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Digital signal processing for accurate body temperature measurement

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ABSTRACT

The relevance of the subject matter is conditioned by the need to find the most effective and stable point for measuring body temperature using special measuring instruments. The main purpose of this scientific research is to develop a method for the most accurate implementation of these operations through the use of scientific and theoretical apparatus of digital signal processing. The study used methods of analysis and synthesis of information about the main provisions necessary in the process of finding an effective place for measuring the temperature parameter. The main points of body temperature measurement were established, including the key provisions of the digital temperature signal processing technique for measuring these parameters, which are required to assess the real state of a person. The presented mathematical formulas reflect the possibilities of calculating the average body temperature, as well as the skin temperature parameter, determined depending on the temperature indicators at individual points. Temperature curves for various types of diseases were presented. The practical significance of the results obtained lies in the possibility of their use in the activities of institutions of various profiles to find an effective method of measuring human body temperature to assess the physical condition.

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1. INTRODUCTION

In a world where public health is a priority, accurate and rapid body temperature measurement plays a critical role in diagnosing, monitoring health conditions and prescribing appropriate treatment. Given global challenges such as pandemics and the rise of infectious diseases, the need for effective methods of measuring body temperature is becoming especially urgent. One of the main problems in this area is the lack of clear scientific approaches to selecting optimal temperature measurement points and methods for processing the received digital signals. Existing technologies, although they allow obtaining temperature data from different parts of the body, do not always provide sufficient accuracy and speed of measurements. Determining the optimal temperature points and the principles by which the average temperature value is calculated opens up new opportunities for studying the physical condition of a person in various conditions, both in professional activities and in everyday life [1].

A scientific study by Yan *et al.* [2] investigated the problematic aspects of electrostatic sensors in various sectors of life. In particular, it is noted that electrostatic sensors, which are used in medical institutions to measure body temperature, are simple in design, they are economical and suitable for a wide range of installation conditions. According to researchers, these devices, when properly configured, allow qualitatively and objectively measuring a person's body temperature to assess their physical condition. In turn, Guba *et al.* [3] in a study of the principles of functioning of a differential thermometric system with two cells for measuring body temperature came to the conclusion that the correct choice of equipment for measuring body temperature contributes significantly to the correct diagnosis. According to researchers, the development of a digital temperature signal processing device for measuring body temperature is the most important task in the context of organising a full range of therapeutic measures. Proshin *et al.* [4] examined a number of problematic aspects of the evolution of devices for measuring body temperature. Kazakh scientists pay attention to the fact that the process of evolution of devices for measuring body temperature involves a consistent improvement of technical characteristics, which provides more accurate measurement parameters as a final result. In the future, this opens up additional possibilities for optimising the process of measuring body temperature, which is important for obtaining accurate data on the real physical condition of a person.

Bosmans *et al.* [5] conducted a study of the features of procurement, commissioning, and quality assurance of solutions based on artificial intelligence systems. Researchers note that systems based on artificial intelligence are penetrating deeper into medical practice, in particular, it concerns the issues of measuring body temperature. According to researchers, the tasks of medical physics specialists include ensuring the high quality of systems of this kind, since this affects the assessment of the real physical condition of patients and the course of treatment in the future. In particular, the use of systems based on artificial intelligence allows improving the quality of processing the temperature signal, which provides high accuracy of measuring the body temperature parameter. Uchida and Izumizaki [6] in a joint scientific study examined the general principles of using portable devices to predict two-phase basal body temperature of patients. According to scientists, distinguishable wearable devices help to effectively solve the problems of predicting the date of ovulation in women, which is of fundamental importance from the standpoint of family planning prospects. The functionality of such devices is based on measuring skin temperature with subsequent processing of the results, and measurements are carried out automatically on a 24-hour basis.

