PRIMENA KOGNITIVNIH ELEMENATA ZA MONITORING SOLARNIH ELEKTRANA

THE APPLYING OF COGNITIVE ELEMENTS FOR THE SOLAR POWER PLANTS MONITORING

Ivan APHANASYEV, Tykhon SYTNIKO, Yurii ORNOVETSKYI, Vladyslav SULAKO, Valeriy SYTNIKOV
Odessa national polytechnic university, 1, Shevchenko av., Odessa, Ukraine, 65044, sitnvs@gmail.com

Kao i obično, bilo koji tehnički sistem može biti u zastoju. Tehnički tim treba da ga redovno održava. Sistemi poput vetroturbina ili fotonaponskih solarnih panela nisu urbani, zauzimaju ogromnu teritoriju. Detaljna provera i testiranje svake jedinice zahteva dosta vremena. Učestalost ili efikasnost pregleda treba povećati korišćenjem veštačke inteligencije. Primena ovih pristupa u svakom generatoru je veoma opsežna. Biće mnogo jeftinije imati nekoliko robotskih agenata koji će zameniti tehnički tim. Ti agenti bi trebalo da obavljaju rutinske zadatke ljudi, nakon što otkriju kvar, prema potrebi, upravljaju problemom. Teme koje nam omogućavaju da zamenimo neke funkcije stručnjaka su organizacija sopstvenog kretanja, orijentacija u prostoru, kompjuterski vid. Kognitivno računarstvo nam može pomoći da se približimo razvoju svih agregiranih funkcija. Upravo implementacija kognitivnih procesa omogućava razvijanje stvari poput iskustva, postavljanja zadatka za sebe, potpune autonomije.

Ključne reči: *kognitivno računarstvo; praćenje; solarna elektrana*

As usual, any technical systems could be in downtime. The technical team should make maintenance regularly. Systems like wind turbine or photo-voltaic solar panel are non-urban, they take a huge territory. Detailed checkup and test of each unit demands a lot of time. The frequency or effectiveness of checkup should be increased using artificial intelligence. To deploy those approaches in each generator is very expansive. It will be much cheaper to have a few robotic agents which will replace the technical team. Those agents should perform routine tasks of humans, after a malfunction finding, as appropriate, operate the problem. The topics that allow us to replace some technical specialist's functions are organization of one's own movement, orientation in space, computer vision. The cognitive computing may help us get close to develop all aggregated function. Exactly the implementation of cognitive processes allows to develop things like experience, setting a task for oneself, complete autonomy.

Key words: *cognitive computing; monitoring; solar power plant*

1 Introduction

Humanity's use of alternative energy sources is gaining momentum. The modern countries more and more care about ecology approaches of energy generation. Today there is a mind that traditional energy generation is cheaper than alternative but dynamic is declining. The production costs for alternative approaches have been drastically reduced for the last 10 years by the continuous technology's modernization, economies scaling, competitive supplies and development experience improvements. The electricity costs were down for the 85% from 2010 to 2020 years by the photovoltaic solar panels (PV) [1].

The question about importance of using alternative energy is relevant today. Further, more and more ecology practices will be applied on government level, more and more will be carried out the topic researches. Those perspectives are necessary for now than ever because governments are in the process of developing new national climate commitments known like Nationally Determined Contributions or NDC which were initiated after Paris Agreement. The importance is underpinned by a

huge potential with energy safety, energy access, social and economic development, more soft climate changes and health impacts [2-3].

The one of main directions of alternative energy are research and development non traditional renewable energy sources. The reason of research is need to demand an energy from renewable or nearly inexhaustible natural resources and phenomena. The environmental friendliness and economy can be taken into account.

The research of new approaches happens at same time with adapting up old ones. The non-urban energy generators based on renewable resources are applied each year in Europe. For the 2020, the Europe has 205 GW of wind energy capacity. UK has 16%of capacity turnover. Three quarters of new wind generators were onshore. By Europe Green Deal from 2019, the Europe has a plan to become a leader in the renewable energy [4-5].

