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Application of Wi-Fi Communication for Remote Monitoring of Human Body Temperature

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Abstract: Focused on processes of integration capabilities into an automated temperature monitoring device to organize wireless data exchange on external devices using Wi-Fi technology. The experiment explored many models of Wi-Fi devices compatible with the Arduino Nano microcontroller. The most convenient for research is the ESP8266 family of Wi-Fi devices. Among the devices in the ESP-12 series, which belongs to the ESP8266 family, the ESP-12f module is the most convenient for research. According to the results obtained, the ESP-12f module has some inconvenience along with its capabilities. One of them is the problem of power supply. The problem arises when the module is used in conjunction with the Arduino Nano microcontroller. To solve this problem, a 3.3 V power module based on the ams1117-3.3 V chip was used. According to the results obtained, it is enough to organize the exchange of information with external devices using the ESP-12f module. If necessary, it is advisable to reprogram the ESP-12f module to change the necessary parameters.

Keywords: LCD1602 liquid crystal display, I2C protocol, ESP8266 family, ESP-12f module, microcontrollers.

Introduction.

In today's circumstances, the management of public health during a pandemic is one of the urgent issues. The initial sign of COVID-19 is a slight elevation in the temperature of the human body. Timely detection of temperature variations enables the identification of individuals at the early stages of the illness.

To simplify regular monitoring of body temperature, we've developed a device for measuring temperature simultaneously at various points on the body, along with an automated digital data processing system for viewing and maintaining the results. This device allows temperature measurements at up to 127 points on the human body using DS18B20 sensors connected through a single cable. The 1-Wire Protocol is employed for data transmission to a microcontroller via this single cable [4,11,12]. To display measurement results and process data, the device incorporates the LCD1602 liquid crystal display. Signals from the microcontroller to the display are transmitted using the I2C protocol.

The automated temperature monitoring device facilitates data transfer to external computing systems, such as a computer, using a USB serial port. This limitation necessitates the direct presence of external devices near the individual conducting the temperature measurements. While the automated device is portable and suitable for use in various settings like homes, streets, and during walks, the subjects of measurement can include children, the elderly, and individuals capable of self-monitoring, with the aforementioned drawbacks causing additional inconveniences. Consequently, there arose a requirement for wireless remote data transmission by parents or other close individuals to enable remote monitoring results tracking.

Methods. In this research, we aim to explore the potential integration of a Wi-Fi device into an automated temperature monitoring system to facilitate wireless data exchange with external devices.

To begin, the selection of an appropriate Wi-Fi device model aligns with the primary purpose of the temperature monitoring device. Given that the device is intended for widespread use, key considerations include the availability of components at a reasonable cost and user-friendliness for individuals without specialized education or qualifications. Consequently, Arduino Nano microcontrollers were chosen for their compact size and robust computing capabilities.

For the Wi-Fi component, the ESP8266 family emerges as a favorable choice among various models compatible with the Arduino Nano microcontroller. The ESP8266 chip, known for its popularity, is capable of running standard software compatible with Arduino Nano microcontrollers through straightforward commands. An additional advantage is the cost-effectiveness of the ESP8266 chip. Moreover, within each Wi-Fi device series, there are several modifications available. Notably, for our research, the ESP-12f module from the ESP-12 series is deemed most suitable [7, 17, 18, 19]. This module offers convenience and has numerous ready-made modules designed for collaboration with microcontrollers based on the ESP8266 chip, as illustrated in Figure 1.

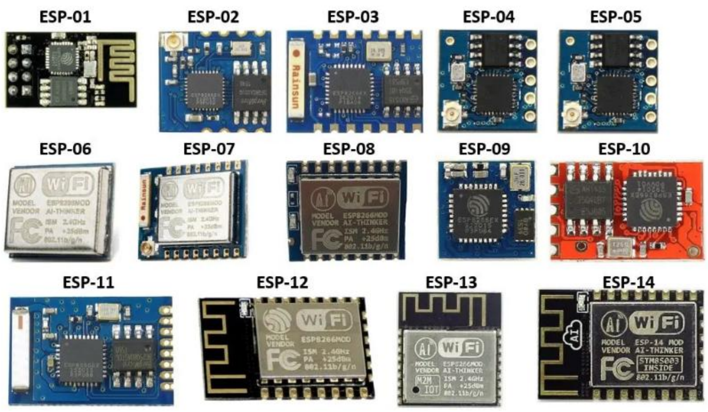

Figure 1. Popular models of VI-Fi modules based on the ESP8266 chip

The ESP-12F module, despite its compact dimensions of 16×24×3mm, boasts a range of features that make it suitable for integration into our automated temperature monitoring device. Here are the key specifications of the ESP-12F module:

Internal Flash Memory: 4 MB of internal flash memory, providing ample storage for data and programs;

UART serial interface: Equipped with UART serial interface for communication purposes.

