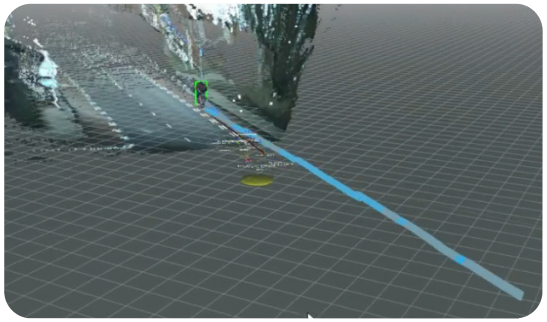
Measuring Driver Perception

Combining Eye-tracking and Automated Road Scene Tracking

Jork Stapel, Mounir El Hassnaoui, Riender Happee



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DRIVER-VEHICLE SYSTEMS IN ADVANCED ENVIRONMENTS

Provide relevant support

- ADAS supporting the driver
- Driving very demanding
- Selective in what to attend

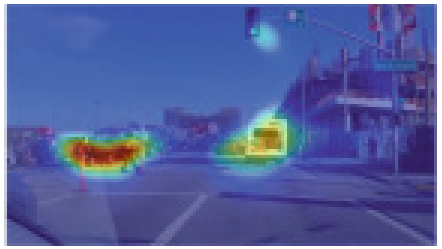
- Timely alert:
  → Observe driver perception, not inaction

Judging awareness from gaze

Use of peripheral vision
Look but failed to see

Judging awareness from gaze

Latent variable



Xia et al. 2019

Verify

Have you seen:

○ Yes ○ No

Xia, Ye; Zhang, Danquing; Kim, Jinkyu; Nakayama, Ken; Zipser, Karl; Whitney, David; *Predicting Driver Attention in Critical Situations;* Asian Conference on Computer Vision (ACCV; 2019)
https://doi.org/10.1007/978-3-030-20873-8 42

Judging awareness from gaze

Verify

- Freeze probe — Limited to simulator
- Real-time probe — Limited in rate of probes; Impractical in complex cases

Our goals:

→Left turns on urban intersections

→Verify awareness for all road users

→On the road, un-choreographed

Judging awareness from gaze

- Testing after the manoeuvre
  - Avoid high workload for driver
- Recognition instead of recall
  - Support recollection
  - Probe implicit awareness (?)
- Automated question generation
  - Avoid high workload for experimenter

Attention in Urban left-turns

Instrumentation

- Vehicle monitors road and driver's gaze
- Gaze metrics for each object
- Generates test images

Procedure

- 13 drivers perform 91 left-turn manoeuvres
- Stop vehicle and start task ASAP **(~60s)**

Recognition task

- Display 8.1 real and 11.8 distractor images on average
- Driver indicates which he/she recognises

On-road eye tracking
data collection + processing

How do drivers observe the road?

13 participants 91 intersections 1824 Images
Per intersection: 8.2 real images 11.8 fake images

	Selected	Not selected
Real images	**29,1%**	70,9%
Relevant objects	36,1%	63,9%
Irrelevant objects	19,4%	80,6%
Dummy images	**6,7%**	93,3%

Not selected ≠ overlooked

Selected = perceived

How do drivers observe the road?

	Relevant objects (minimum gaze angle)						Recognized relevant objects (minimum gaze angle)					
	N	<2°	2-5°	5-10°	10-30°	>30°	N	<2°	2-5°	5-10°	10-30°	>30°
Car	241	79%	10%	6%	4%	1%	34%	33%	39%	40%	22%	33%
Bicycle	83	58%	13%	11%	16%	2%	47%	60%	45%	33%	15%	0%
Pedestrian	14	50%	14%	14%	21%	0%	64%	71%	100%	100%	0%	-
Bus	5	100%	0%	0%	0%	0%	60%	60%	-	-	-	-
Truck	6	50%	17%	0%	33%	0%	33%	33%	0%	-	50%	-
Motor	4	75%	0%	25%	0%	0%	50%	67%	-	0%	-	-
Total	353	73%	10%	8%	8%	1%	39%	40%	43%	41%	19%	20%

	Irrelevant objects (minimum gaze angle)						Recognized Irrelevant objects (minimum gaze angle)					
	N	<2°	2-5°	5-10°	10-30°	>30°	N	<2°	2-5°	5-10°	10-30°	>30°
Car	168	39%	23%	14%	18%	5%	15%	20%	13%	13%	13%	13%
Bicycle	101	19%	13%	18%	44%	7%	15%	11%	23%	11%	14%	29%
Pedestrian	63	16%	16%	13%	46%	10%	33%	50%	50%	13%	31%	17%
Bus	8	25%	25%	25%	25%	0%	63%	50%	100%	100%	0%	-
Truck	5	0%	20%	20%	40%	20%	20%	-	0%	0%	50%	0%
Motor	5	20%	20%	40%	20%	0%	40%	0%	100%	50%	0%	-
Total	353	28%	19%	16%	31%	6%	20%	21%	24%	18%	18%	18%

Can we predict awareness?

	Relevance			Recognition		
	Exp(b)	t	*p*	Exp(b)	t	*p*
Intercept	0.39	-3.629	<0.001	0.262	-4.274	<0.001
Duration <2° [s]	5.452	3.024	**0.003**	1.424	1.591	0.112
Duration 2-5° [s]	2.658	3.273	**0.001**	0.956	-0.157	0.875
Duration 5-10° [s]	2.541	4.188	**<0.001**	1.995	3.153	**0.002**
Duration 10-30° [s]	1.094	0.741	0.459	0.946	-0.402	0.688
Duration >30° [s]	0.693	-1.574	0.116	0.929	-0.444	0.657
1st Saccade angle [°]	1.049	2.756	**0.006**	1.001	0.132	0.895
1st Saccade time [s]	0.901	-0.613	0.54	1.243	1.334	0.183
Preceding fixation [s]	1.087	0.345	0.73	1.361	1.217	0.224

23% 2%

Improvement over intercept model

- We could predict relevance
- But not recognition (in our setup)

How effective is our method?

Findings

- Recognition task confirms awareness, but memory capacity not overcome
  → Reduce 60s delay
- Peripheral road users are recognised
  → Fixation location insufficient for identifying misses
- The task was difficult, and maps were used less than images
  → Include better driving related features (e.g. location in scene)
- Could not judge awareness from track-aggregated predictors
  → Include more temporal aspects

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Thank you.

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