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DEVELOPMENT OF A WIRELESS DEVICE FOR AUTOMATIC ALERT OF A CRYING BABY

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Abstract. The article presents the development of a wireless device for automatic notification of a baby's crying. The aim of the work is to create a system capable of recording the sound of crying using a sound sensor and transmitting a signal to the parental home or another responsible person via wireless technologies such as Bluetooth or Wi -Fi.

The article includes consideration of the components of the system components: microcontrollers (Arduino Uno and Arduino Nano), sound sensors and communication modules. The selection criteria for each component, its technical characteristics and features are considered. The technological process of assembling the device is also described, including design, soldering, programming and testing.

The results of the work show that the proposed device can effectively implement its function of providing reliable notification to parents about the crying of the child, which will increase the level of safety and comfort at home.

Keywords: *wireless device, microcontroller, Arduino, sound sensor, Wi -Fi.*

INTRODUCTION

In the modern world, automation of processes is becoming a part of our lives. One of the urgent tasks is to create a wireless device that can record a child's cry and transmit a signal to the lighting of his parents or a responsible person. This article discusses the key components of the system, as well as the stages of development and assembly of a device that will provide reliable and timely notification.[1]

Developing a wireless notification device requires careful selection of the hardware platform, which directly affects the stability, accuracy and reliability of the entire system. The basis of such a system, as a rule, consists of three key components: a microcontroller (the central control element), sensors (in this case, acoustic ones that record sound signals) and a communication module that ensures data transmission to a remote device or server. Below, we consider in detail the selection criteria, technical characteristics and functional features of each of these components.

The microcontroller, as the "brain" of the system, plays a critical role in collecting, processing and transmitting information from sensors to actuators or cloud services. As part of this development, it was decided to consider and compare two popular families of microcontrollers: Arduino Uno and Arduino Nano. Both solutions are based on the AVR architecture and use the ATmega328P microcontroller, but have significant differences in size, power consumption, connectivity options, and design ergonomics.

Arduino Uno is an open, general-purpose microcontroller platform designed to quickly move from an idea to a working prototype. It is widely used in monitoring, automation, and control systems due to its successful combination of functionality, cost, and availability. In the context of developing a wireless notification device, the choice of Arduino Uno is driven by the need for stable digital control, integration with sensors and ease of interfacing with communication modules. [2,3]

Arduino Uno is based on the ATmega328P microcontroller and is supplied as a complete printed circuit board with the minimum necessary bindings for immediate start of work. The key difference of this model is the presence of a built-in USB interface, providing fast firmware of the microcontroller and data transfer without the use of external programmers. The board architecture simplifies both hardware and software integration with a wide range of peripheral devices. (Figure 1)

Figure 1. Appearance of the Arduino board Uno

One of the design advantages of Arduino the Uno is a standard pinout that fits into a DIP package, making it compatible with breadboards and a variety of available shields. This makes it easy to extend functionality without soldering or PCB design. (Figure 2)

