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PANEL
ADAPTIVE/COGNITIVE

Challenges in Managing Fleets of Drones and Driverless Cars

MODERATOR:
Petre Dini, IARIA

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Facts I

- http://money.cnn.com/2016/02/29/autos/google-self-driving-car-accident/
- **“… on February 14, a Lexus 450 hybrid SUV with Google's self-driving technology had a scrape with a city bus in Mountain View, California, the company's hometown. It said no one was injured in the accident. "**

  "Google said the car was in the right lane of a city street, and was about to turn right. But after initially moving to the right side of the lane, it moved back to the center of the lane to avoid sand bags that had been placed around a storm drain. The bus, coming from behind, hit the left side of the car. "

  ""From now on, our cars will more deeply understand that buses (and other large vehicles) are less likely to yield to us than other types of vehicles, and we hope to handle situations like this more gracefully in the future," said the company. "

Prediction

- **…. they are part of a 10-year plan to make the need to own a car obsolete.**

Facts II

- **mini-drone fleet: Perdix**
  http://adevarul.ro/international/statele-unite/video-ultima-arma-pentagonului-roiul-drone-mici-dimensiuni-perdix-pregatit-lupta-1_5874fa115ab6550cb8513c7b/index.html
  https://www.defense.gov/News/News-Releases/News-Release-View/Article/1044811/department-of-defense-announces-successful-micro-drone-demonstration

- **home protection: Sunflower Home Awareness System**
  http://www.digitaltrends.com/cool-tech/sunflower-home-awareness-system/
- http://money.cnn.com/2016/11/03/technology/drone-home-alarm-system/

- **self-driving bus: OLLI**

  http://www.cnn.com/2016/10/20/world/ollis-electric-bus/

  helsinki: http://www.curbed.com/2016/8/31/12691516/self-driving-bus-vehicles-finland-helsinki-transportation

  singapore: http://www.cnbc.com/2016/10/19/all-aboard-singapore-now-to-try-out-self-driving-buses.html

  tokyo: http://www.wsj.com/articles/japans-dena-says-get-on-the-self-driving-bus-1467884109

  usa; michigan, Ann Arbor: http://www.nbcbayarea.com/on-air/as-seen-on/Self-Driving-Shuttle-Bus-Makes-its-Debut-406048596.html

  las vegas: olli jan 7 | http://www.reviewjournal.com/business/self-driving-bus-olli-still-its-way

  germany:
  https://www.dezeen.com/2016/07/19/mercedes-benz-self-driving-future-bus-autonomous-vehicle/

Ideas | Starting points

Separation - avoid crowding neighbors (short range repulsion)
Alignment - steer towards average heading of neighbors
Cohesion - steer towards average position of neighbors (long range attraction)

In flocking simulations, there is no central control; each bird behaves autonomously. In other words, each bird has to decide for itself which flocks to consider as its environment. Usually environment is defined as a circle (2D) or sphere (3D) with a certain radius (representing reach).

On flocking: birds vs. drones

Birds:

- **Group behavior vs. Individual behavior**
- **Environmental observation**
- **Security distance vs. movement parameters**

Fleets:

- **Flocking rules**

or/and

- **Leader-based coordination**

or/and

- **Central coordination**

Panelists

Moderator

Petre Dini, IARIA, USA

Panelists

- Knud Thomsen, Paul Scherrer Institut, Switzerland
  Mutual communication and understanding
- Yuji Iwahori, Chubu University, Japan
  Vision | Moving Objects
- Petre Dini, IARIA, USA

