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IoT AIDED MONITORING SYSTEM FOR AGRICULTURAL 4.0

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Abstract. *Agriculture is becoming one of the most important sectors of the world economy. Smart technologies help the agro sector to enter confidently the digital era and optimize processes qualitatively. This will ensure efficient use of natural resources. The use of the IoT (Internet of Things) system will increase agricultural productivity, improve quality, increase crop yields, as well as it will ensure food security. The use of sensors in agriculture is an important step in creating an intellectual farm. They provide a real-time data on condition of objects in tens of square kilometres, particularly, the parameters of humidity, temperature, vegetation, and light intensity. This paper discusses four different ways of a remote cultivation process of plants (flowers) in agriculture. Plants were grown in different pots and in different locations to determine the air temperature, humidity, soil moisture, and light intensity in view to predict the plants' growth. The Arduino microcontroller was used for the sensor system, plant growth was monitored by means of the sensors and the Arduino.*

Keywords: *industry 4.0, agriculture, IoT, Arduino Uno, sensors, communication, plants (flowers).*

СИСТЕМА МОНИТОРИНГА СЕЛЬСКОГО ХОЗЯЙСТВА 4.0 НА ОСНОВЕ IoT

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Introduction

The agricultural sector is going to face serious challenges in the near future in order to feed the 9.6 billion people who are projected to have populated the planet by 2050. Food production is set to increase by 70% despite limited availability of arable land, growing demand for fresh water (agriculture consumes about 70 percent of the world's fresh water), and other less predictable factors such as climate change, global population growth, global warming and food security are among the most complex issues worldwide. To increase agricultural production from available arable land, one option is to invest in technology to meet global food demand. Various phases of the agricultural revolution aim to develop new ideas for sustainable development, food production, energy, and agricultural technology. Agriculture is becoming one of the most important industries in the global economy. Smart technologies will help the agricultural sector to confidently enter the digital era and efficiently optimize processes. This will ensure efficient use of natural resources [1].

The IoT (Internet of Things) system is a technology that will bring agriculture to a new level of application of IoT technology for agriculture:

Ensures

- Large crop yields;
- Best quality;
- Identification of factors that affect the growth and yield of crops;
- Food security.

Reduces

- Transport costs: human intervention only when necessary;
- Time spent;
- Numbers of dead plants due to diseases or adverse weather conditions;
- Cost savings by reducing the use of fertilizers, pesticides and consumables;
- Combating drought, scarcity and famine.

From the sources listed above, in this article we will examine the process of remote growth of plants (Flowers) in agriculture in four different ways [2-5].

Agriculture in IoT

The Internet of Things is not a single technology, but a whole system of technological solutions. This is a global network infrastructure, which consists of computer networks of physical objects, the traditional IP Internet network and various devices (Gateway, Border router, etc.) that connect these networks [6].

Computing networks of physical objects consist of "smart" sensors and actuators (execute ve-devices) united in a computer network (personal, local and global) and controlled by a central controller (gateway or IoT Habs, or IoT platform) [8-10].

The system of technological components of the industrial Internet of things includes:

- measuring instruments: gauges and sensors, consumption metering devices, measuring systems;
- means of identification: optically recognized identifiers bar codes, Data Matrix, QR codes, location tools, various protocols;
- means of communication and data transmission: various communication channels - wired and wireless;
- platforms for managing data, systems and devices;
- software for information analysis;

Аннотация. *Сельское хозяйство становится одним из важнейших секторов мировой экономики. Умные технологии помогают агропромышленному комплексу уверенно входить в цифровую эпоху и качественно оптимизировать процессы. Это обеспечивает эффективное использование природных ресурсов. Использование системы IoT (Интернет вещей) повышает продуктивность сельского хозяйства, урожайность, улучшает качество, обеспечивает продовольственную безопасность. Использование датчиков в сельском хозяйстве – важный шаг в создании интеллектуальной фермы. Они предоставляют в режиме реального времени данные о состоянии объектов на десятках квадратных километров, в частности параметры влажности, температуры, растительности и освещенности. В данной статье процесс дистанционного выращивания растений (цветов) в сельском хозяйстве проводится четырьмя различными способами. Растения выращивали в разных горшках, в разных местах, чтобы определить температуру и влажность воздуха, влажность почвы и интенсивность света для прогнозирования роста растений. Эксперимент Arduino был использован для сенсорной системы, рост растений отслеживался с помощью датчиков.*

Ключевые слова: *индустрия 4.0, сельское хозяйство, IoT, Arduino Uno, датчики, связь, растения (цветы).*