There are significant gaps in the research that need to be further explored to improve body temperature measurement. Insufficient attention has been paid to optimizing measurement points and equipment selection, which affects diagnostic accuracy. Although electrostatic sensors are economical, their potential for high-quality measurement in different situations has not been explored. Studies on the evolution of devices show the need to improve technical characteristics, but do not highlight the integration of new technologies, such as artificial intelligence, to ensure high quality data processing. The article develops the scientific, theoretical, and methodological foundations of digital temperature signal processing based on mathematical models for measuring body temperature. The main novelty of the study is the optimization of the temperature measurement process by analyzing the dynamics of temperature changes in different conditions, which has not been studied to this extent before. The most effective temperature measurement points have been identified, which allows obtaining more accurate data on the physical condition of patients. The relevance of the study will be demonstrated by improving the quality of disease diagnosis and the possibility of early detection of health disorders through a more detailed analysis of temperature curves and their fluctuations. This opens up new prospects for the development of medical technologies in Kazakhstan and abroad. The main purpose of this study is to create a technique for the most objective measurement of human body temperature using a digital temperature signal processing device.

2. METHOD

The methodological approach in this study is based on a theoretical study of the basic principles of digital processing of a temperature signal when measuring the temperature of a person's body in order to assess their physical condition. The theoretical basis was the analysis of the results of research papers aimed at studying topics related to the declared within the framework of this scientific research. Regulatory documents regulating the procedure for measuring the average temperature of human skin and the average body temperature, relevant at the moment from the standpoint of the current legislation of the Republic of Kazakhstan, were also used.

In this scientific study, the method of analysing the most effective and stable point of measuring body temperature was applied through the use of certified measuring instruments. This has made it possible to establish the main instruments used in medical practice to measure temperature, as well as to identify types of temperature curves. In addition, the use of this method of theoretical analysis made it possible to determine the average temperature parameters in different parts of the human body and to establish the general provisions of thermoregulation. The method of synthesising information obtained during theoretical analysis into a complete system was also applied. This provided objective data on the sequence of construction of the workflow for finding an effective place to measure human body temperature. In addition, the synthesis of information formed a working mathematical method for the most accurate temperature measurement and a method for digital processing of the temperature signal for effective measurement of body temperature necessary to assess a person's physical condition.

The study uses both standard and novel experimental approaches to measure body temperature. Standard methods, such as contact measurement with mercury or electronic thermometers, are used to obtain accurate data at commonly used measurement points (armpit, mouth, and anus). These methods are highly reliable and are often used in medical practice, which ensures the results are generally accepted and accurate. The study also introduces a new approach-digital processing of temperature signals, which is based on the use of mathematical models to analyze data obtained from different measurement points. This approach allows to take into account the dynamics of temperature changes in different conditions and provides a more detailed assessment of the physical condition of patients. The rationale for choosing the methods is their ability to ensure accuracy, speed, and objectivity of measurements. Standard methods are time-tested, while new technologies, such as digital processing, open up new opportunities for improving diagnostics and health monitoring, making the study relevant and important for the development of medical technologies.

The combination of these methods of theoretical research suggested the possibility of using as its materials regulatory documents defining the procedure for determining human heat content and relevant in the Republic of Kazakhstan today [7]. This made it possible to draw up mathematical positions for the measurement of body temperature at various points and average values for human skin temperature and average body temperature. The application of this normative document as a material for this scientific study provided data on the dynamics of changes in the values of mixing coefficients when calculating the average body temperature. Data were obtained regarding the actual range and accuracy of certified measuring instruments that must be used to determine the average body temperature according to the method specified in this regulatory document. In addition, equations were obtained for determining the rectal temperature of the human body:

$$TR = 0.65 * To + 13.6 \tag{1}$$

$$TR = 0.51 * Ta + 19 \tag{2}$$

where T_o is oral temperature and T_a is axillary temperature.
The formula for calculating the average parameter of skin temperature:

$$TS = \alpha 1 * TK1 + \alpha 2 * TK2 + \alpha 3 * TK3 + \alpha 4 * TK4 + \alpha 5 * TK5 \tag{3}$$

where, α_1-α_5 is the weighting coefficients, which are taken respectively: 0.07; 0.5; 0.05; 0.18; 0.2; T_{K1}-T_{K5} is skin temperatures in various areas, respectively: forehead, chest, back of the hand, thigh, and lower leg, expressed in ℃.
The formula for calculating the average body temperature:

$$Tav = \alpha * TKav + (1 - \alpha)TS \tag{4}$$

where, T_{Kav} is average value of skin temperature in various areas; α is the mixing coefficient, the value of which depends on the ambient temperature, the level of physical activity, and the associated energy costs.

