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WIRELESS SYSTEM FOR MONITORING AND CONTROL OF ENVIRONMENTAL PARAMETERS

BY

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Abstract. Technology has come to occupy an important place in our daily routine, it is almost impossible for us to live without using its benefits. We improve a complete system for monitoring and control of a few environmental parameters by coding and assembling it into a box to make it more enjoyable and useful. Our system displays and transmits data such as room temperature, humidity in an enclosure, and it detects the presence of a human being within 7 meters. In the future, it can be modified, updated, or fitted with a smoke or gas sensor that can wirelessly transmit data on gas or smoke emissions. We have specified that this type of module can be used in greenhouses, hospitals and schools. Also, it can be beneficial for parents who have small children or for the elderly who suffer from certain diseases.

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1. Introduction

We chose to present in this work a measurement system for monitoring and control of environmental parameters, and its benefits. We chose this theme because it is very important for us to live in a pleasant environment according to everyone's requirements (Pahuja *et al*., 2017). Technology has come to occupy an important place in our daily routine, so it is almost impossible for us to live without using its benefits (Balendonck *et al*., 2014). It helps us to increase business performance, improves our comfort, we use it both for treating certain illnesses and for fun and relaxation. One of the most popular and most used technology platforms in the last 5-10 years is the Arduino platform. In 2005, the first Arduino was launched by a student from the Italian Institute of Interaction Design, the main target of which was to provide a simple solution for beginners and professionals to create devices capable of interacting with the environment. Arduino is an open-source platform used to create flexible and easy-to-use software and hardware prototypes. It is considered to be the simplest microcontroller platform that can be used to create simple robots, thermostats or detectors. The microcontrollers were designed in such a way as to obtain a small chip size to reduce costs and to include memory slots and IO (Input / Output)interfaces on the chip: the digital control system consists of UCP (Universal Computer Protocol - microprocessor core), data and program memory, interfaces and peripheral controllers. Today, both passionate people and professionals around the world use it to design and implement electronic projects, from prototypes to complex systems (Kermadi *et al*., 2015). Arduino consists of a microcontroller and an electronic board, it can connect various sensor types, such as sensors: alcohol, of fire, liquid petroleum gas, for the detection of carbon monoxide; accelerometer; gravity; temperature; humidity; sound, vibration, distance estimation (Doroftei *et al*., 2018; Akyildiz *et al*., 2002). In order to determine what can be done with the help of Arduino and the sensors mentioned above, we list some project examples: an alcohol sensor that can be connected to a PC-integrated Arduino which gives a warning before letting the user post on Facebook based on the amount of alcohol in the user’s expired air; an autonomous robot that can avoid obstacles; a robot that can be controlled by Bluetooth, using your mobile phone or laptop; a device for painting eggs, for checking temperature, humidity and atmospheric pressure (temperature sensor humidity sensor, atmospheric pressure sensor, and Ethernet card can be used to transmit the data collected from the environment to Google Docs within 10 seconds). Also a robotic hand can be constructed based on a glove with bending sensors and servomotors; a drone, that can capture information on the temperature and wind speed of the environment it is in; a system built with Arduino, which can monitor the electricity that is consumed in a particular room or home; an access control system based on RFID with Twitter notifications, and so on (Kermadi *et al*., 2015).

By making a comparison between Arduino and other microcontroller based development systems, we draw the following conclusions: component purchasing costs are lower for Arduino boards than for other products on the market, any operating system can be used, regardless of whether it is Linux, Windows or MacOS, with most of the other boards being limited to Windows, and it has a simple and easy to learn programming environment. Both the development board and the programming environment are open sources. On the market we find several types of Arduino: official, compatible or derivative. Some of them are equivalent and can be used alternately (Kermadi *et al*., 2015; Mancuso and Bustaffa, 2006). Most have the main platform base platform, with output drivers added to simplify small robots. There are variants that use totally different processors but have a high level of compatibility. At the latest centralization, it has been found that up to 16 Arduino hardware versions have been introduced on the market.