IoT ga ASOSLANGAN 4.0 QISHLOQ XO‘JALIGIDA MONITORING TIZIMI

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Annotatsiya. *Qishloq xo‘jaligi jahon iqtisodiyotining eng muhim tarmoqlaridan biriga aylanib bormoqda. Aqlli texnologiyalar agrosektorning raqamli davrga ishonch bilan kirish va jarayonlarni sifatli optimallashtirishga yordam beradi. Bu tabiiy resurslardan samarali foydalanishni ta’minlaydi. IoT (Internet of Things) tizimini qo‘llash orqali qishloq xo‘jaligida hosildorlik o‘sishi, sifat yaxshilanishi, ekinlar unumdorligi oshishi hamda oziq-ovqat xavfsizligi ta’minlanadi. Qishloq xo‘jaligida datchiklardan foydalanish intellektual ferma yaratish yo‘lidagi muhim qadamdir.*

Ular o'nlab kvadrat kilometrlardagi obyektlarning holati, xususan, havo namligi, harorati, o'simliklar holati va yorug'lik intensivligi parametrlari to'g'risida real vaqtda doimiy ravishda ma'lumotlar uzatadi. Ushbu maqolada qishloq xo'jaligida o'simliklar (gullar)ni masofadan turib o'stirish jarayoni to'rt xil usulda ko'rib chiqildi. O'simliklar o'sish holatini taxmin qilish uchun havo harorati, namlik, tuproq namligi va yorug'lik intensivligini bilish maqsadida o'simliklar turli joylarda turli idishlarda o'stirildi. Sensor tizimi uchun Arduino tajribasi qo'llanildi va sensorlar yordamida o'simliklarning o'sish monitoringi olib borildi.

Kalit so'zlar: *sanoat 4.0, qishloq xo'jaligi, IoT, Arduino Uno, sensorlar, aloqa, o'simliklar (gullar).*

- models of the system's response to various situations;
- systems and solutions in the field of data transmission security;
- services and products for various industries (Fig. 1).

Although the concept of Industrial Internet of Things is primarily associated with manufacturing, factories and heavy industries such as mining, power plants, aviation, etc., it is also used in industries and areas such as agriculture, public services, as well as in cross-industry solutions[12-15]. Thus, the following segments of the Internet of Things market ecosystem can be distinguished:

- Solutions for production and business. Technological solutions for manufacturing and various industries and services that optimize processes, increase efficiency and reduce costs.
- Solutions for mass consumption. Office buildings and public spaces, smart home systems and personal devices.
- Solutions for the public sector. Smart cities, traffic control, resource management, security systems.

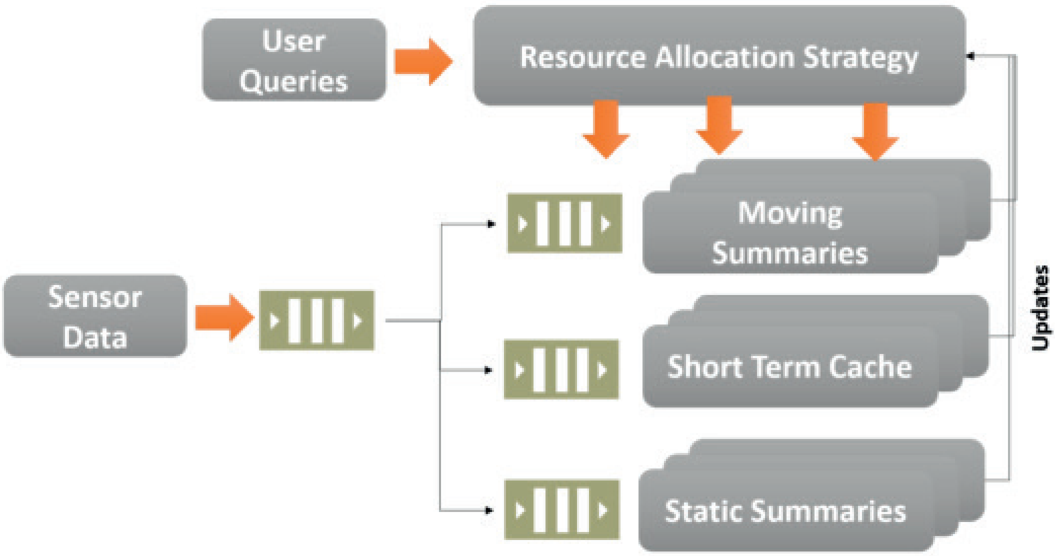

Figure 1. Data collected sensor

Sensors and sensors

The use of sensors in agricultural activities is an important step towards creating an intelligent farm. Spaced over tens of square kilometers, they can continuously transmit information about the state of monitored objects, in particular, the value of parameters such as humidity, temperature, plant health, fuel supply, etc., via radio channels [16].