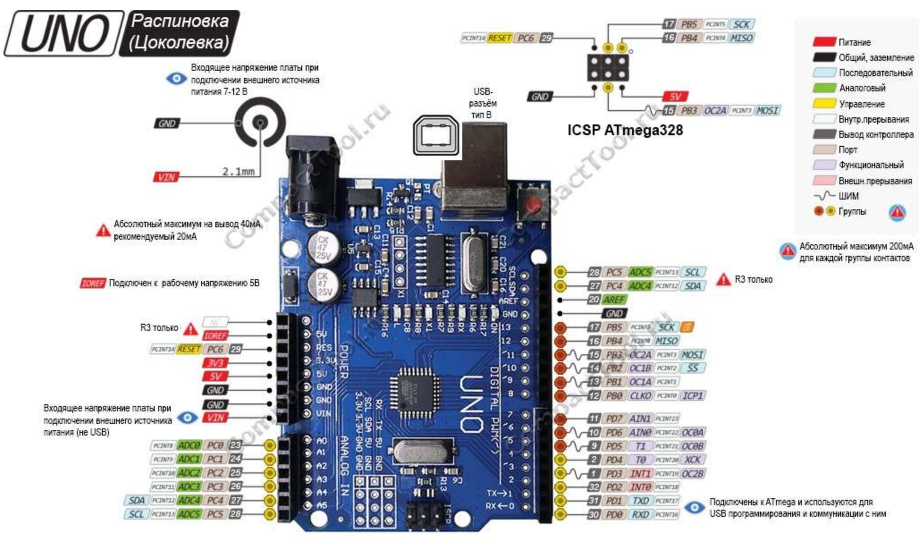

Figure 2. Arduino board pinout Uno

In terms of electrical characteristics, the Arduino Uno supports input voltage up to 12 V via the power connector, making it resistant to unstable sources. The built-in linear stabilizer converts it to 5 V, suitable for powering both the controller itself and the connected modules. It is recommended to use USB power in cases where the device does not require significant currents, especially at the debugging stage. (Figure 3)

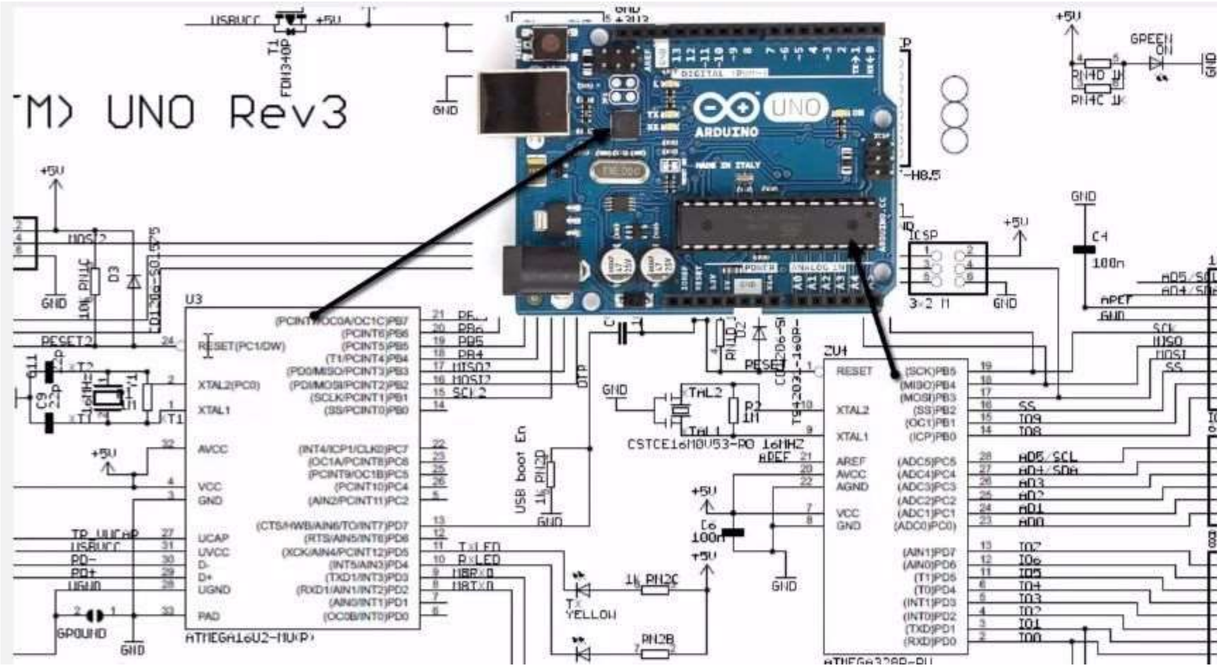

Figure 3. Arduino power supply diagram Uno

It is also important to note the support of several digital communication interfaces - SPI, I2C and UART. This allows you to integrate Arduino Uno with various modules, including radio modules (such as the HC-12 or NRF24L01), sensors, and external memory chips and displays. Although the hardware resources are limited - in particular, only 2 KB of RAM and 1 KB of EEPROM - this is quite sufficient for implementing control logic in systems that do not require intensive calculations or processing of large arrays of data. (Figure 4)

