Road Sight Unit: Edge Image Processing for Vehicle Trajectory and Collision Prediction

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The problem

"Accidents between cars and vulnerable road users are one of the most frequent accidents"– Euro NCAP

56% of road deaths are VRUs - WHO - Global status report 2021

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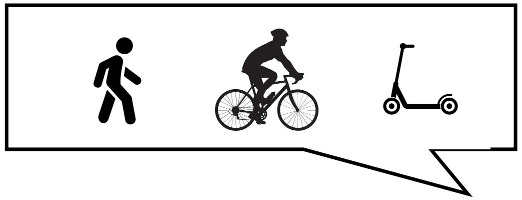

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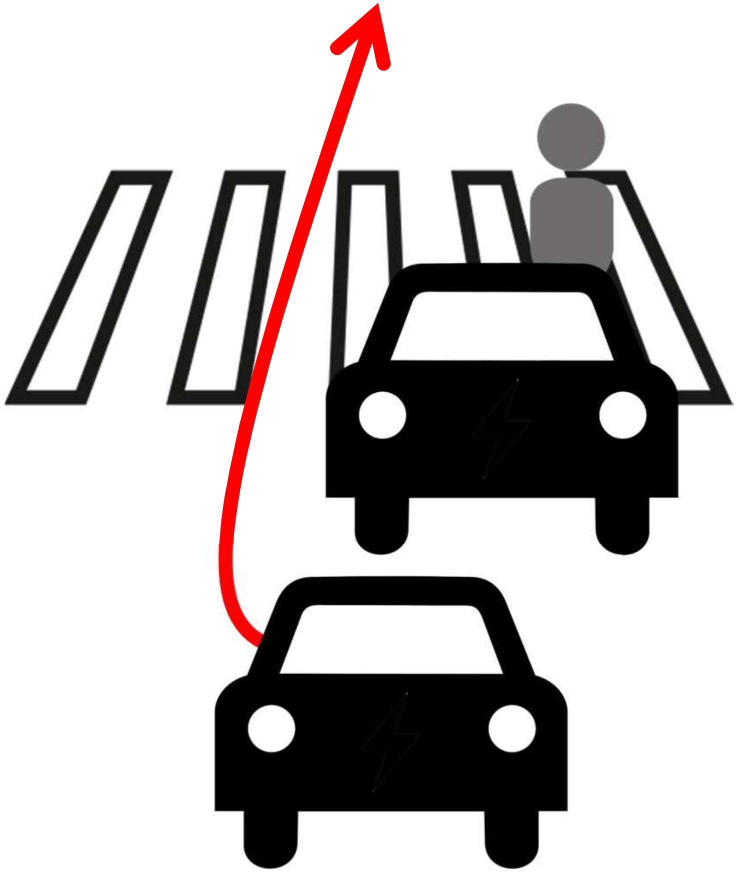
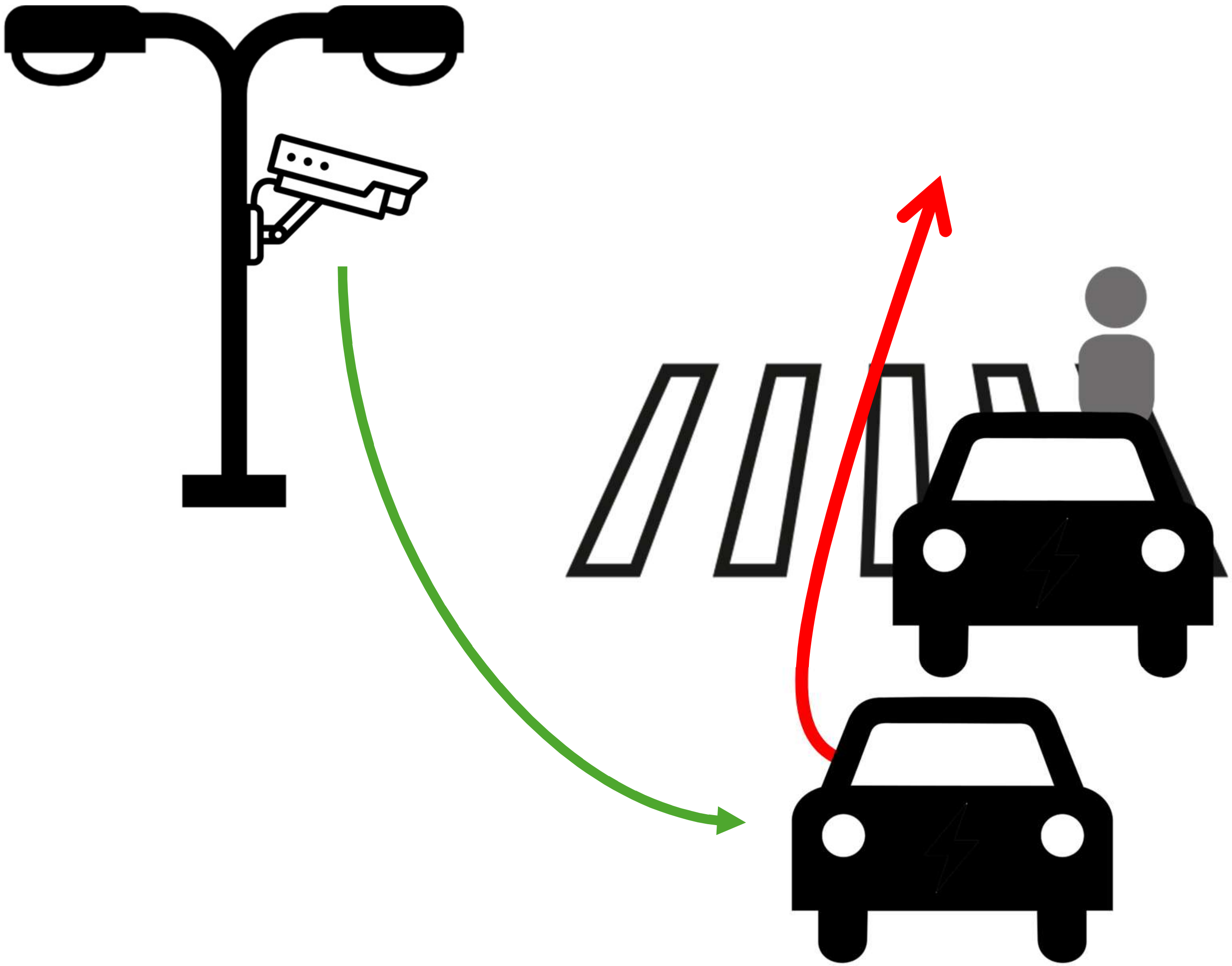
Non-Line-of-Sight