For example, the basis of the system for determining the characteristics of the soil are sensors that are installed at control points. These sensors are designed to detect heterogeneity (topography, soil type, lighting, weather, weeds and parasites).

Also sensors and sensors are intended for:
- detection of weeds;
- identification of pests;
- recognition of plant diseases;

- yield estimates;

Based on the above data, we will study the soil of plants (flowers) in agriculture. Data from the ground as a plant medium is sent to an LCD with an IoT platform for storage and display of data collected from the Arduino, which is recorded as a variable by various sensors connected to them. Data (Fig. 2) [17].

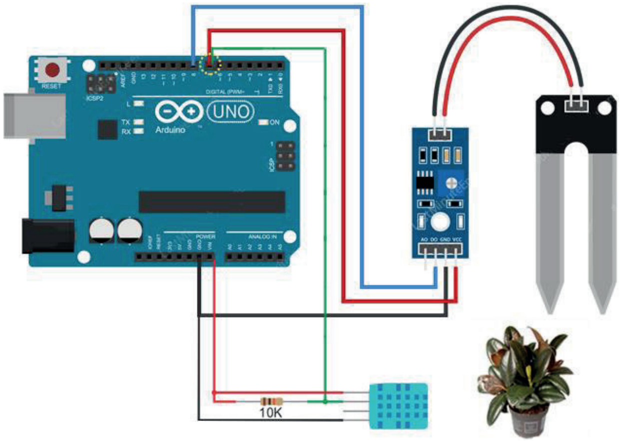

Figure 2. Research on the soil of plants (flowers)

Scope of research

Based on the above data, we will study the soil of plants in agriculture. Data from the ground as a plant medium was sent to an LCD with an IoT platform for storage and display of data collected from the Arduino, which was recorded as a variable by various sensors connected to them. Information [18].

The Arduino Uno acts as a board designed to collect data and send it for storage. The connection between the Arduino and all sensors must be made by connecting the device to the Arduino. The sensors collect climate data to determine conditions around the plants, e.g. : temperature, humidity, soil moisture and light intensity. The Arduino receives real-time climate conditions to receive data from sensors that collect data via code and store in internal variables. It should be sent to the Arduino so that the data can be stored and tracked (Fig. 3).

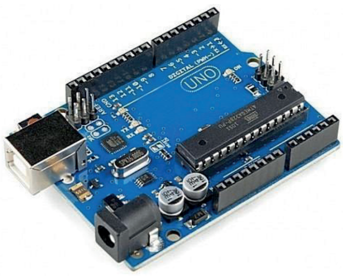

Figure 3. Arduino Unoplates

The soil moisture sensor consists of two probes that measure the amount of water in the soil. Both probes allow electricity to pass through the soil and measure soil moisture according to its resistance.

The more water there is, the more electricity the soil conducts, which means less resistance. Thus, the humidity level is high. Dry soil reduces permeability. Thus, when water is present, the soil conducts less electricity, which means it has more resistance. Thus, the humidity level is low. We used a YL-38 soil moisture sensor (Fig. 4).

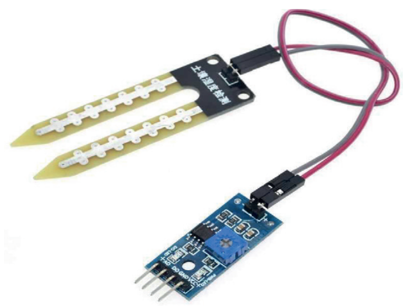

Figure 4. YL-38 soil moisture sensor

D.HT11 sensor – this temperature and humidity sensor uses a digital collection technique and humidity sensor technology to ensure a calibrated digital signal output and its bar resolution and reliability depends on the chip computer (Fig. 5).