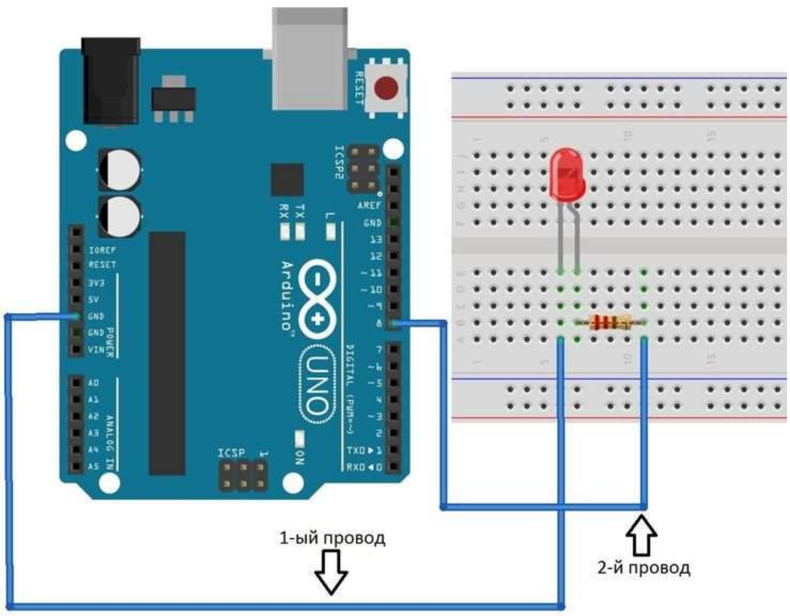

Figure 4. Example of connecting modules to Arduino Uno

In relation to the task of remote notification, Arduino Uno provides basic functionality for polling sensors (such as microphones or sound sensors), processing thresholds and generating an alarm, as well as transmitting data via an external communication module. Additional convenience is provided by compatibility with Arduino libraries, which include ready-made solutions for working with GSM, Wi -Fi and Bluetooth modules, which speeds up the implementation of the system's communication layer. [4-5]

However, for all its versatility, the Uno has some limitations. In tight spaces, its dimensions (68.6 mm × 53.4 mm) can be an obstacle when installing it in miniature cases. In addition, the ATmega328P architecture does not fully support power-saving modes, which reduces efficiency when powered autonomously, for example, from batteries or solar panels. In such cases, it is more appropriate to use alternatives - for example, the Arduino Pro Mini or an ESP32-based board.

To sum it up, it can be noted that Arduino Uno is a robust, well-documented, and easy-to-integrate platform suitable for prototyping and early debugging. It is particularly effective in environments where rapid implementation of basic control and alarm logic is required and the system hardware constraints are within the capabilities of an 8-bit architecture. However, when developing serial or compact solutions, the hardware base will need to be reconsidered in favor of more energy-efficient and miniaturized alternatives.

Arduino Nano is a full-featured microcontroller board designed with miniaturization and embeddability in mind. When developing devices where size, weight, and power consumption are critical, Nano is the optimal solution, combining the capabilities of Arduino Uno with significantly smaller physical dimensions. The board is based on the same ATmega328P microcontroller as the Uno, but the layout, form factor and connection method to host systems are completely different. (Figure 5)

