**Ministry of Education and Science of Ukraine**

***Odessa National Academy of Food Technologies***


**International Competition of Student Scientific Works**

# BLACK SEA SCIENCE 2021

## Information Technology, Automation and Robotics

**Proceedings**

Odessa, ONAFT 2021

**UDC 004.01/08**

## Editorial board:



**Black Sea Science 2021**: Proceedings of the International Competition of Student Scientific Works. Information Technology, Automation and Robotics. / Odessa National Academy of Food Technologies; B.Yegorov, M. Mardar, S.Kotlyk (editors-in-chief.) [*et al.*]. – Odessa: ONAFT, 2021. – 526 p.

These materials of International Competition of Student Scientific Works «Black Sea Science 2021» contain the works of the contest participants in the section «Information technologies, automation and robotics» (not winners).

The author of the work is responsible for the accuracy of the information.

## Organizing committee:

**Prof. Bogdan Iegorov,** D.Sc., Rector of Odessa National Academy of Food Technologies, Head of the Committee

**Prof. Maryna Mardar,** D.Sc., Vice-Rector for Scientific and Pedagogical Work and International Relations of Odessa National Academy of Food Technologies, Deputy Head of the Committee

**Prof. Stefan Dragoev,** D.Sc., Vice-Rector for Scientific Work and Business Partnerships of University of Food Technologies (Bulgaria)

**Prof. Baurzhan Nurakhmetov,** D.Sc., First Vice-Rector of Almaty Technological University (Kazakhstan)

**Prof. Mircea Bernic,** Dr. habil., Vice-Rector for Scientific Work of Technical University of Moldova (Moldova)

**Prof. Jacek Wrobel,** Dr. habil., Rector of West Pomeranian University of Technology (Poland)

**Prof. Michael Zinigrad,** D.Sc., Rector of Ariel University (Israel)

**Dr. Mei Lehe,** Ph.D., Vice-President of Ningbo Institute of Technology, Zhejiang University (China)

**Prof. Plamen Kangalov,** Ph.D., Vice-Rector for Academic Affairs of "Angel Kanchev" University of Ruse (Bulgaria)

**Dr. Alexander Sychev,** Ph.D., Assoc. Professor of Sukhoi State Technical University of Gomel (Belarus)

**Dr. Hanna Lilishentseva,** Ph.D., Assoc. Professor, Head of the Department of Merchandise of Foodstuff of Belarus State Economic University (Belarus)

**Prof. Heinz Leuenberger,** Ph.D., Professor of the Institute of Ecopreneurship of University of Applied Sciences and Arts (Switzerland)

**Prof. Edward Pospiech**, Dr. habil., Professor of the Institute of Meat Technology of Poznan University of Life Sciences (Poland)

**Prof. Lali Elanidze,** Ph.D., Professor of the Faculty of Agrarian Sciences of Iakob Gogebashvili Telavi State University (Georgia)

**Dr. V. Kozhevnikova,** Ph.D., Senior Lecturer of the Department of Hotel and Catering Business of Odessa National Academy of Food Technologies, Secretary of the Committee

# The jury for the section «Information technologies, automation and robotics»

***Head of the jury:***

**Sergii Kotlyk** – Ph.D., Associate Professor, Director of the P.M. Platonov Educational-Scientific Institute of Computer Systems and Technologies "Industry 4.0" of Odessa National Academy of Food Technologies (Ukraine)

***Members of the jury:***

**Piotr Artiemjew -** Dr hab., Associate Professor in Decision Systems of the Faculty of Mathematics and Computer Science,University of Warmia and Mazury in Olsztyn (Poland)

**Francisco Antonio Augusto** – Dr., International Relations Manager of Higher Institute of Information and Communication Technologies (Angola)

**Andrey Kuprijanov** – Ph.D., Associate Professor of the Department of Software for Computers and Automated Systems of Belarusian National Technical University (Belarus)

