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CYBERPHYSICAL SYSTEMS: BENEFICIAL PENETRATION

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Cyberphysical systems (CPS) are considered to be a rather complicated ambiguous notion as they are located at the intersection of various subject areas and influence different spheres of peoples' lives. A cyberphysical system can be viewed as a set of closely interrelated computational and physical elements possessing the competences of getting real-time data from the surrounding environment and applying this information for subsequent optimization of the management procedures [1].

Several basic technological conditions can be distinguished in the context of CPS designing and engineering. Firstly, there is a constantly growing number of devices with embedded data processing and storing capabilities and rather branched sensor networks efficiently implemented in practically all developed smart systems and structures as well as enhanced medical care facilities and smart homes. Secondly, there is commonly observed insertion of separate components into much larger systems, such as IoT, World Wide Sensor Net which helps to gain better results and higher productivity. Thirdly, there is an evident limitation of people's memory and cognitive possibilities, that unfortunately develop much slower than those of an intelligent machine. Thus, of course, we are likely to face the situation when humans can no longer perceive and analyse the scope of information necessary to make quick and well thought out decisions and they will have to delegate some of their responsibilities to the CPS, thus eliminating the person from the management loop. However, in certain situations CPS can stimulate and improve person's disquisitive powers therefore we can say that there is an evident need to create interactive frames combining the cooperation of a person and a CPS both sharing their abilities and functionality.

As we have already mentioned above, the operating principle of cyberphysical systems depends entirely on the interconnection and interaction of their physical and computational elements. Artificial intelligence,

performing the function of the system's brains, receives initial data from various input devices, primarily sensors, processes and analyzes this data, and then applies them to subsequent control of physical environment. Based on this interaction, the cyberphysical system can demonstrate high efficiency and reliability under permanently altering conditions, with the operation cycle "Management – data acquisition – data handling – management" achieving highly effective results and each time creating new benefits [1].

For example, Toshiba Company practically implements the principle of cyberphysical systems in its virtual power plant project, which uses Internet of Things technologies to coordinate the operation of the frame consisting of distributed energy sources (solar, hydrogen and wind energy), electric vehicles working on it and energy accumulation/storage units. Using data from IoT devices and AI technologies creates possibilities for enhancing efficiency of energy consumption by the system, predict its development scale and ultimately achieve maximum energy savings.

Among other applications of cyberphysical systems, it is necessary to mention autonomous navigation and vehicle control systems that have the ability to receive real-time road information from other traffic participants and urban road infrastructure in order to choose the most optimal route taking into account the current traffic situation, prevent accidents and ensure the safety of all road users; medical equipment that is capable of remotely monitoring the physical conditions of patients, helping in diagnosing illnesses and conducting surgical operations and manipulations, as well as which can be used to create simulations of situations in order to study the abilities and capabilities of the human body. It can definitely be said that the use of cyberphysical systems facilitates people's lives, increases their standard of living, and creates conditions for the further development and improvement of intelligent systems.

The ability to "make people's lives better and easier" with the help of these systems can be perfectly illustrated by the example of smart cities. According to research statistics, Singapore is considered to be the most intelligent city in the world, while the government, scientists, and programmers are making every effort to further implement the Smart Nation project, which is a joint program of Singapore authorities to develop and improve urban infrastructure. Many innovative start-ups are jointly looking for solutions affecting almost all areas of daily life of city residents:

from law enforcement agencies involved in detecting offenses and taking measures to anticipate and prevent them due to the implementation of a developed autonomous video surveillance system in the city to the management of the urban transport network, as well as energy and water resources distribution, and healthcare. And this brings its own rewards, for example, the traffic management system helps Singapore drivers save thousands of hours a year, and according to the safety ranking made by Economist Intelligence Unit, Singapore is recognized as the safest city in the world due to its extremely low crime rate.

Another option for a "smart" approach to urban planning is the city of Masdar in the United Arab Emirates, which is being built near Abu Dhabi. According to the views of the local authorities Masdar is supposed to become an eco-city that totally meets its needs with renewable energy sources, fully recycles all produced waste and completely abandons traditional modes of transport in favour of public and personal autonomous transport. Of course, the latest technologies, including cyberphysical systems, will be used in Masdar to effectively manage resources and traffic flows.

Summing up, it should be noted that in the last decade cyberphysical systems have made a big leap in their development, which was facilitated by an increase in the number of intelligent devices and systems as well as sensor networks being developed, and their natural integration into larger, more complex systems. But according to Toshiba technical director, Doctor Shiro Saito, the transition to open innovation is very important for the future of these systems. "It is extremely important not to fall into the trap of wanting to achieve everything on your own," he notes [1]. Therefore, companies engaged in the development and implementation of such systems actively invest in the development of modern technologies, support and study all innovative ideas related to artificial intelligence, and cooperate widely with research and educational institutions. The task of such companies is to make the most effective use of modern products and techniques to solve urgent daily socio-economic issues.

References

1. The Rise of Cyber-Physical Systems [Electronic resource] – Mode of access: https://www.nationalacademies.org/news/2023/11/the-rise-of-cyber-physical-systems. – Date of access: 01.03.2024.