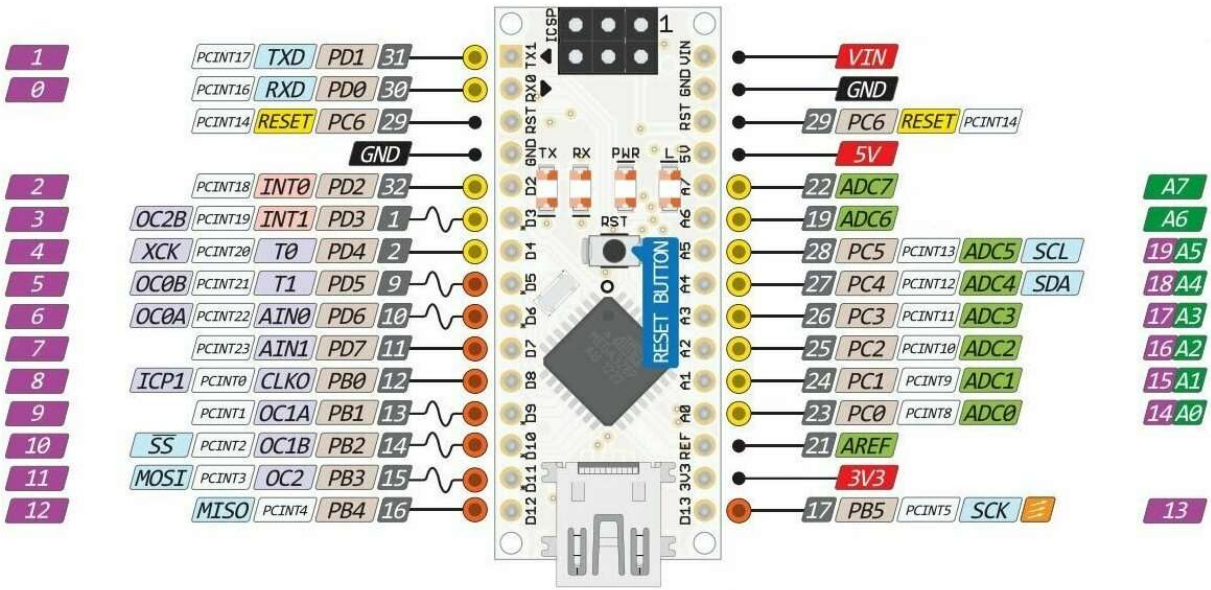

Figure 5. Arduino board pinout Nano

Basic physical and electrical parameters of Arduino Nano : dimensions — only 18 × 45 mm, height with installed components is about 8 mm; power supply — from 6 to 12 V via the VIN pin or directly 5 V along the VCC line; connection connector — mini -USB type B (in early versions) or micro -USB (in Chinese analogs); pin configuration — 30 pins , including 14 digital and 8 analog inputs; firmware — via a built-in USB-UART converter (most often — the FT232RL, CH340G or CP2102 chip, depending on the version); current consumption — in sleep mode it can be reduced to

0.2–0.5 mA, with an active project — up to 30–35 mA; weight — less than 10 g, which makes the board indispensable in wearable devices.[5]

Unlike the Uno, the Nano does not have a standard power jack and requires voltage to be supplied to the corresponding pins, which, on the one hand, complicates the initial work, but, on the other hand, allows for a more flexible organization of the power supply system of the device. Thanks to the dual-row pinout (with a pitch of 2.54 mm), the board is ideal for installation in breadboards or mounting boards, and can also be soldered directly to a designed printed circuit board, which is critical when creating prototypes.

In terms of functionality, Arduino Nano is a complete duplicate of Uno: it supports SPI, I2C and UART interfaces, interrupt management, sensor and actuator connection. However, the architectural advantage of Nano is its ability to be used in confined spaces. This makes it particularly relevant for applications such as smart bracelets, activity sensors, medical devices, environmental control systems, miniature security systems and portable notification modules.

An additional advantage is the wide choice of board modifications: there are versions with 3.3 V power supply, with alternative USB conversion chips, as well as with different layouts, including combined boards with Bluetooth or Wi -Fi modules. This opens up prospects for creating combined solutions without significantly complicating the design. In addition, the low power consumption of Arduino Nano makes it possible to implement autonomous projects based on batteries, solar panels or super capacitors.