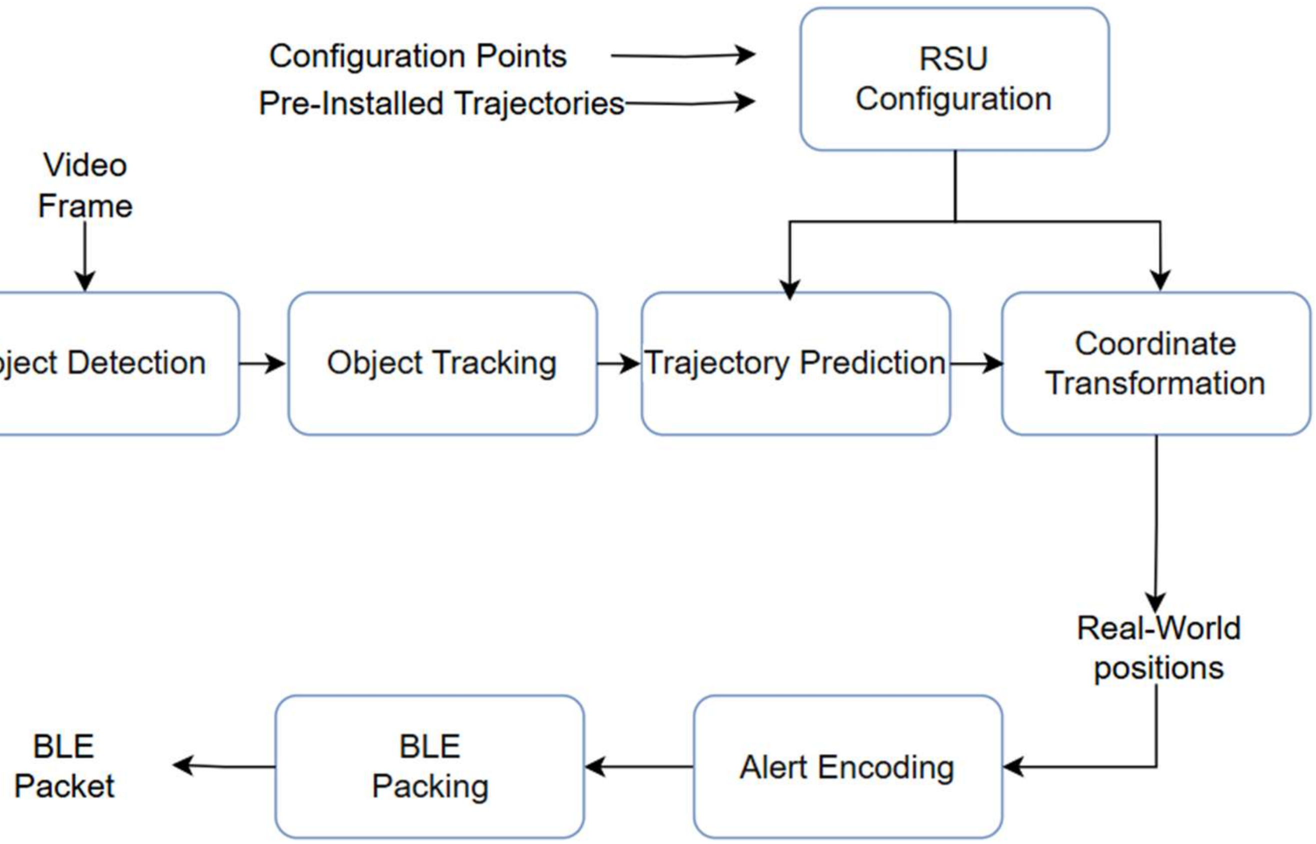


Main goal

- Develop an information source that is resilient to non-line-of-sight limitations of vehicles
- Share this information with other road users to enable warnings about hazards



Road Sight Unit workflow