  Driverless fleets

Open discussion

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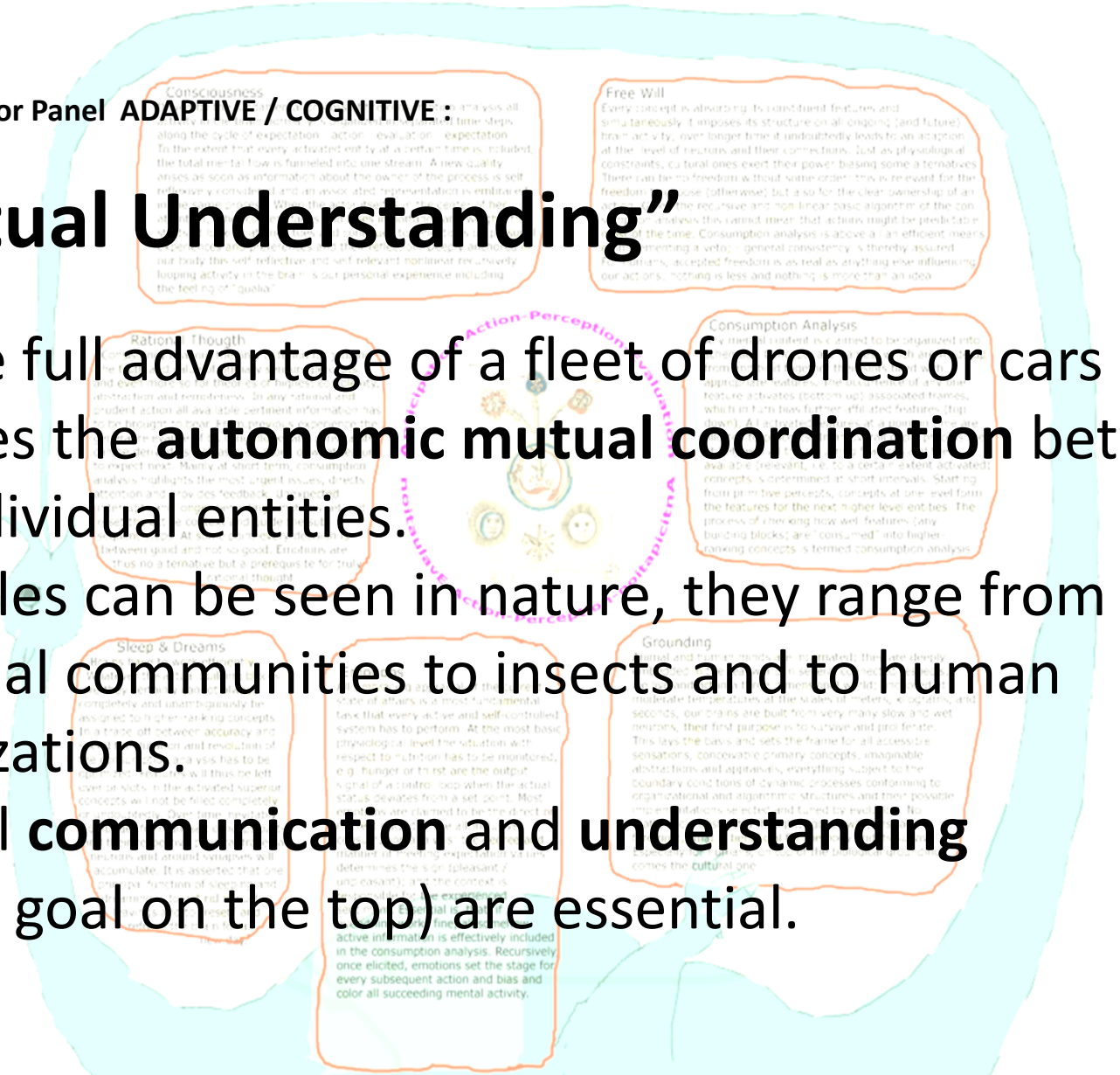
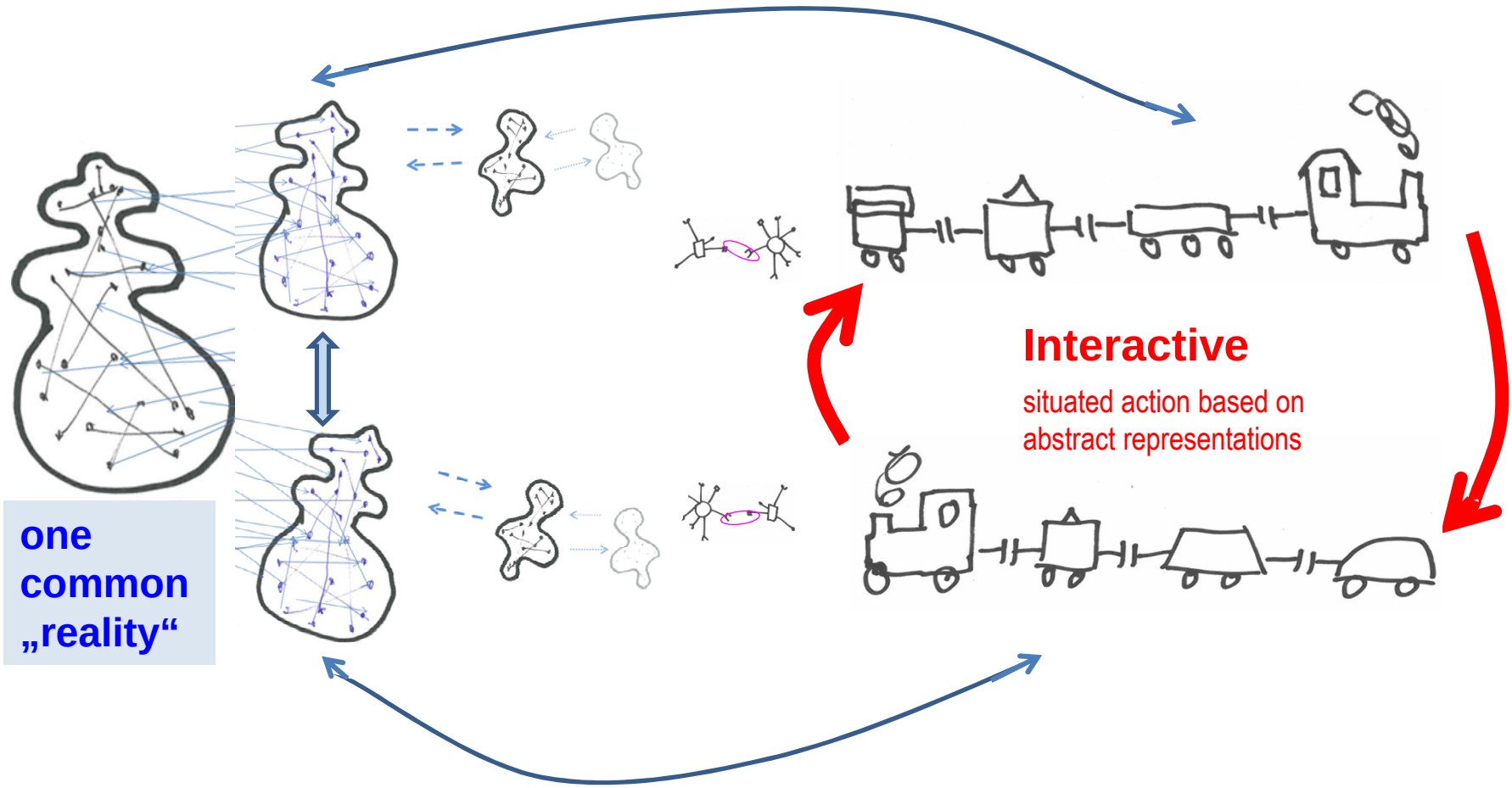
K. Thomsen for Panel ADAPTIVE / COGNITIVE :

“Mutual Understanding”