One of the few drawbacks of the board is its vulnerability to voltage surges and the need to maintain precise power parameters, especially when connecting sensitive sensors or high-precision ADCs. The board also does not have its own ISP connector, which makes it somewhat difficult to reflash via a programmer in case of bootloader damage. However, these shortcomings are compensated by excellent integration with the Arduino IDE, support for a huge number of libraries, and stable operation in projects with limited resources.

Arduino Nano demonstrates a successful combination of compactness, functionality and flexibility, being the best choice for tasks where it is necessary to integrate control into a small space while maintaining all the advantages of the Arduino platform. It is especially effective at the final stage of device development, when the prototype needs to be implemented in the most miniature form.

Choosing between Arduino Uno and Arduino Nano depends largely on the device's form factor, size requirements, and power source. For remote notification tasks, especially in tight spaces, Arduino is the best option Nano.

The next important component of the system is sound sensors, the main task of which is to register acoustic signals, such as claps, voices or other sharp sound changes that can be interpreted by the system as alarm signals. Among the solutions available on the market, we can highlight the KY-037 and KY-038 microphone modules, widely used in amateur and educational electronics. These sensors are equipped with electret microphones with a high gain, as well as built-in comparators for generating a digital signal when a specified volume level is exceeded.

The KY-037 features increased sensitivity and an analog output, allowing for more flexible signal level analysis. This makes it possible to implement a system that can not only respond to noise, but also classify signals based on their amplitude or duration.

In addition, for increased accuracy, it is recommended to use the MAX9814 module, which is an amplifier with automatic gain control (AGC), which provides a stable high signal level regardless of the distance or intensity of the sound source. Using such a module significantly increases sensitivity and reduces the level of false alarms, which is especially important for systems operating in noisy environments.

The third key element is a communication module that provides data transmission to a server, mobile device or other control unit. This project assumes the use of wireless technology, so the following modules are considered among possible solutions: Bluetooth HC-05/HC-06, Wi -Fi ESP8266 or ESP32, as well as LoRa modules (for example, SX1278). For the considered device based on Arduino Nano the best choice is an ESP8266 module, such as NodeMCU or ESP-01, connected via UART interface. This module has a built-in TCP/IP stack, allows you to send HTTP requests and interact with cloud platforms such as Blynk, Thingspeak , Firebase , etc.

It is also important to note that the choice of power supply plays an important role in the reliability of the entire system. When using Arduino, the Nano and ESP module can be powered by a lithium-ion battery with a TP4056 charging module, which will allow you to create a completely autonomous device.

Summarizing the above, we can conclude that the most suitable configuration for implementing a compact and functional wireless notification device is the following hardware platform: Arduino Nano – the main control microcontroller; MAX9814 sound sensor – for precise detection of acoustic signals; ESP8266 module (ESP-01) – for wireless data transmission; battery + TP4056 – autonomous power supply. This configuration provides an optimal ratio of size, performance, power consumption and functionality, allowing you to create a system suitable for everyday use, both at home and at remote sites. (Figure 6)