3. RESULTS AND DISCUSSION

3.1. Results

Body temperature is the most important factor in the diagnosis of numerous diseases and painful conditions. Thermometers are used to measure temperature, differing from each other by the principle of operation and the specifics of their use in the diagnosis of patients' conditions. Thermometry (temperature measurement) is a mandatory element of the patient examination, since it is used to recognise all hypothermic conditions [8]. In medical practice, two main types of thermometers are used to measure human body temperature: contact and non-contact. In turn, contact thermometers are divided into liquid and electronic (digital). The principle of operation of liquid thermometers is based on the expansion of the liquid. As a working substance, they contain mercury or alloys of various metals of liquid consistency [9].

A classic thermometer, in which mercury is used as a working substance, looks externally like a transparent device with an internal temperature scale and a capillary at the end of which there is a thickening with the specified working substance. The index of its thermal expansion is about several hundred times higher than the same parameter of glass, which guarantees a significant change in the level of mercury in the capillary with a relative constancy of its magnitude. The temperature value fluctuation range is in the range of 34-42 ℃, with the set value of the division price 0.1 ℃. The electronic (digital) thermometer does not contain mercury, the measurement of the patient's body temperature takes place within 10-30 seconds, while ensuring high accuracy of the results [10]. Such a thermometer has a shock-resistant casing, is equipped with an audible signal notifying the end of the measurement, and also has sensor protection against moisture penetration. The practical application of such a thermometer ensures measurement accuracy within 0.1 °C, the measurement range is within 0-100 ℃ [8].

As a rule, the temperature is measured in the armpit, in rarer cases in the groin fold or rectum. Basal temperature is the body temperature that is measured immediately after the morning rise before meals [11]. These values are used in the study of relative changes in body temperature, in the digital processing of the temperature signal in order to assess the real physical condition of the patient. Infrared thermometers are used for non-contact measurements. The tip of such a measuring device is placed in the patient's ear, while the temperature is determined by determining the level of fluctuations of thermal radiation in the ear canal. As a rule, this measurement method is used to determine the body temperature of infants, because it provides high accuracy of results. Measurements are carried out quickly and do not involve invasive intervention.

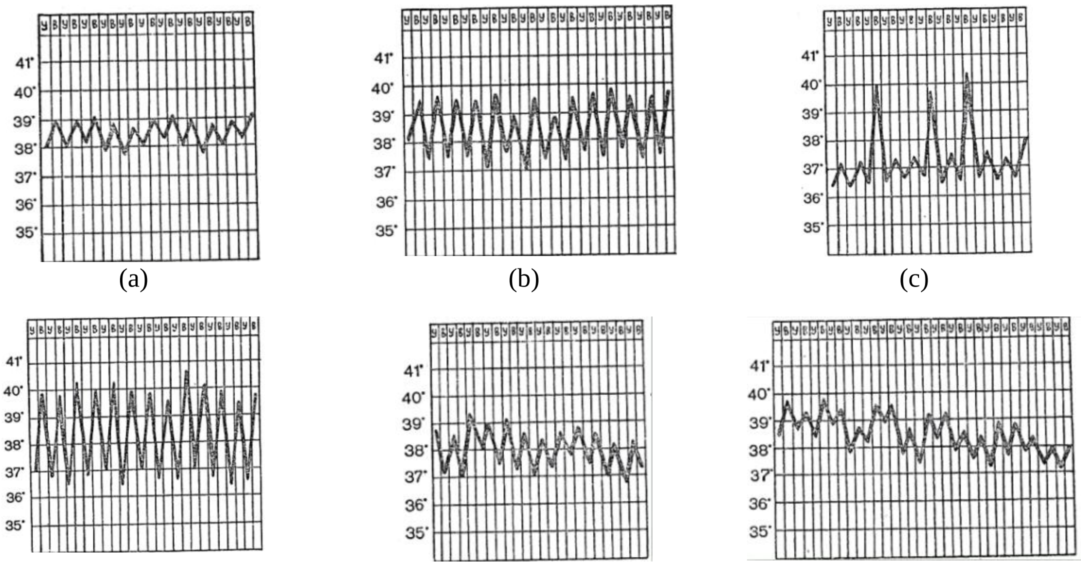
The results of thermometry, as a rule, are recorded in the register of medical personnel, as well as in the temperature sheet of the patient's medical history. In addition, data in digital format is entered into the temperature sheet, displaying changes in body temperature, weight, as well as a number of other parameters that are considered during the treatment of the patient. Digital processing of a temperature signal in computing involves arithmetic processing of temperature readings equidistant in time. In addition, digital processing also implies multidimensional and one-dimensional arrays of temperature measurement data at various time intervals. In this context, it is important to observe the principles of constructing temperature curves that reflect the dynamics of fluctuations in the patient's temperature during the day. In each case, the type of temperature curve reflects the nature of the factor causing the disease, as well as the reaction of the human body. At the same time, there are the following types of temperature curves: continuous; relapsing; intermittent; remittent; warped; and hectic [12].

