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Gastroenterological Signals Processing algorithms

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ABSTRACT: The paper presents algorithms and programs of preliminary processing biomedical signals. The results of research into the direction to digital filtration of the lowest-frequency biomedical signals (in the range of 0.01 - 0.25 Hz) and removal trends before processing both in time and frequency areas are considered.

Keywords: biomedical signal, digital filtering, trend, gastrogram, enterogram, filter coefficient, visualization.

I. INTRODUCTION

Modern computer methods and tools for studying biomedical signals have been widely developed, especially in the areas of electrocardiography (ECG) and electroencephalography (EEG). At the junction of medicine and informatics there are important problems of fundamental and applied nature, without solving which it is impossible to make a significant advance in the field of medical science knowledge [1,3,7].

In recent years in various countries, including Uzbekistan, new specialized, computerized methods and means of processing and research of various biomedical signals have been intensively developed. New informative methods of data analysis are being developed and widely introduced into clinical practice. Computers have long been used in medicine and many modern diagnostic methods are based on information technologies (IT). Examination methods such as ultrasound or computer tomography are unthinkable without computers. It is difficult now to find a field of medicine in which computers would not be used more and more actively. But the use of computers in medicine is not limited only diagnostics. They are increasingly being used in the treatment of various diseases - from drawing up an optimal treatment plan to managing various medical equipment during procedures [2,9,10,11,12,13,14,15].

At the present stage of development medical informatics systems the methods and means of electrocardiography (ECG) and electroencephalography (EEG) on the basis of computer technology have received the greatest development. At the same time, in recent years in many countries of the world significant progress has been made in creating computer-based diagnostic systems for such medical fields as gastroenterology. Invasive methods of examination abdominal cavity organs condition, i.e. those connected with introduction of sensors into the organism (for example, ballonography, gastroscopy, pH-metry), which causes painful feelings of patients, give way to noninvasive methods. The latter are largely based on the achievements of electrogastrography (EGG), i.e. the methods of recording and subsequent analysis of the dynamics bio potentials removed from the body surface and delivering information on the muscle activity to the gastrointestinal organs (gastrointestinal tract). Further improvement of mathematics and software of information systems for EGG necessaryimprovement of characteristics of corresponding equipment. [13,14,15].

1. BIOMEDICAL SIGNAL PREPROCESSING

Methods related to the EGG area are used both in therapeutic and surgical treatment diseases of the gastrointestinal organs. Their advantage is that the indicators of human organs can be quantified. This is especially important from the point of view prevention diseases of the population, as well as timely treatment of detected disorders of the GIT organs.

Processes in gastrointestinal tract organs are characterized by the most low-frequency character fluctuations in comparison with other organs and non-stationary. A local stationary mathematical model of a gastro-signal based on a discrete short-term Fourier transform (FT) is widely used for frequency-time analysis of gastro- and enterograms, which in particular, allows to study changes in spectral power density and other characteristics of signals in time within certain limits[4,5,6,8]. The possibility of more detailed processing of EGE signals appears with the use of wavelet analysis, in which the basis of the signal space is formed by offsets and large-scale transformations of some oscillating function localized in time and frequency [5,7,8]. In this paper the results of research in the direction of spectral processing the most low-frequency biomedical signals (in the range of 0.01 - 0.25 Hz) and revealing their local features both in time and frequency regions are considered.

Table 1.shows the frequency ranges of gastroenterological signals for different (four organs) GIT group normal (i.e. healthy person).

Table 1. Distribution of organ parameters

GICT for group normal

№	File name	Organ GIT	Frequency range
1	Common. txt	Common GIT	0.03 – 0.22 Hz
2	Chn1.txt	Stomach	0.03 – 0.07 Hz
3	Chn2.txt	Ilenium	0.08 – 0.12 Hz
4	Chn3.txt	Skinny intestine	0.13 – 0.17 Hz
5	Chn4.txt	Duodenum	0.18 – 0.22 Hz

The functioning of the digestive tract in the work is illustrated by two types of graphsgastroenterograms, which differ from each other in a number of features:

•Enterograms of a patient "norm" group and a sick patient, in which there is practically no trend;

• Gastrograms of sick patients containing linear trends. They are characterized by the irregular, inharmonic nature of oscillations. The preliminary processing of gastroenterograms is performed automatically, even before any information is provided to the user. This is due to the fact that the data loaded into the program for processing from files is represented by digital decimal or binary codes and, therefore, for convenient and correct visualization of the signal and its subsequent study, it is necessary to convert the data to volts, bipolarize the signal, search for the maximum amplitude and etc.