Outputs (RX and TX): Includes two outputs, RX (data receiving) and TX (data transfer), for UART communication.

SPI interface: Supports Serial Peripheral Interface (SPI) for high-speed communication.

GPIO output pins, 17 General Purpose Input/Output (GPIO) pins for versatile functionality.

Chip activation pin: A pin dedicated to activating and restarting the module.

Analog-to-digital conversion pin: Features an analog-to-digital converter (ADC) for converting analog signals. Reset pin, improved internal PCB antenna, 2.4 GHz radio blog (compatible with 802.11 b/g/n). The ESP-12f module has 22 pins, with their targets listed below.

GPIO0-GPIO16-contacts, input/output data for general purposes. Some of these can be redirected to other features listed below, txd (GPIO1)–data transfer pin via UART tires, RXD (GPIO3)–UART tire data receiving pin, RST (EXT_RSTB, RESET)–module restart pin, ADC (TOUT)–analog-digital converter (ADC). Fixed input voltage 0-3.3 v,GND-common mass pin, VCC–5 volt power source, en–pin for device activation and passivation, SCLK (GPIO6)–takt–giving pin in I2C mode, MOSI(GPIO8)–setting input mode for"Master" pini, MISO(GPIO7)–setting output mode for "Master" pini, CS0 (GPIO11) - setting chip selection pin.

Results. It should be noted that the ESP-12f module, along with its capabilities, has some inconvenience. One of them is the problem of power supply. The problem arises when the module is used in conjunction with the Arduino Nano microcontroller. The ESP-12f module requires electricity with a voltage of 3.3 V and consumes current around 300 mAh. The total power of the microcontroller output current is no more than 200 mA/s, which means it cannot power a Wi-Fi module. An additional source of energy is required. In order not to increase the volume of the body temperature monitoring device, it is recommended to apply the energy source of the microcontroller. However, the voltage of this source is either 5v (when using a USB port) or 7 to 10V (via a VIN microcontroller pin). Such voltage is not permissible for ESP-12f, they can lead to a failure of the module.

To solve this problem, a 3.3 V power module based on the ams1117-3.3 V chip is used. This module can be converted from 4.4 to 7V input voltage into a stable energy source with a voltage of 800ma 3.3 V (see Figure 2). Stable 3.3 V is the most effective for ESP-12f.

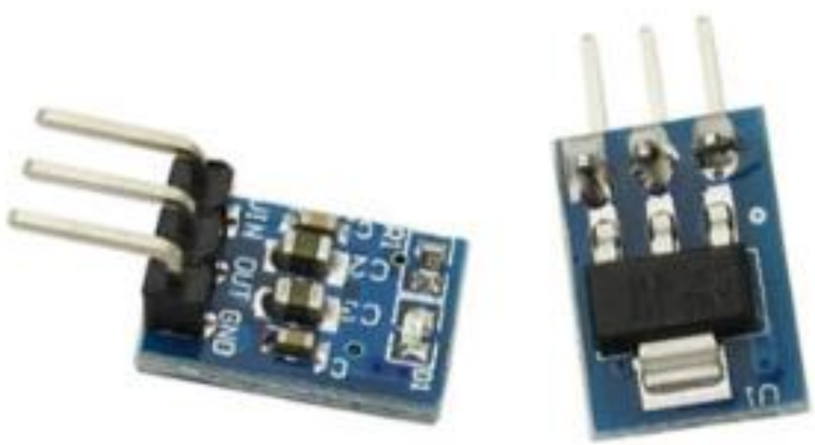

Figure 2. AMS1117 is a 3.3 V power supply module based on the 3.3 V chip.