**Simon Milbert** – Vice-President of Xtra Information Management, Inc. (USA)

**Ivan Palov** – D.Sc., Professor of University of Ruse "Angel Kanchev" (Bulgaria)

**Degla Gérard Hugues** – Communications and Training Manager of "MAPCOM solutions informatiques" company group (Benin)

**Nugzar Kereselidze -** Academic Doctor of Informatics (Computer Science), Associate Professor of the Department of Natural Sciences, Mathematics, Technology and Pharmacy, Sukhumi State University (Georgia)

**Etibar Seyidzade -** Associate Professor of the Department of Computer and Information Technolohies, Baku Engineering University (Azerbaijan)

**Vladimir Golenkov,** D.Sc., Professor of the Department of Intelligent Information Technologies, Belarusian State University of Informatics and Radio Electronics (Belarus)

**Zhanar Omirbekova -** Ph.D., Associate Professor of the Department of Automation and Management, Satbayev University (Kazakhstan)

**Ivan Palov -** D.Sc., Professor of the Department of Power Supply and Electrical Equipment, University of Ruse "Angel Kanchev" (Bulgaria)

**Siarhei Palavenia -** Ph.D., Associate Professor, Head of the Department of Telecommunication Systems, Belarusian State Academy of Communications (Belarus)

**Alexander Goloskokov -** Ph.D., Professor of the Department of Software Engineering and Information Technology Management, National Technical University "Kharkiv Polytechnic Institute" (Ukraine)

**Peter Nikolyuk -** D.Sc., Professor of the Department of Computer Technology, Vasyl Stus Donetsk National University (Ukraine)

**Vladimir Palagin -** D.Sc., Professor, Head of the Department of Radio Engineering, Telecommunications and Robotics Systems, Cherkasy State Technological University (Ukraine)

**Viktor Khobin** – D.Sc., Professor, Head of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

**Valeriy Plotnikov** – D.Sc., Professor, Head of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**Sergii Artemenko** – D.Sc., Professor, Head of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

**Fedir Trishyn -** Ph.D., Associate Professor, Vice-Rector on Scientific and Educational Work, Odessa National Academy of Food Technologies (Ukraine)

**Valerii Levinskyi** – Ph.D., Associate Professor of the Department of Technological Processes Automation and Robotic Systems of Odessa National Academy of Food Technologies (Ukraine)

**Viktor Yehorov** – Ph.D., Supervisor of the Laboratory of Mechatronics and Robotics of Odessa National Academy of Food Technologies (Ukraine)

**Pavlo Lomovtsev** – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**Yurii Kornienko** – Ph.D., Associate Professor of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

**Serhii Shestopalov** – Ph.D., Associate Professor of the Department of Computer Engineering of Odessa National Academy of Food Technologies (Ukraine)

**Anatoly Galiulin -** Ph.D., Associate Professor, Acting Head of the Department of Electromechanics and Mechatronics, Odessa National Academy of Food Technologies (Ukraine)

***Secretary of the jury:***

**Oksana Sokolova** – Senior Lecturer of the Department of Information Technology and Cybersecurity of Odessa National Academy of Food Technologies (Ukraine)

# APPLICATION OF ARDUINO MICROCONTROLLER SYSTEM IN THE EDUCATIONAL PROCESS

Author: ***Yakovleva Katerina***
Advisor: ***Volchkov Igor***
Professional college of oil and gas technologies, engineering and service infrastructure of the Odessa National Academy of Food Technologies (Ukraine.)

***Abstract***

*This paper considers the possibility of using the microprocessor system "ARDUINO" in the learning process. In today's world, students of technical schools must be well versed in digital technology, programming and have some technical skills in the use of modern microcontrollers.*

*Microcontrollers are very complex devices and in order to understand the operation of these devices you need to spend a lot of time studying the technical documentation as well as a good knowledge of technical English. In addition, you need to know the programming language (eg C ++) and have a programmer with which to program the microcontroller. This paper presents the development of a universal laboratory stand for learning the basics of programming and studying the hardware of microcontroller technologies.*

***Keywords:*** *Arduino, digital technologies, microcontrollers, programming.*

## I. Introduction

The use of modern microprocessor systems for the educational process requires large financial costs for laboratory equipment and the purchase of certified equipment and software.

