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Hardware for Providing Smart Farming Technologies

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***Abstract*—Modern agricultural and horticultural technologies have made it possible to obtain higher yields with smaller areas, which supports the ever-growing population. Agriculture is inherently unstable. This is largely due to the influence of external environmental conditions on productivity from year to year. The desire for greater consistency and stability in agriculture prompts the introduction of another type of modern technology in this field.**

Keywords—farming technologies, information systems, LoRa, Wi-Fi, Core Independent Peripheral, wireless components

I. Introduction

Indeed, we may be on the threshold of the Second Green Revolution. Crops are being sewn and fertilized using fancy new tractors with cabs that resemble cockpits, gathering and wirelessly transferring field data collected by myriad sensors that can be used to maximize yields during the growing season while planning next year’s crop.

Another element of the Second Green Revolution is addressing the inextricable link between agriculture, energy use and even climate change. While the first Green Revolution provided the template for feeding a hungry world, the next great transformation of agriculture must also address related energy and environmental challenges, as well as what sustainability researchers call "food security" [1].

The Green Revolution taught humankind how to grow more food using less soil. Among the hurdles to ending hunger and improving nutrition are better distribution channels needed to feed humans plagued by poverty and war.

Among the biggest innovations of the last five years has been the introduction of cloud-based platforms that use steadily improving broadband connections to collect and organize field data swept up by sensors.

Modern farming technologies make it possible to significantly increase productivity, which is extremely necessary in the conditions of the constantly growing population of the country. However, agriculture is inherently unstable. First of all, this is due to the influence of external environmental conditions on the yield from year to year. The desire for greater consistency and stability in the agricultural economy prompts the introduction of a new type of modern technology in this field [2].

II. Built-in and Wireless Solutions for Information Complexes

The availability of modern livestock condition monitoring systems has led to improved product quality. Remote systems for monitoring the state of the environment and plants make it possible to monitor the state of the crop with high accuracy. Thanks to modern sensor systems with built-in wireless communication elements, "smart agriculture" will soon have the tools and capabilities needed to increase yields and profitability while providing the level of quality society demands.

Field data collection and analysis has transformed traditional equipment manufacturers into data management information centers for a growing list of software tools. It's a way for farmers to view operations in real-time and get information on how to improve operations, including spending less money to improve yields. The goal is to gain control over all variables related to agriculture by understanding yield data across space and time.

Modern information systems, based on an extensive network of sensors and controllers, can help make the best decisions for producers, allowing them to grow crops and livestock with a higher level of productivity, while reducing the use of water, pesticides and fertilizers. This can help reduce the farm's impact on its natural environment, ensuring a future for posterity.

The main solution for ensuring the efficiency of a modern farm is to provide farmers with information about the state of the production process. Thanks to the innovations of today's embedded and wireless components, this goal can be achieved by implementing large arrays of low-cost sensor networks. Sensors monitor on-site conditions – temperature, acidity, light, humidity, pressure, water level, workflow data, motion detectors, presence, animal physical condition sensors and coordinates – on agricultural plots. This data is then transferred to a centralized database (cloud) via wireless networks such as 4G/5G cellular and LoRa [3].

Data can be accessed in real time on any device connected to the Internet. This allows the manufacturer to access information from anywhere in the world and provides the opportunity to make appropriate adjustments to correct a certain situation.

With an increase in the number of sensors, the area of the automated system increases, the efficiency of control algorithms increases, and the use of distributed systems becomes more efficient.

The maximum benefit from a distributed system is achieved when the controllers work independently, and the exchange of information between them is minimal.

The distributed system has the following characteristics:

- greater speed, this is achieved due to the use of parallel distribution of tasks between processors;
- the system uses a simplified modernization algorithm;
- resistance to failures;
- increased reliability;
- simpler expansion of reconfigured systems;
- must have a great simplicity of design, layout, configuration, diagnostics and maintenance of the system [4].

Network sensor nodes are not a new concept; but to ensure a certain level of performance and reliability in such a complex space, some key requirements must be met. First, they need a reliable power source, which is a difficult task, since the space of the farm is not limited by meters.

The components must have autonomous power that will work for months or even years without replacing the battery. This requires high energy efficiency, usually achieved by implementing a microcontroller-based system that can perform complex tasks without intensive core usage and minimizes sleep power consumption.

Second, sensor nodes on a smart farm must remain operational in harsh, remote areas and monitor moving objects. Individual components must work in the field for a long period of time and not require hardware maintenance. All software updates must be performed remotely and securely. This requires a reliable remote connection through the WAN infrastructure within the sites and LoRa [5].

Thus, the ideal solution of the system will be the general design of the base node, which can be easily adapted to the needs of a separate farm. To achieve this, the base node must be flexible enough to interact with a wide range of analog and digital sensors.

Another, more complex design challenge concerns the wide variety of engineering disciplines required to implement such a system. Smart farm component developers or engineering teams must have expertise in classical embedded design methods, radio frequency communications including the intricacies of LoRa, Wi-Fi and cellular topologies, and network security. understands cloud infrastructure [6].

Therefore, the beginning of the development of the structure of a smart farming system begins with the search for the most energy-efficient solutions among the component base.

8-bit microcontrollers have been known for 50 years. The latest devices that have appeared recently have received new functions that meet the needs of smart systems. Among the many new features are Core Independent Peripheral devices (CIP) that expand the capabilities of embedded systems. Core Independent Peripherals and integrated analog features are designed to implement a variety of functions and applications that do not need constant interaction with the Central Processing Unit. Because CIPs can enable many simultaneous functions in a single MCU, you can use a smaller and more cost-effective device to implement complex control systems and create innovative designs. These blocks of configurable hardware intelligence require little to no code, consume minimal power and are much smaller than the RAM or Flash needed to implement the same functions in software. CIPs can operate independently of the kernel, allowing developers to configure them to perform routine and repetitive tasks with the lowest power consumption. An additional benefit of CIPs in maintenance-free environments is their ability to increase system reliability. CIPs are actually built into the device structure of the FPGA cell included in the MCU, and are virtually immune to software collisions such as stack overflows or underflows.

To minimize the number of external components, micro controllers have various interfaces for connecting digital sensors, as well as analog converters. It is also necessary to remember the availability of development environments that support a wide range of modern MCUs.

Smart farming technology

Adoption cannot be rushed. In the next few years, the world's population will grow to more than 9 billion. Food production is estimated to increase by 70%, making full adoption of precision agriculture necessary to meet demand. For developers, this means that there is still a lot of potential in the market for agricultural sensor systems. Modern agriculture is experiencing another technological revolution. Access to real-time data on plant and animal health and condition via the global network is changing the way farms are managed, resulting in ever-increasing yields and improved land viability. At the forefront of this revolution is remote control, but its hardware will continue to be based on the familiar 8-bit microcontroller. Modern MCU architectures are becoming key components in bridging the gap between the sensor and the cloud for today's productivity-enhancing product developers [7]. It’s unclear whether a Second Green Revolution will solve our pressing global problems. But it does seem likely that the tools of precision agriculture can help raise living standards around the world. That alone is reason for hope.

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