Vehicle Semantics Extraction and Retrieval for Long-term Carpark Video Surveillance

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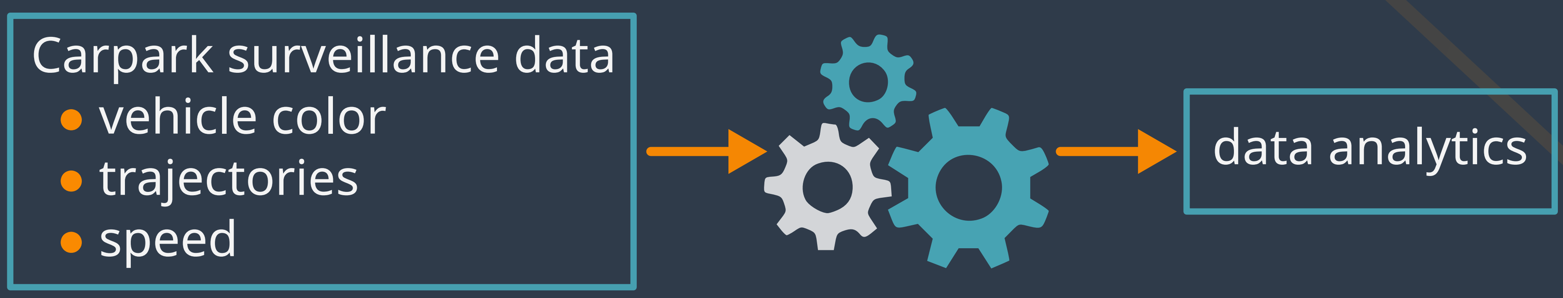
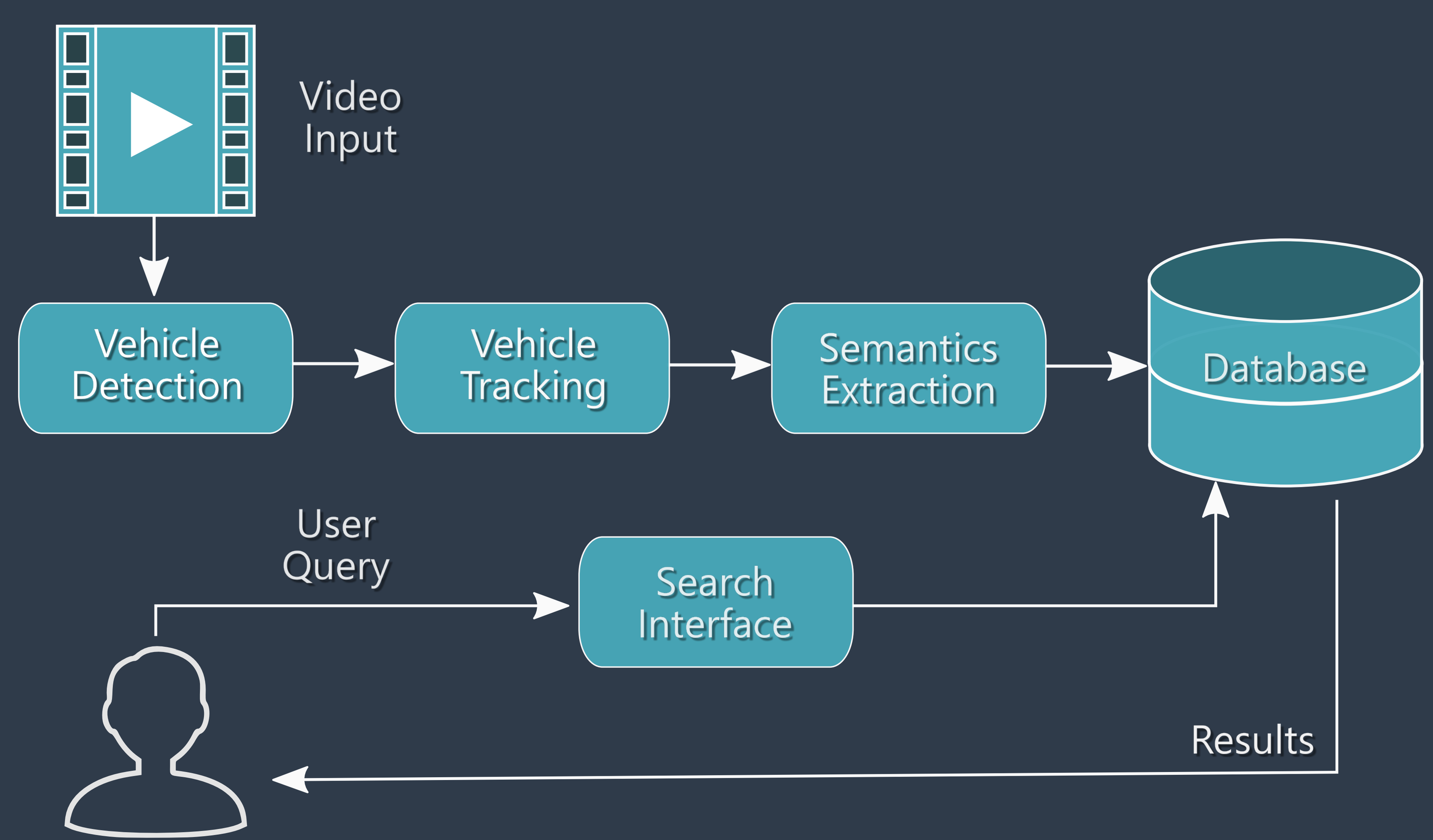
Abstract