The important fact that the typical renewal generators are non-urban. Those systems are harder for the maintenance. Average costs for one solar panel are from 450$ to 780$ per year for Americans. The solar power plants support includes the maintenance for complex electrical systems. In additional to the big number of solar panels in plant. To support the renewable energy plants, need to have a highly paid specialists' team. Besides planned check, solar panel cleaning from dust, the extremal weather environments could be a potential risk. In dusty regions such as Rajasthan in India, cleaning will be required once a week [6-7].

Figure 1. Solar power plants in south regions of Ukraine

The south Ukraine has a huge possibility to become in the region's leader over deploy of the renewable energy systems. Recently, the new solar power plants have been built actively in the region. The companies have been evolved whose business is built over solar panel integrations for the private houses. Applied practices like in private enterprises or in state enterprises are requiring automatization. In general cases, the manual approaches are used for the maintenance, static monitoring for the territory and web-applications for viewing gathered analytics [8-10].

At intelligent system sage, the automatization of support process may well save the maintenance costs for the non-urban renewable energy systems. The computer systems could be applied both for IoT way and for replacing technical team by using active robotic agents.

2 Automatization of the inspection process for the solar panels

Today, the engineer team carry out the inspections of solar panels. Their main execution tool is thermal imaging camera. The thermal imaging cameras are effective in usage, they could identify any production defects, fissures, nonfunctional components, faulty bypass diodes, or even temporary dimming of solar panels [11].

The rarer approaches are inspections using UAV. Today it is the most efficiently. Comparing the manual and UAV, the following general advantages:

1. Costs reducing. The UAV guaranties that using new method the costs and event possible downtime will be reduced for equipment, maintenance, inspection.

2.Improved efficiently — UAV gathers data nearly to 50 times faster then do it manually. It makes UAV extremely economical. Since solar farms tend to be installed over long areas, drones equipped with thermal and RGB sensors can effectively cover a larger area for defect detection than manual procedures.

3. Improved data quality and volume. The UAV could be improved by AI and machine learning. The air drones accurately make required tasks and don't lose problems from vision which could be hidden in manual control.

4. The importance of environment. The UAV cannot work in extremely weather environments.

There are the most frequently used inspection techniques in UAV for solar panels, following:

1. Visual inspection. This method primally used for inspection of the suitability of PV systems for operation. Visual inspection can successfully detect defects such a dirt, fissures, delamination, discoloration, and even the snail marks on panels.

2.Electroluminescence. This method should be applying in dark environments for more accuracy detection of defects. The damaged areas reflect dark light in process, while healthy area reflects transparent light. For example, the electroluminescence will recognize defects like fissures in the dark lines form. The procedure has a several disadvantages. The solar power plants inspections cannot be performed during their operation. It causes of the downtime.

3. Infrared Thermography. Any temperature above absolute zero emits the thermal radiation in the form of electromagnetic waves in proportion to their body temperature. The thermal imaging cameras could find the radiation, map in electrical signal, create thermograms in which each pixel contains temperature values [12]

Figure 2. The defects examples in solar panels

The applying of UAV techniques provides a huge benefit over the manual approaches. More valuable are cost and speed values. Such approach is not fully automated. Another type team is necessary for approach implementation.

Non-urban systems require some time for dislocation of inspection teams. For hard-to-reach places, the approach remains expensive. Those non-urban plants, the different inspection approaches will be required.

Such like problem could resolve full automated robotics. Agents that do not require technical team. The agents will replace the team. In this case, the need is completely eliminated in dislocated technical engineers. The agent hub will be located not far from solar power plants. When inspection time is required, the agents could perform the inspection without human intervention.

That robotics realization is very complex and expensive process. Today that robotics are not existed which replace human but by new approach the availability of reach and efficiently solar panel support can be reached. The maintenance problems are known for today, the engineers can get requirements for those systems right now and start the development process.

Modern research areas of "humanization" the robotics is cognitive systems topic. Researching topic, it is possible to achieve fully automated and adapted systems which could replace technical engineer teams for the solar power plants maintenance.