Trajectory Prediction

Extended Kalman Filters (EKF)

- Handles non-linear motion models
- Does not require training data
- Computationally efficient
- Widely adopted and tested

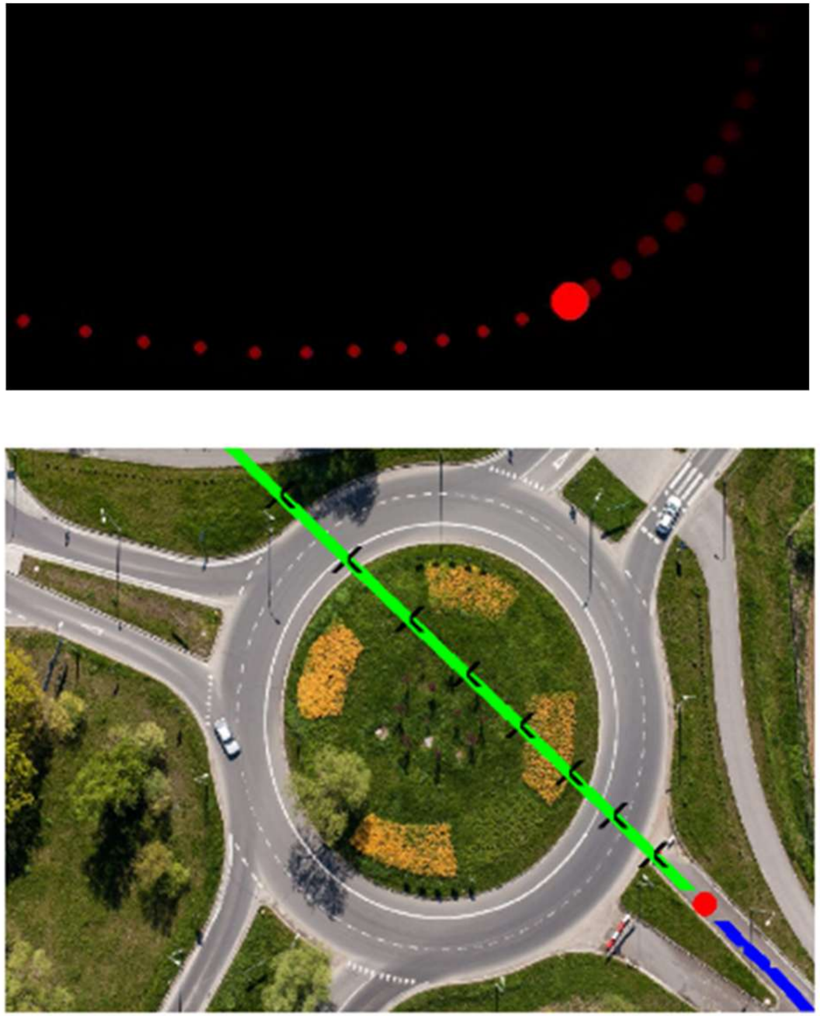
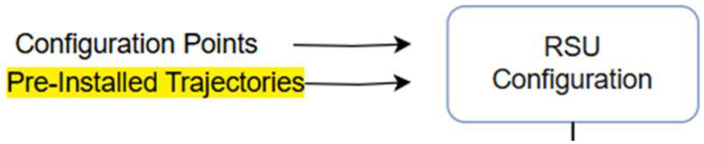