2. Filtration Of Gastroenterological Signals

In connection with switching fully digital methods of processing gastro- and enterograms, it is necessary to consider the possibility of software implementation of digital filtering over the entire set channels in almost real time. Filtering the wanted signal can be done without explicitly moving into the frequency domain. By the convolution theorem, multiplying the signal spectrum by the function of a rectangular window is equivalent to convolution in the time domain of the signal and the filter operator — the function obtained as a result of the inverse Fourier transform of the window. The sum of the filter coefficients determines the gain average signal values in the filter window and remains constant over the whole data array, and the sum of the filter coefficients is normalized.

The non-recursive band-pass filter performs the operation convolution of the samples to the discrete signal and the digital filter operator $\{h_j\}$:

$$y_i = \sum_{j=0}^{m-1} h_j x_{i-j}. \qquad (6)$$

If you briefly characterize the smoothing windows used, you can see that the smoothing procedure using the Goodman-Enoxon-Otnes (GEO) window according to the 7-point algorithm:

$$\bar{x}_i = \sum_{l=-3}^{3} q_l x_{i+l}, \qquad (7)$$

gives the following one-sided coefficients: a0 = 1, a1 = 0.1817, a2 = –0.1707, a3 = 0.1476. It is one of the most effective terms of the effectiveness suppressing the side components of the frequency response. 5-

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point and 3-point Hamming and Hanning windows are also used in digital filtering, but they weaken additional components to a lesser extent.

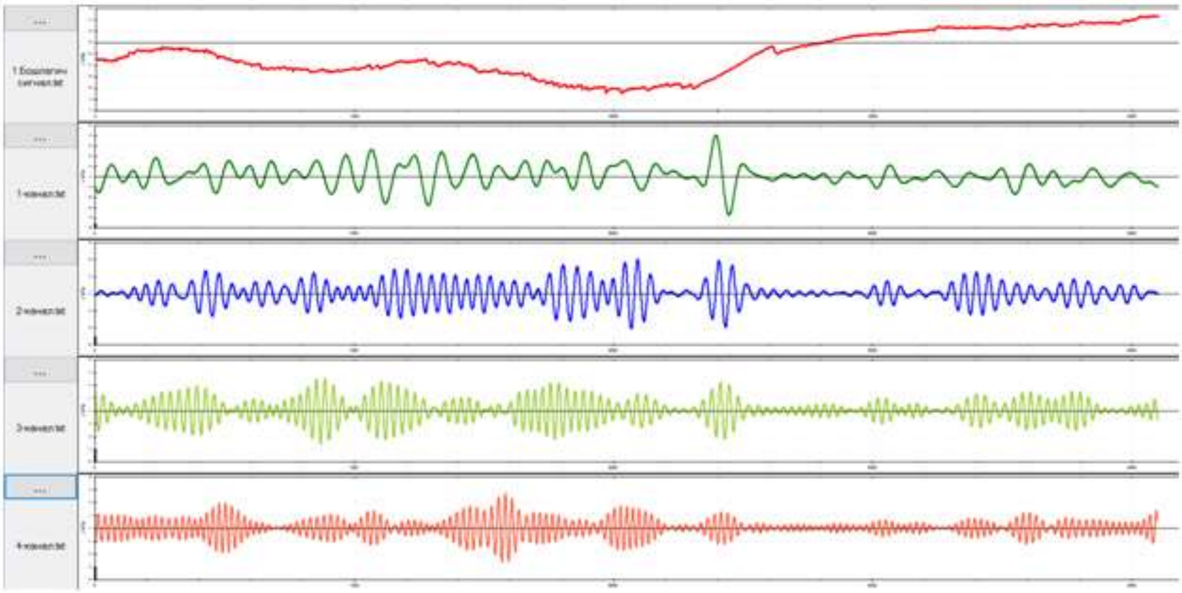

Fig. 1. Source signal, gastrogram and enterograms of healthy patientsAвgraphical form.

Digital filtering gastroenterological signal over the entire set of channels was carried out by a filtering program based on (6), which is written in C #. The program is designed to filter and visualize the results in the form of gastrograms and enterograms. In Fig. 1.shows the initial signal, gastrogram and enterograms of healthy patient A in graphical form.