The module has 3 pins: GND–total mass (minus), for in–input voltage, out-3.3 V stable output pin. The module dimensions are 25×11mm, allowing biomedical signals to be placed inside a digital processing unit. Below is the scheme for connecting the ESP-12f module to the Arduino Nano microcontroller in Figure 3.

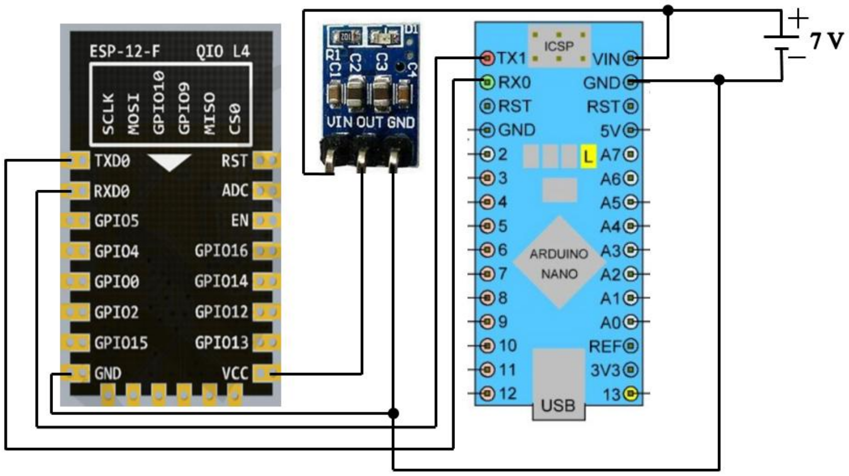

Figure 3. ESP-12f Arduino Nano microcontrollerigai coupling scheme.

This module serves as a prefix for sharing information with peripherals over Wi-Fi. Here it is important to note that when connecting a microcontroller, the TX pin of the microcontroller is connected to the module's DX pin and, conversely, the DX pin of the microcontroller is connected to the module'S TX pin.

Programming the ESP-12f module using the Arduino IDE.

As a programming tool, it is possible to use the Arduino IDE environment. To do this, it will be necessary to install the appropriate driver and function libraries. To work with boards based on ESP8266, we must first install the appropriate driver. It can be found on the internet sites of device manufacturers [6,10,13,15]. Download Esp8266-3.0.2 archive file.zip and place it in the Work folder.

Later, you need to open the archive in the service folder of the Arduino IDE environment. In our example, there is an address in this folder C:\Program Files (x86)\Arduino\ hardware\ esp8266 \ (see Figure 4).

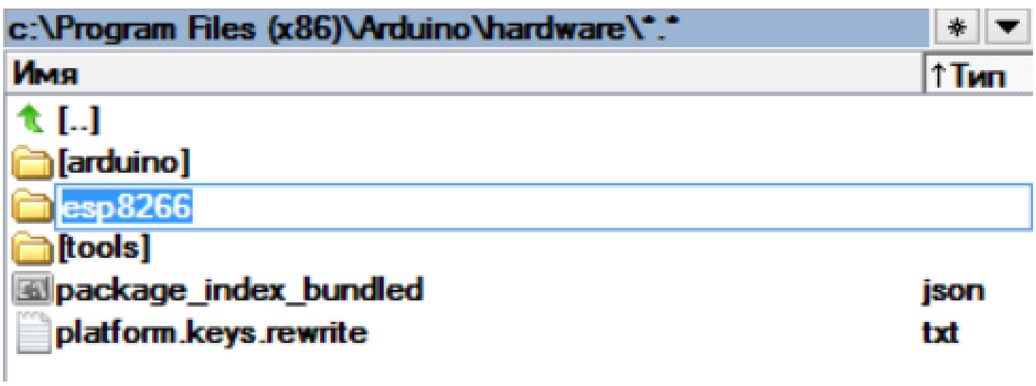

Figure 4. Folder to place the driver for the Esp8266 family of devices.

We run the Arduino IDE environment and show the" general ESP8266 module "as the board in the" Tools " menu (See Figure 5).

