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IoT BASED AGRICULTURE 4.0: CHALLENGES AND OPPORTUNITIES

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IoT BASED AGRICULTURE 4.0: CHALLENGES AND OPPORTUNITIES

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Abstract: In recent years, the world's population growth has been intensifying, resulting in specific problems related to the depletion of natural resources, food shortages, declining fertile lands, and changing weather conditions. This paper has been discussed the use of IoT technology as a solution to such problems.

At the same time, the emergence of IoT technology has given rise to a new research direction in agriculture. Soil analysis and monitoring using Zigbee wireless sensor network technology, which is part of the IoT, will enable the creation of an IoT ecosystem as well as the development of smart agriculture. In addition, entrepreneurship, marketing and market opportunities in agriculture will be created with the help of IoT technologies. Therefore, this paper is studied the existing problems in agriculture and suggested ways and solutions use IoT technology in overcoming them.

Keywords: Internet of Things (IoT), Wireless Sensor Network (WSN), ZigBee, short message service (SMS), circuit switched data (CSD), General Packet Radio Service (GPRS).

I. Introduction

At present, IoT technology has developed its application opportunities in many areas around the world, namely in the areas of smart home, smart energy, smart agriculture, health and logistics. By 2050, the world's population will reach 9.7 billion, it is estimated that in such cases the demand for food will be high.

The depletion of these natural resources, the fertility of fertile lands, and changes in weather conditions make food security a major concern for countries. In the coming years, the world is moving to the use of IoT in conjunction with a database (MB) to meet food needs [1-2].

In the agricultural sector, IoT devices are projected to increase from 45 million in 2020 to 75 million by 2025. The application of modern technologies in agriculture has become the basis for the creation of intelligent agricultural infrastructure and has led to an increase in productivity and productivity in the industry. IoT technology is an important factor in the development of knowledge in crop care, assessment of the situation in the cultivation of agricultural products, the right decision-making and automation [3-4].

Recent research on IoT in agriculture has focused on addressing the challenges of large-scale farming in the entire supply chain in the field of agro-technologies. Some of these issues are new business models, security, privacy, weather, monitoring and other relevant research in data management smart agriculture has been carried out mainly using wireless sensor technologies [29], [32].

This study will be the basis for the development of new methods of agriculture 4.0 through remote communication, although there are problems in the application of IoT of food supply stock to deal with sensor technology [5].

II. Evolution of wireless communication

We are actively aware of the promising new generation wireless high-speed data transmission networks around the world, and that IoT technology is also evolving [28], [33]. «G» means «generation», so we will consider the technology «G» fig. 1:

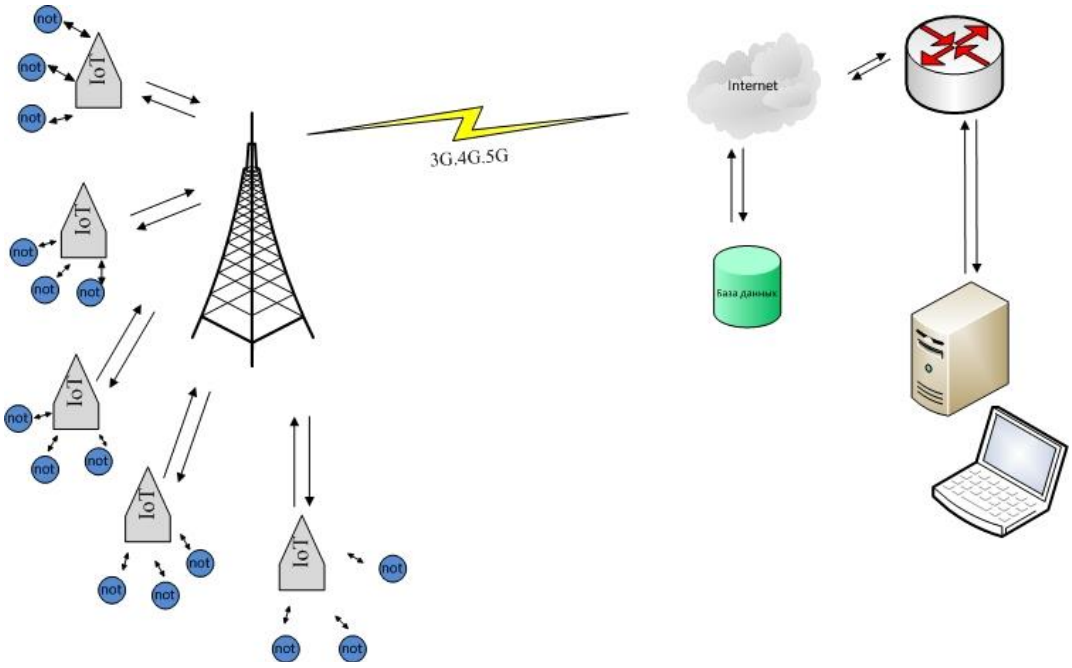

Fig. 1. IoT and G technologies

1G technology: The 1980s began with the emergence of several innovative network technologies: NMT and TACS in Europe and AMPS in the United States. While there have been several generations of mobile services in the past, triple NMT, TACS and AMPS. 1G is the first generation of wireless network, but the data transfer rate was very low because wireless communication was more prone to distortion and noise than conventional wired communication. Also, the cost of a minute of conversation was so high that only a wealthy man could afford mobile.

