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INVERSE LINK UNIT FOR PARAMETERS CONTROL OF ELECTROSLEEP THERAPY DEVICE

Annotation. This article examines the option of controlling the parameters of the device for electrosleep therapy in order to facilitate the procedure and avoid the patient's unpleasant sensations during therapy.
Keywords: electrotherapy, electrosleep, low frequency current, pulsed current, human resistance, Arduino.

INTRODUCTION

Physiotherapy – an area of medicine that studies the physiological effects of natural and artificial physical factors, also develops methods for the treatment of prophylactic use. This therapy is a very important component of physical rehab, which makes it relevant. Based on the fact that the therapy process and devices need improvement, it was decided to choose one of the methods of physiotherapy for study, namely, electrosleep therapy.

But the problem of determining the current strength, by which will be conducted therapy is actual, because the value of current strength is determined individually for each person in a practical way, that is, from the smallest value to a comfortable for a person.

THEORETICAL BACKGROUND

A method such as the electroshock was developed by Soviet scientists more than 60 years ago. They found a favorable effect of pulsed low-frequency pulse on the central nervous system. The result of this effect was stimulation of the trophic (nutritional) function of the autonomic nervous system. So scientists have discovered a new method of electrotherapy called the electrosleep, which is up to date.

The goals of electrotherapy:

- analgesic and sedation in various inflammatory diseases of the peripheral nervous system, such as radiculitis, radicular syndrome, etc.;
- stimulation of the neuromuscular system under muscular atrophy, flabby paresis and paralysis, with peripheral nerve damage, arthrosis of joints, and the like;
- muscle relaxation in the presence of spasms and inflammation, tonic tension in spastic paresis and paralysis, and the presence of inflammation in the joints. [1]

The greater the sensitivity of a person to the electric current, the less value of the current strength is required for the action of the latter. So, we can say that sensitivity is the inverse of the value of resistance to electric current, therefore it will be more convenient to work with the magnitude of the electrical resistance of the human body.

The human body is a conductor of electric current. The conductivity of living tissue, unlike ordinary conductors, is due not only to its physical properties, but also to the complex biochemical and biophysical processes inherent in living matter. The electrical resistance of various tissues of the human body is uneven: skin, bones, fatty tissue, tendons and cartilage have relatively high resistance, and muscle tissue, blood, lymph and especially the dorsal one and the brain are small resistance.

From these data, it follows that the skin has a very high specific resistance, which is the main factor defining the resistance of the human body as a whole. [2-3]

DEVELOPMENT

On the basis of the above information, it was decided to develop the inverse link unit in the electrosleep therapy device to control the parameters of the device, namely, the strength of the current for influence the patient. Control is carried out using microcontroller board Arduino, which is an effective way to control parameters via feedback. The advantages of using Arduino boards are affordability and low cost.

At Figure 1 shows a functional diagram of the electrosleep therapy device, inverse link unit and interaction with humans (object).

The object – human – is the main link of the scheme. The object is supplied with an electric current under the control of the feedback unit.

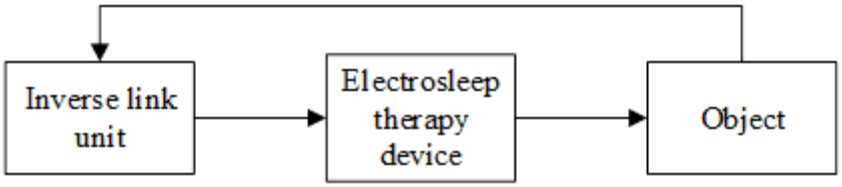

Figure 1. Functional diagram

The next step is to register the signal using the electrodes that are applied to the eyebrows and head and connected to inverse link unit. In the inverse link unit, data processing is carried out, namely the computation of the required values, and a signal is sent to the electrosleep therapy device, namely, the magnitude of the electric current that should act on the object.

The inverse link unit include:

- microcontroller board Arduino;
- model board;
- connecting wires;
- electrodes;
- personal computer (if necessary).

For the realization of the problem and understanding of the process, an algorithm of the feedback operation was developed, which is reflected in Figure 2. The algorithm takes into account all the components of the functional scheme proposed earlier.