In the first part of our work we presented the images and the description of the components used in the project: Arduino Compatible Board LOLIN 32 WeMos V 1.0.0 - Breadboard 830, Power Source 3.3 / 5 V Fire Jumper, LCD2004 – a small liquid-crystal display, Module I2C (Inter Integrated Circuit), Temperature and humidity sensor DHT11, Presence sensor - RCWL-0516 (Radar), Temperature sensor 18B20, Module 4 Relays - 2PH63083A, Led RGB, Led Tape - White Light, LDR photoresistance and the buttons. The second part includes the stages of the project itself, starting from the driver downloading, designing and assembling the components, writing the code up to the final product. The last part of the paper is dedicated to the conclusions; here we have specified the importance of the project and its usefulness. We have specified that this type of module can be used in greenhouses, hospitals, schools, grocery stores, and it is beneficial for parents who have small children or for the elderly who suffer from certain diseases (Park *et al*., 2009). The Arduino development boards and its compatible ones are very reliable, relatively inexpensive and easy to use. It offers a wide range of prototype solutions, robots, automation, or more complex systems.

2. Experimental Part

We used an Arduino compatible plaque - Lolin 32WeMos V 1.0.0 (Fig. 1). We chose this plaque because it has a chip that can get the best RF power and performance. Versatile and reliable, it can be used in a wide range of applications and profiles. The board has a two-core processor that can be individually controlled and processor frequency is adjustable from 80 MHz to 240 MHz. The user has the ability to stop a processor and use the coprocessor for low power consumption in constant monitoring of peripherals. ESP32 VROOM-32 is the complete name of the processor used by this development plaque.

Fig. 1 – Module WEMOS LOLIN 32.

The CPU model integrates a rich set of peripherals such as touch capacitive sensors, magnetic sensors, SD Card, Ethernet, SPI (Serial Peripheral Interface), UART, I2S (Inter-IC Sound), and I2C interfaces. The board incorporates Bluetooth LE and WIFI that provide a wide range of applications that can be made and enhanced in the future. Using the WIFI connection, it can connect directly to the Internet and it can have a fairly wide coverage by helping a wireless router. The Bluetooth connection can allow the user to connect to the mode via Bluetooth-enabled devices, such as your phone, laptop or tablet. In Fig. 2 to be presented, we will see the detailed listing of pins on the nameplate and peripherals such as battery/battery connection, Serial to USB CP210 converter, and reset button (alldatasheet.com). Our circuit is made on a Breadboard 830 Kit, with 3.3 / 5 V power supply and jumper. This kit is very easy to use because it allows the components to be placed without soldering, so it will facilitate assembly and also allow it to be modified if we want to add other components to the project in the future. As display we chose the 2004 model LCD, which we will use in the project. This LCD model allows you to display 80 characters on four lines. The adapter facilitates I2C communication. It only takes two wires to communicate with the development pad, which are used for clock and data. This module has a potentiometer to adjust the brightness of the display. The DHT11 Digital Temperature and Humidity Sensor is one of the most used temperature and humidity sensors because it is affordable as it is compatible with almost all Arduino development plates, is simple to use, has a small size and provides good accuracy in data transmission (Sun *et al*., 2009). It can measure humidity in the air for the range of 20% - 90%, the accuracy being 5% and the temperature comprised between 0-50°C with an accuracy of 2% (Sun *et al*., 2009).