2G technology: In the early 1990s, the first digital mobile networks emerged with a number of advantages over analog systems, such as improved sound quality, increased performance, increased security, and so on GSM began to develop in Europe. The second generation of the 2G wireless network already supported short message service (SMS) as well as circuit switched data (CSD), which allowed data to be transmitted digitally. All this allowed to increase the data transfer rate to 14.4 kbit/s

2.5G technology: GPRS (General Packet Radio Service) is an addition to GSM mobile technology that performs packet data transmission. GPRS allows the mobile phone user to exchange information with other devices in the GSM network and external networks, including the Internet GPRS receives the report based on the amount of data transmitted/received, not the time.

3G technology: In addition to the aforementioned data rate requirements, the EDGE standard was developed to implement the new 3G. EDGE was first produced in 2003 in North America. Using a mobile phone that supports EDGE, subscribers will be able to double the GPRS speed.

In 2004, EDGE was most actively supported by GSM operators in North America

3.5G technology: HSPA (High Speed Packet Access) is a technology that further develops the 3G-related UMTS standard. HSPA is based on HSDPA standards, which regulate the transfer of data from a database station to a subscriber, and HSUPA standards, which regulate the transmission from a subscriber to a base station.

4G technology: Similar to the 3G standard, ITU acquired 4G management and linked it to a specification called IMT-Advanced [12]. The specification sets the input data rate to 1 Gbit/s for fixed terminals and 100 Mbit/s for mobile devices. This is a very high speed that can directly across a broadband connection [26].

5G technology: In April 2019, technologies for 5G networks were deployed in South Korea (the first country to launch 5G commercial services), Switzerland, and China [22]. The main manufacturer of the equipment is the Chinese company Huawei. “The main task for the fifth generation networks will be to expand the range of frequencies used and increase the capacity of IoT networks [30-31] (Table 1).

Table 1. Evaluation of wireless mobile networks

Generation	3G	3,5G	4G	5G
Start developing	1990	<2000	2000	
Make it happen	2002	2006-2007	2008-2010	2018
Services	even higher power, speeds up to 2 Mbit/s	increase the speed of third generation networks	large power, IP-oriented network, multimedia support, speeds up to hundreds of megabits per second	High average data transfer rate - from 1 Gbit/s, The average number of simultaneous connections is 1 million per km², Delay - up to 1 ms, High energy efficiency
Transmission speed	up to 3,6 MBit/s	up to 42 MBit/s	100 MBit/s - 1 GBit/s	from 1 GBit/s to 6,5 GBit/s
Standards	WCDMA, CDMA2000, UMTS	HSDPA, HSUPA, HSPA, HSPA+	LTE-Advanced, WiMax Release 2 (IEEE 802.16m), Wireless MAN-Advanced	MC-UWB, CDMA, LAS-CDMA, OFDM, Network-LMDS
Network	packet data network	packet data network	packet data network	Fully IP-based network

III.Application of IoT in agriculture

There are several examples of the use of IoT in agriculture. Examples include crop and livestock, machinery, irrigation and water quality monitoring, weather monitoring, soil monitoring, disease and pest control, and crop monitoring without such use [6], [27].

The application of IoT was based on the following functions:

- monitoring
- observation
- Agricultural machinery
- mental agriculture

A. Monitoring: Several factors can be observed in agriculture. These factors depend on the agricultural sector. The main factors to be observed are highlighted and discussed as follows.

- In addition, timely and accurate weather forecasting data, such as climate change and precipitation, can improve yields, such data can help farmers at the planning stage and reduce labor costs. Farmers can take corrective and preventive measures based on the information provided. It can be used to collect pest movement data and remotely control pests on farmers [7-8].

B. Monitoring and tracking. IoT can activate and provide information to agricultural companies to make better decisions.

Inspection and tracking of agricultural products allows the consumer to know the complete history of the product, as well as increase confidence in product safety, health issues [9]. GPS tracking allows you to collect product data and link the store to a database to bring the product stock remotely with tracking. Monitoring and tracking allows multiple data to be collected across the supply backup so that the consumer can see the collateral from a full distance [24].

C. Greenhouse production. At the present time, regardless of the time of year, agricultural products are grown because of the production of warm rooms using new

technologies, these plants are grown under control.