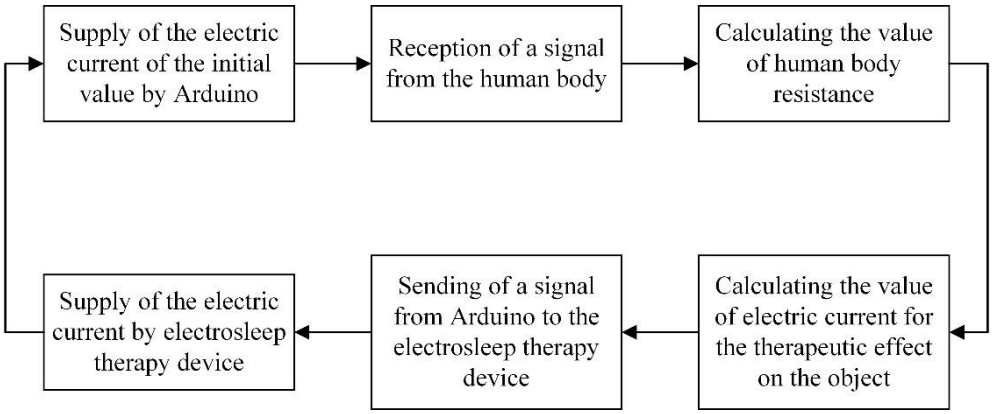

Figure 2. The algorithm of the feedback operation

The first stage of operation of the device is a controlled supply of the electric current to the object. This current supply is controlled by the Arduino microcontroller board.

After the interaction of the electric current with the human body, the microcontroller board Arduino takes the original values from the human body, fixing the required values [4].

After registering data from the human body, the Arduino microcontroller calculates the data to obtain the value of human body resistance.

With the obtained value of resistance of a human body, the necessary value of electric current for the therapeutic effect on the object is calculated. The fifth stage of the algorithm is the sending of a signal to the electrosleep therapy device. The signal contains the required value of electric current for a comfortable procedure.

The final stage of the work is the supply of electric current to the human body from the device.

So for realization of inverse link unit was selected the Arduino Uno microcontroller board, also for the creation of the inverse link unit required model board, connection wires, resistor and electrodes for testing.

Configuring the microcontroller board, writing to it the code and testing are carried out using a personal computer; the computer connects the board with a USB cable.

Ready inverse link unit connects to the electrosleep therapy device with a separate port for power supply, that is, the inverse link unit and device have a single power supply and the process takes place without the participation of the computer.

At Figure 3 shows the code implemented in the Arduino IDE, which is necessary to determine the skin-galvanic reaction of human skin. This reaction is recorded by the microcontroller board using the electrodes and the current directed to the object. The program code contains the simplest operations and commands that are provided in most Arduino training manuals.

```
void setup()
{
  Serial.begin(9600);

}

void loop ()
{
  delay (100.25);
  float sensorValue = analogRead(A0);
  float InputVoltage=sensorValue*0.0049;
  Serial.println(InputVoltage);
  delay (99.75);
}
```

Figure 3. The Arduino IDE software code for the Arduino microcontroller

Explanation to the code:

void setup ()

{

Serial.begin (9600);

}

Set up the exchange of information between the motherboard and the PC and set the speed of data transfer.

void loop ()

{

float sensorValue = analogRead (A0);

float InputVoltage = sensorValue * 0.0049;

Serial.println (InputVoltage); }

Launching a loop in which "int sensorValue = analogRead (A0)" denotes reading data from the analog input A0;

"Int InputVoltage = sensorValue * 0.0049" - bringing the value entering the analog input A0 to the actual value of the voltage.

The converted value is displayed in the form 5 V / 1024 = 0.0049. Thanks to the built-in ADC, the inputs can read the voltage applied to them, but each value input to the analog input is divided by 0.0049. The microcontroller used in Arduino Uno includes a six-channel ADC whose resolution is 10 bits. This allows the output to get values from 0 to 1023 (only 1024 gradations).

"Serial.println (InputVoltage)" - output the received value to the screen.

In this case, in order to influence the object and read signals from it, different electrodes are required: active (for influence) and passive (for reading the signal). To simplify the design, one pair of electrodes (for the eye and neck) are needed that will change the condition, depending on the actions needed to work. This is possible because the device influences the pulsed electric current: at the moment of the therapeutic action of the device, the electrodes are active, at a time when there is no therapeutic effect, the electrodes are in a passive state and can receive the signal of the object.

Suppose the therapy passes with the following parameters:

The frequency of the pulses passing - $\nu = 5$ Hz, that is, 5 pulses in 1 second;

Duration of pulses - ti = 0,5 ms.

Calculate the duration td of the time intervals in which data from the object a will be read: $td = ti \cdot \nu = 0.5 \cdot 5 = 2.5$ ms The time interval for data readout is also 5. Then we have 1 - 0.0025 = 0.9975 sec for 5 data readings in 1 second, one reading is 0.9975 / 5 = 0.1995 sec = 199.5 ms.

"Delay (100.25)" - a delay of 100.25 ms at the beginning of the cycle, used to read data from an object in a gap when the impulse device is not operating;

"Delay (99.75)" is a delay of 99.75 ms at the end of the cycle, used to prevent reading from starting before the start of the pulse, that is, before the start of the cycle.

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