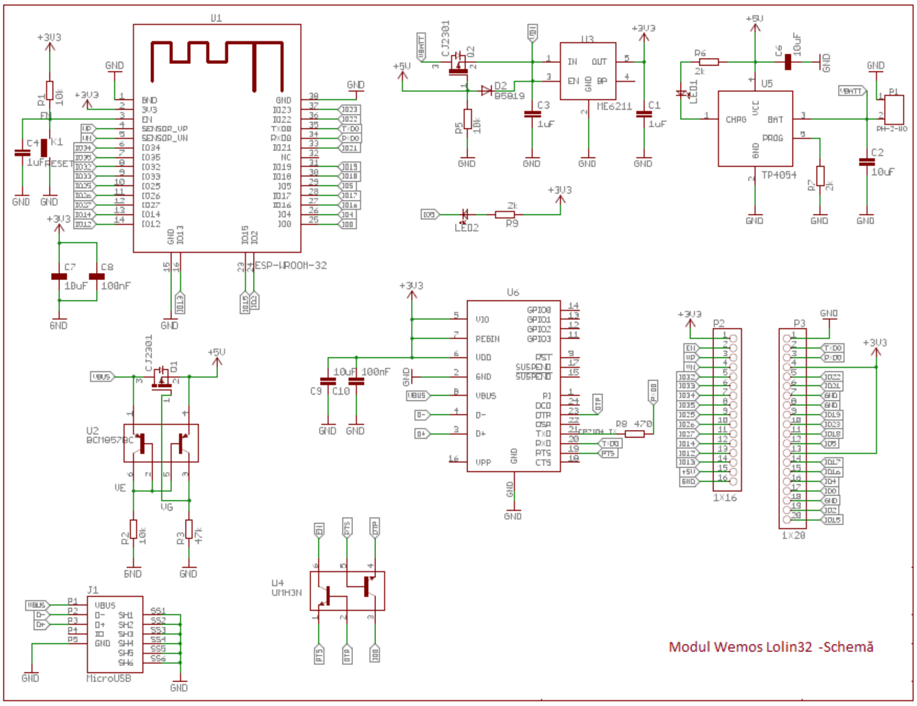

Fig. 2 – Electrical scheme of WEMOS LOLIN 32.

The radar presence sensor, model RCWL-0516 seen in Fig. 3, uses the Doppler effect to detect movement over a distance of 7 m, this being done using radio waves. Radio pulses are emitted when a body moves nearby and the response time changes. The OUT pin will be activated at the time of triggering.

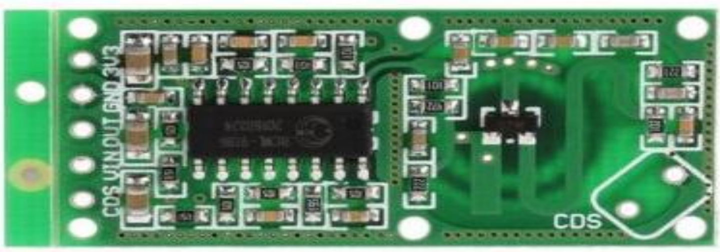

Fig. 3 – RCWL-0516 Radar Sensor.

The temperature and humidity sensor, is highlighted by two important features, can be digitally used with the OneWire protocol, or can be fed through the data thread. The OneWire protocol allows the various peripheral devices to be interconnected directly on the Arduino board. The module 4 relay is useful for controlling several high voltage devices.

Each relay on the plate is ordered separately from an optocoupler. With this module, we can set remotely via the internet or Bluetooth, various devices in this case the temperature we want in a room. Also we used a blank LED is highlighted, indicating three different signals. These signals will be repeated in three colors, red - when it exceeds the optimal temperature, yellow - when the temperature is in normal and blue when the temperature is lower than the set temperature.

3. Setup Implementations

The first step to be taken before programming the development plaque is to install the driver in order to make communication between the PC and the Module. This is done to program the device later.

We will use the Windows operating system, so you will need to install the drivers. We downloaded the .zip archive and unzipped it in the Downloads directory. The download driver, which fits with the LOLIN 32 WeMos V 1.0.0 is the CP210X USB to UART Bridge Virtual Comport. After installing the drivers, we will download and install the latest version of the Arduino IDE application. With this application, you will program and load the module (alldatasheet.com).

In order for the software to recognize the module, it is necessary to install a Git application on git.scm.com and perform some steps in the plate recognition. Once we have properly executed the steps listed above, we have moved to the assembly of the components. First we plugged the development pad with the LCD through the connectivity wires, then we placed them on the breadboard and run a simple program that would display characters on the display, this we did to check the good component operation (alldatasheet.com).

Before loading the first tested program we made the selection of WEMOS LOLIN32 from the Boards manager in the Arduino IDE environment, in Fig. 4 we will see exactly this step, then set the communication speed 115200 and the serial port selection. The last step required before uploading the program to the module is to download the libraries required to use all the components used in the project. Libraries are downloaded from the Arduino "Library Manager" software menu.

The connectivity of the components is as follows. The LCD connects to the development module on pin 21 (SDA) and 22 (SCL), we selected the I2C connection mode to reduce the number of pins you use. The DHT11 and DS18S20 sensors are connected via the following pins: DHT11 is connected to pin 23 (programmed as digital input), and the DS18S20 sensor is connected to pin 17 (programmed as digital input). The two temperature sensors were chosen because the DHT 11 also contains the humidity sensor and has a high latency. The second DS18S202 sensor was added to the project because we wanted to have a more accurate accuracy of the displayed results (ogamtech.com; sensirion.com).