This problem can be simplified if applied to the learning process.

ARDUINO microprocessor system kit that allows you to study both hardware and programming (in a language that is very similar.

In the algorithmic language C ++). The ARDUINO microprocessor system consists of separate modules that can be purchased separately as needed. The software is on the site and can be downloaded to your computer free of charge via the Internet. The software is focused on the operating system WINDOWS, Mac OS, LINUX. In the software There are a number of programs (sketches) that are test and can be used with various additional modules that can be purchased separately. Main module: this is the module on which the ATmega328 microprocessor and additional elements for its operation are located.

A standard USB cable is used to write the program (sketch) to the microcontroller board, which connects to the USB port of the computer and a USB detachable microcontroller board. The programming process takes a few seconds. The written program (sketch) can be controlled with the help of software before programming the microcontroller board. Manufacturers produce a range of microcontrollers devices. The cheapest costs 73 UAH, the most expensive device costs 260 UAH. Some devices, when connected to a computer, appear as an external drive (ie as an FLFSH drive), and some, more budget-friendly ones require the

installation of a driver on the SN-340 computer, which also distributed free of charge. The price of the microcontroller module is 30-40 percent cheaper with constant functionality. For connection of a board of the microcontroller with functional blocks conductors with contacts and various assembly boards which do not demand the soldering are provided. In the microcontroller, the manufacturer has already recorded the boot loader and a test program called BLINK. On the microcontroller board provided several light emitting diodes, one of which is a test. When connected via the power connector, the LED (on and off) starts working with a period of 1 second.

The purpose of this work is to develop a budget version of the laboratory stand based on the microprocessor system "**ARDUINO-UNO**" for the educational process of programming microprocessors and the development and installation of electronic circuits.

## II. Features of the ARDUINO microprocessor system

The program from an incomprehensible set of English words turns into an algorithm for controlling a real device, just assembled with their own hands. It motivates, arouses interest in this activity. Application of Arduino in the learning process. In real conditions, the student does not have enough knowledge about only one microcontroller, device or sensor. In most cases, to solve practical problems, these devices need to be combined into large circuits, which is not always possible in the laboratory. When using the Arduino platform, this process is simplified. It is proposed to divide the work with Arduino into three stages:

*The first stage* of students' work is offered to write the algorithm of the device. This stage of work allows in practice to consolidate the skills of compiling algorithms for their further implementation.

*In the second stage,* a software implementation of the proposed algorithm should be developed. Since students did not have the skills to work in the development environment, although C / C ++ or other programming languages were familiar, standard code examples for a particular job of each of the devices used in development could be used to reduce uptime, but were slightly reworked. for the correct operation of all components of the device according to the proposed algorithm.

*In the third stage* of work, students must study the characteristics and interfaces of the proposed hardware components. By studying information from open sources on their own, they should assemble a working device and check its operability. What can the Arduino give to the learning process? First, it is, of course, consolidating programming skills in C ++. Second, the Arduino gives some idea of microelectronics. This is definitely a necessary knowledge for a software engineer, as they give an idea of the hardware platform for which the software is written. Third, the Arduino allows you to clearly demonstrate the operation of the code. By downloading the program to the board, you can see its effect on real physical objects (the operation of the LED, for example). Material costs (cost of used components) are about 1000 UAH. The use of simpler versions of Arduino (for example, Arduino Uno) will reduce costs to 400-500 UAH.

Modern education must interact with the use of modern technologies. One such novelty is the Arduino family of controllers. Arduino is a fairly simple tool for creating electronic devices and implementing various ideas. This platform is built on a printed circuit board with an integrated environment for writing software. At the heart of the hardware is a microcontroller family ATmega 328 and the minimum required for operation strapping.