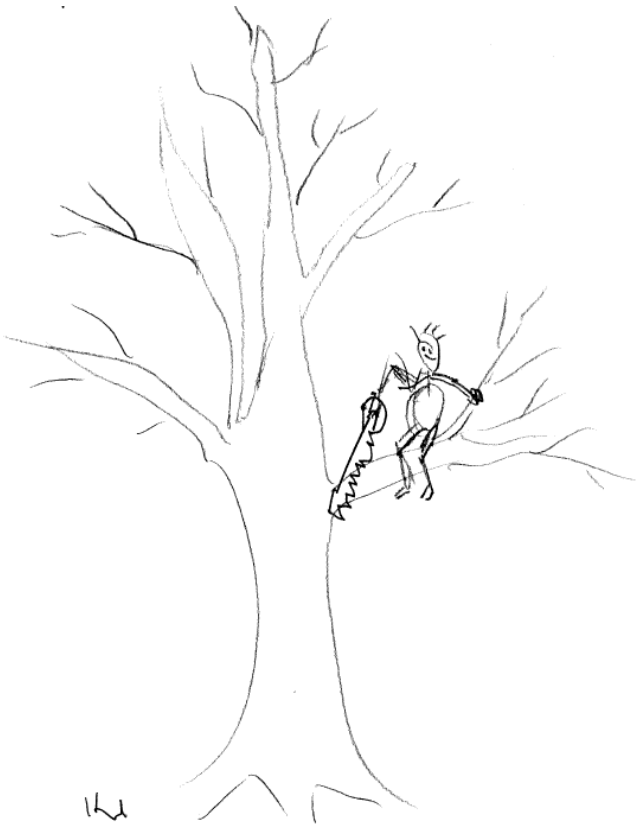
To take full advantage of a fleet of drones or cars requires the **autonomic mutual coordination** between the individual entities.
Examples can be seen in nature, they range from bacterial communities to insects and to human organizations.
Mutual **communication** and **understanding** (as the goal on the top) are essential.

Communication as sketched by the Ouroboros Model:

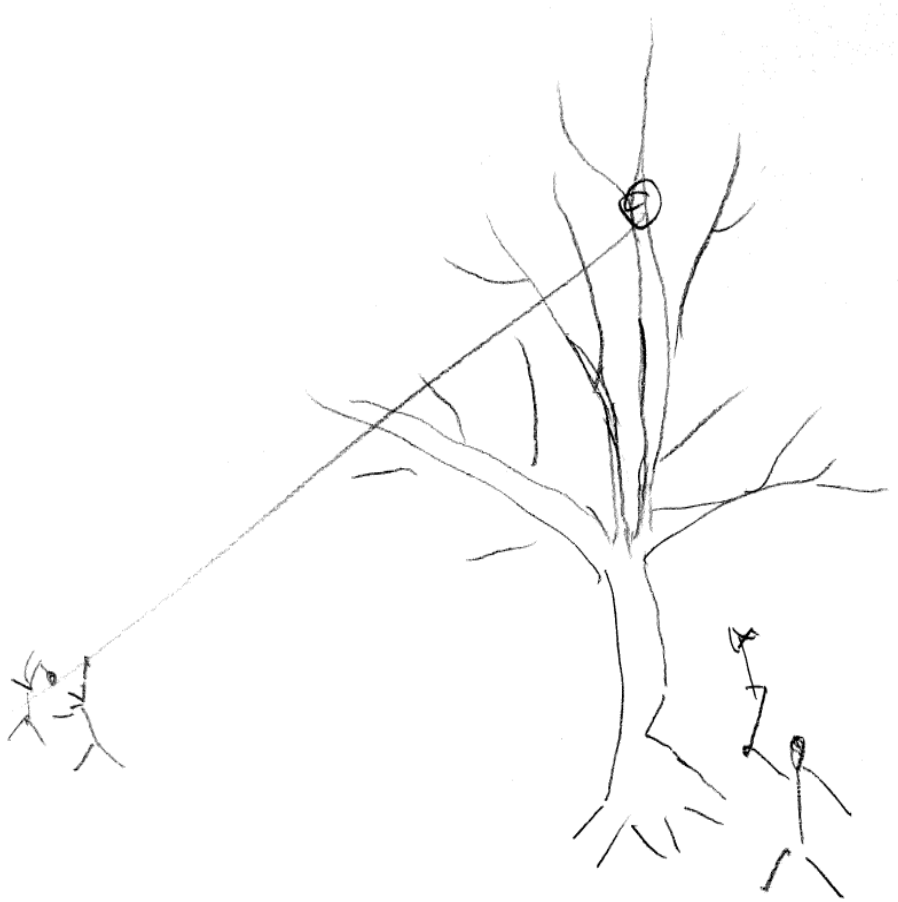


All discourse relies on some shared content, it cannot work without a minumum of common reference (and grounding)

K. Thomsen,The Ouroboros Model embraces its sensory-motoric foundations. Studies in Logic, Grammar and Rhetoric 2015;41:105–125.



A lack in self-awareness can easily become costly to an agent in the real world.



Clever is, who applies an understanding as wide as possible, chooses appropriate tools as available and accepts help from friends.

K. Thomsen, Stupidity and the Ouroboros Model, in: Bach, J., Goertzel, B., and Iklé, M. (Eds.): Artificial General Intelligence, Lecture Notes in Computer Science Vol. 7716, (pp. 332–340). Berlin, Heidelberg, Springer, 2012.