3 The cognitive systems applying in robotics

There may not be the outward differences in cognitive and noncognitive robotics. Those systems also have specific modules which receive and handle data properly. Main difference is architecture of processes inside robotic systems. The cognitive architecture suggests to build the processes based on cognitive psychology discipline.

Typical robotic system for inspection of solar panel includes vision module, UAV module, network module for data transmissions, data processing pipelines modules. Specialized system built on typical modules can perform pre-assigned tasks by strict steps. Often agents are managed by specialist manually.

By full automated approach, the per-assigned methods will be not efficiently because robotic systems will be in unknown for developer environments or conditions. The active robotic agents should be full adaptive on situation changes. Also, the agent should have interactivity to interact with solar panels. For this, the agent should have the identification and recognition abilities [13].

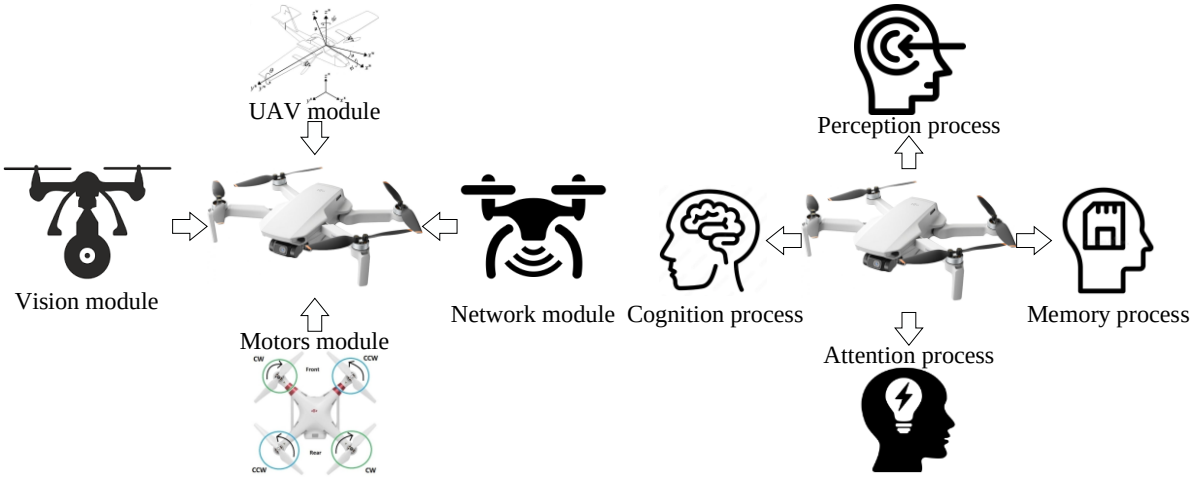

Figure 3. The most popular robotic modules and cognitive processes inside cognitive system

The cognitive process inside robotic systems built on human processes examples. They number up to ten. The picking out of one cognitive process is complex task because all process inside human brain is high coupled. The realized memory module in robotics does not guarantee that, system is cognitive. Full realization all cognitive process inside robotics is complicated task which is located at the intersection of the different humanities with implicit models. Thus, it is much easier to implement agent close to cognitive system taken the several processes. Comparing robotic systems and humans, there are vision, hearing, smelling. There is availability to extract some data processing

module, reaction on environment events module. There is the possibility to store all information or very necessary.

The perception is human analog of information input. The process organizes all possible kinds of images processing like vision, hear, smell, tactility. The parallel images are generated by modalities. The perception realization problem is images consistency. When from one object the signal goes through two modalities, there may no doubts that may be different objects [14-15]

Human perception built on way that we person can perceive almost everything around us, all input signal. But the human brain protected from intensive information flow by memory and attention mechanisms. Human memorizes only important information and handles prioritized information. The attention process is are source-based, which is expressed in the ability of the brain to work effectively. To prevent harm itself, the brain limits its capabilities.