## III. Technical parameters of the microprocessor system "ARDUINO-UNO"

The ARDUINO-UNO board has the following parameters: ATmega328 microcontroller with a clock frequency of 16 MHz, operating voltage-5 Volts, FLASH memory - 32 KB (0.5K is used by the bootloader), number of analog inputs-6, SRAM memory -2 KB.

Number of digital inputs / outputs -14 (6 of which can be used as PWM), For analog information output.

Input voltage 7-12 Volts, memoryEEPROM-1KB /

The Arduino can receive digital and analog signals from different devices and has the ability to control various executable modules.

There are a large number of different microcontrollers. It is difficult to find the necessary and presented in an accessible form information about them, not to mention the implementation of any practical tasks with their use. Sometimes this results in a fairly long learning process with deep immersion in the slums of circuitry and microelectronics. Arduino, in turn, simplifies the process of working with microcontrollers and has a number of undeniable advantages over other devices for teachers, students and amateurs:

• low cost. Arduino boards are relatively cheap compared to other platforms.

• cross-platform. With Arduino you can work on systems running Windows, Mac OS and Linux.

• simple and clear programming environment. The development environment is designed for beginners unfamiliar with software development. However, this does not prevent experienced users to create quite complex projects. The environment is an application that includes a code editor, compiler and a special module for firmware. The programming language used in the Arduino is a **Wiring** implementation. Simply put, it is **C / C ++**, supplemented by some libraries.

• the possibility of hardware expansion. The capabilities of Arduino boards can be expanded with the help of special schemes called "shields". Shields are installed on top of the main board and provide new opportunities. For example, there are expansion cards for connection to the local network and the Internet (Ethernet Shield), to control powerful motors (Motor Shield), to obtain coordinates and time from GPS satellites (GPS module) and many others.

Students, having created the program, can immediately observe the results of their activities. The program from English words turns into an algorithm for controlling a real device, just assembled with your own hands. This motivates and arouses interest in this activity.

## IV. Application of microprocessor system "ARDUINO-UNO"

What can the Arduino give to the learning process?

The first is, of course, the consolidation of **C ++ (Wiring)** programming skills.

Second, the Arduino gives an idea of how microelectronics work. This is definitely a necessary knowledge for an engineer, as they give an idea of the "iron" for which the software is written.

Third, the Arduino allows you to clearly demonstrate the operation of the code. By downloading the program to the board, you can see its effect on **real physical objects** (flashing LEDs, for example).

In the College of Oil and Gas Technologies, Engineering and Service Infrastructure of the Odessa National Academy of Food Technologies of Odessa

It is planned to use Arduino in the educational process of students from 2020, in particular in laboratory work, which will allow students to better understand the principles of electronics. As well as interested and talented students to show their abilities in designing and implementing their own developments.

A significant problem in the field of "Telecommunications and Radio Engineering" is the limited use of modern advances in science and technology in the educational process, including the use of unified microcontroller platforms, as it is difficult to imagine a radio device that would not control a microcontroller or microprocessor. The problem is partially solved by using software packages for electronic circuit simulators, which have the ability to debug programs for microcontrollers in real electrical circuits. However, theory without practice is quickly forgotten and work in such electronic stimulators becomes uninteresting for students, it is increasingly difficult to find ways to stimulate students to learn. To solve the problem, it is proposed to introduce platforms such as Arduino in the educational process. The main advantage of these platforms is that their practical use will deepen and consolidate knowledge of the principles of microprocessor systems, design and construction of electronic units and modules with microcontroller control, and in the postgraduate period on the basis of these platforms students can design devices with different the level of complexity of the functions performed: from LED panel switches to systems for selection, pre-processing and visualization of signals. In general, the use of the Arduino platform can significantly increase students' interest in the learning process, and provide basic knowledge on the design of electronic devices with microcontroller control.