Petre Dini - Panelist

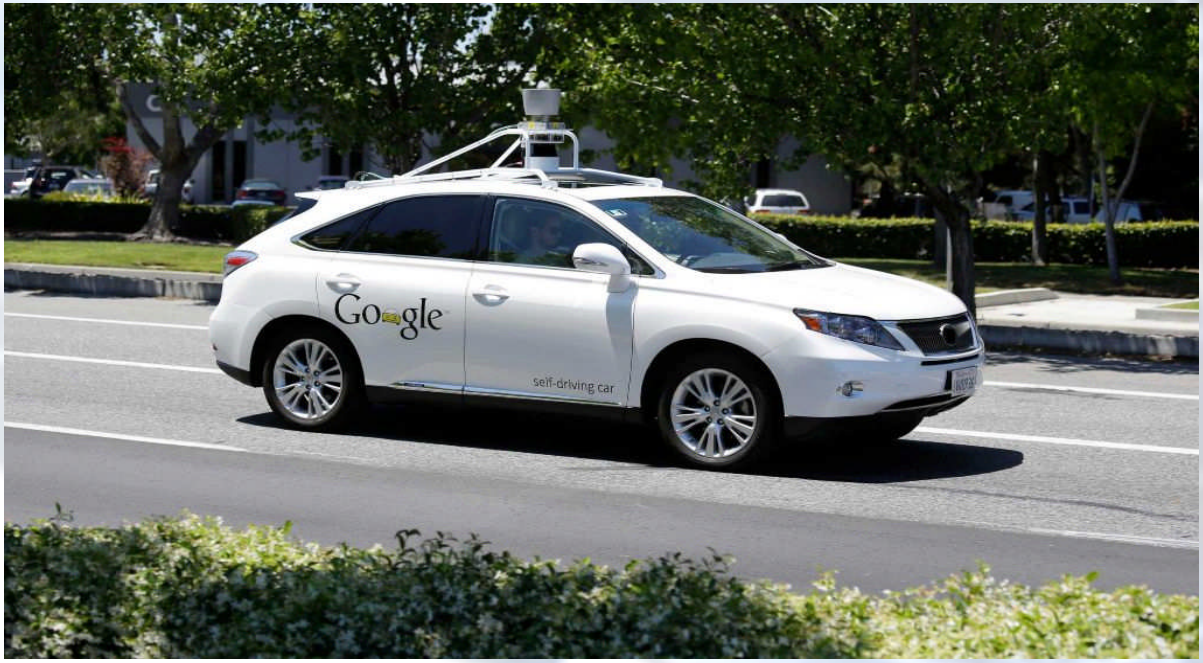
Issues and Achievements on Driverless Cars

Petre Dini, Concordia University, Canada | IARIA, USA

Self-driving I *Legal aspects*

- **Driverless car journey starts in Las Vegas**
- ***Published 7:59 pm, Friday, May 30, 2014***
- **http://www.timesunion.com/business/article/Driverless-car-journey-starts-in-Las-Vegas-5517869.php#photo-6379150**
- **The Nevada Legislature and the Department of Motor Vehicles have enacted legislation and regulations to enable the testing and operation of autonomous vehicles in the Silver State. Currently, the DMV is accepting applications for testing only. Autonomous vehicles are not available to the general public.**

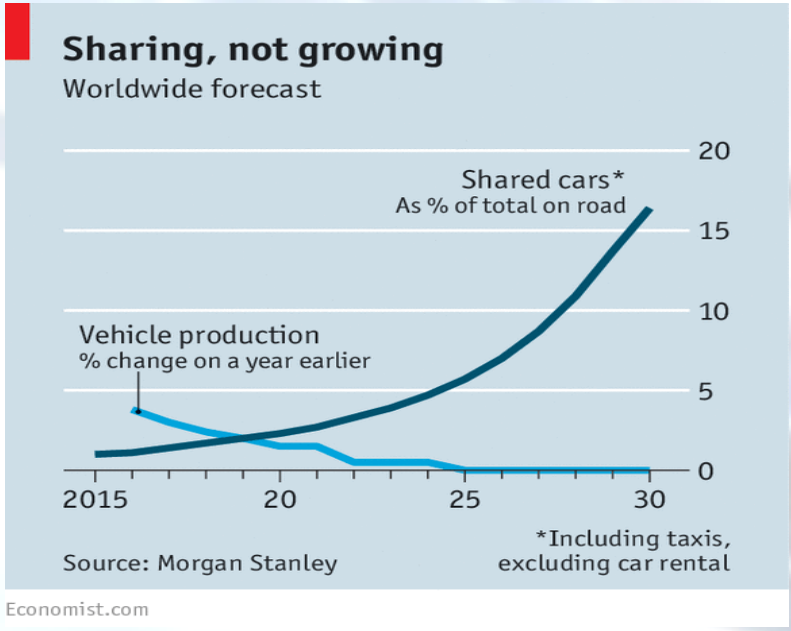
- **http://www.dmvnv.com/autonomous.htm**



Self-driving II | *Partnership and Incentives*

Partnership
http://www.economist.com/news/business/21685459-carmakers-increasingly-fret-their-industry-brink-huge-disruption

"A rumored tie-up between Ford and Google to produce driverless cars failed to materialize at the show, but even the rumors underlined the disruption that tech firms are bringing to the motor industry. And other partnerships were announced: Ford is teaming up with Amazon to connect its cars to sensor-laden smart homes. It was also revealed at CES that Toyota would adopt Ford's in-car technology, which is a competitor to Apple's CarPlay and Google's Android Auto, to access smartphone apps and other features."