Endless data flow in cognitive system requires the realization of streaming information processing. Data are conveyed though all cognitive processes, starting from perception to long-term memory. In these systems there is no unidirectionality, all processes are intersected or parallel [16].

Having significant limitations in the cognitive system implementation, for today, perhaps the best way would be a partial realization of a robotic system based on only elements of cognition. To define important cognitive processes in side system, need to extract requirements for future system.

4 Common monitoring algorithm of the cognitive robotics for solar panel plants

The algorithm example for monitoring using cognitive elements system inside, following:

1. Time to start inspect process of solar power plants. The process can be started by server as initial or by agent cognition about time. By second version, the agent will send server message about wake up.
    a. Robotic modules: Communication module
    b. Perception – The agent obtains signal by some network protocols. Potentially, agent should have another modality for networking. Or it should be social modality like more complex way
    c. Attention –The server command must be in high priority. Agent should react mandatory. Before, an agent could be under another load, but next command might interrupt process.
    d. Memory – The agent should store server request in memory
2. The agent goes out from awaiting location and disposes itself on safe height. The agent should understand how to get out from build, what a way to get out, what a safe height.
    a. Robotic modules: UAV module, Vision module, Movement module
    b. Perception – Need to organize data stream from different modules. There are a lot of noise and useless data.
    c. Attention – Need to keep attention over crucial task and sub tasks like (another objects, walls, height, obstacle)
    d. Memory – Need to store path which used to get out building
3. Agent need to reach destination. Agent should recognize direction, endpoint of plant. The serve should send coordinates of place in initial message.
    a. Robotic modules: Movement modules, UAV modules, Vision modules
    b. Perception – Data organization of a lot of signals in process of movement
    c. Attention – Agent should keep attention over direction. Each step, the agent should coordinate, check itself
    d. Memory –Agent should store traveled distance and rest of the way
4. Agent reached the endpoint. After that, an agent needs to confirm about destination. Using vision module, need to recognize the solar plant to confirm destination. Could make coordinate with central server about arrival.
    a. Robotic modules: Vision module

b. Perception – on this step the vision modality is main in cognitive processes
c. Attention –The agent has same high priority task about inspection but for this step, the agent needs to use attention to find plant
d. Memory – The agent should store the view of solar electric plant

5. Agent should inspect each solar panel on plant. Should find first top-left unit in matrix, come up, get up over panel, use vision model to find defect on solar panel. After all, agent should send message to server about panel status. Agent can make different action for inspection.
    a. Robotic modules: Vision module, UAV module, movement module
    b. Perception – Also on current step, the process should organize data stream from all robotic modules.
    c. Attention – Need to keep attention over all micro actions: position over panel, next panel to inspect
    d. Memory – Need to stoke inspect results, need to store view of solar panel to find them in arrays
6. Agent finishes inspection of plant. Agent should send message to server about results. Agent needs back to initial position
    a. Robotic module: Vision module, UAV module, movement module, communicate module
    b. Perception –No difference with another steps
    c. Attention – No difference with another steps
    d. Memory – Agent need to store the results of inspection. They should be used for next inspection or for analytics.

By extracted requirements for robotic active agents there is conclusion that the cognitive processes involved in all agent actions. It is possible that for building full cognitive system there is need to involve all robotic modules. Sometime it makes sense, by analogy with the human brain, the person uses vision for social perception. In our case, for communication with server-side there are no effects from vision. If the requirement will be extracted for the interactivity with human, in this case, the vision module is mandatory,

5 Conclusion

Regardless of complexity for the robotic systems with cognitive processes, taking into account all internal limits, the final robotic agents will be able to completely replace the inspection team. There is important limitation for thesis – all important cognitive processes should be realized inside robotic systems.

The implementation of partial cognitive process inside robotic system will allow to automate and adapt the make-decision process in final agents. Also, will allow to increase intelligent part in specific production processes.

However, onstate-of-the-art stage it is enough to know general tasks or requirements for systems, which a personal meet in the work process, to start push research for the perspective direction. The perspective is not only for alternative energy topics.

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