## V. Laboratory stand based on microprocessor system "ARDUINO-UNO"

At the College of Oil and Gas Technology, Engineering and Infrastructure service of the Odessa National Academy of Food Technologies of Odessa developed a laboratory stand based on the microprocessor system "ARDUINO-UNO" with additional modules that are located compactly on the circuit board.

On the circuit board are:

-module microprocessor and "**ARDUINO-UNO**"

-board with LEDs in the amount of ten pieces and one color RGB LED.

-potentiometer for work with analog input.

-acoustic generator and switch.

-button to simulate the signal.

-cross board to which all the main foams of the microcontroller board are connected.

On a cross-board the power supply +5 Volts and contacts for connection of additional modules is deduced, in addition. The digital outputs of the microcontroller from the cross-board are connected by a cable to the board on which the LEDs are located. If necessary, this cable is disconnected and various other modules are connected to the cross-board by means of standard conductors with contacts which are provided for this purpose. From above the microprocessor module "**ARDUINO-UNO**" is closed by a transparent protective cover (for protection against damages). The power source can be a standard USB port that outputs + 5 Volts, but the current should not exceed 0.5 Amps, or an external DC power supply with a voltage of +7.0 volts to +12.0 Volts.

On this laboratory stand it is possible to perform a number of laboratory works and conduct various experiments using both digital inputs-outputs of the microcontroller and analog inputs, it is also possible to conduct experiments with RGB LED, getting different colors and shades, writing and configuring the program (sketch). . At the same time, students will be able to clearly see how red, green and blue can be obtained many different shades of colors.

The laboratory stand has dimensions: 140x120x40 millimeters and weighs 200 grams, and does not require additional equipment other than a standard USB cable.

To connect to a computer. The cost of all components does not exceed 300 hryvnias. Photos of the laboratory stand and some components are provided in the appendices: 1-3. An example of a written sketch is given in the appendix: 4.

The use of the ARDUINO hardware and software complex in the innovative activity of future specialists in the field of telecommunications and radio engineering is of great practical importance and is very expedient because it does not require large material costs.

Students, performing a variety of laboratory work have the opportunity to immediately see the results of their work, the opportunity to quickly correct the program (sketch), or hardware.

This paper considers the problem of using information tools in educational and research activities of students - future professionals in the field of telecommunications and radio engineering .. Highlights the educational capabilities of the hardware and software complex Arduino in the context of training future professionals and organizing student innovation, in particular, on specific examples show the possibility of its use for setting and solving various problems, as well as for students to create their own innovative products. Research and testing of educational capabilities of the Arduino hardware and software complex were conducted during an experimental scientific group of students - future specialists in the field of telecommunications and radio engineering - at the College of Oil and Gas technologies, engineering and service infrastructures of the Odessa National Academy of Food Technologies of Odessa (in the disciplines: "Telecommunication

transmission systems, telecommunication switching systems.", as well as in extracurricular activities). The possibility of using the Arduino complex in the innovative activities of students, which is unfolding in the educational process, was also studied. These studies have shown that the Arduino hardware and software complex can play an important role in extracurricular educational and cognitive activities of future professionals (in particular, to enhance their innovative activities). This indicates the expediency of acquaintance with this complex in technical educational institutions.

The hardware part of the complex is an I / O board for analog and digital data based on a programmable Atmega microcontroller of various modifications. Depending on the modification, the board has from 6 to 12 analog inputs (inputs of analog-to-digital converters, otherwise - digital voltmeters) and up to 20 digital inputs / outputs, 6 of which can be used in the mode of pulse-width modulation ). The I / O board operates programs written in a language very close to C ++, which can be easily mastered by a person far from professional programming (especially students). To write, configure and download programs (they are called "sketch") uses a special programming environment (IDE), which includes a program test editor, compiler and program loader. A special boot module is written in the memory of the microcontroller. It allows you to download created sketches without the use of additional programmers, as is usually done on other types of controllers. The measurement results can be displayed as a table in the serial port monitor window, stored in f or on the SD card or, when using the SerialPortPlotter program, be displayed on a computer monitor graphically (up to three graphs). On the ARDUINO UA website you can find a detailed description of Arduino boards of different types and corresponding sensors, a programming manual, examples of sketches, etc. Among the possible experimental problems that can be solved with the Arduino complex, the following should be noted:

1. Registration of time change of data from three sensors with their output on the computer monitor in the form of graphs. These data can be, for example, the following physical quantities: temperature at three different points, • illumination at three different points, humidity at three different points, • temperature, illumination and humidity at a selected point.