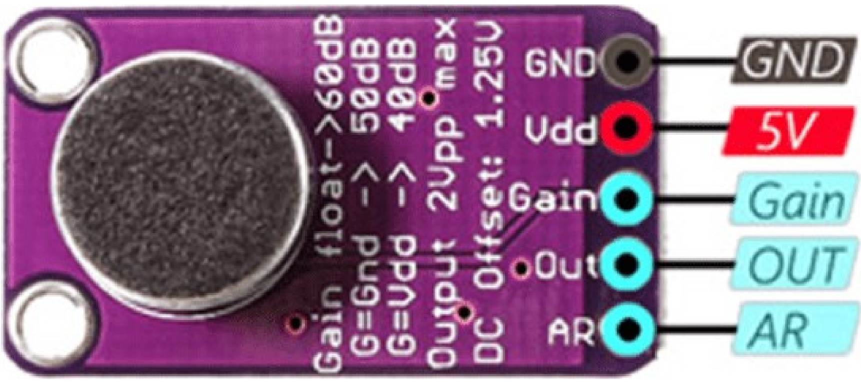

Figure 6. Pinout sound sensor MAX9814

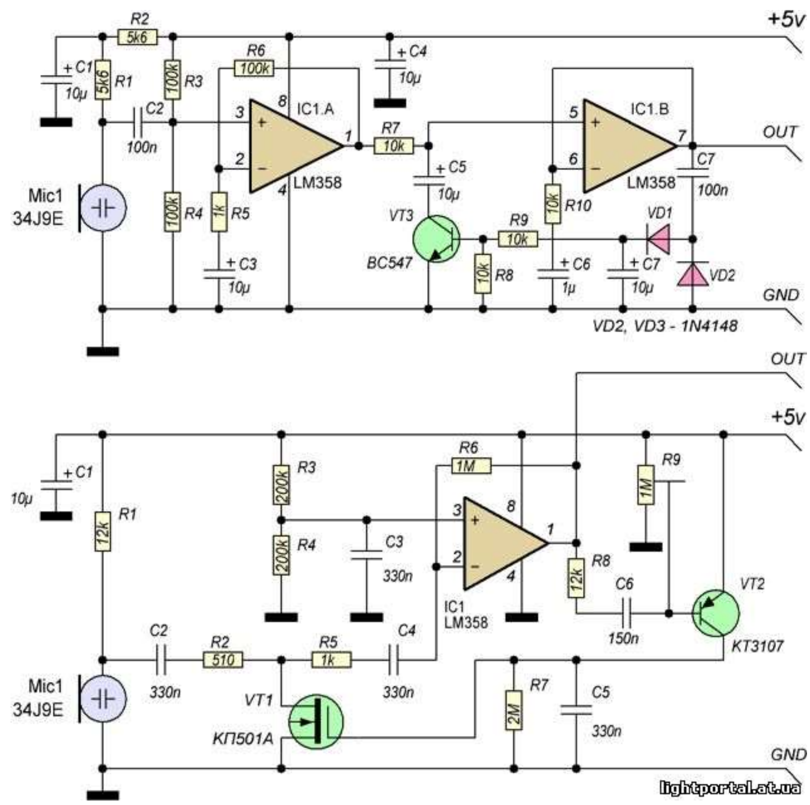

Figure 7. Microphone amplifier

Studio condenser microphone. But, if necessary, you can change it to an electret one, because high quality is not necessary, the main thing is loud and intelligible conversation. What is the name of the amplifier? The DVD should have a microphone input. We connect the DVD to the amplifier, and the microphone to the DVD and everything should work fine. A studio microphone will not work, it needs to be provided with phantom power. [6-9]

TECHNOLOGICAL PROCESS OF DEVICE ASSEMBLY

The technological process of assembling the device begins with careful preparation of all necessary components and tools. First of all, a suitable microcontroller platform is selected, for example, Arduino Nano or ESP32, which has wireless data transmission capabilities, such as Wi -Fi or Bluetooth, which is critical for implementing the remote notification function. Next, a high-sensitivity microphone module is selected, capable of capturing acoustic signals even at a low level, which allows recording a baby's cry with minimal delay. An amplification cascade is connected to the microphone, ensuring reliable capture and transmission of an analog signal to the ADC of the microcontroller.

After the initial circuit layout, all connections are soldered onto a circuit board or breadboard, depending on the stage of development. The signal lines from the microphone are connected to the analog input of the controller, while the power and ground are routed through a stabilized voltage source to eliminate noise and fluctuations in the power supply. Capacitors are also included in the circuit to smooth out pulsations, ensuring stable operation of the sensitive elements of the circuit.