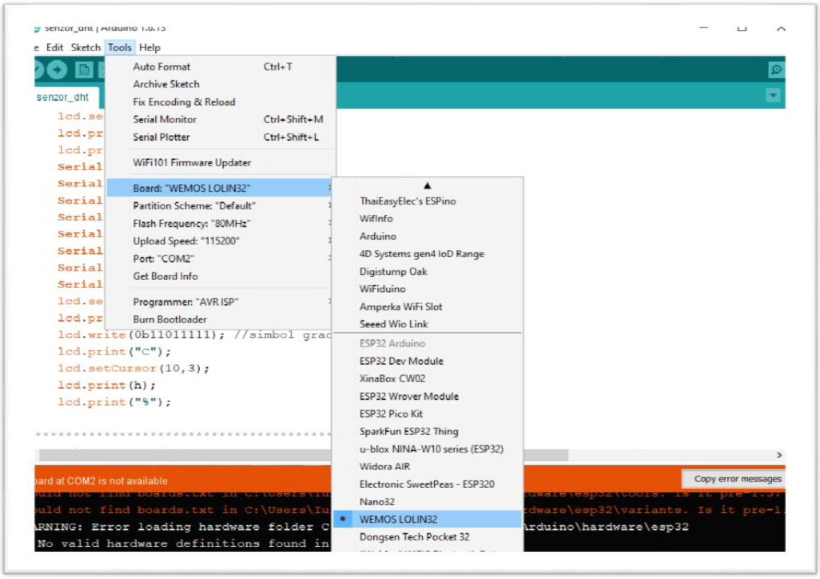

Fig. 4 – Selecting the Plate Type in the Meniu.

The drive's module contains 4 relays, of which only 3 are used, the input of the relays being connected to the pins 19, 5 and 16. Also from the actuator is the RGB LED, which indicates the status of the functions performed. The physical connection of components is presented in Fig. 5 and to make a more realistic picture of the connectivity described above, we will see Fig. 6.

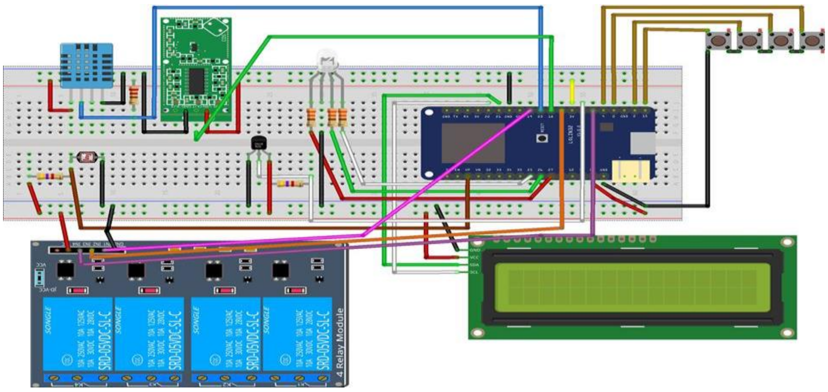

Fig. 5 – The physical connection of components.

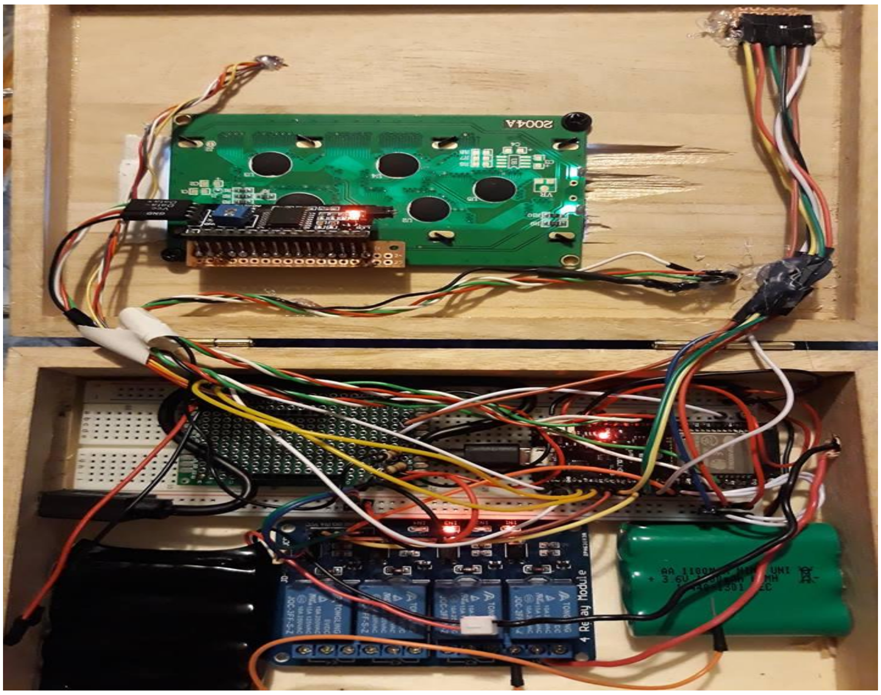

Fig. 6 – Implementation of connection in real case.