2. Obtaining the dependences of some physical quantities on others (with their graphical representation). For example, the dependence of the resistance of the photoresistor on the illuminance; the dependence of the resistance of the thermistor on temperature; charge-discharge curves.

## VI. Conclusions

The use of the ARDUINO-UNO microcontroller system in the educational process has positive consequences. First, the availability of components that can be purchased in a store or ordered online (it will be cheaper). Secondly, a large number of different modules and signs for microcontroller boards are made. Third is open and free software, which is constantly being improved and distributed, as well as a large amount of educational material in accessible, free technical literature and in the form of videos in Yor Tube.

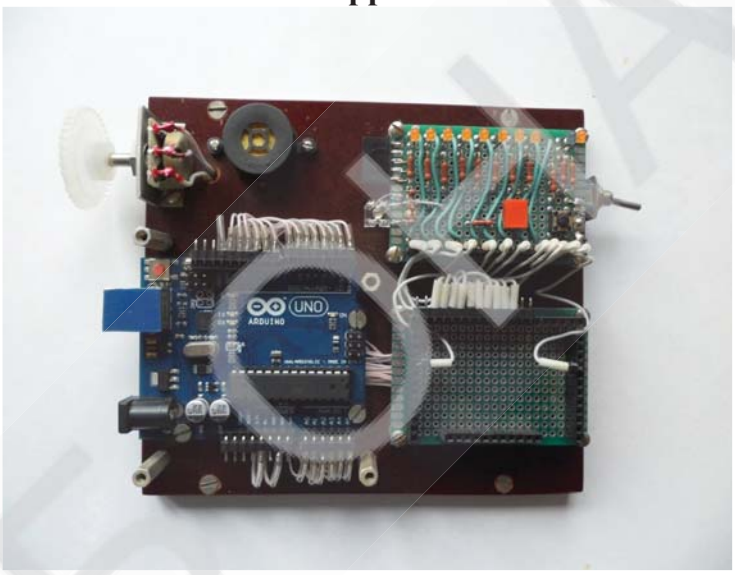
Developed laboratory stand based on microprocessor system ARDUINO-UNO allows students to perform a variety of laboratory work to study programming, algorithms and mastering electronics and circuitry. The laboratory stand itself is safe from the point of view of safety because there are no large electrical voltages (5 volts are used when powered by a computer and 12 volts when powered by an adapter). The laboratory stand can be applied in that complete set that is, or to use additional modules having connected their conductors to the laboratory stand.

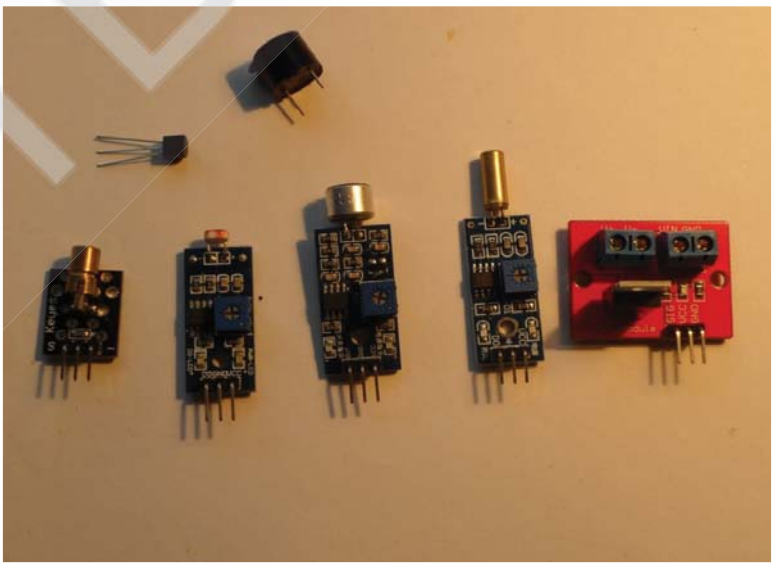
As the initial experience of application of a laboratory stand in a student's circle on studying of electronics and circuit engineering showed at students there is a lively interest in writing of programs and carrying out experiments.