3. TREND DELETE ALGORITHM

Often, when viewing gastrograms and enterograms, a phenomenon such as trends (long-term trends in the studied signal) manifests itself, which is especially pronounced in sick patients. An example of an electrogastrogram containing a trend is shown in Fig. 2.

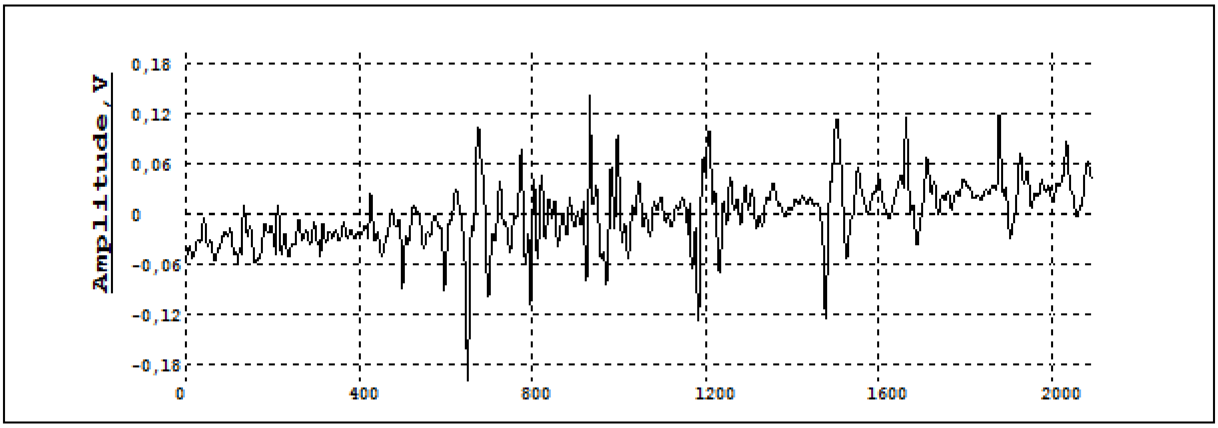

Fig 2.A gastrogram containing a trend.

A signal containing a linear trend can be described by a mathematical model of the form:

$$x_j^*(t) = x_j(t) + \gamma t \quad (8)$$

where is the amplitude of the $x_j(t)$ sample of the signal, is the slope of the straight line passing through point (0; 0) and point $(t; x_j(t))$. Trends of higher degrees can also be described by a set of linear models on individual recording segments. A fairly effective, empirical method of eliminating trends are used. The average signal value on the i-th segment and the average value on the (i + k) -th segment of the gastroenterogram are calculated. After that, the offset equal to the average in the initial section is eliminated, and then the recording tilt angle is determined. The gastroenterogram rotates at a predetermined angle. The software model to eliminate the trend in the segment [i_0 ; i]gastroenterograms can be written as follows:

$$\gamma^{(i)} = \frac{\sum_j (x^{*(i)}_j - x^{*(i+k)}_{j+k})}{(i-i_0)^2}; \; j = \overline{i_0, i} \qquad (9)$$

$$x^{(i)}_j = x^{*(i)}_j - j \cdot \gamma^{(i)}$$

In fig. 3.a gastro program is presented, the trend on which is deleted in accordance with (9);