The types of temperature curves are shown in Figure 1. A continuous temperature curve takes place at a continuously high temperature (Figure 1(a)). As a rule, the average daily temperature difference between morning and evening measurements does not exceed 1 ℃. A similar kind of temperature curve is characteristic of pulmonic fever. The remittent temperature curve displays consistently high temperature values at which fluctuations do not exceed 1-2 ℃ (Figure 1(b)). At the same time, the minimum morning values exceed 37 ℃, but the indicators of normal temperature are not reached. This type of temperature curve is observed in tuberculosis, purulent diseases, viral lesions, as well as in the third stage of typhoid fever. The intermittent temperature curve includes a period of short-term temperature rise to values of 39-40 ℃, followed by a sharp decrease within a few hours (Figure 1(c)). At the same time, after a period of time that takes from 1 to 3 days, another temperature increase occurs. Similar fluctuations in the temperature curve take place over several days or weeks. The type of temperature curve under consideration is characteristic of malaria, with periods of temperature rise taking place against a background of chills, while a decrease in temperature is accompanied by profuse sweating.

The warped temperature curve reflects the excess of the morning temperature over the evening (Figure 1(d)). This curve is typical for sepsis, tuberculosis and a number of rheumatic diseases. The relapsing temperature curve is characterised by the presence of strict alternation between periods of a sharp rise in temperature and periods of its normal values (Figure 1(e)). At the same time, the high temperature can last for several days, after which it should decrease. This type of temperature curve is characteristic of typhus recurrens. The hectic temperature curve contains significant (up to 3-4 ℃) temperature fluctuations, while there is an alternation of temperature parameters falling to normal values (Figure 1(f)). Such temperature changes are observed several times during the day against the background of profuse sweating. This temperature curve is observed in severe pulmonary tuberculosis, abscess ulcers, and septic lesions [13].

In a completely healthy person, the body temperature is constant and undergoes slight fluctuations in the morning and evening. At the same time, the temperature indicators of different areas of the skin and internal organs differ significantly. The skin temperature varies in different parts of the body, while in the armpit it is higher than on the skin of different parts of the trunk. On the extremities, the temperature decreases, reaching the lowest values on the skin of the toes.

Thermoregulation is a complex reflex process in which skin receptors perceive temperature fluctuations in the internal and external environment. At the same time, pulses of temperature fluctuations enter the central nervous system (the centre of thermal regulation in the medulla oblongata). In the process of human activity, there is a process of continuous production of heat in the internal organs and muscles. Heat transfer of the skin surface mainly occurs due to venous blood, which, after cooling in the lung area, spreads through a large circle of blood circulation, while warming peripheral tissues, and through the skin releases excess heat into the environment. Overheating of the body causes vasodilation on the surface of the skin, while there is an increase in the volume of blood circulating in it and heat transfer to the environment. In the event that heat losses begin to exceed the volume of its production (low temperature, high humidity, and air velocity), there is a narrowing of peripheral vessels, which causes a decrease in heat transfer [14]. At the same time, a pilomotor reaction begins (“goose bumps”), the development of small tremors is possible, and the release of heat into the environment increases sharply. The gradual narrowing of the vessels of peripheral tissues leads to the saving of heat by the body as a whole. However, not all parts of the human body have this ability. In particular, narrowing of the vessels of the head does not occur even with significant heat losses of the body. In addition, at an ambient temperature of -4 ℃, about half of all the heat produced in the body at rest is lost through the head if it is not covered [15], [16].