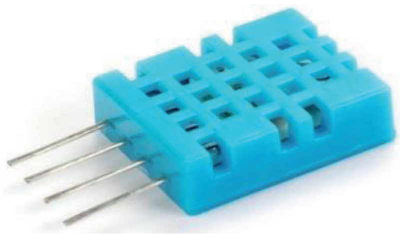

Figure 5. Temperature and humidity sensor

Automatic imitation monitoring system

We create a simulation model of the above sensors using the proteus software environment. Proteus is a universal program using which one can create various virtual electronic devices and perform their simulation. It contains a huge library of analogue and digital microcircuits, sensors, discrete elements: resistors, capacitors, diodes, transistors, etc. There is also a wide range of optoelectronic components: displays, LEDs, opt couplers, etc.

The main advantage and difference between Proteus and other similar programs for simulating the operation of electrical circuits is the ability to simulate operations of microprocessors and microcontrollers (MC).

The Proteus library contains the following main types of MK: AVR, ARM, PIC, Cortex (Fig. 6).

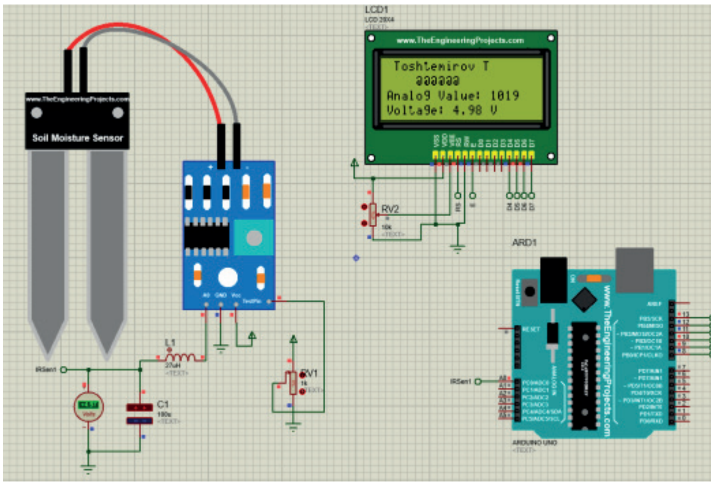

Figure 6. Automatic imitation monitoring proteus

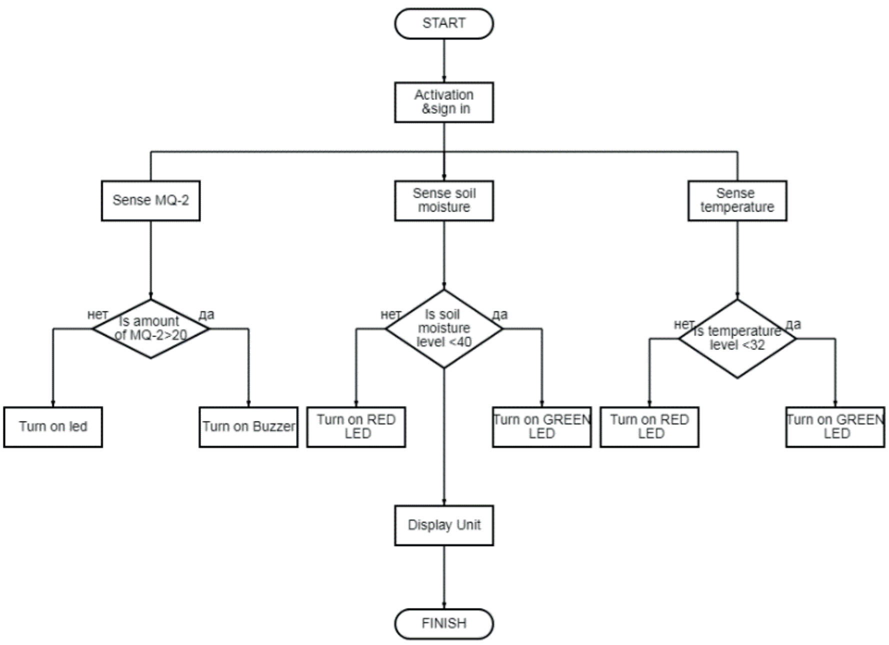

Figure 6.1. Automatic imitation monitoring algorithm

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```
#
include<LiquidCrystal.h>
// initialize the library with the numbers of the interface pins
LiquidCrystallcd(13, 12, 11, 10, 9, 8);
intSensorPin = A0;
void setup() {
 // set up the LCD's number of columns and rows:
lcd.begin(20, 4);
 // Print a message to the LCD.
lcd.setCursor(1,0);
lcd.print("Toshtemirov T");
lcd.setCursor(4,1);
lcd.print("@@@@@@");
lcd.setCursor(0,2);
lcd.print("Analog Value: ");
lcd.setCursor(0,3);
lcd.print("Voltage: ");
 }
void loop() {
intSensorValue = analogRead(SensorPin);
floatSensorVolts = analogRead(SensorPin)*0.0048828125;
lcd.setCursor(14, 2);
lcd.print(SensorValue);
lcd.setCursor(9, 3);
lcd.print(SensorVolts);
lcd.print(" V");
delay(1000);
// sensorValue = analogRead(sensorPin);
// lcd.setCursor(4,2);
// lcd.print(sensorValue);
