Trends, challenges and applications of cognition in modern autonomous systems

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Cognition in autonomous systems

- Acquisition of the environment
- Preprocessing
- Training/Decision
- Data base/Knowledge
- Neuroscience
- Actions to change the environment

Example of an autonomous intelligent agent:

1. As shown in the general view
2. Example – self-navigating drone or plane
3. Self-driving car

IoT – now AoT (Agent of Things)
TOP-3 TRENDS THAT WILL DRIVE THE MARKET FOR AUTONOMOUS VEHICLES

1) Real-time route optimization
Connected together with Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) mechanisms.

Enables driverless vehicles to gain real-time information on the condition of the roads as well as exchange protection and mobility information with the surrounding infrastructure and redirect the routes accordingly.
2) Increased lane capacity
This technology adjusts the vehicle’s speed mechanically to ensure a safe distance between the vehicles on the road. These technologies will optimize the lane capacity and reduce accidents, ensuring greater passenger comfort and safety.

3) Reduced energy consumption
Autonomous vehicles are lighter than the conventional automobiles. Thanks to the lightweight composites used for building the modern, further aided eco-friendly driving technologies and practices as smooth deceleration and acceleration.
1. Adaptation of new added network devices to automatically adjust their QoS parameters to the backbone ones;
2. Predict the congestion and early traffic redirection
Resolving Deny of Service attacks (DoS)

[Graphs showing baseline versus DoS over time]
Cognitive robotics - trends

Summarized functional abilities needed for cognitive robots:

• They have to operate reliably and safely around humans and they will be able to explain the decisions they make;

• Knowledge acquisition and generalization. Cognitive robots will continuously acquire new knowledge and generalize that knowledge so that they can undertake new tasks by generating novel action policies based on their history of decisions.
• **Adaptive planning.** Cognitive robots will be able to anticipate events and prepare for them in advance. They will be able to cope with unforeseen situations, recognizing and handling errors.

• **Personalized interaction.** (understanding of the person's preferences)

Cognitive robots will personalize their interactions with humans, adapting their behaviour and interaction policy to the user's preferences, needs, and emotional or psychological state.
• Self-assessment. They will be able to assess the quality of their decisions.
• Learning from demonstration. Cognitive robots will be able to learn new actions from demonstration by humans and they will be able to link this learned knowledge to previously acquired knowledge of related tasks and entities.
• Evaluating the safety of actions. When they learn a new action, cognitive robots will take steps to verify the safety of carrying out this action.
• Knowledge transfer to other robots. Even to those having a different physical, kinematic, and dynamic configurations and they will be able to operate seamlessly in an environment that is configured as an internet of things (IoT).
• Collaborative action. Cognitive robots will be able to communicate their intentions to people around them and, vice versa, they will be able to infer the intention of others, i.e. understanding what someone is doing and anticipating what they are about to do.
In my opinion, artificial intelligence can not be better than the biological, it will only try to imitate it. This is because the people are the ones who set the algorithm of behaviour and the robot self-learning is controlled.
• **Saving risk** by the inspection of high tension electrical towers with Unmanned Aerial Vehicles (UAVs).
• **Utilizing drones for resource management and fire management** missions.
• **Delivery of critical supplies** like medicine to remote areas.
• **Wireless internet hotspots to restore service after a natural disaster.**
• The use of a **thermal imaging camera to find a lost person in remote areas.**
TRENDS

• Some investment organizations have predicted that the sales of civilian UAV will maintain an annual growth rate of 50% or more.

• Can not only fly along routes autonomously, but also detect and avoid obstacles in real time.

• Some of them can fly in formation and cooperate with each other autonomously.

Spatially Targeted Communication
Intelligent breading buildings
FPGA with implementation of a neural network
Real-time NN implementation in Programmable Logic Controllers (PLCs)
Do we need Input Data pre-processing?
Complex structures of neural networks resembling human behaviour
Off-line image processing

On-line image processing

Train and optimize

PLC Communication

Industrial camera
Edges = 7
Caliper1 = 2
Caliper = 9
Qualität = SCHLAECHT
Beer OK!
- CCD Camera Nikon D7100,
- CMOS 23.5x15.6 sensor
Resolution of 4494x3000 pixels.
• $H(g) = \frac{[H_L(g) + H_R(g)]}{2}$
• $\frac{dH(g)}{dg} = \frac{[H(g_j) - H(g_i)]}{(g_j - g_i)}$

some emotional conditions cause blur
60 samples
60%-10%-30% (i.e. 36 – train samples,
6 – validation, 18 – test samples
60 samples
60%-10%-30% (i.e. 36 - train samples,
6 - verification samples, 18 - test samples

120 samples
Applying both: 72 - train samples,
12 - verification samples,
36 - test samples
## Industry Sectors affected by Cognition in Autonomous Systems

<table>
<thead>
<tr>
<th>Sector</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation &amp; Logistics</td>
<td>76.2%</td>
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<tr>
<td>Manufacturing</td>
<td>73%</td>
</tr>
<tr>
<td>Automotive</td>
<td>71.4%</td>
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<tr>
<td>Industrial Automation</td>
<td>63.5%</td>
</tr>
<tr>
<td>IT</td>
<td>47.6%</td>
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<tr>
<td>Aerospace &amp; Defense</td>
<td>42.9%</td>
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<tr>
<td>Energy &amp; Utilities</td>
<td>30.2%</td>
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<tr>
<td>Telecommunications</td>
<td>28.6%</td>
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<tr>
<td>Retail &amp; Consumer Goods</td>
<td>25.4%</td>
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<tr>
<td>Oil &amp; Gas</td>
<td>19%</td>
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<tr>
<td>Chemicals</td>
<td>17.5%</td>
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<tr>
<td>Pharma &amp; Lifesciences</td>
<td>15.9%</td>
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<tr>
<td>Association &amp; Research</td>
<td>6.3%</td>
</tr>
<tr>
<td>Other</td>
<td>1.6%</td>
</tr>
</tbody>
</table>
Survey Report - referred to 2018

Company size by number of employees

- 49.2% < 1,000 employees
- 14.8% 10,001 - 50,000 employees
- 11.5% 1,000 - 5,000 employees
- 9.8% 5,001 - 10,000 employees
- 8.2% > 100,000 employees
- 6.6% 50,001 - 100,000 employees

- 34% Board Member / Vice President / C-Level
- 48% Director / Head of / Leader
- 18% Senior Manager / Project Manager
Company’s budget spent on development of autonomous systems

How high on your agenda and strategic outlook is the *integration of cognitive machines and autonomous systems* in your company?
Challenges of Autonomous Systems Integration

What are the biggest challenges the companies are facing in taking the first steps towards autonomous systems and cognition implementation?
Thanks for your attention!