"So when will the fully autonomous car hit the showrooms? Google, whose cars have done 1.3m test miles (2.1m km) on public roads, once promised 2018, whereas most analysts reckoned the 2030s more plausible as carmakers introduced automated-driving features in stages.
Barclays, another bank, forecasts that the fully driverless vehicle will result in the average American household cutting its car ownership from 2.1 vehicles now to 1.2 by 2040. A self-piloting car may drop off a family's breadwinner at work, then scuttle back to pick up the kids and take them to school. The 11m or so annual sales of mass-market cars for personal ownership in America may be replaced by 3.8m sales of self-driving cars, either personally owned or part of taxi fleets, Barclays thinks.
Driverless cars still have problems in bad weather. They may struggle to recognize that light shining off a puddle is harmless or guess that a pedestrian is about to step into the traffic without looking. But sophisticated systems for hands-free driving on motorways, and for automated parking, are already available on a number of manufacturers' models. Fully driverless cars will ferry workers round GM's technical centre in Detroit in late 2016."

Self-driving III | *Drones + IoE*

- **CES 2016: drones, driverless cars and smart brewers**
- **http://www.telegraph.co.uk/technology/ces/12081995/CES-2016-drones-driverless-cars-and-smart-brewers.html**
- **Beyond the Internet of Everything, drones took centre-stage. The Telegraph's picks of drones on the showfloor include winner of the CES 2016 Innovation Award, Lily Robotics which makes a "throw-and-shoot camera" – a 2.8 pound camera drone ($799, shipping begins in February 2016), which follows the user via a tracking device.**

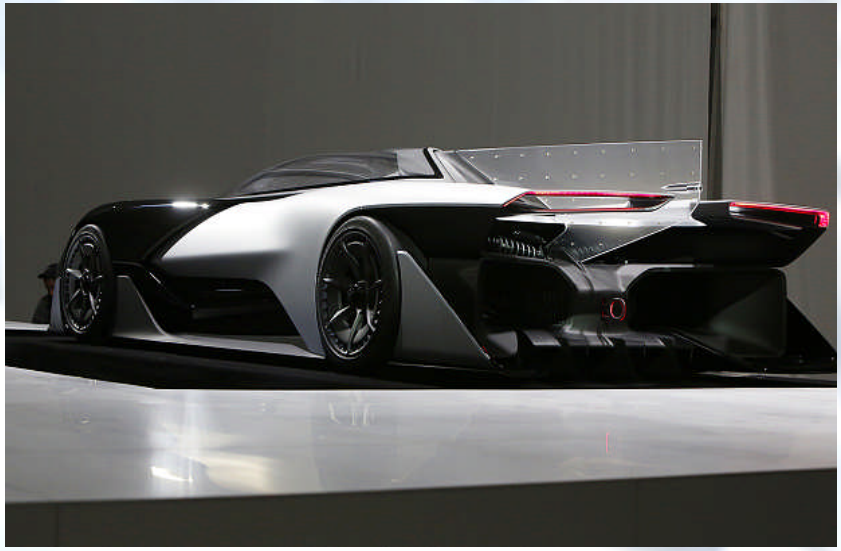
"Chinese drone giant DJI showcased its new Phantom 3 4K – its first-ever sub-$1000 drone with a 4K camera and WiFi transmission upto 1.2km.
And finally, popular drone-maker Parrot showed its giant Disco Drone – a 50-miles-per hour sleek fixed-wing aircraft with a 1080p camera onboard, weighing just 700 grams.
When the show opens officially on Wednesday, there will be an Unmanned Systems marketplace, with 26 different exhibitors."

Self-driving IV | *Computing for vehicles*

Connected cars

http://www.telegraph.co.uk/technology/ces/12081995/CES-2016-drones-driverless-cars-and-smart-brewers.html

- **That prophecy has already started to fulfill itself – GPU chip maker Nvidia kicked off the week's keynote speeches with the announcement of its "supercomputer" for driverless cars. This new system apparently has power equivalent to 150 Macbook Pros, squeezed into a lunchbox-sized case and can tell apart cars, humans and street signs.**
- **Its supercomputer is already being tested in cars by companies ranging from Volvo to BMW, Daimler, Ford and Audi, which managed to train its cars to read German road signs better than any other computer, and even humans could.**
- **Nvidia wants to supercharge the self-driving car phenomenon by launching a supercomputer designed specifically for the vehicles.**



The Faraday Future Zero 1 concept car was unveiled at the Consumer Electronics Show in Las Vegas, Jan. 4, 2016. Photo: David Gilbert

Drive and Steer by Web / *e-Vehicle*

http://www.altreonic.com/content/steer-web-kurt

Altreonic has demonstrated for the first time "steer by web" capability for its KURT vehicle.

Using a camera input and a smartphone, the vehicle was remotely steered over Internet using a web application. Even with the application server and the vehicle being widely apart (about 3000 km) and using a standard ADSL connection, the control was with minimal delay.

This brings KURT in the domain of Internet of Things, enabling semi-autonomous driving for a fleet of KURT vehicles.

events (March 2016)

http://www.citycarsummit.com/ http://www.autotechnica.be/en

→ **urban mobility (uncontrolled behavior of the pedestrian crowd, driverless, drones,…)**

→ **driverless cars, e-vehicle, exceptions handling**

→ **special regulations**

To be done

- Legal back-up and regulations
- Social acceptance
- Cognition/adaptation advanced theory/algorithms
- Encouraging partnership/incentives
- Specialized/high performance computing devices
- Appropriate monitoring/surveillance infrastructures
- Urban computing to be carefully supported
- Continuously revisiting progress/issues
- Governmental enforced regulations