It allows you to take advantage of any plant by growing it anywhere, anytime, creating appropriate environmental conditions. A lot of work has been done on the use of wireless sensors in the greenhouse to monitor environmental conditions. Recent work with the use of IoT:

- Human resource reduction
- Energy saving
- Improving the efficiency of greenhouse monitoring
- Allows customers to connect directly to the greenhouse farmers.

In agriculture, the use of IoT in increasing productivity and production with accurate data analysis plays a major role. Recently, image processing in agriculture is of high quality showen Fig 2.

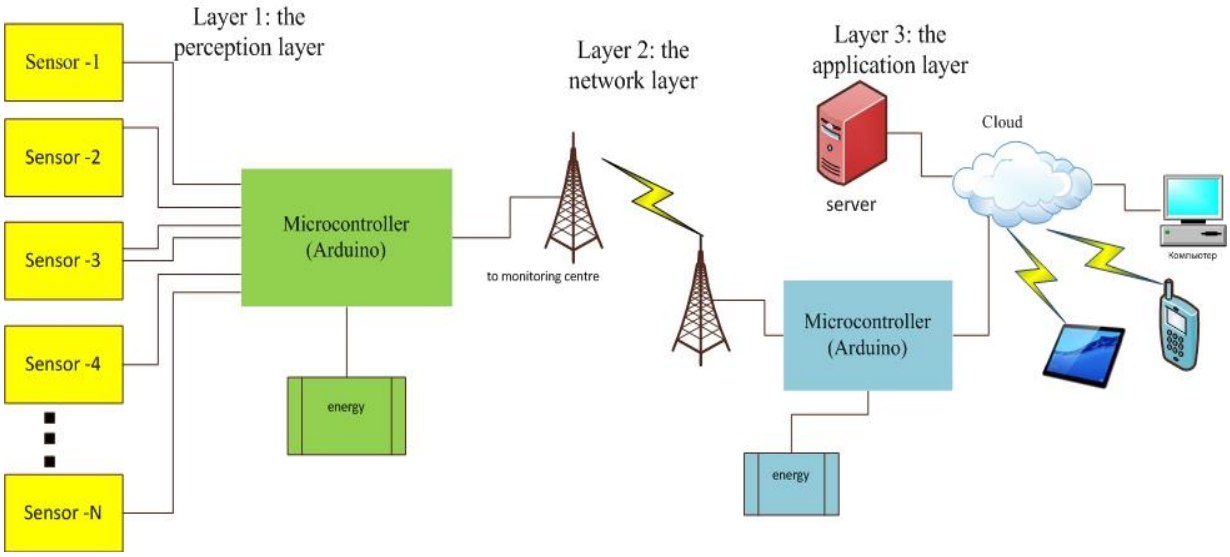

Fig. 2. Obtaining data using IoT devices

Layer 1 (the perception layer): At the level of perception, we encounter technologies such as wireless nodes with less processing power and storage capacity. Typically, a wireless sensor assembly consists of a processing module, usually a low-power microcontroller unit (MCU), one or more sensor modules (built-in or external analog or digital sensor devices) and radio frequency communication module, usually supports low-power wireless communication technologies.

Layer 2 (the network layer): At the second level, wireless sensors interact with physical objects and/or their environment, communicate with its neighbors or gateway, creating networks through which data is usually sent to a remote infrastructure for storage, further analysis, processing and dissemination of valuable knowledge that can to be retrieved. Regarding wireless communication communications created a large scientific literature in sensor networks, solving several problems such as energy efficiency, network functions, scalability and reliability [23].

Layer 3 (the application layer): The application tier is the third tier of the Internet of Things. This is of high importance and, in many ways, this is what the implementation of the Internet of Things contributes. The application layer faces several issues that need to be addressed, such as identifying the device as unique entities. Identifying and manipulating billions of devices around the world will provide direct, Internet access and control over the Internet of the future. Use of software and hardware as it is technology independent when it comes to implementing services. Future interconnected IoT devices in agriculture may include sensors connected to the network.

Appliances and vehicles, weather stations, internet gateways, network storage,

RFID scanners, smartphones, tablets, wearable devices and many other devices [25].

