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Constructing Information Mathematical Model For Creating Noninvasive Glucocometr

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Abstract: This article aims to determine blood glucose levels in diabetes mellitus. It has been shown that the most commonly used invasive glucometers consist of 3 modules.

Keywords— Pancreatic islets; arterial hypertension; diabetes; non-invasive glucometer sensor

INTRODUCTION

It is no secret that effective positive changes in all spheres of society are directly related to the introduction of information and communication technologies. It is natural that scientific research aimed at finding solutions to problems and issues arising in the process of integration of information and communication technologies with the field in question requires tools for systematic analysis, data processing and management. In many cases, the integration process is reflected in the introduction of automated system management tools and methods. In particular, the application of the recorded instruments to the field of medicine which requires rapid analysis of experimental results and information flow and the adoption of appropriate science-based solutions are requirements of times. The creation of a glucometer device based on non-invasive methods of rapid (express) determination of blood glucose in diabetes in the world is important in the selection of effective ways to prevent and treat diabetes.

The creation of a model, methods and equipment for processing data obtained by non-invasive methods on the basis of advances in information and communication technologies, tools and methods is a requirement of the times. As a result, the development of algorithmic and software systems that ensure the rapid processing and transmission of measured data allows the physician to choose the fastest and most effective methods of prevention and treatment of any disease. This serves as an information support system for the decision maker. According to the World Health Organization "The incidence of diabetes in the total population of the world is projected to increase 1.5 times from 549 million from 2018 until 2025, which is 6-8% of the total population. 1 diabetic patient dies every 7 seconds. The rise of funding for research in all countries to prevent and treat rapidly developing diabetes is the beginning of a new era in diabetes prevention. According to 2017 data, $ 375 billion is spent annually to treat all diabetics in the world. 93 million has been spent Russia during one year. While it accounts for 10-15% of the EU's total budget, it is estimated that this figure is expected to reach 18.5% by 2020. It was agreed that from 2017, the International Consortium for Diabetes will expand international scientific cooperation. The development of information and automation systems around the world is leading to the emergence of effective ways to positively manage certain issues in medicine.

The state attaches great importance to the quality and effective implementation of informatization, information and communication technology services in our country. The development of modern information and communication technologies, communication systems and their widespread implementation is being carried out systematically.

There are 3 types of invasive glucometers that are widely used today, for example: photometric, electrochemical and Ramonovsky methods.

1. Photometric glucometers consist of a special plate that senses its color change in a special place in the apparatus and when a drop of blood is dropped on the plate, a different color is formed under the influence of glucose. As a result, the basis for the change in the amount of glucose in the blood is determined by the table of changes in the amount of color on the plate.

2. Electrochemical glucometers also consist of a special test strip. The color of the strip is the basis of modern instruments for determining the amount of glucose in the blood.

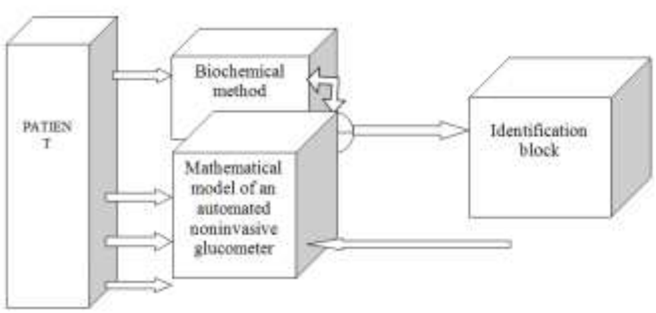
3. Ramonovsky's glucometer is also called the future glucometer by many medical professionals. The principle of operation of the glucometer is determined by separating the distribution spectrum of the amount of glucose in the blood from the total spectral distribution wave of the skin as a result of the comparison method.

Cyclic process stages of modeling:

Step 1. Stages of model appearance. Research requires an initial knowledge of whether the object being studied is original.

Step 2. A process is taken as an object and the process is studied independently at this step. This kind study experiments with a model. The experiment is performed on specific equipment without consciously modeling the parameters of the model, resulting in a set of knowledge about the model**.**

Step 3. The object is copied from the knowledge model to the original. Knowledge of the object is accumulated.



Step 4. It is necessary to apply in practice the knowledge obtained as a result of experiments conducted in the model and to create a generalized theory of the object.