Thanks

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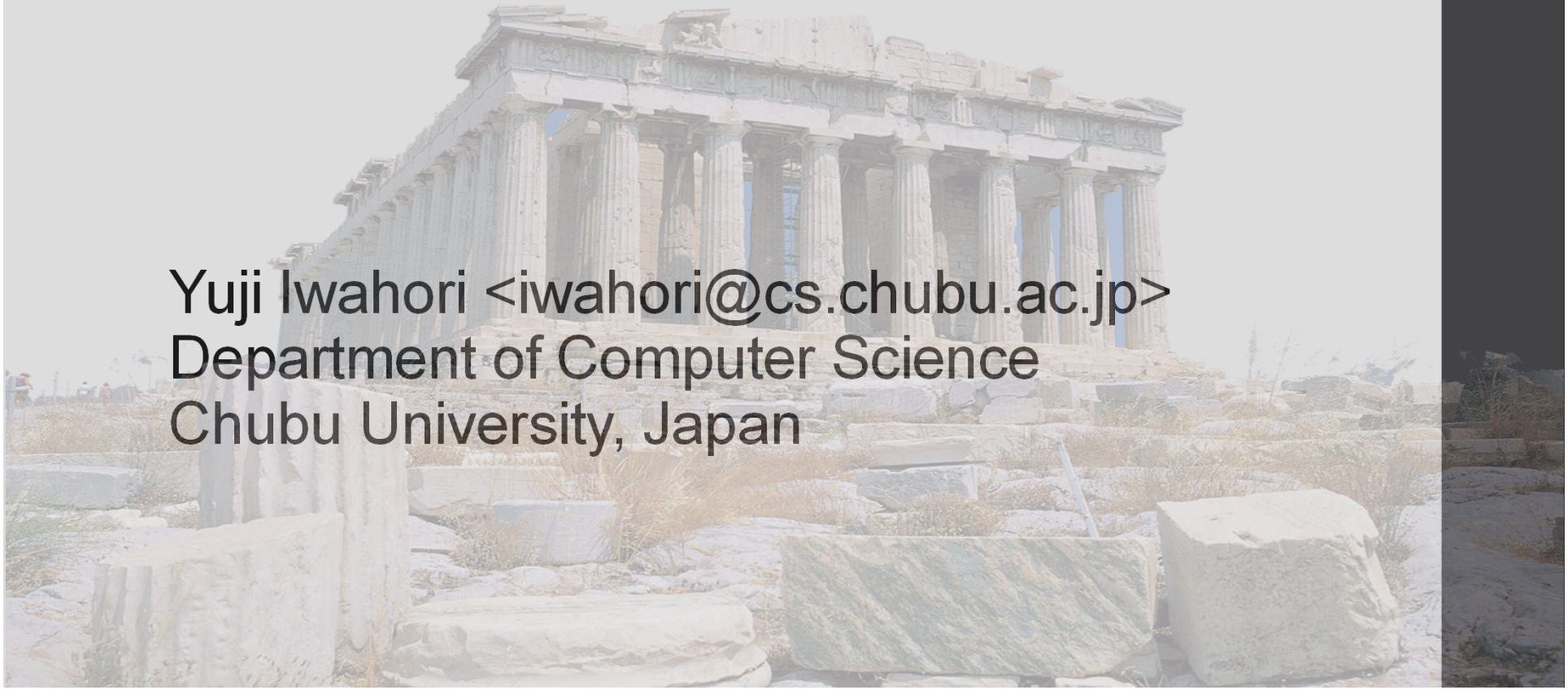
Constructing Background Model to Extract Moving Objects



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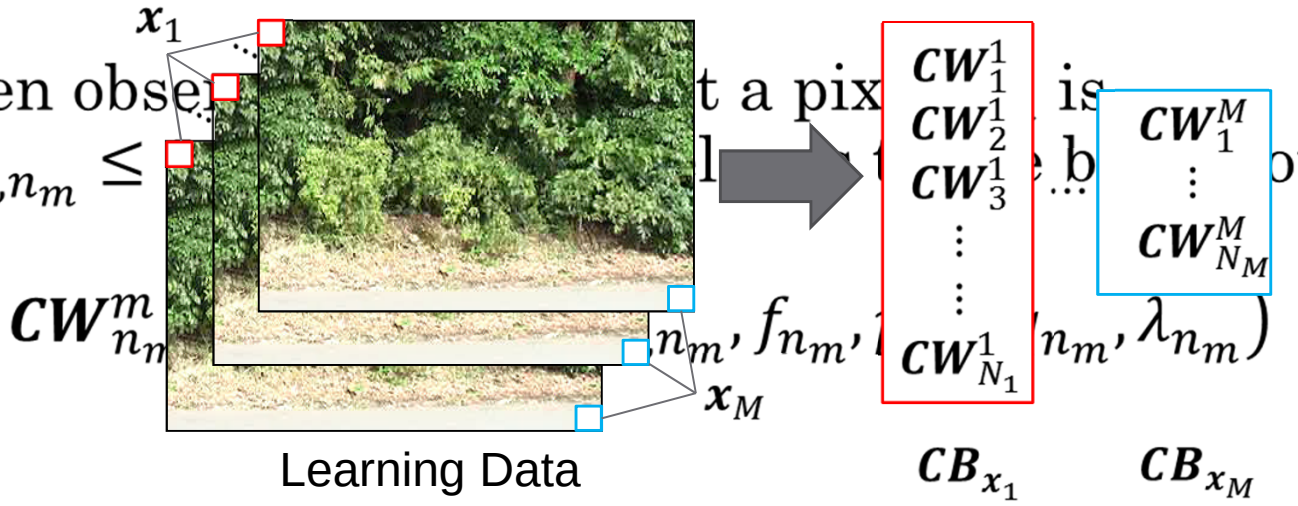
Chubu University, Japan

Background Model by Codebook[1]

- Codebook (CB) is generated at each pixel
- CB records observed data to CodeWords (CWs)
- CW is defined by $(\boldsymbol{I}_{\min}, \boldsymbol{I}_{\max}, f, p, q, \lambda)$

  $\boldsymbol{I}_{\min}$: Minimum Value, $\boldsymbol{I}_{\max}$: Max Value, f : Frequency
  p : Time when CW is generated q : Time of last access
  λ : Period during which CW is not used

- When obse… t a pix… is … $\boldsymbol{I}^m_{\min,n_m} \leq$ … l … e b… ound.