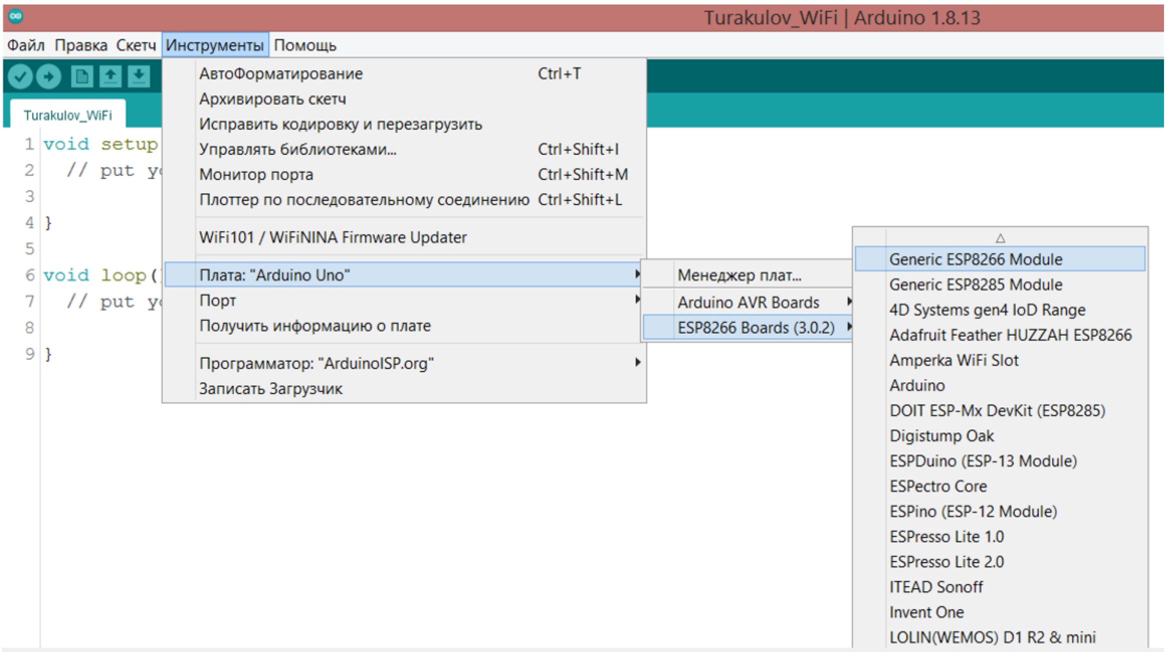

Figure 5. Installing a common ESP8266 Module board in an Arduino IDE environment

As mentioned above, we have provided the possibility of reprogramming for cases of changing the standard program or using the computing resources of the Wi-fi module to process information. In our case, we are very pleased with the software that is loaded by manufacturers to work with IT teams [7,9,20].

Discussions.

Only a standard program for working with AT commands is loaded into the module memory by manufacturers. This is enough to organize the exchange of information with external devices using the ESP-12f module, in which case the module will only play the role of consoles for data transfer and reception. The computational capability of the module is not used, which can save the energy resources of a portable body temperature monitoring device. If necessary, you can reprogram the ESP-12f module to change the necessary parameters. As a programming tool, it is possible to use the Arduino IDE environment. To do this, it will be necessary to install the appropriate driver and function libraries.

Conclusion.

Based on the above studies, the following conclusions can be drawn:

When transferring data from body part temperature sensors to a microcontroller, it is recommended to use a three-wire cable using the 1-wire wired protocol. Such an architecture allows us to measure and transmit heat signals up to 127 parts of the body at the same time.

For digital signal processing, it is recommended to use an Arduino Nano miniature microcontroller, so the dimensions of a person's body temperature monitoring device will not increase.

In order for the proposed device to be used by a wide range of the population, the results obtained after the digital processing of biosignals must be displayed on the device itself. To describe the temperature of different parts of the body in the form of numbers, an LCD 1602 miniature monitor is recommended. When transferring data from a microcontroller to a monitor, it is recommended to use the device and the I2C protocol to minimize the number of pins occupied.

For long-term storage of results and graphic visualization, it is recommended to use external devices as computers, laptops, mobile phones, etc.for wireless data transmission, it is recommended to use an ESP-12f Wi-fi device based on the Esp8266 processor, which is quite suitable in terms of small size and large capabilities. To be more precise, it is recommended to create a user interface using the SCADA System [8].

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