Industry4.0 in agriculture

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Agriculture production sector is the key economic area in Israel and Poland. As a result, the productivity in the agriculture is in the centre of interests of private companies and research institutes in both partner countries.

Recently the world is facing the fourth industrial revolution called INDUSTRY 4.0. The idea of INDUSTRY 4.0 is to bring the productivity on the higher level not by the more intensive exploitation of resources, but by more effective management of resources and introduction of elements of artificial intelligence cooperating with the humans in industrial processes.

Application of ideas of INDUSTRY4.0 in the agriculture (known as the FARMING4.0 or AGRICULTURE4.0) was proposed soon after introduction of the idea of INDUSTRY4.0 [1]. As in other areas, FARMING4.0 is based on the "produce more with less" concept. It is estimated, that implementation of FARMING4.0 in the agriculture will lead to the increase of efficiency of production up to 15%. Considering, that agriculture (and accompanying services for agriculture) participation in gross domestic product (GDP) of Israel is about 9% whereas in Poland it is about 8% (accordingly to GUS (Statistical Office if Poland), Eurostat and OECD), implementation of FARMING4.0 in 35% of agriculture production process will lead to increase GDP of Israel and Poland by 0.37% and 0.42% respectively. It should be stressed, that this increase will happen without increase of intensity of exploitation of natural resources or energy consumption. For this reason, problems of INDUSTRY4.0 are in the focal point of interest of national governments as well as private companies offering solution for agricultural business as well as individual farmers and farming companies.

Recently developed solutions for FARMING4.0 are based on the standardized industrial automation equipment, such as programmable logic controllers (PLC), industrial sensors or devices for specific methods of data transmission (such as GMS or low power radio) [2]. Such solutions are useful for research activities or for feasibility studies, however, its possibility of wide implementation to the agriculture is strongly limited. This limitation is caused by the lack of energy consumption optimization, limited information about models of used sensors as well as limited knowledge about electromagnetic compatibility of applied hardware.

From the point of view of information technology, previously developed systems were oriented on demonstration of specific functionality of intelligent farming or predictive maintains in agriculture [3]. As a result, possibility of wide application of developed systems was limited. Moreover, due to the limited scale of implementation, the development of artificial intelligence-based optimization models was limited to specific cases due to lack of critical mass of collected data, necessary for machine learning process.

System developed in the bilateral Poland-Israel project responds on recent trends aiming introduction of INDUSTRY 4.0 ideas to the agriculture. The main goal of the project is to develop INDUSTRY 4.0 oriented, cyber-physical system for distributed monitoring and control in the agriculture production. Proposed system, accordingly to the conception of INDUSTRY 4.0 will cover four layers:

- Decision support (fourth layer)
- Data processing (third layer)
- Data acquisition and transmission (second layer)
- Sensors (first layer).

The sensor layer (the lowest layer) of the system will not be oriented towards specific sensors, but will enable the 'plug-and-play' connection of low-level sensors to the developed system. For this purposes standard analogue industrial interfaces will be implemented (4-20 mA, 0-10V) together with serial interfaces such as RS-232/485, SPI and Bluetooth. As a result commonly used industrial sensors (like liquid level sensor, temperature sensors, rotation and position as well as crystallization sensors) and more sophisticated modules (such as GPS positioning) will be efficiently connected to the system feeding it with real time, real world data.

The second system layer, data acquisition and data transmission layer will be developed on the basis of the real-time operating system (RTOS), implemented in the embedded ARM microcontroller architecture. Developed subsystem will collect measuring data in the real time, pre-process it and provide information for the cloud computing. To enhance reliability of the system, it will be powered from industrial battery or accumulator recharged by the solar batteries. From physical/sensor layer point of view, the multimodal data transmission will be implemented covering cable (LAN) and wireless data transmission, such as GSM and WiFi. The module will automatically change the transmission channel according to availability. In special cases, satellite data transmission will be implemented by the INMARSAT D/D+/IsatM2M system.

For the data transmission system, the specialized, cloud oriented RESTful API web service will be implemented. This web service is the most interoperable and universal, commonly used in IT industry for machine-machine and machine-human interaction. For data protection the specific authorization framework will be implemented according to OAuth 2.0 specification and requirements.

Data processing layer (third layer) will cover verification of data coherence, real time estimation of uncertainty of data as well as data fusion focused on different sources with dependable data coherence. As a result sensors will be the subject of continuous validation on the base of data received form ERP system concerning e.g. tank refilling quantity or by the comparison among the sensors with similar characteristics. As a result, during the operation, proposed system will develop autonomously the database and rules enabling scoring the quality and accuracy of sensors, indicating in advance possible malfunction or decreases of quality of measurements. Proposed scenario of predictive maintains of measuring systems can be adapted also to other, non-agricultural oriented industrial applications.

The top layer, decision support system (fourth layer) will be based on artificial intelligence prediction algorithms enabling predictive maintenance of agricultural industry infrastructure as well as just-in-time delivery of materials such as liquid fertilizers. On the base of collected data provided to the cloud, the decision support system will perform the optimisation of delivery system on the base of trends extrapolation and machine learning.

Efficiency and functional parameters of developed system will be practically verified in cooperation with "Deshen Ha'zafon" company, which is the operator of large scale liquid fertilizers tank network as well as different collective communities in Israel. On the Polish side verification will be carried out in cooperation with BioAlt Ltd. as well as AMP Hobda agricultural company.

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