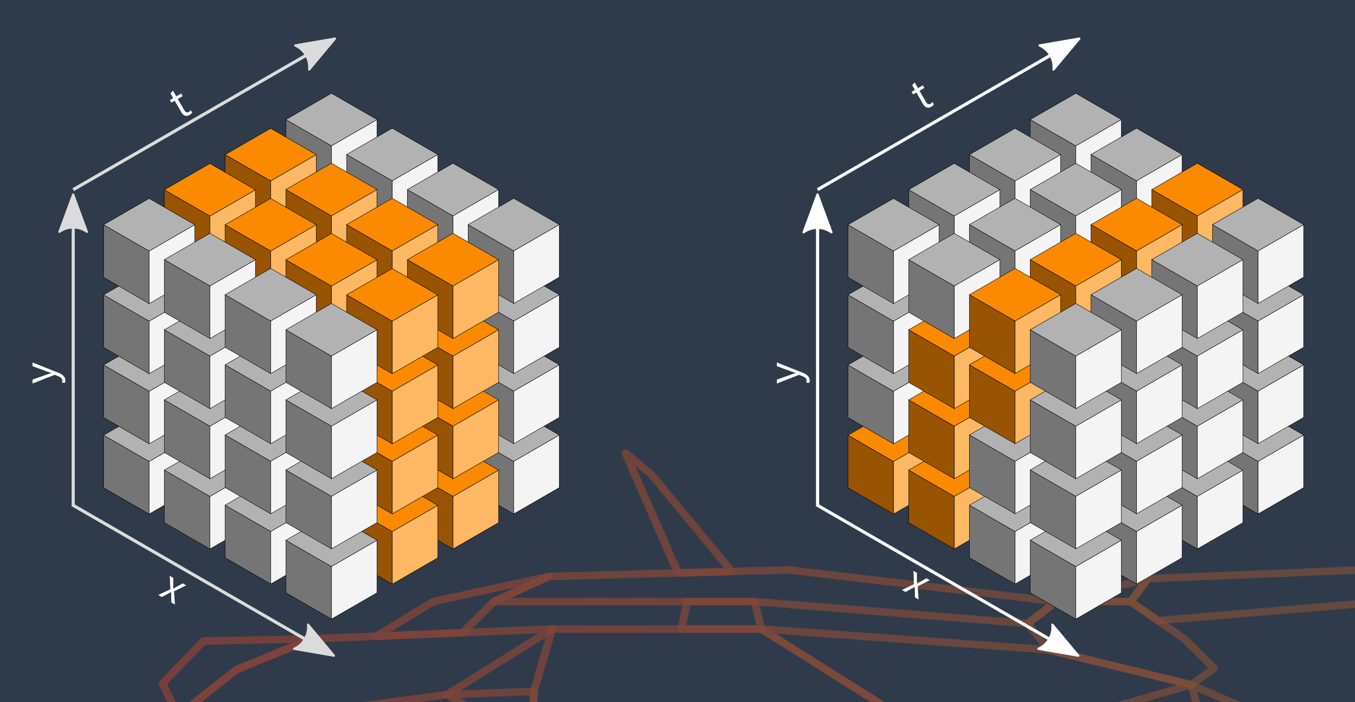
Challenges

- outdoor scenarious - various illumination & weather conditions
- retrieval time may increase as the data size grows



Key Concepts

- We adopted the concept of "atoms" - to quantize a video input into individual 3D spatial-temporal cubes which consist of the X-axis, Y-axis and T-axis.
- This enabled us to easily tag each vehicle with a unique sequence of atoms (x-position, y-position, and t-position).
- These sequence of atoms can then be used in the retrieval process based on the user-described motion of a particular vehicle.