From Fig. 7, we notice that the Air condition Status is displayed on the screen. The set temperature and actual room temperature as well as humidity are displayed. The module is in the final presentation stage, it is able to perceive temperature differences, change in real time the values displayed on the screen if there are fluctuations in temperature or humidity increase (Gomes *et al*., 2015).

Fig. 7 – Parameter Monitoring and Control Module.

4. Results

Through this paper, we wanted to highlight the need for a monitoring and control system in an enclosure. If our home does not provide us with the comfort needed for mental and physical relaxation, then there will be another pressure on us. The architecture used in our experiment is illustrated in Fig. 8. We monitored two identical environmental spaces during period of the day. The monitoring system can control the temperatures and the humidity with an air condition cooler also by wireless controlled.

Fig. 8 – Architecture of measurement setup.

The system we have presented comes to our aid, as we can track real-time comfort from rooms. We will be given data on the temperature in the enclosure, data on humidity, and we will specify whether a being invades the territory. People who want to cultivate certain plants need an environment framed between certain parameters to develop properly, and this system can be used in a greenhouse to monitor the temperature and humidity as we show in Fig. 9 (Pawlowski *et al*., 2009; Ferentinos *et al*., 2016).

It can also be used by people with certain disabilities, or by parents who have small children. Another use of this project is of an industrial type, for example a pharmaceutical depot or a perishable food store, may also be useful in a data center where the operation of equipment in optimal parameters is critical.

The presented system may monitor and control at this moment two different enclosures. The novelty is that we measure in real time the humidity and the temperature from enclosures and also, with an air conditioning unit, we can adjust the monitored parameters remotely. On the other hand, with this system developed, we can keep the humidity level optimum for miscellaneous activities; so, the difference between "monitored humidity" and "controlled humidity" is that "controlled humidity" is the humidity that the system attempts to create, and "monitored humidity" is the real humidity of the room. In principle, after a period of time of functioning in an undisturbed room, the system will bring the humidity exactly to a desired level, so that "monitored" and "controlled" humidity become equal. In practice, the two humidities are almost always slightly different because of interference. Also, without being in direct contact with the monitored spaces, we can correct the temperature.

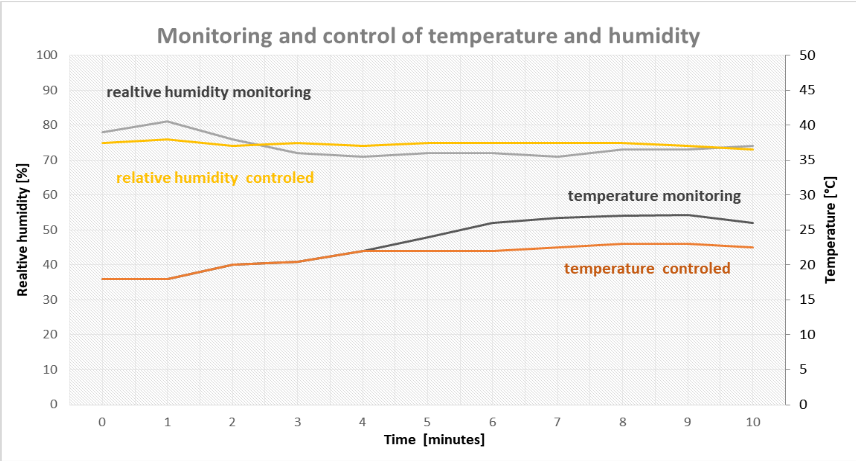

Fig. 9 – Control of environmental parameters.

