

Ensuring environmental safety using Internet of Things (IoT) technologies

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Abstract. The article discusses the features of using industrial Internet of Things (IoT) technologies to ensure the environmental safety of territories. The authors analyzed the main problems in the implementation of IoT systems in environmental monitoring, as well as the prospects for using the considered technologies for biodiversity conservation. In addition, the article analyzes the use of Internet of Things technologies as a tool for ensuring the sustainable development of the region.

1 Introduction

In 2017 Geneva hosted "IoT Week". As part of this event, the participants developed an international declaration "Internet of Things for Sustainable Development". The declaration clearly articulated the main directions for using IoT technologies to ensure environmental safety and sustainable development of regions:

- Conservation of biodiversity.
- Carrying out environmental monitoring.
- Fight against climate change.
- Addressing issues of food security and drinking water supply [1].

Over the next few years, analysts from the World Economic Forum analyzed already implemented projects with implemented IoT technologies. It was found that about 80% of all projects lead to the implementation of sustainable development goals. These are projects aimed at the recycling of production and consumption waste, the introduction of innovative urban infrastructure, the development of "green" energy, etc. [2].

However, the introduction of these technologies also entails certain risks, for example, an increase in energy consumption, as well as the problem of recycling failed hardware components of information systems. Therefore, one should consider not only the benefits of using modern technologies of the Internet of things, but also assess the risks of their implementation. Take a closer look at the most popular areas of application of IoT technologies in the framework of ensuring environmental security.

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2 Materials and methods

2.1 Environmental monitoring

The most common area of application of IoT systems in environmental protection is environmental monitoring.

Over the past decades, the number of road transport has sharply increased as the main source of air pollution. In addition, large industrial enterprises also contribute to atmospheric and hydrosphere pollution. The main pollutants in the atmospheric air are:

- Nitrogen dioxide (NO₂).
- Carbon monoxide (CO).
- Sulfur dioxide (SO₂).
- Fine suspended particles (PM-10, PM-2.5).

Table 1 presents the maximum allowable concentrations of the main air pollutants for human health.

Table 1. The main indicators of pollutants in the atmospheric air.

Air quality index	PM-10, mg/m ³	PM-2,5, mg/m ³	NO ₂ , ppb	O ₃ , ppb	CO, ppb	SO ₂ , ppb
	Average daily concentration	Average daily concentration	Average hourly concentration	Average hourly concentration	Average eight- hour concentration	Average hourly concentration
Good 0 to 50	0-54	0-12	0-53	0-54	0-4.4	0-35
Satisfactory 51 to 100	55-154	12.1-35.4	54-100	55-70	4.5-9.4	36-75
Harmful to sensitive groups 101 to 150	155-254	35.5-55.4	101-360	71-85	9.5-12.4	76-185
Harmful 151 to 200	255-354	55.5-150.4	361-649	86-105	12.5-15.4	186-304
Very harmful 201 to 300	355-424	150.5-250.4	650-1249	106-404	15.5-30.4	305-604
Dangerous From 301 and more	425 and more	250,5 and more	1250 and more	405 and more	30.5 and more	605 and more

Human exposure to the substances listed in the table leads to a serious deterioration in the health status of both current and future generations.

Thus, at enterprises and organizations of various levels, as well as at the regional and federal levels of government, there is a need for regular control and monitoring of the state of atmospheric air.

2.2 Production and consumption waste management

Analyzing the data on the amount of production and consumption waste generation (Figure 1), it should be noted that there is a huge problem with MSW management all over the world [3].

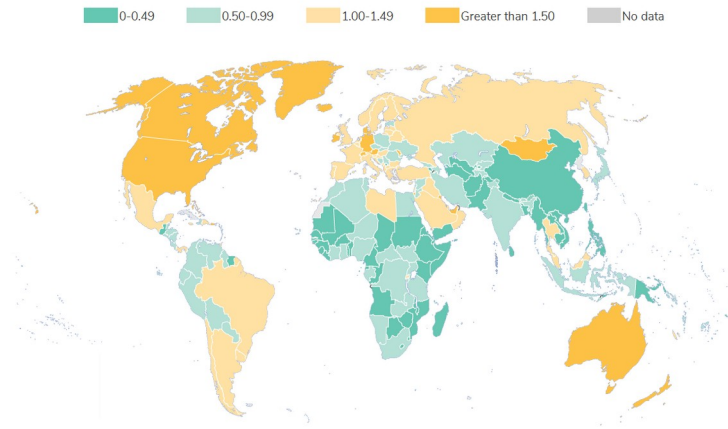


Fig. 1. The amount of production and consumption waste generated per capita in the world, kg.

Some problems in the field of MSW management can be solved by Internet of things technologies:

- Daily continuous monitoring of waste accumulation in containers at collection sites.
- Automated formation of routes for the removal of accumulated MSW, etc.

2.3 Ensuring the environmental safety of agricultural products

Considering the prospects for the development and implementation of Internet of Things technologies, it is worth noting such an industry in ensuring environmental safety as agriculture. This is primarily due to the fact that the quality of agricultural products directly affects the quality of human life and health.