Figure 5.5: EKF results

Pre-Installed Trajectories

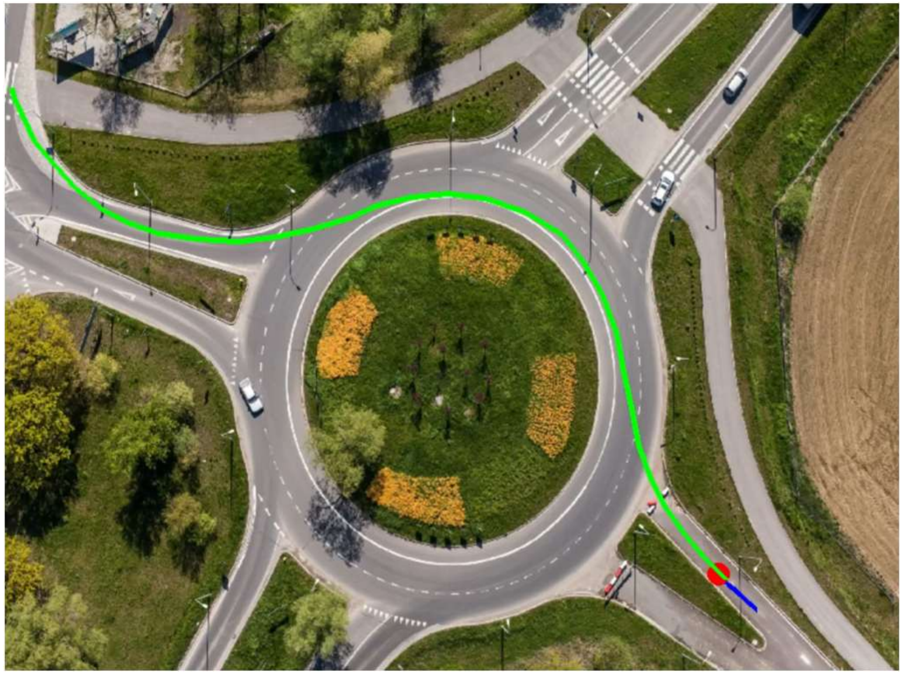


- Save baseline trajectories

Figure 4.2: Downtown Coldwater, MI, USA traffic camera with trajectory visualization over 5 minutes

Similarity Based Predictor (SBP)

- Utilizes knowledge of the road layout
- Predictions are made over longer distances
- Due to road constraints, a large dataset is not required for accurate predictions
- Delivers very fast results



(Video example)

Adapted Confusion Matrix

Table 5.7: Performance Comparison of EKF and SBP Using Video Overlay Data from Downtown Coldwater

Method	TP	TP (>4s)	NM	FP	FP (Sidewalk)	FN	Precision
EKF	4	2	4	8	4	3	50%
SBP	6	4	4	2	0	1	83%

Conclusion

- Many vehicles have advanced sensors, but they cannot “see” from diferente vantage points

- The static position of the roadside unit allows for highly specialized knowledge of the location

- The tests carried out showed that it is possible to have a system with a single camera capable of generating useful information in the context of road safety.