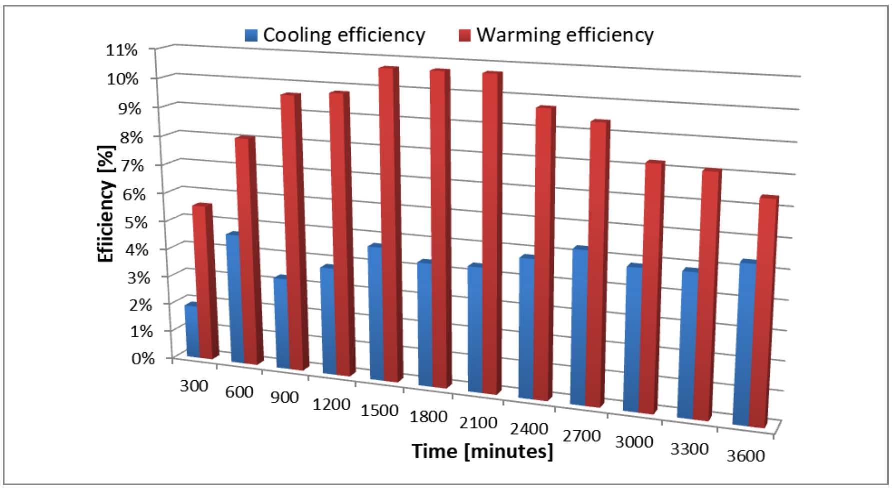

Fig. 10 – Efficiency of the prototype system at cooling and warming.

In order to test the efficiency and reliability of the proposed prototype system, some measurements were made both on cooling (by using an ACC system) and heating (by using a heating source) both controlled by our system and a thermostat, at the same time, on the same conditions, during 3600 min (continuously, starting with cooling, then with warming) (Fig. 10).

A cooling efficiency of up to 5% and up to 11% for heating by controlling with the prototype system was observed. We specify that the efficiency of the heating control by the prototype system is greater because the cooling is more efficient, so the environment will warming up at a lower rate and control is more efficient.

5. Conclusion

The presented project is still in the prototype stage. At the moment, this system can be used to determine room temperature, room humidity and human presence. Also we can control some of these parameters with the help of the air cooler.

All of the data listed above will be displayed on both the project and online display.

This system can be improved in the future; we will be able to set the automatic air conditioning on-line by online transmission, to reach our preferred temperature before reaching the premises. Gas and smoke sensors can be added, in order to remotely switch off the gas connection if emissions are sensed.

We are working at the moment to improve the system with organic electronic components to reduce the volume and to minimize the electronic circuits (Prelipceanu *et al*., 2007a; Prelipceanu *et al*., 2007b; Prelipceanu *et al*., 2007c).

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SISTEM WIRELESS DE MONITORIZARE ȘI CONTROL AL PARAMETRILOR AMBIENTALI

(Rezumat)

Tehnologia a ajuns să ocupe un loc important în viața noastră de zi cu zi și ne este aproape imposibil să trăim fără a folosi beneficiile sale. Am proiectat și îmbunătățit un sistem complet de monitorizare și control al unor parametri meteorologici. Sistemul prezentat în această lucrare prezintă posibilitatea de detecție a prezenței unui om în limita a 7 metri și afișează toate datele de care avem nevoie, cum ar fi temperatura camerei și umiditatea relativă. Acest tip de modul poate fi utilizat în sere, spitale și şcoli. De asemenea, poate fi benefic pentru părinții care au copii mici sau pentru persoanele în vârstă, care suferă de anumite boli și a căror existență necesită supraveghere și atenție sporită. În prima parte a lucrării este prezentat un scurt istoric, o mică descriere și enumerarea câtorva proiecte ce s-au realizat până în prezent cu ajutorul plăcuțelor de dezvoltare ,,Arduino”. De asemenea sunt enumerate cei mai importanți și mai folosiți senzori din proiectele cu plăci de dezvoltare ,,Arduino”. În a doua parte a lucrării sunt prezentate etapele realizării proiectului propriu zis, pornind de la descărcarea driver-ului, proiectarea și asamblarea componentelor, scrierea codului până la realizarea produsului final. Datele din prezentul articol fac parte dintr-un proiect finalizat în întregime de echipa de implementare. Pe viitor, sistemul poate fi modificat, cu ajutorul unor circuite organice electronice, care să reducă dimensiunea acestora și să mărească performanțele. La acest sistem se mai poate adăuga un senzor de fum sau de gaz, datele fiind de asmenea transmise wireless.