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DEVELOPMENT OF DIGITAL TECHNOLOGIES IN THE FIELD OF AGRICULTURAL PRODUCTION

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In the context of rapidly developing digital technologies, their active implementation is being carried out in all areas of agricultural production, in particular in the field of fertilization. The main tasks of the intellectualization of agriculture are automation, robotization, collection and processing of information at all stages of agricultural production while reducing the cost of its production and minimizing the influence of the human factor. Automation in the field of agricultural production is one of the most difficult components of intellectualization due to the specifics of processes and a large number of manual operations [1].

There are several definitions of automation, but their essence boils down to the introduction of modern control and monitoring devices for each period of time. ongoing technological production processes in order to increase productivity while minimizing manual labor [1-3]. The degree or level of automation can be used as an evaluative characteristic of the automation of production processes in agriculture: partial, complex and full automation. The essence of the latter lies in the complete transfer of the management function and decision-making to technical means, which at this stage of development in agriculture, and in particular when applying fertilizers, is impossible. At the same time, in the considered area of agrochemical support of agriculture, partial automation is more relevant and realizable, since during the operation of applying solid mineral fertilizers, or any other operator is directly involved.

Automation improves labor productivity and production volumes; improve product quality and reduce raw material costs; optimize management processes; improve safety, environmental friendliness and profitability of production; to remove a person from industries hazardous to health; exclude the human factor from production; to master previously impossible methods of production (in vacuum, at high pressure, various temperature conditions, etc.); improve both individual elements of technology and the entire technology as a whole.

The main tasks of the microcontroller are: to receive and process signals coming from external sources, for example, sensors; control the connected devices through the control relay (working parts of the equipment, pumps, electric motors) based on the programmed logic; accumulate processed

information, as well as adapt and display them in a form convenient for humans.

Microcontrollers are widely used on modern agricultural machines, in particular on distributors of solid mineral fertilizers. On these machines, microcontrollers perform the function of controlling the working bodies of the distributor, control the parameters of input / output of information, and regulate the application rate depending on the required application dose. To control the working bodies on these machines, various types of sensors and actuators are installed, which are responsible for the amount of fertilizer supplied to the working bodies, measure and adjust to the moment of inertia on the spreading disc, measure the mass of fertilizers remaining in the hopper and received on the spreading disc, and other parameters of the technological process of applying solid mineral fertilizers. Actuators act as actuators on these machines - they move metering gates at a given distance, thereby increasing or decreasing the dose of fertilizer application, while synchronizing with the speed of movement of the machine and tractor unit. On machines with a hydraulic drive system, solenoid valves and taps are used to regulate the oil pressure in the hydraulic system, thereby increasing or decreasing the rotational speed of the working bodies. For headland spreading, one of the spreading discs is switched off by disconnecting the electromechanical clutch in the mechanical drives and shutting off the line by means of a solenoid valve or a crane in the hydraulic drives. But the connecting element in the machine-operator system is a microcontroller, which receives signals from sensors, processes them, displaying information on the operator's display, and transmits them to the actuators, automatically adjusting the specified application dose depending on the MTA movement speed and geo-position on the field. Based on this, we can conclude that the most important role in the operation of the automation system of the mineral fertilizer spreader is assigned to the microcontroller and its characteristics.

Due to the fact that the scope of microcontroller equipment is constantly expanding and microcontrollers with certain properties and parameters, the number of their modifications is constantly growing, and with it the number of enterprises - manufacturers of this equipment, and its choice becomes not so obvious.

Recently appeared single-board computers, such as the Arduino, are able to simultaneously accept and process information from several sensors, send signals to the control mechanism, as well as accumulate information and control several processes. However, these boards also have their limitations and disadvantages, especially those related to the specifics of agricultural equipment (dustiness, vibrations, power surges, aggressive environments, humidity, etc.). These are power surges, magnetic fields and other interference that can damage these controllers or cause them to work incorrectly [4,5].

Currently, AVR microcontrollers will not be able to meet most of the needs for automation, and even more so for the robotization of modern agriculture. But they can be used for the tasks of collecting and transforming information or managing unresponsible (light) technological processes of agricultural production, as well as in laboratory conditions.

One of the leaders in this industry segment, both in the technological and in the computing segment are Intel microprocessors. In particular, the Intel Quark X100x processor family and single-board computers based on this processor, which have high processing power and multitasking compared to competitors, which allows you to manage several complex processes at the same time.

However, the main disadvantages of Intel processors are their high cost and energy consumption, high entry threshold, low distribution in Russia. Moreover, the high cost applies both to the equipment itself and to the intellectual development environments for programming these processors. All of the above leads to the low prevalence of these microprocessors.

The MSP and DSP TMS microcontrollers from the American company Texas Instruments are modern and more widespread than the AVR microcontrollers. In general, Texas Instruments' products have two directions in this segment - the MSP430 controller family and the TMS320 DSP family.

The MSP430 family is a family of 16-bit low power microcontrollers. Their advantage is simplicity of operation, good documentation and low energy consumption. The minimal set of commands makes them convenient for beginners. They are used in many fields of activity, in particular in the manufacture of consumer electronics [6,7].

The disadvantages of the MSP430 include low processing power, which does not allow them to be used for modern tasks, which are aimed at automation, and they are not intended for industrial equipment.

The DSP TMS320 family is a powerful, modern 32-bit microcontrollers, in part using the ARM architecture. These microcontrollers have impressive computing power, as well as rich, extensive peripherals. Supports multiple data transmission channels. They were developed for use in industrial equipment for various purposes. To this end, Texas Instruments Corporation manufactures them with a high degree of reliability and security comparable to PLCs.

Microcontrollers based on the ARM architecture. ARM architecture is currently the most popular architecture in the world. Microcontrollers based on it are installed on almost all modern mobile devices. The lineup consists of both 16-, 32- and 64-bit boards, which is still a rare phenomenon in this area. Many companies produce products under the ARM license, such as STMicroelectronics, Intel XScale, NVIDIA Tegra, Texas Instruments, OMAP, Samsung Hummingbird, etc.

One of the brightest representatives in this segment is STMicroelectronics. It is a European company specializing in the production of microelectronic products. Their STM32 microcontrollers and development boards such as Discovery and Nucleo are leading the market. This family has very good documentation and a set of ready-made solutions for automation and robotization of equipment, which increases the efficiency of developing electronic devices based on this family. The main disadvantage of STM32 is the complexity of development due to the rich periphery of these devices. However, STM32, despite its shortcomings, occupies one of the leading positions in the field of microcontroller equipment and is an excellent option for automating technological equipment and processes in agriculture.

A common disadvantage of the considered domestic microcontrollers is their extremely low documentation and popularity in the manufacturing country, which, according to some data, is lower than that of competitors of foreign origin. All this strongly hinders the development of the Ukrainian computer and microelectronic industry.

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