The next step is to integrate a wireless module, such as HC-05 for Bluetooth or ESP8266/ESP32 for Wi -Fi, to transmit data to the receiving device, which can be the mother's smartphone, tablet, or standalone receiver with a buzzer or vibration. Particular attention is paid to setting up the connection: unique addresses, pairing parameters, transfer speeds, encryption protocols, if required, are specified. Then an indicator unit is added to the circuit, such as an LED indicator or an audible alarm that turns on when the sound of crying is detected.

Once the hardware assembly is complete, programming of the microcontroller begins. The code implements the functions of digitalizing the sound signal, filtering background noise, and recognizing a certain volume level or frequency range characteristic of a child's cry. The program includes algorithms for analyzing the amplitude of the sound in real time, and when the set threshold is exceeded, the wireless transmitter is automatically activated, sending an alarm signal. The recipient, in turn, activates vibration, sound notification, or text notification on the screen, depending on the type of device.[10-14]

At the final stage, the device is placed in a protective case that ensures safe operation, protection from dust and moisture, and reduces the likelihood of mechanical damage. The case is selected from environmentally friendly materials, especially if the device is planned to be used near a baby. A final check of the operation of all modules is carried out: the microphone sensitivity, reliability of signal transmission, response of the receiving device, and resistance to interference are tested. If necessary, the response thresholds and response speed are re-adjusted. The device undergoes a cycle of autonomous operation from the battery to check the duration of operation without recharging and correct operation in real conditions.

The technological process of assembling a wireless device for transmitting a signal about a baby's cry includes a complex and responsible cycle from the selection of components, soldering and programming to the final assembly and testing, and requires both engineering precision and reliability, since it is directly related to the safety and comfort of the baby and his mother.

This section examines the step-by-step technological process of assembling the developed device. The assembly included several successive stages: design and preparation of housing drawings, laser cutting and processing of parts, mechanical assembly of the housing, installation and assembly of electronic components, soldering, connection and testing. Each stage was important for ensuring the reliability and operability of the final device. During the assembly, special attention was paid to the accuracy of manufacturing parts, the quality of electrical connections and the overall ergonomics of the design. (Figure 8)

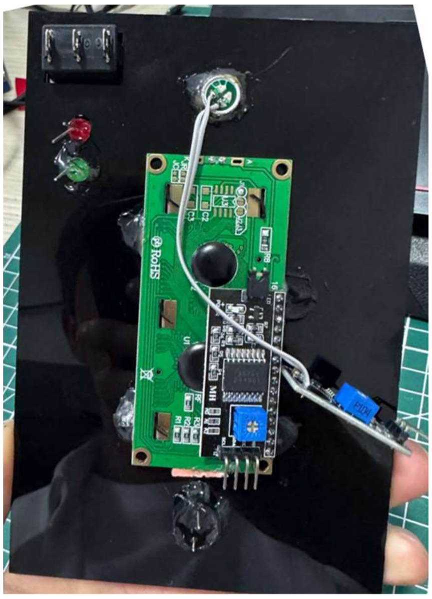

Figure 8. Front and rear view of the device

The image shows a simple electrical circuit based on Arduino Nano, which includes a button and a piezo buzzer (sound signal). Such schemes are often used in alarm systems, notification devices, and also in interactive projects, when a sound signal is heard when a button is pressed. With this scheme, the user can ensure that when a button is pressed, a sound signal is turned on.