Currently, IoT technologies in agriculture allow solving the following problems:

- Soil moisture control.
- Control over the agrochemical composition of the soil.
- Soil temperature control and other important indicators.

Next, we analyze the existing practices for applying IoT technologies for each described industry.

3 Results

Consider the existing IoT technologies that have found application in the field of ensuring the environmental safety of the industries considered.

Various sensors have been used for quite a long time to monitor the environment. However, with the advent of IoT technologies, the process of monitoring the quality of the natural environment began to be carried out in real time, which allows you to quickly identify various deviations in indicators and take measures to eliminate the identified violations. As an example, consider the Smart Environment PRO sensor shown in Figure 2 [4].

The main characteristics of the sensor in question:

- Measurement of carbon monoxide, carbon dioxide, ozone, oxide and nitrogen dioxide, sulfur dioxide, ammonia, methane and hydrogen sulfide, as well as suspended particles of various sizes.
- Measurement of temperature, humidity, atmospheric pressure.

- Measurement of illumination.
- Noise measurement.



Fig. 2. Smart Environment PRO sensor.

The sensors work with any wireless technology and any cloud platform. The sensors are powered by solar panels.

Based on the measured indicators, the air quality index is determined. All indicators are measured and transmitted to the server in real time. The installation of such sensors in cities will allow for operational monitoring of changes in atmospheric air indicators and respond to deviations from the norms.

As an example of the use of IoT technologies in waste management systems, one should first of all note interactive sensors that signal the filling of containers for collecting MSW. Such sensors are installed directly in each container and promptly notify the organization responsible for waste disposal when certain containers are filled. This avoids overflowing and getting garbage directly to the MSW collection site.

In addition, the introduction of IoT technologies will allow automated formation of MSW collection routes from container sites, taking into account data on their filling [5-6].

The implementation scheme of the described technology is shown in Figure 3.



Fig. 3. Scheme of automated formation of MSW collection routes, taking into account the filling of container sites.

In addition to the solutions described, there are several more areas for using IoT technologies in the field of waste management:

- Use of sensors for more efficient sorting of waste.
- Tracking in real time the movement of waste from the moment of their collection to the moment of disposal or processing.

As an example of the use of IoT technologies in agriculture, the already implemented system of “smart” land irrigation WaterBee, the implementation scheme of which is shown in Figure 4 [7-8], should be noted.

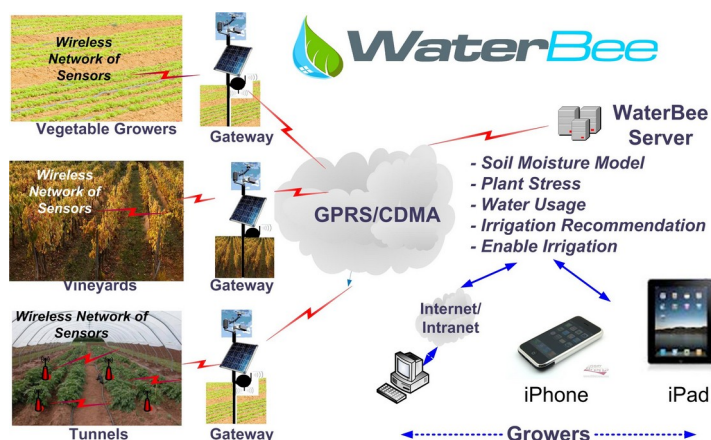


Fig. 4. Scheme of the system of "smart" irrigation of the land WaterBee.

This system is implemented using sensors located in greenhouse complexes or on agricultural land, which collect meteorological data in real time, as well as information about the state of the soil and transmit it to the server, where the information received is processed and the corresponding procedures are automatically launched to restore optimal indicators.

In addition, systems of this kind also exist to control the state of aquatic farms, as well as control the population of bees [9-10].

4 Discussion

Undoubtedly, the use of modern information technologies, including the technologies of the Internet of things, allows us to solve many problems in the field of ensuring the environmental safety of the natural environment and humans. However, it is worth noting some shortcomings and problems that appear in the process of implementing and using such technologies.

One of the key problems is the problem of disposal of used equipment. Each technical system has its own service life, and no matter how reliable it is, there is always a risk of breakage or failure of any of its elements. And the more technologically advanced the system, the more difficult it is to dispose of or recycle its components.

Another equally serious problem is the increase in energy consumption. For the smooth operation of any server requires a huge amount of energy. "Green" energy is currently not enough to cover all existing needs, so the first place in the production of electricity is still occupied by traditional methods, which, unfortunately, are not always harmless to the environment.

5 Conclusion

The use of IoT technologies has significant advantages for ensuring environmental safety and sustainable development of the region:

- Continuous monitoring of atmospheric air quality and, as a result, the implementation of measures to improve it and reduce the negative impact on the human body.
- Control over the state of forest plantations and agricultural land.
- Automated implementation of procedures in the field of waste management.

And this is only a small part of all the areas in which IoT technologies can find application.

However, at present, some problems that arise in the process of implementing IoT technologies still remain unresolved. Therefore, special attention should be paid not only to the advantages, but also to eliminate the emerging shortcomings and imperfections when using the described technologies.

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