IV. IoT Opportunities in Agriculture

There are a number of benefits to be gained from the use of IoT in agriculture;

- Community farming: The use of IoT can help promote community farming, especially in rural areas. It is possible to promote services that allow to have common data storage, data and information exchange, increase cooperation between farmers and agricultural specialists. Mobile applications and IoT facilities can also be integrated within the community through free or paid services through the use of equipment [10], [11].
- Safety control and fraud prevention: The challenge in agriculture is not limited to the ability to provide safe and nutritious food, not just pests and pests. Food fraud poses a health challenge and can have negative economic impact Discussion of food fraud components Some product and data integrity can be addressed using IoT technology. IoT can be used to ensure food quality [12].
- Competitiveness: Increased demand for food products and the use of innovative technology are expected to make the agricultural sector very competitive. It also opens up a sales, monitoring, and marketing direction that allows agriculture to collect data using IoT [13].
- Cost reduction and benefit: One of the perceived advantages of IoT is the ability to remotely monitor devices and equipment. Applying IoT in agriculture can save time and money when inspecting large areas. The ability to know when and where to use IoT reduces costs and waste [14].
- Awareness: Information on markets, prices, services in the field of IoT agriculture can be accessed through mobile applications. Also, the implementation of public services and regulatory standards related to various farm production is rapidly becoming available. In addition, consumers interested in new products can easily find farmers or be alerted when new products are available.
- Management: IoT provides real-time monitoring of farm assets and machinery against theft, is used to replace parts and maintain regular crop products in a timely manner [15].

V. Problems of IoT in Agriculture

There are several problems associated with the use of IoT. Some problems are lack of security and privacy, data convergence and mutual flexibility, uncertainty in business models.

Devices: There are several costs associated with IoT in agriculture, which can be divided into adjustment costs and operating costs. Setup costs include the purchase of hardware (IoT devices, gateways, base station infrastructure). Operating costs include the use of centralized services or IoT platforms, which allow the management of IoT devices, the exchange of information among other services. Other additional costs stem from the exchange of data between IoT devices, gate-way and cloud server, power and service [16].

Entrepreneurship models: Farmers are interested in entrepreneurship - there are models that support income generation from data collected from their farms using IoT technologies. The information provided is exploited by IoT service providers and this remains a disputed area by farmers for control and ownership of their data.

Lack of sufficient knowledge: Lack of sufficient knowledge is a major factor slowing down the adoption of IoT in agriculture, especially among farmers living in rural areas. It is common for many of these farmers to be unaware of modern technologies evolving where they are found in rural areas and mostly uneducated. The farmer's inability to access information can be a major barrier in the absence of human intervention.

Interference: The placement of large IoT devices for agricultural and other purposes, especially using unlicensed spectrum such as ZigBee causes interference with IoT devices. This intervention can lead to data loss and reduce the reliability of the IoT ecosystem [17-18].

Reliability: IoT devices are expected to be placed outdoors. This causes the devices to be exposed to harsh environmental conditions, which can lead to the breakdown of distributed sensors over time and communication failures. The physical safety of distributed IoT sensors and systems must be ensured to protect valuable equipment from severe weather conditions such as floods and storms.

Nodes and networks: Billions of IoT devices are expected to be deployed in the agricultural sector. Existing gateways and networks will need to support a large number of IoT devices nodes and networks. This requires a smart IoT management system for identification numbers for each node and network [19], [27].

Expanding opportunities in agriculture: Considering the existing opportunities in the field of IoT technologies in agriculture, we present them on the basis of the following directions:

- Technological innovations
- Programming options
- Marketing

Technological innovations are the introduction of new and broken technologies in agriculture, but with the development of time, information technologies are entering every field, that is, the development of IoT technology for agriculture is supported only by certain crops or livestock (also known as IoT). This allows local stores and consumers to easily support everything from crop and livestock management and monitoring to mobile apps to sell products. Such technologies are free from any geographical and regional constraints and can serve many products in agriculture [20].

This technology will need to be deployed from hundreds of different wireless sensors for a real-time monitor. Because a simple network management protocol needs to be developed to support communication between objects and the server with less load. Current protocols are specifically designed for networking techniques and can increase heavy data traffic on the network and the above reason, as well as power requirements for IoT devices.

Software Features - Research is currently underway on communication technologies that can enable IoT devices to access low-cost, high-data and expand capabilities through programming capabilities. It is expanding its capabilities in agriculture not only by IoT technologies, but also by programming drones that can monitor, control and control from the sky.

Marketing: The widespread use of IoT devices allows to reduce the human workforce, save time, obtain complete data, remotely monitor, control, engage in sales. More work is expected to be done on standardization in the use of IoT in agriculture. Involvement of the government level or the Department of Agriculture in the regulation of IoT-related trade should be ensured [21].

VI. Conclusion

Introduction of IoTs to agriculture Using wireless sensor networks to develop this direction, monitoring, control, security, marketing, crop, aquaponics, forestry, greenhouse production, database organization and remote monitoring in Agriculture 4.0 based on the data presented in the above article it is possible to increase the production of agricultural products and increase food security.

We have reviewed several standards and protocols in carrying out these processes, including the IEEE 802.15.4 low-level wireless personal networking standard, the expansion of entrepreneurship and the digital economy using the ZigBee protocol, and the greater use of less manpower to expand agricultural 4.0 opportunities.

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