Thank you

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Main results

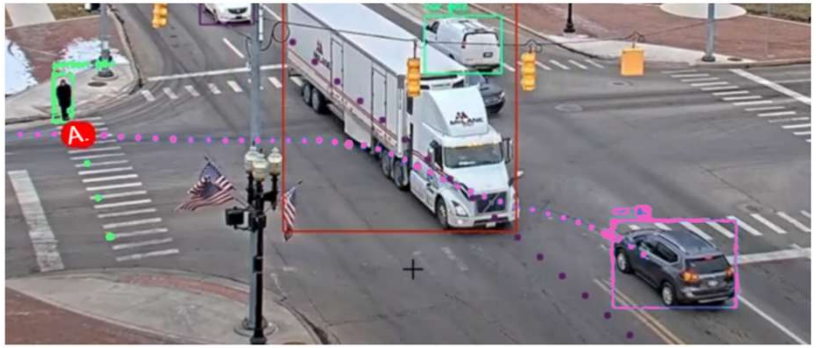

Figure 5.12: Downtown Coldwater, MI, USA traffic camera: Trajectory prediction and real-time overlap verification

Figure 5.13: Coordinates obtained from trajectory overlay according to Google Earth

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Data Structuring and Broadcast

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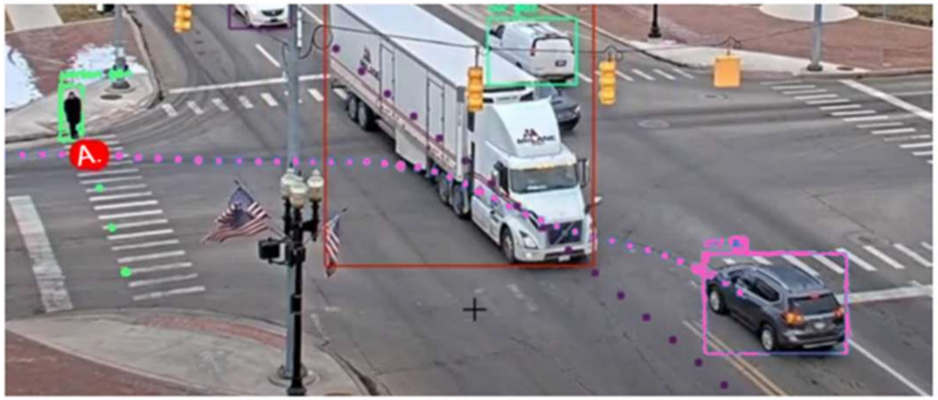


Figure 5.12: Downtown Coldwater, MI, USA traffic camera: Trajectory prediction and real-time overlap verification

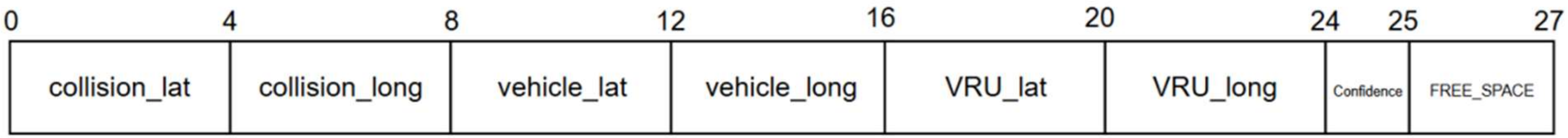
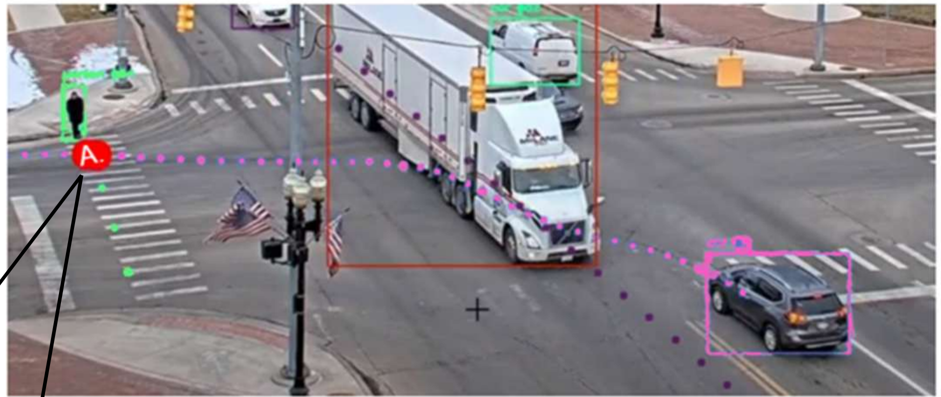