The use of the developed laboratory stand has a positive result in the educational process and research work.

## III. Supplements:

### Supplement I

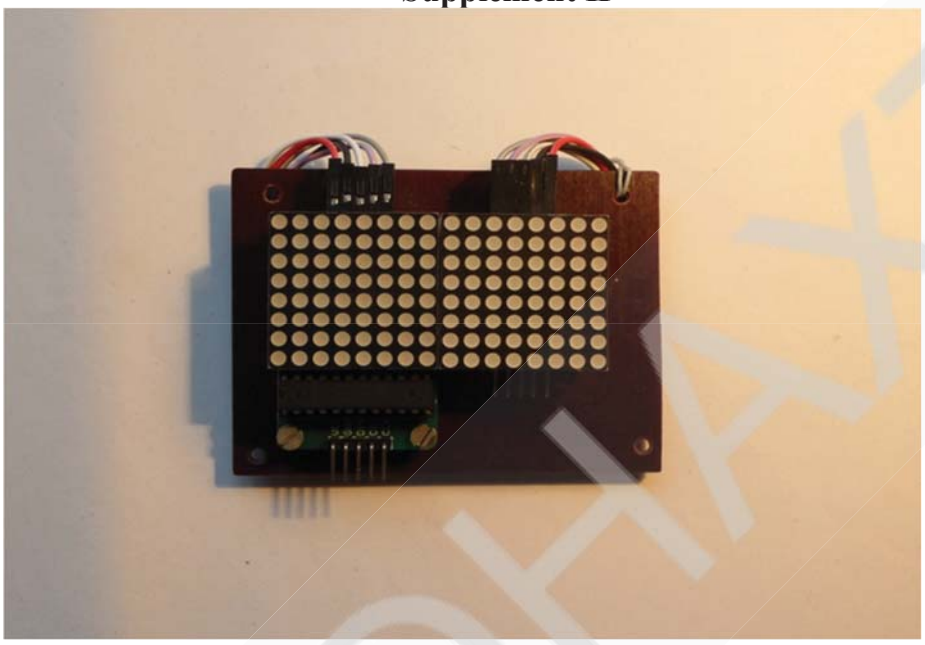


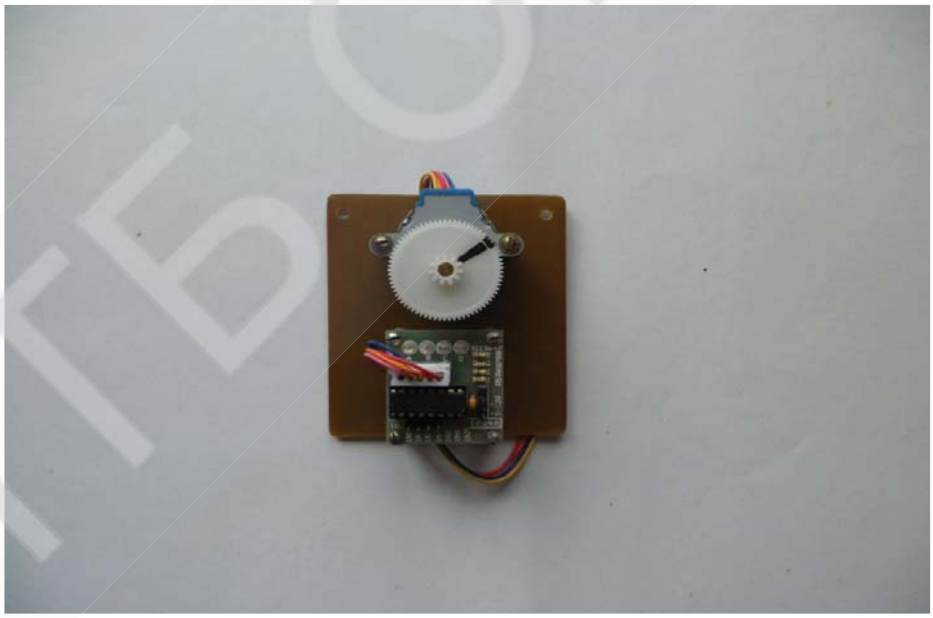



On the top photo there is a laboratory stand with the module “ARDUINO-UNO”.

On the bottom photo there are flexible modules that can be connected to the stand.

**Supplement II**





On the top photo there is a single 8x16 matrix.

On the bottom photo there is a small dvigun with a keruvannya board.

**Supplement III**

On the top photo there is an electrical adapter 220/12 Volt, 1 Ampere.

On the bottom photo there is a USB -2.0 cable for connecting the ARDUINO-UNO module to a computer.

**Supplement IV**

Butt written by programs (sketch)

```
// CONTROL SERVO DRIVE FROM THE POTENTIOMETER
#include <Servo.h>

Servo myservo;  // create servo object to control a servo
 int potpin = 0;  // analog pin used to connect the potentiometer
```

```
int val;    // variable to read the value from the analog pin
 void setup()
{
  myservo.attach(9);  // attaches the servo on pin 9 to the servo object
}
 void loop()
{
  val = analogRead(potpin);            // reads the value of the potentiometer
(value between 0 and 1023)
  val = map(val, 0, 1023, 0, 179);     // scale it to use it with the servo (value
between 0 and 180)
  myservo.write(val);                  // sets the servo position according to the
scaled value
  delay(15);                           // waits for the servo to get there
}
```

## VII. References

1. Massimo Banci ARDUINO M, 2012.
2. Jeremy Bloom Studying Arduino BHV-Petersburg, 2015.