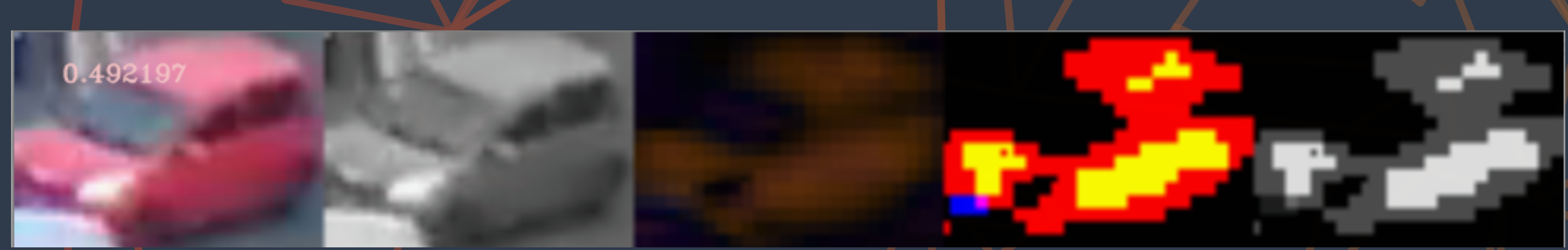


Time Slicing Query Region of Interest Query

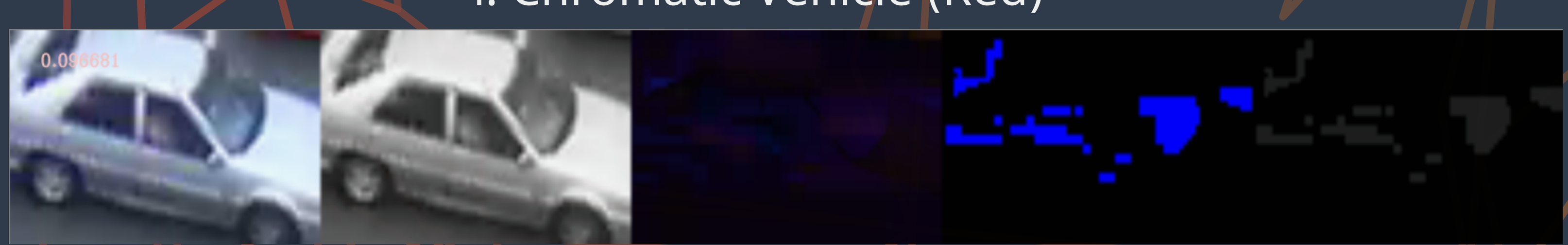
Framework

Object Specific Semantic Extraction

i. Color Information
ii. Motion Information



i. Chromatic Vehicle (Red)



ii. Achromatic Vehicle (Gray/White)

Fig: (From left) Original image; Grayscale image; Absolute difference; Binary threshold absolute difference; Threshold difference in grayscale

Color	Gray	Black	White	Red	Blue	Orange	Yellow	Green	Pink	Purple	Brown
#	365	182	150	60	19	15	13	10	9	7	7
%	43.6	21.7	17.9	7.2	2.3	1.8	1.6	1.2	1.1	0.8	0.8

Table: Ground truth distribution vehicle colors ordered by occurrence

(a) (b) (c)

Fig: (a) Black & White Filter Response, (b) 8+1 Directional Bins, (c) 11 Color Categories (Clockwise - Black, Gray, White, Red, Orange, Yellow, Purple, Pink, Brown, Blue, Green)

Experiment & Results

The method was tested on 2 days of continuous outdoor carpark data (20 hours, 10 each day). The performance is recorded as below.

Actual Color \ Predicted Color	Gray	Black	White	Red	Blue	Orange	Yellow	Green	Pink	Purple	Brown
Gray	**236**	61	68	0	0	0	0	0	0	0	0
Black	48	**134**	0	0	0	0	0	0	0	0	0
White	26	4	**120**	0	0	0	0	0	0	0	0
Red	27	25	0	2	0	0	0	0	4	**2**	0
Blue	3	10	0	0	**6**	0	0	0	0	0	0
Orange	8	3	0	0	0	**3**	0	0	0	1	0
Yellow	3	1	2	0	0	0	**7**	0	0	0	0
Green	5	1	4	0	0	0	0	**0**	0	0	0
Pink	1	0	0	**3**	0	0	0	0	**5**	0	0
Purple	3	3	0	0	0	0	0	0	0	1	0
Brown	3	4	0	0	0	0	0	0	0	0	**0**

Result	Gray	Black	White	Red	Blue	Orange	Yellow	Green	Pink	Purple	Brown
Precision	65.01	54.47	61.86	40.00	100.00	100.00	100.00	N/A	55.56	25.00	N/A
Recall	64.66	73.63	80.00	3.33	31.58	20.00	53.85	0.00	55.56	14.29	0.00
F1 Score	64.84	62.62	69.77	6.15	48.00	33.33	70.00	N/A	55.56	18.18	N/A

Fig: (left to right) Motion Test Case 2 (TQ2), Samples of 3 retrieved shots from Motion Test Case 2 (TQ2 - turning into a junction)

No. of Input		CV: 70%			CV: 80%			CV: 90%		
		Precision	Recall	F1 Score	Precision	Recall	F1 Score	Precision	Recall	F1 Score
TQ1	5	93.82	61.53	**74.32**	95.34	33.19	49.24	95.34	33.19	49.24
	6	90.09	36.84	52.29	90.09	36.84	52.29	89.13	16.59	27.98
	7	87.27	38.86	53.78	88	17.81	29.62	87.87	11.74	20.71
	8	86.88	21.45	34.41	84.61	13.36	23.07	89.65	10.52	18.84
TQ2	4	16.28	80	27.06	28.69	73.33	41.25	28.69	73.33	41.25
	5	65.3	71.11	**68.08**	73.33	48.88	58.66	73.33	48.88	58.66
	6	55.81	53.33	54.54	55.81	53.33	54.54	57.69	33.33	42.25

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Selected References

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