Figure 4.3: BLE advertisement packet

Data Structuring and Broadcast



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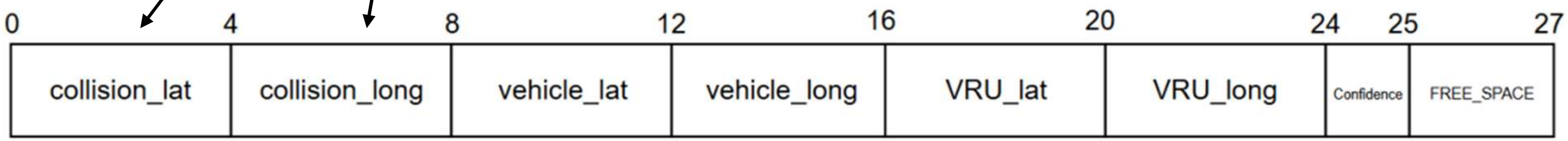

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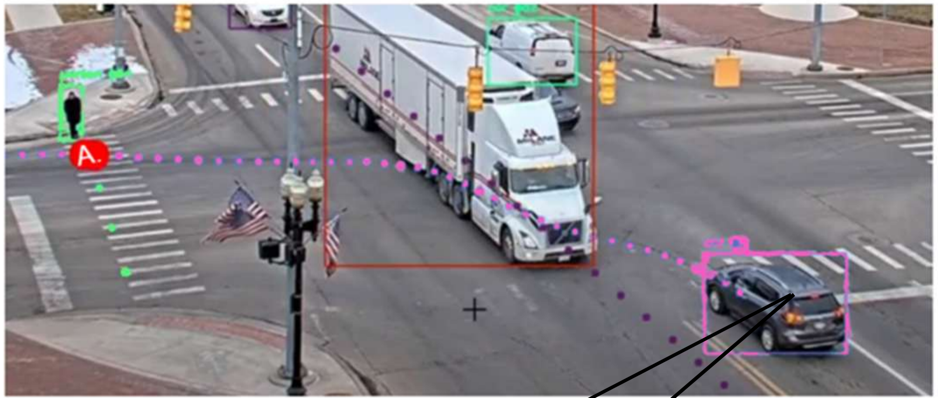

Figure 5.12: Downtown Coldwater, MI, USA traffic camera: Trajectory prediction and real-time overlap verification

0 4 8 12 16 20 24 25 27

collision_lat	collision_long	vehicle_lat	vehicle_long	VRU_lat	VRU_long	Confidence	FREE_SPACE

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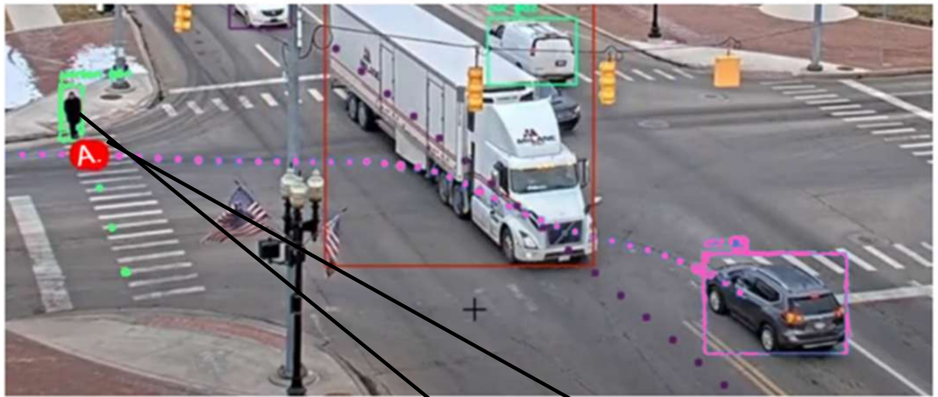

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0	4	8	12	16	20	24	25	27
collision_lat	collision_long	vehicle_lat	vehicle_long	VRU_lat	VRU_long	Confidence	FREE_SPACE	

Figure 4.3: BLE advertisement packet