(a) (b) (c)

(d) (e) (f)

Figure 1. Types of temperature curves; (a) continuous temperature curve, (b) remittent temperature curve, (c) intermittent temperature curve, (d) warped temperature curve, (e) relapsing temperature curve, and (f) hectic temperature curve [13]

According to the normative documents adopted today in Kazakhstan regulating the procedure for determining the heat content of a person, it is allowed to measure the average body temperature in the armpit, in the area under the tongue, and in the anus, while the procedure for measuring rectal temperature is not provided by this standard [7]. The normal temperature in the rectum is assumed to be 37 ℃, while it is 0.2-0.3 ℃ higher than in the oral cavity and 0.3-0.4 ℃ higher than in the armpit. The most effective and stable point for measuring body temperature should be considered the point in the middle of the axillary region. When using certified measuring instruments to determine the temperature parameter at a given point, it is possible to develop and implement an optimal method for analysing the dynamics of changes in body temperature. In the last few years, sufficient data have been obtained indicating the insignificant significance of the results of temperature measurement in the oral cavity, anus, and sublingual area for determining the average body temperature of a person. The specified standard determines the dependence of the mixing coefficient on the environmental parameters. A graphical representation of the values of the mixing coefficient α when calculating the average body temperature is shown in Figure 2. Table 1 presents data on the ranges and accuracy of human body temperature measuring instruments.

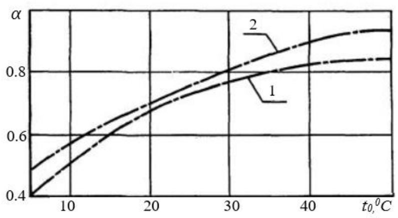


Figure 2. Values of mixing coefficients when calculating the average body temperature

Note: α is mixing coefficient; t_0 is ambient temperature parameter; *℃* is an average body temperature; *1* is value of the desired coefficient when a person is at rest; *2* is value of the desired coefficient when performing work corresponding to energy consumption in the amount of 800 W [7].

Table 1. Range of measuring instruments and their accuracy

Measured values	Equipment	Measurement interval	Permissible fluctuations in values		
			Displaying device	Recording device	ECM
Body temperature, ℃	Resistance thermometer	35-42	±3	±2	±2
Skin surface temperature, ℃	Resistance thermometer	20-40	±3	±1	±1
Temperature change rate, deg/min	PEPI-42, a device for measuring the rate of temperature change	0.007-0.085	±5	±3.5	±3

Note: PEPI-42 is electric receiver of alternating radiation and ECM is electronic computational machine (source: [7]).

Digital processing of the temperature signal involves the use, if necessary, of combined temperature measuring devices, which are measuring instruments with additional elements. Such additional elements are switching and signal contacts [17], [18]. They are designed to be triggered when the temperature signal reaches a specified threshold value. The process of digital processing of the temperature signal during body temperature measurement involves conducting consecutive temperature measurements (orally, under the arm) using any thermometer, setting the frequency of measurements according to the patient's physical condition, and determining the dynamics of changes in rectal temperature and the average skin temperature. Additionally, the average temperature at the control points is analyzed, temperature change graphs are drawn, and the patient's physical condition is assessed based on the identified dynamics. The technique of digital temperature signal processing can be represented in the form of a flowchart (Figure 3).

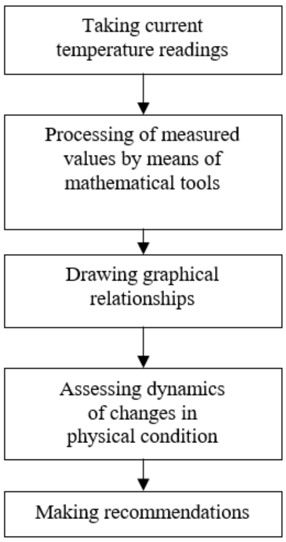


Figure 3. Technique of digital processing of the temperature signal (source: compiled by the authors)

The presented technique may undergo adjustments depending on the change in the physical condition of a person. First of all, this concerns recommendations for its improvement in case of detection of unfavourable trends in the temperature signal. This technique can be successfully implemented when creating a device for digital processing and filtering of a temperature signal. Digital processing of the temperature signal involves the conversion of discrete temperature signals coming to a separate device and is performed in real time. Digital filters with temperature signal detection function can be presented in one of three types: recursive; non-recursive; and containing a method for determining the coefficients of the linear Fourier transform [19]-[22]. Digital filters of temperature signal processing devices of the first two types are the most common and effective [23]-[25]. In general, the side diagram of the device for digital processing of the temperature signal has the following form.