3. Brian W. Evans Arduino programmer notebook S.F. 2007
4. www.arduino.cc
5. www.wiring.org.co
6. http://cslibrary.stanford.edu/101/

# ATDH-REMOTE

Authors: ***Yevhenii Khytruk, Roman Didenko, Andrii Rozhanskyi***
***Advisors: Tetiana Makhometa, Ivan Tiahai***
Pavlo Tychyna Uman State Pedagogical University (Ukraine)

***Abstract.*** *The paper considers the hardware and software of the developed ATDH-Remote device based on the Arduino UNO board. The operation of sensors that can measure body temperature and environment, humidity, atmospheric pressure, as well as automated antiseptic spraying is described.*

***Keywords:*** *Arduino UNO, sensors, infrared jammer, non-contact thermometer, barometer.*

## I. INTRODUCTION

The development of technology, automation and robotization of production makes a significant contribution to the lives of people in the XXI century. It is impossible to imagine the life of modern society without various mechanisms that simplify, improve performance or completely replace a person in a particular field of

# International Competition of Student Scientific Works

# BLACK SEA SCIENCE 2021

# Information Technology, Automation and Robotics

# Proceedings

# Odessa National Academy of Food Technologies

The collection includes student works of the participants of the competition, which were not included in the number of prize-winners. The texts of the competitive works are published in the form in which they were submitted by the authors. The authors of the articles are responsible for the content and form of submission of the material.

**Responsible for the issue: Sergii Kotlyk**

**Computer typesetting and layout: Oksana Sokolova**

**Odessa 2021**