According the mathematical definition of the problem, the amount of glucose in the blood is taken as the output parameter Y, the problem of estimating the input parameters in the electrical resistance obtained from the informative representative biologically active points – x1,x2,x3,….xN. The main object is diabetes mellitus and patients undergoing endocrinology in the 1st clinic of the Tashkent Medical Academy and will have to perform non-invasive measurements of electrical resistance from biologically active points in parallel with the use of computer scanning biometrics and electropuncture diagnostics. As a result, the basis for the creation of a mathematical model of a diabetic invasive glucometer can be evaluated using the electrical resistance obtained from the informative biologically active points x1,x2,x3,….xN.

In the figure X1-X2… .Xn - the amount of electrical resistance at the informative biologically active point; £ - biochemical orthotoliudine method (the most accurate working method); The results obtained by the method of biochemical ortholyudine, which measures the amount of glucose in the blood U0;

model, a new noninvasive method; S - regression coefficient; C) $Q=Q\ (Y_o,Y_m)$- is an assessment criteria. баҳолаш мезонлари.

The identification block forms a set of informative biologically active points and performs the function of sorting by informatics; the electrical resistances at the biologically active points sorted by informational color go to the next non-invasive glucometer mathematical model block; the mathematical model of blood glucose is displayed, Evaluation criterion Q = Q (Yo, Yv) - determines the difference between the results of blood analysis obtained from the biochemical orthotoliudine method and the results obtained from the mathematical model of a noninvasive glucometer.

METHODS OF FORMATION OF A SET OF INFORMATIVE PARAMETERS

In the process of its development, science is moving to the study of more complex objects. The requirements of the practice primarily involve the creation and dissemination of effective methods.

The theory of the formation of a set of informational parameters which is one of the elements of intellectual data analysis (Data Mining) is also effectively used today in many applied areas of our lives.

In this chapter the main basis for determining the set of biologically active points that affect the amount of glucose in diabetes mellitus is:

- formation of a set of informative parameters;
- methods of constructing a decisive rule;
- Mathematical expression of the problem of formation of a set of informative parameters and its statement.

A comparative analysis of the existing scientific and practical results on the above issues the purpose of forming a set of informative parameters which is another stage in the modeling process of the dissertation and strategic plans for the study of the problem. The formation of a set of information parameters consists of the following steps:

- Extensive analysis of existing equipment for obtaining information from biologically active points and improvement of bio-measuring equipments in accordance with this dissertation work;
- statistical processing of clinical data from biometers;
- to select the local criteria, to determine the correlation between the input and output parameters and to solve the problem of choosing criteria for the formation of a set of informative parameters;
- Development of a new method of multivariate variance in the formation and sorting of information parameters.

Methods and algorithms for the selection of information parameters:

Functional changes in the human body are reflected in biologically active points; It was found that there are direct and inverse relationships between them. The existence of a set of biologically active points in diabetes mellitus and the effects of the disease which is being researched is also discussed in detail in Chapter 1. The results of the experiments conducted in the first chapter were focused on the identification of a set of informative biologically active points by forming the first statistical processing sequence. The research in the second chapter aims to establish the relationship between the electrical resistance measured from biologically active points (non-invasive method) and the parameters obtained from the blood by invasive method on the basis of local criteria.

The initial data obtained from the selected biologically active points are processed by local criteria and as a result of "voting" the level of informativeness of the biologically active points against the disease is sorted (ranked). In order to increase the level of accuracy, the results of the data obtained from local criteria are analyzed, rearranged by the method of multi-criterion varianc where informativeness of the meridians is further clarified.

In many cases, the large number of parameters or classes makes it difficult to solve the problem of building a direct model in practice. For example, if we take parameters when the initial parameter system is selected and it can be much more than necessary. Of course, having a large number of parameters is "good" on the one hand and it is "bad" on the other hand. The advantage is that an increase in the number of parameters allows a complete description of the disease or objects. On the downside, it leads to an increase in 'noise' during system application, making it harder to operate creating additional time and costs in implementation.

Therefore, if the initial data is statistically processed, its application in practice will be more perfect, the management system will be able to make decision-making classes and working groups of informative parameters will be formed as:

- Development of special algorithms that control the operation of the detection system;
- Selection of performance indicators of the detection system and the formation of criteria for evaluating their values.

It should be noted that the objects under consideration often have a complex structure. At the same time, the mathematical models that describe them are too complex or it is impossible to describe the object at all. Based on such observations, a statistical approach is used which takes into account the decisive rule when considering the formation of a set of informative parameters.

