accuracy	Error
North	767	786	0.98	0.02	North	773	788	0.98	0.02	North	848	921	0.92	0.08
South	863	782	1.10	0.10	South	1088	1031	1.06	0.06	South	880	759	1.16	0.16
East	436	417	1.05	0.05	East	297	291	1.02	0.02	East	488	461	1.06	0.06
West	186	186	1.00	0.00	West	0	0	-	-	West	290	278	1.04	0.04
Total	2252	2171	1.04	0.04	Total	2159	2110	1.02	0.02	Total	2505	2419	1.04	0.04

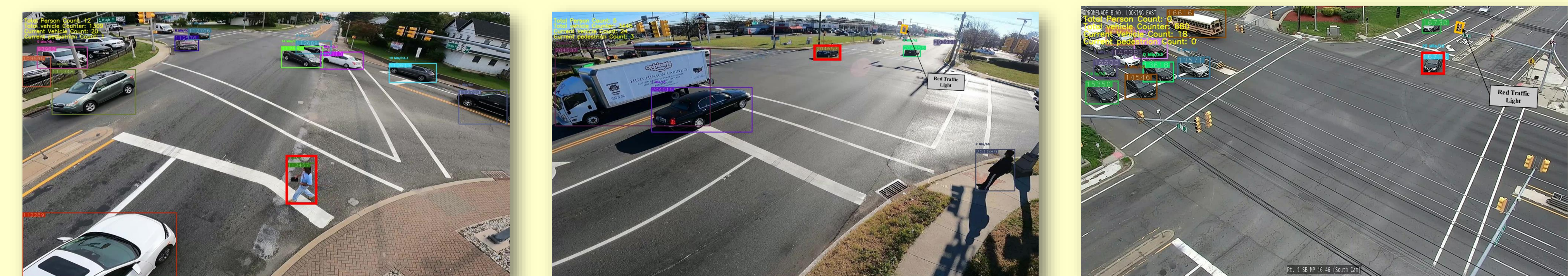
Delsea Dr. N and Greentree Rd.					Delsea Dr. N and West St.				
Start Direction	Detection Counts	Manual Count	Accuracy	Error	Start Direction	Detection Counts	Manual Count	Accuracy	Error
North	678	738	0.92	0.08	North	904	850	1.06	0.06
South	1120	1026	1.09	0.09	South	887	984	0.90	0.10
East	309	309	1.00	0.00	East	0	0	-	-
West	0	0	-	-	West	569	552	1.03	0.03
Total	2107	2073	1.02	0.02	Total	2360	2386	0.99	0.01

Delsea Dr. N and High St.				
Start Direction	Detection Counts	Manual Count	Accuracy	Error
North	898	846	1.06	0.06
South	458	644	0.71	0.29
East	372	404	0.92	0.08
West	347	371	0.93	0.07
Total	2075	2265	0.92	0.08

Vehicle and Pedestrian Non-compliance Counts

Table 2. Detection results: Vehicle and pedestrian non-compliance counts

Location	Vehicle			Pedestrian		
	Total Counts	Non-compliance Counts	Rate of Non-Compliance	Total Counts	Non-compliance Counts	Rate of Non-Compliance
Delsea Dr. N and Donald Barger Blvd.	23904	21	0.0009	91	20	0.22
Delsea Dr. N and Greentree Rd.	16213	24	0.0015	101	35	0.35
Delsea Dr. N and Fishpond Rd.	16284	28	0.0017	113	30	0.27
Delsea Dr. N and West St.	18898	30	0.0016	102	17	0.17
Delsea Dr. N and New St.	19290	157	0.0081	194	46	0.24
Delsea Dr. N and High St.	17201	132	0.0077	94	40	0.43
Total	111790	392	0.0035	695	188	0.27



(Figure 3. An illustrations of a pedestrian walking outside the crosswalk and vehicle red light running event)

Safety Analysis Results: Post-Encroachment Time (PET) and Time-to-Collision (TTC)

Table 3. Analysis results: Post-Encroachment Time (PET) and Time-to-Collision (TTC)

Location	PET Events			TTC Events	
	< 20 Seconds	< 5 Seconds	< 1.5 Seconds	< 5 Seconds	< 1.5 Seconds
Delsea Dr. N and Donald Barger Blvd.	10991	958	75	989	102
Delsea Dr. N and Greentree Rd.	615	134	15	136	20
Delsea Dr. N and Fishpond Rd.	929	191	46	181	49
Delsea Dr. N and West St.	1649	196	28	205	43
Delsea Dr. N and New St.	4291	754	91	794	116
Delsea Dr. N and High St.	2764	438	36	445	42
Description	Arbitrary Count	Possible Conflict	Dangerous Conflict	Possible Conflict	Dangerous Conflict

Conclusion

- The results demonstrated the detection and tracking accuracy between 92 and 99 percent
- Safety analysis parameters can help in investigating the relationship between human driving behaviors and collision risk at an intersection
- Overall, the developed tool would help the state department of transportation, and local agencies evaluate intersections' safety with less effort

Acknowledgement

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