The circuit is shown as a layout created in the Fritzing program using the Arduino platform. Nano, one push - button, one piezo buzzer, one resistor, and a breadboard. Electrical connections are made with multi-colored wires, each clearly indicating the purpose of the connection. All components are neatly arranged and connected to the Arduino microcontroller. Nano. (Figure 9)

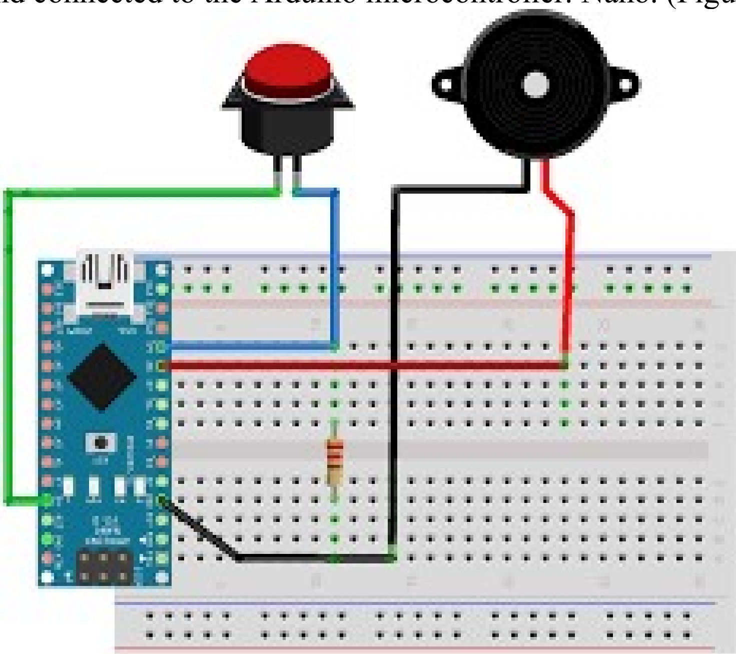

Figure 9. Alarm system with a button based on Arduino

The main element of the circuit is Arduino the Nano is a compact yet powerful microcontroller that can be connected to a computer via USB for programming and power. Pictured is an Arduino the Nano is located on the left and is connected to a breadboard, from where connections lead to the rest of the components.

From the digital pin D2 of the Arduino, there is a green wire connected to the tact switch. This button is installed on the breadboard, and when it is pressed, the Arduino receives a signal on pin D2. One of the pins of the button is connected to the ground (GND) through a resistor. This resistor acts as a pull-down resistor, that is, it holds pin D2 at a low logical level (LOW) when the button is not pressed. This is necessary so that the pin does not "hang in the air" and does not give false triggering. Without such a resistor, instability in the circuit design is possible.

Also shown in the diagram is a piezo buzzer connected to pin D3 of the Arduino via a red wire. The negative leg of the buzzer (usually via a black wire) is connected to the common wire (GND), providing a closed electrical circuit. This element emits a beep when it receives a control voltage from the Arduino. A typical piezo buzzer is used, which can emit signals of different frequencies depending on the program code.

To build the circuit, a breadboard was used, which allows you to connect components without soldering, which is convenient for educational and experimental purposes. Arduino The Nano is connected to one edge of the board, and all connections are made via rows of contacts. The colored wires make the diagram easy to read: green is signal, black is ground, and red is power or control signal.

The principle of the circuit is as follows: in the program code, the Arduino monitors the state of pin D2. When the button is pressed, the pin goes HIGH, and the Arduino activates pin D3, supplying voltage to the buzzer. As soon as the button is released, the signal stops and the buzzer stops ringing. This is a simple but very useful design that can be used in real-life projects, such as doorbells, alarms, interactive games, or just for educational purposes.

This circuit is a great example for beginners who want to learn the basics of electronics and programming on Arduino. It helps to understand how digital inputs and outputs work, how to connect external components via a breadboard, how to interact with buttons and produce sound signals. Despite its simplicity, the project is very functional and can be used in a variety of practical tasks.

Conclusion

Developing a wireless child payment notification device is a complex and responsible process associated with the selection of related components and technologies. Using Arduino microcontrollers, sound sensors and communication modules such as ESP8266 allows you to create a compact and effective solution. As a result, this device will ensure safety and comfort for parents, increasing the level of control over the child's condition in their absence. The assembly process requires not only technical knowledge, but also attentiveness, since it directly affects the reliability and functionality of the final product.

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