The study showed that digital processing of the temperature signal significantly increases the accuracy of body temperature measurement, which is important for timely diagnosis. Compared to previous studies, the emphasis on mathematical models for analyzing temperature dynamics is a new approach that reduces measurement time and increases accuracy. The conclusions of the article indicate the potential for optimizing measurement points and integrating new technologies, including artificial intelligence, to improve the quality of medical services. This may lead to the development of new devices for fast and accurate measurement, which will improve the treatment and monitoring of patients. The implications of the findings may include improved diagnostics, new standards for temperature measurement in medical facilities, and automation of health monitoring processes. The research findings have practical applications not only in medicine, but also in areas where public health monitoring is a priority, such as educational institutions and industries.

3.2. Discussion

The results of the study clearly correlate with the main goal, which was to develop a method for the most accurate implementation of operations through the use of scientific and theoretical principles of digital signal processing. The implemented methods of temperature signal processing allowed us to achieve an increase in measurement accuracy, which confirms the hypothesis about the effectiveness of digital technologies in this area. The data obtained indicate that new signal processing algorithms can provide a more detailed assessment of the physical condition of patients, which meets the objectives of the study.

Wright [26] in a study aimed at investigating the general principles and patterns of the evolution of thermometers and their application in clinical medicine draws attention to the fact that the history of the use of thermometers dates back to ancient times, when their first prototypes were used to measure the body temperature of patients with fever. According to the researcher, the specifics of measuring human body temperature suggests the need to implement a system for tracking changes in the temperature signal over time to adequately determine the physical condition of the patient and the choice of general directions of their treatment. The opinion of the scientist is fully correlated with the results obtained in this study.

In turn, Wu *et al.* [27] investigated general principles of temperature measurement based on non-luminescent thermometers. The authors note that human body temperature indicators are extremely important for biological research due to the fact that the processes of heat energy transfer are closely related to biochemical reactions. According to researchers, the complex intracellular environment largely influences the processing features of the temperature signal. This, in turn, causes the need to improve the quality of processing the temperature signal, which in the future enables better assessment of the real condition of patients.

For its part, Lee *et al.* [28] draw attention to the fact that the use of flexible, highly sensitive paper sensors in devices for measuring patients' body temperature provides a higher sensitivity of the devices in which they are used. At the same time, paper sensors can be used in removable pads of thermometers attached to the body, which allows monitoring the patient's body temperature almost continuously. Researchers have come to the conclusion that such sensors are optimal for providing temperature signal processing in order to obtain a real assessment of the patient's physical condition. The researchers' conclusions are consistent with the results of the study, as both approaches emphasize the importance of accurate temperature measurement to obtain a realistic assessment of patients' physical condition. The results of this study demonstrate that digital processing of temperature signals can improve measurement accuracy, just as flexible paper sensors contribute to the sensitivity of devices.

Kim *et al.* [29] examined the features of the effect of radiofrequency exposure on the skin when measuring patients' body temperature in real time. It is noted that radio frequency radiation is able to generate heat in the human body. As the experiments have shown, the parameters of digital processing of a temperature signal for measuring human body temperature largely depend on fluctuations in the effects on the patient's code that occur over a certain period of time. The conclusions drawn in the authors' study are consistent with the results of the present study, as both approaches emphasize the importance of taking into account external factors that can affect the accuracy of temperature measurements. The results of our study show that digital processing of temperature signals should include the analysis of various influences that occur during measurement. The authors' research opens up new prospects for further studying the effects of various types of radiation on human skin. The introduction of modern technologies that take such effects into account can significantly improve methods of monitoring body temperature and assessing the physical condition of patients.

In turn, researchers [30], [31] conducted a study of the general principles of distinguishing cryotherapy in both sexes. According to the researchers, obesity, embedded in the percentage of fat mass, should be considered the main parameter of the body's thermal resistance, which should be considered when determining protocols for men and women. It was concluded that when developing a device for digital processing of a temperature signal, it is necessary to consider the average efficiency of body cooling for representatives of each sex separately. These findings are consistent with the results of the present study, as they emphasize the importance of an individualized approach to body temperature measurement and data processing.