[1] K. Kim, T.H. Chalidabhongse, D. Harwood, L. Davis, "Real-time foreground background segmentation using codebook model," *Real-time imaging*, vol.11, no.3, pp.172-185, 2005

- Problem
  - Cast shadows of moving objects are obtained as objects
- Solution
  - Features robust to illumination changes are used
    - Shadows can be regarded as local illumination changes
  - Feature is changed depending on the region
    - Shadows usually cast onto steal regions (ground, floor, wall, …)
    - Frame is segmented to still regions and small movement regions by the number of CWs

Our Approach

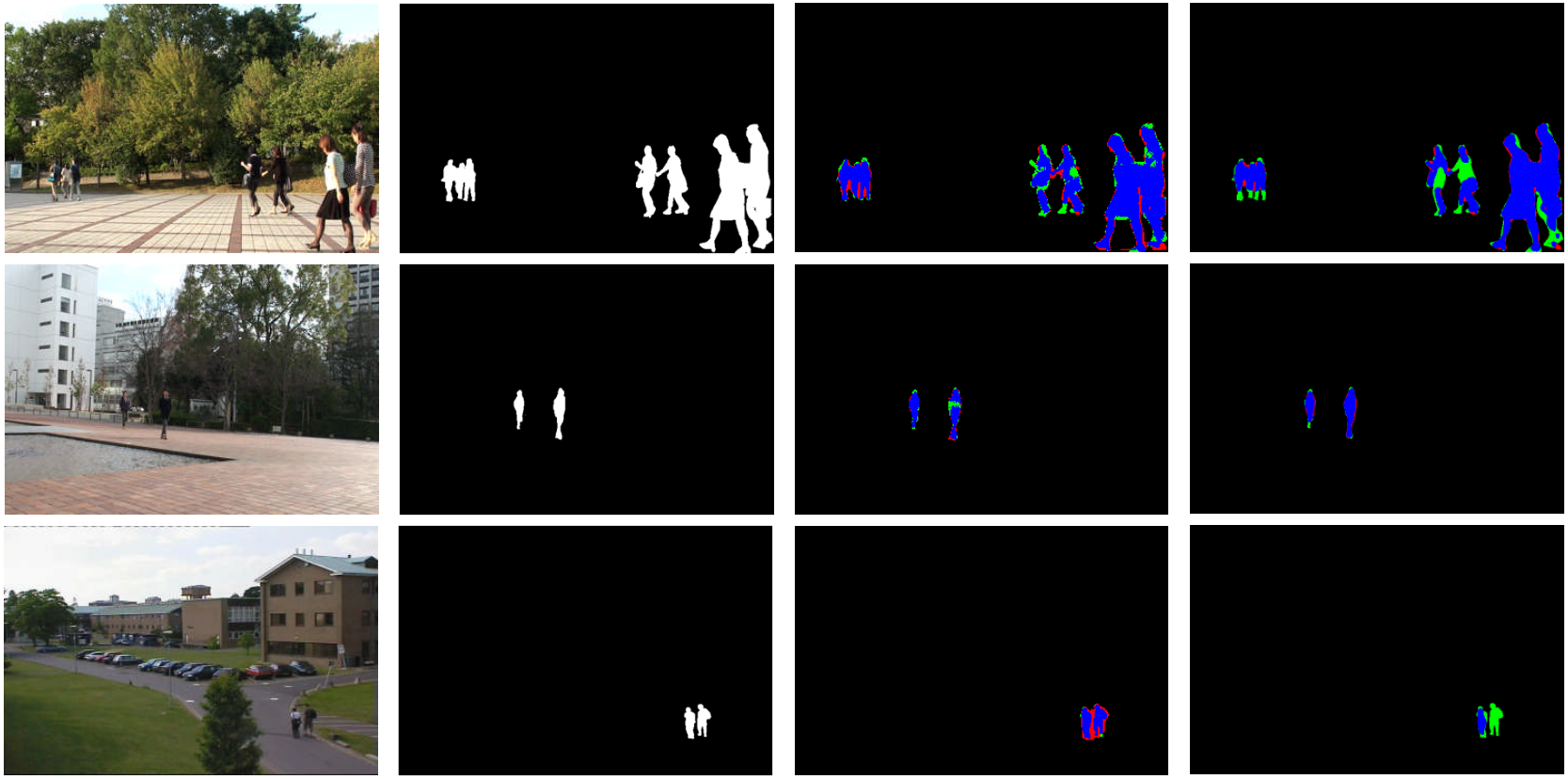
- UV of YUV and SILTP[2] are used
  - UV are used in small movement regions
  - SILTP is used in still regions
- Procedure

1. Generation of CWs with SILTP at each pixel
   - $\mathbf{CW}_{SILTP} = (L_{\mathrm{SILTP}}, f, p, q, \lambda)$
2. Segmentation by the number of CWs
3. Generation of CWs with UV in small movement regions
   - $\mathbf{CW}_{UV} = (\mathrm{U}_{\mathrm{min}},, \mathrm{U}_{\mathrm{max}}, \mathrm{V}_{\mathrm{min}}, \mathrm{V}_{\mathrm{max}}, f, p, q, \lambda)$
4. Object Detection
5. Update of CWs

[2] S. Liao, et al. " Modeling pixel process with scale invariant local patterns for background subtraction in complex scenes," *Computer Vision and Pattern Recognition (CVPR)*, pp. 1301-1306, 2010.