Typically each object is characterized by a unique set of "parameters". As parameters can be obtained quantitative and qualitative indicators of various properties of the object and sometimes functional dependence. However, only their numerical values are used as parameters of objects.

It is known that the decisive rule is mainly constructed for a set of objects selected from the main set. Such a set of objects is called a training option. It is known in advance which class all the objects in the curriculum belong to and this information will be provided by an expert and will be based on experiences.

The size of the training sample means the number of parameters that make it up and the size means the number of parameters and their quantity. Usually in the process of finding the decisive rule that defines a particular disease, it is necessary to carry out calculations on a very large scale. These calculations can usually only be done on a computer. In addition, the time spent on calculations depends polynomially on the size and size of the training sample and if there is the larger the size and dimensions, there are the greater the specified costs and difficulties.

In order to overcome considered difficulties, the size of the sample is reduced, the parameters that provide the most information from the initial set of parameters are selected. The newly generated parameters represent together the most distinctive features of the classes. Reducing the size of the sample is useful in two ways:

Firstly, the computational volume is reduced and secondly, when the sample size is small or the informative parameters are omitted, the reliability of the model adequacy increases.

It should be noted that if the size of the training sample is small or if we reduce the size of the parameters, the reliability of the adequacy determination will decrease. In conclusion from the above, it can be said that the scope and size of the study selection should not exceed certain limits.

The selection of the most informative parameter part space, the size of which is not very large, constitutes an independent classical problem of the disease detection theory, which is called the selection of informative parameters.

There are different ways to determine information parameters. None of them can be strictly considered a value or preference, because methods that work well for one class of issues may be inconvenient for other classes and may not give the expected result. Along with TTTu, their implementation will also depend on the available technical means. Based on such considerations, it can be said that the choice of a particular method is made depending on the issue at hand and the available practical possibilities. In addition, it cannot be overlooked that many other methods of determining the set of parameters are invariant with respect to existing informational criteria. As the calculation of the criteria used here is not taken into account, they do not guarantee that the results obtained are perfect.

Based on the above data, it can be said that one of the most urgent tasks today is to develop a method of "own" improvement for the most widely used informational criteria,

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taking into account their mathematical properties and economic feasibility.

Training options are given in the following forms:

$$X_1 = \begin{pmatrix} x_{11}^1 & x_{11}^2 & \dots & x_{11}^N \\ x_{12}^1 & x_{12}^2 & \dots & x_{12}^N \\ \dots & \dots & \dots & \dots \\ x_{1m_1}^1 & x_{1m_1}^2 & \dots & x_{1m_1}^N \end{pmatrix}, \dots \quad ,$$

$$X_k = \begin{pmatrix} x_{k1}^1 & x_{k1}^2 & \dots & x_{k1}^N \\ x_{k2}^1 & x_{k2}^2 & \dots & x_{k2}^N \\ \dots & \dots & \dots & \dots \\ x_{km_k}^1 & x_{km_k}^2 & \dots & x_{km_k}^N \end{pmatrix}.$$

Here are the types of diseases $X = \bigcup_{i=1}^{k} X_i$, $X_i \cap X_j = \varnothing$, $(i \neq j,, i, j = \overline{1,k})$ x_{pj}^i - p - i-experiment of the j-parameter corresponding to the parameter; -number of disease types; - - is the number of parameters.

$X = \{x^1, x^2, \dots, x^N\}$ is given the initial space of the parameters, it will be necessary to reduce its size. In that case $F: X \to Y$ the reflection must be found so that the resulting condition $\dim X >> \dim Y$, $J(Y) = J(F(X)) \to extr$ is satisfied. Here: $J(\circ)$ informative criterion.

The reduction of the initial parameter space measurement has been reported in other sources. We enter a vector $\lambda = (\lambda_1, \lambda_2, \dots, \lambda_N)$ that explains which parameter of the disease is involved or not. The vector components given here assume a value of one or zero and whether or not these parameters participate accordingly. If it is necessary to transfer the initial parameter space to the □-informative parameter space, then the reflection can be as follows:

If it is necessary to transfer the initial parameter space to the ℓ- informative parameter space, then the reflection can be as follows:

1)

$$Y = F(X) \Leftrightarrow y_i = f_i(x_i) = \lambda_i x_i, (i = \overline{1,N}), \sum_{i=1}^{N} \lambda_i = \ell \quad ; \qquad (1)$$

2)

$$Y = F(X) \Leftrightarrow y_i = f_i(x_1, x_2, \dots, x_N), (i = \overline{1,\ell}) \quad . \qquad (2)$$

The reflection F given in such a view can be interpreted as follows. First, the reflection in view (1) is intended to isolate or omit the parameters from the space of the initial parameters, which is the most informative relative to the others.