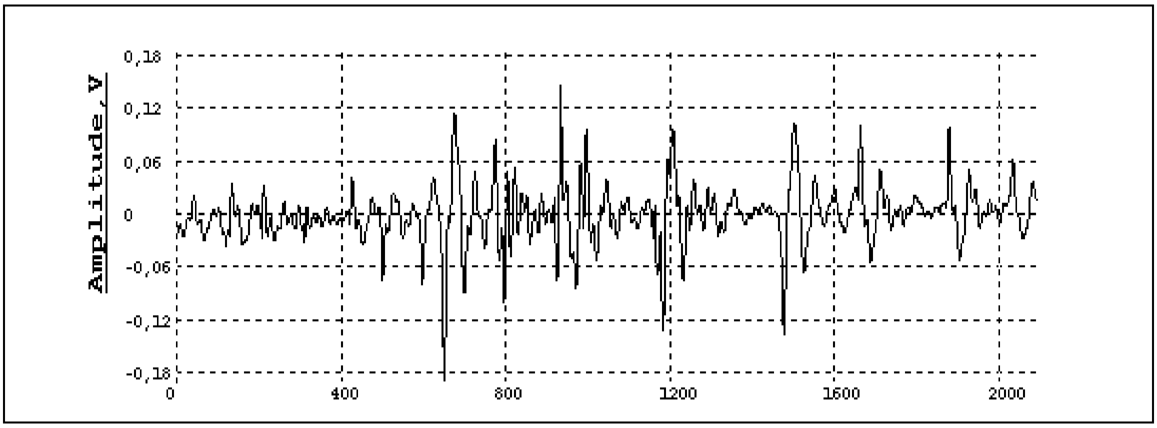

Fig 3.A gastrogram with a remote trend.

Any biomedical signal is pre-processed. Gastroenterological signals pre-processing is understood as digital filtering of the total initial signal (usually in the frequency range 0.01 - 0.25 Hz) for the purpose of dynamic channel separation of the analog gastrointestinal signals, as well as the process of trend removal.

II. CONCLUSION

Thus, the paper proposes and implements an algorithm for dynamic channel separation of analog gastrointestinal signals based on the digital band pass filtering method and an algorithm for eliminating trends, which are especially pronounced in patients

REFERENCES

[1]. Sablin OA, Grinevich VB, Uspensky Y.P. and other functional diagnostics in gastroenterology. SPB. YMA publishing house, 2002.
[2]. Svinin S.F and other software-instrumental complex for functional diagnostics in surgical gastroenterology // "news of universities - instrument making". 2006. no. 11. s.71-74.
[3]. Yakovenko Y.N, yakovenko S.V, selective electroenterogastrograph. patent no. 2023419. bull. "discoveries, inventions" no. 22, 1994
[4]. .ОтнесR., Enoxon L. Applied analysis of time series. M .: Mir, 1982.
[5]. Blatter K. Wavelet analysis. Fundamentals of the theory. M .: Technosphere, 2006.
[6]. Zainidinov H.N. Methods and means of signal processing in piecewise polynomial bases. Monograph. Tashkent - “Science and technology” - 2014, 190 p.Popov A.I. Mathematical models and a set of programs for the functional diagnosis of biomedical signals the low-frequency range. Abstract.

dissertations for the degree of candidate technical sciences, Petrozavodsk, 2010
[7]. Zaynidinov H.N., Dannanjay Singh, Hoon Jae Lee. Piecewise-quadratic Harmut basis function and their application to problems in digital signal processing. International Journal of Communication Systems, John Wiley & Sons, Ltd. ,DOI: 10.1002/dac.1093, Jan. 2010. London, SCI-E. www.interscience.wiley.com
[8]. Dhananjay Singh, Madhusudan Singh, HakimjonZaynidinov "Signal Processing Applications Using Multidimensional Polynomial Splines", Springer Briefs in Applied Sciences and Technology Series, Springer, Singapore, (Indexed by EI-Compendex, SCOPUS and Springerlink). ISBN -978-981-13-2238-9, Series ISBN - 2191-530X, DOI: 10.1007/978-981-13-2239-6.
[9]. Ivashkin V.T., Lapina T.L. Treatment of peptic ulcer: a new century - new achievements - new questions // Russian Medical Journal. Digestive apparatus diseases. - 2002. - T. 4. - No. 1.
[10]. HakimjonZaynidinov, BunyodAzimov. Biomedical signals interpolation spline models // International Conference on Information Science and Communications Technologies: Applications, Trends and Opportunities, ICISCT 2019 (2019). https://ieeexplore.ieee.org/document/9011926
[11]. Shcherba E. V. Application analysis of interpolation and extrapolation methods as used for image restoration. Computer Optics. 2009, vol. 33, no. 3, pp. 336–339.
[12]. Stupin V.A., Smirnova G.O., Baglaenko M.V., Siluyanov S.V., Zakirov D.B. Peripheral electrogastroenterography in the diagnosis of disorders motor-evacuation function of the gastrointestinal tract. Therapist. - 2005. - No. 2.Tokmakci M. Analysis of the Electrogastrogram Using Discrete Wavelet
[13]. Transform and Statistical Methods to Detect Gastric Dysrhythmia M. Tokmakci // Journal of Medical Systems. NY: Plenum Press, Aug 2007 № 4 V.31. - C. 295-302.