



# The Internet of Things is Applicable in Greenhouses



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## Introduction

The industry of growing plants in conditions of artificial microclimate today uses devices that connect to the Internet. The Internet of things in the industry of growing plants create a "smart" greenhouse with improved performance that can bring more profit, to improve the ease of maintenance of technological equipment, and provide efficient flow of the technological processes at all stages. The industry of growing plants and the construction industry of greenhouses are divided sectors, design and construction of greenhouses occur in different geographical regions. Online greenhouse provides a unique opportunity to solve many technical problems at the initial design stage. The system in the presence of sensors in the early stages of construction of the greenhouses will allow you to monitor the progress of construction. Constant monitoring of the process of construction for compliance with the project allows you to cut costs, avoid mistakes and make decisions, checking the results of calculations in real time in the design office at any place of work with the system.

IoT-technology can solve many problems. The energy is distributed rationally between the systems of the microclimate. Monitoring and forecast is made for weather conditions. The control monitors the technical condition and location of equipment in real time. The full provides information about the condition of the plants. The staff analyzes current and historical data, then makes decisions which allows a more efficient use of process equipment, saving time and fuel. The online greenhouse is a from a technological point of view, the consolidation of critical components of the greenhouse as part of a single network to provide them access to each other and exchange information. A network of sensors provides communication. The sensors are part of the technical equipment and interacting with one another. Sensors produce information which is received and accumulated throughout the life cycle of the greenhouse.

IoT- technologies should be used in research work. The problem requires new innovative solutions. Technological method grows plants on the basis of three elements of aeroponic

technology with the use of led lighting and instrumentation system for automation of control of technological processes based on IoT technologies. A conceptual model of the industry of growing plants contains two test-object: synthetic adjustable microclimate and plants. Artificial microclimate creates habitat for plants using engineering equipment. Engineering equipment is formed in a separate lighting systems, heating, conditioning, ventilation, irrigation, power, gas composition and so on. The system of microclimate maintained automated control systems using measurement and control equipment to coordinate the operation. Currently ignored three facts. The first fact artificial microclimate shape the technologies that plants subjected to the action of physical fields of different nature: optical, electrical, magnetic and other.

The second fact artificial microclimate depends on the capabilities of biotechnology, where there is a large Arsenal of different tools and techniques to create plants with specific parameters and qualities. The third fact artificial microclimate is not able to establish a direct relationship with the plants. I conducted an analytical review of existing scenarios, organization of a scientific experiment. The object of research is led lighting in the artificial microclimate and the response of the plants. Problem associated with LEDs and plants showed that despite some progress, the technology remains poorly applicable in practice. The results of many studies pay attention to individual approach to each plant. The choice of factors and the criterion is done empirically. According to the analysis made preliminary conclusions that the problem for the industry of growing plants is:

- 1) Construction of an artificial microclimate require large capital investments. Evaluation of the efficiency of greenhouse production gives a low degree of forecast process
- 2) Development of technologies for growing plants in conditions of artificial microclimate associated with a long preparatory phase material and time costs

- 3) Requires large number of laboratory data obtained in experimental models
- 4) The results obtained in the study correlated poorly with the scale of production
- 5) Scatter the recommended parameters of the artificial climate for different crops is quite wide, and therefore requires an individual approach to each plant according to varietal characteristics
- 6) Empirical search of certain combinations of characteristics of temperature and humidity environment, light environment, a gas environment and a nutritious basal medium
- 7) Search for plants with the appropriate internal genetic potential for adaptive plasticity

Our study is intended to prove that the solution of problems related to the methodology of scientific research system of artificial climate, requires a comprehensive interdisciplinary approach. The main goal of our study is to develop a structural organization of a scientific experiment to study the response of plants to an led system using IoT-technology.

Research is important to overcome the difficulties associated with the study of the peculiarities of the process of growing plants under LEDs in conditions of artificial microclimate. Difficulties arise in the complexity of the organization of the technological

process, which is a combination of many interrelated subsystems, as well as imperfect methods and the mathematical apparatus, which does not allow to adequately describe such a set.

Plant as an object of study should be characterized with more General methodological positions. As one of them can be a system approach, is the methodology of scientific research and practical development of complex object. In this case, in the first place is not an analysis of the constituent parts of the object, and the characteristics of the system as a whole, disclosure of the mechanisms and linkages that maintain the integrity of the object. Structural-parametric modeling and optimization of led lighting, underlying the proposed information technology are the rational change components of the light environment, depending on the condition of the plants in the dynamics of the vegetation development. Thus, the concept of biofeedback through the accumulation of a complete image as metamerism design of set logic the system should be more efficient than the classical concept of traditional Cybernetics and systems analysis. Attempts to mathematically postulate what should be a parametric climate, how it should react the plant, the phenomena outside their holistic entirety, will remain in the framework of private applied research. The proposed concept will now, at the level of modern technical equipment and data management systems to guarantee the proper functioning of the systems of artificial microclimate, create intelligent bioengineering systems such as virtual greenhouses.



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