The second (2) is the transition to a new ℓ-dimensional space that is functionally dependent on the initial parameter space.

The first is called the selection of informative parameters in literature and the second is called the reduction of the parameter space dimension. The following are the most commonly used methods for constructing a set of informative parameters and their analysis.

Suppose that the transition from one space to another is made using a linear switch. Below we consider one of the linear substitutions.

$$y_i = \sum_{j=1}^{N} a_{ij} x_j ,$$

here: $\|a_{ij}\|$ - is a diagonal matrix, $a_{ij} = 0 \vee 1$.

Such linear reflection means the exclusion of certain parameters from the initial space of the parameters

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and the rest constitute a set of informative parameters.In general, (1) is equivalent to (2).

The method that separates the set of ℓ-information parameters from the parameter space with the greatest accuracy is the full selection method.

The essence of this method is that $\sum_{j=1}^{N}\lambda_j = \ell$ the functional value I (λ) is calculated for all λ vectors satisfying the condition from which the vector λ is given, which gives the function an extremum value.

Finally, the parameters corresponding to the non-zero components of this λ vector form a set of dimensional informative parameters. If we look for a set of λ informative parameters in this view, this method gives its perfect solution for an arbitrary I (λ) function.

It should be noted that the main disadvantage of full selection is the execution of large-scale calculations. It is known to make it happen $C_N^\ell = \frac{N!}{\ell!(N-\ell)!}$ it is necessary to calculate the value of I (λ) several times and to distinguish from them the one that gives the function an extremum value. If we define a set of informative parameters in this complete selection method, then the total number of calculations will be $2C_N^\ell - 1$.

In conclusion, it can be concluded that it is expedient to implement this method when the value of N is not large.

It is recommended to use suboptimal methods based in part on selection, if the number of parameters is large. While such methods do not select the perfect informative parameter set, they do provide the worst parameter set.

1) Here is the simplest way to select a set of informative parameters from the initial parameter space. The procedure for selecting IPM in this method is as follows: the level of informativeness of each parameter is assessed;
2) on the second, the characters are placed in descending order of informativeness; ℓ та параметр ажратиб олинади.

The number of all considered options is equal to the number of calculations $C_N^1 = N$, ie □ - the number of extracts from the set of informative parameters $N + \frac{N(N-1)}{2}$.

Such an approach to the selection of an informative set of parameters guarantees a perfect solution only when the parameters are not statistically interrelated. In most cases the characters are statistically related to each other.

Below we use a vector $\lambda = (\lambda_1, \lambda_2, ..., \lambda_N)$ to select the informative parameters. Here, $\lambda_i\ (i = \overline{1, N})$ assuming a value of one or zero indicates whether or not these parameters are present in the informative parameter set. The following is the “Serial Separation” algorithm. The operation of this algorithm is as follows:

First, $\sum_{j=1}^{N}\lambda_j = N - 1$ The λ vectors are obtained, the value of I (λ) is calculated, and the vector λ, which gives the greatest value, is separated, and the parameter corresponding to the zero component is subtracted from the parameter space. Thus, the N-dimensional parameter is passed from space to N-1.

The same process is continued for the second, third, and so on until the parameter space is measured. In this method, the number of calculations of the functional value I(λ) is much smaller than the number of calculations per unit and N is large, $\frac{(N+\ell+1)(N-2)}{2}$ the number of calculations is small. However, as mentioned above, this algorithm does not guarantee the perfection of the result obtained. A directional selection algorithm or a "serial forward sorting" algorithm is recommended. In this algorithm, in contrast to the previous one, in the first step only one component of the vector λ is considered to be non-zero and the value of I (λ) is calculated. The component that gives the greatest value to this function is taken to be λ_1, i.e. the parameter corresponding to that component is definitely involved in the set of informative parameters. In the second step, λ_1 and one more component are checked for non-zero vectors, again the vector with the greatest value for I (λ) is obtained, λ_2 is formed. In this method, the non-zero component of the λ vector is found. The found vector λ is perfect for a given method and the parameters corresponding to its equal components together form a set of informative parameters.

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