The researchers [32], [33] investigated general principles of ensuring the quality of human safety and health monitoring based on the measurement of vibration and body temperature data. According to a group of researchers, modern technological solutions allow effectively monitoring a person’s physical condition based on data obtained by measuring the level of vibrations and temperature changes using special sensors. These technologies use as data sources information obtained from special devices that monitor these parameters. After that, by means of digital processing of the temperature signal, a qualitative assessment of the real condition of the patient is provided and recommendations for its improvement are prepared, if necessary. The conclusions of the research team are fundamentally consistent with the results obtained in this paper, while opening up additional research prospects in the field of using special sensors to track changes in patients’ body temperature.

Sravanthi and Chandrasekhar [34] conducted a study of a real-time healthcare management system based on the internet of things, during which it was concluded that IoT security has been widely recognised in the healthcare sector. According to scientists, the use of technologies of this kind provides the possibility of remote patient care and monitoring the quality of all necessary manipulations, in particular, measuring body temperature, taking tests, and monitoring the general condition of patients. These conclusions correlate with the results of the present study, as both emphasize the importance of timely body temperature monitoring for assessing a person’s physical condition. This study emphasizes that digital processing of temperature signals can significantly improve the accuracy of measurements, which in turn is critical to ensuring the effectiveness of the IoT system in tracking patient conditions.

Karunanithy and Velusamy [35] reviewed the general principles of data collection and the use of edge devices in an intelligent health monitoring system using a wireless network of the human body. According to researchers, the use of wireless networks allows effectively monitoring the condition of patients in a remote interaction format without disrupting their daily activities. At the same time, high-quality digital processing of the temperature signal is often difficult due to excessive overload of the equipment used in performing such manipulations. To resolve the situation, regular monitoring of the body’s wireless network is required, with an analysis of the effectiveness of the interaction of all its nodes. The opinion of scientists fundamentally coincides with the results that were obtained in this study, while revealing the potential of using wireless networks to track the condition of patients in a remote format. Thus, the discussion of the results obtained in this study, in the context of their analytical comparison with the results and conclusions of a number of other researchers who developed problematic aspects of processing a temperature signal for measuring body temperature, demonstrated their fundamental correspondence in the main aspects. This is a confirmation of the scientific reliability of the results and the expediency of their application in the practical plane.

The study has several limitations that may affect its results. First, the temperature measurement methods used may be subject to errors, in particular due to incorrectly installed thermometers or variations in the measurement conditions (ambient temperature and physical condition of the patient). Secondly, limitations in the number and diversity of study participants may affect the generalizability of the results, as the results may not reflect the full diversity of physical conditions of different population groups. Finally, the mathematical models used for digital signal processing may have their limitations, which may affect the accuracy of predictions and conclusions.

4. CONCLUSION

In the course of this study, it was possible to establish that in the process of thermoregulation of the human body, there is a perception of fluctuations in the external and internal environment by thermal receptors. The results show that digital processing of the temperature signal significantly improves the accuracy of body temperature measurements, which is critical for the diagnosis of various diseases. It is substantiated that optimization of measurement points, in particular in the middle axillary region, provides the best stability and accuracy of the results. It has been established that the use of mathematical models to analyze the dynamics of temperature changes helps to assess in detail the physical condition of patients in different conditions. In addition, the study confirmed that the systematic analysis of temperature curves can serve as an important indicator for detecting diseases and monitoring treatment processes.

In the process of digital processing of the temperature signal for effective measurement of body temperature, the differences between the internal and external temperatures should be considered. It is also necessary to consider changes in ambient temperature as a factor that has a significant impact on the process of thermoregulation of the body. In addition, these differences should be taken into account when analysing differences in temperature readings on individual parts of the human body. Periodic hypothermia is also important, in which there is a significant excess of the amount of heat given by the body to the external environment over the amount of heat received by the body.

The prospects for further scientific study in this area are determined by the rapid pace of scientific and technological progress. Further research could focus on developing new mathematical models that take into account the impact of internal and external temperatures on the body's thermoregulation. This includes the study of various compensation methods for episodic overheating and periodic hypothermia that affect measurement results.

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