Results

Blue Pixels: Correct
Green Pixels: Incorrect (Undetected)
Red Pixels: Incorrect (Overdetection)



(1)
(2)
(3)

Sample Images | Ground truths | Results of our method | Results of method[3]

[3] P. L. St-Charles, G. A. Bilodeau and R. Bergevin, “SuBSENSE: A Universal Change Detection Method With Local Adaptive Sensitivity,” *in IEEE Transactions on Image Processing*, vol. 24, no. 1, pp. 359-373, Jan. 2015.

Method	Scene	Recall	Precision	F-measure
Our Method	(1)	87.51	84.99	86.23
	(2)	77.98	83.33	80.56
	(3)	88.85	72.83	80.05
Method[3]	(1)	74.20	87.76	80.41
	(2)	94.1	87.23	90.54
	(3)	57.61	91.12	70.59

$$\text{Recall} = \frac{TP}{TP+FN}$$

$$\text{Precision} = \frac{TP}{TP+FP}$$

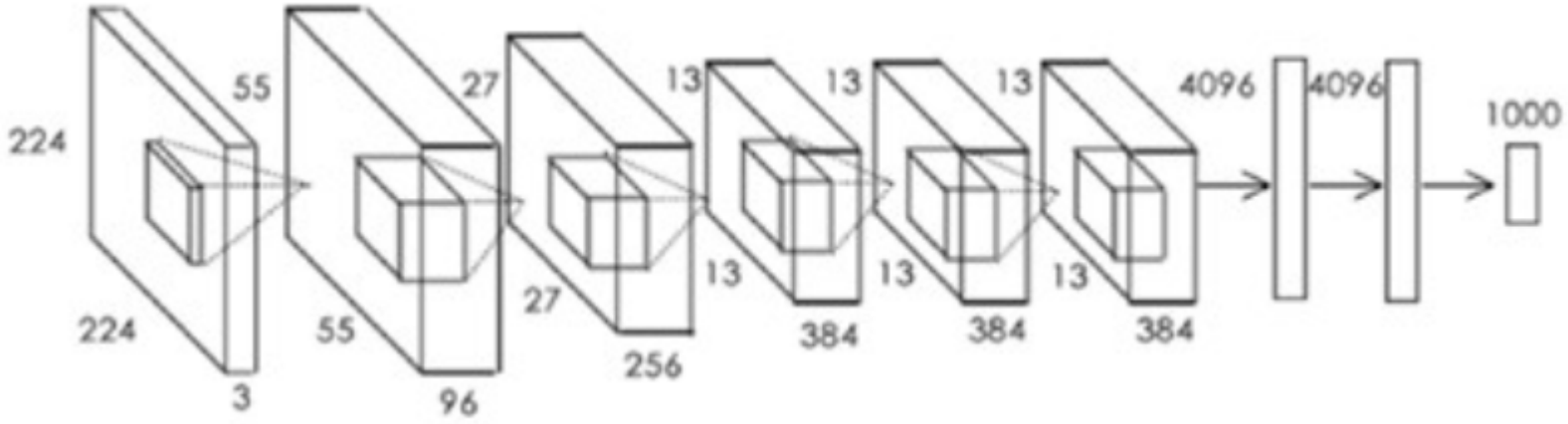
$$\text{F-meausre} = \frac{2 * Precicion * Recall}{Precision+Recall}$$

TP : True Positive

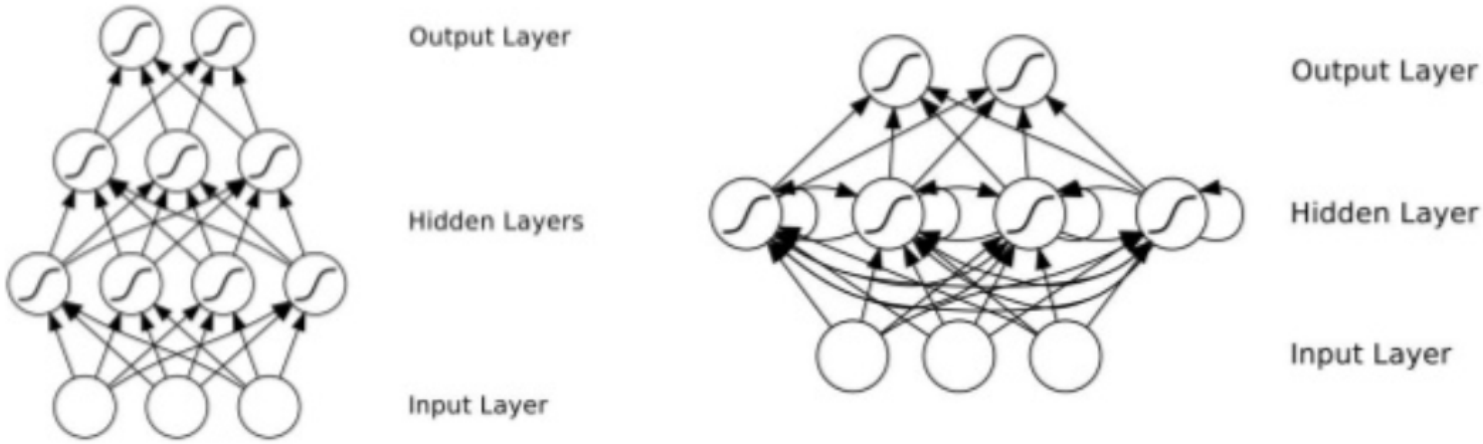
FP : False Positive

FN : False Negative

AlexNet (CNN Model)



Feedforward NN vs. Recurrent NN



Example of Faster RCNN for Object Recognition

https://drive.google.com/file/d/0B51wBlYOrV0AN0dTbklFRHM5Qms/view

Happy solution is target is also moved with moved background under moving camera. One camera is still available for this solution. This is an example for further solution.