// delay(1000);
```

Experiment models

If the monitoring system receives data automatically from the plants under certain humidity conditions. (Fig. 7).

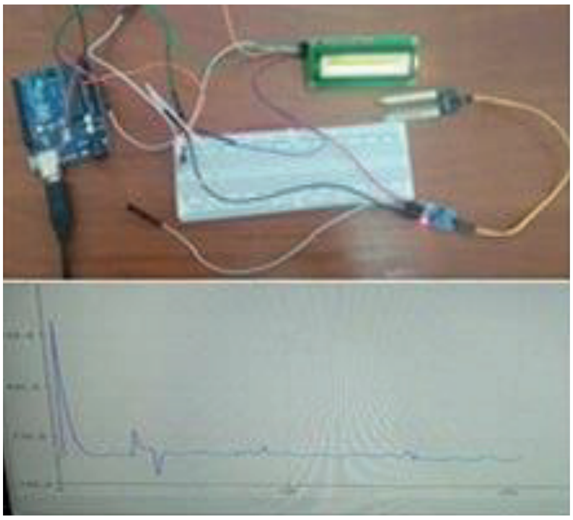

Figure 7. Arduino Uno monitoring system

The first container is placed at normal temperature, normal air, normal soil, as well as strong sunlight [19-22].

The second container is a normal temperature of sunlight, slightly dry air, moist soil.

The third container is placed in the wax even with a little cold air temperature, normal air humidity, normal soil moisture, weak sunlight.

The fourth container is cold air, normal air humidity, very high soil moisture, low sunlight [23].

In a few days we will check the growth (Table 1).

Table 1

	Air temperature (° C)	Humidity (%)	Soil moisture (%)	Lighting Intensity	Growth quality
1	25	34	41	It's too hot	Good
2	28	43	55	Good	The best
3	23	42	53	Normal	Satisfactory
4	21	45	70	Bad	bad

Arduino was used and findings from the analysis of the data based on the Table 1, are shown in (Fig. 8).

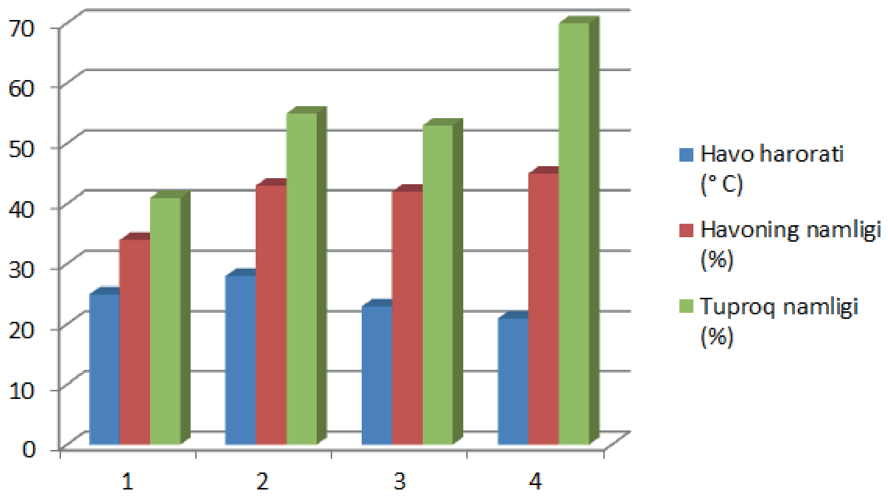

Figure 8. Result

Conclusions

From the experience, it can be concluded that plants (in flowers) can be cared for in healthy and optimal conditions, depending on the abundance, temperature and light intensity. We have set the experiment in 4 different scenarios, placed each container at certain time, and analyzed findings to give different values. The best growth quality is 28 degrees soft, 43% humidity, 44% soil moisture and good light intensity as a result of experience in plants. We conclude that the plant grows better provided that humidity and light intensity indicators are higher.

This means that in order to get these results in real time, we can monitor this technology in agriculture, not only in plants, but also in other vegetables and horticulture.

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