Review

by Prof. Dr. Mihail Matveev, IBFBMI – BAS, of the materials submitted for participation in a competition for the academic position of "Associate Professor" in the field of higher education 5. "Technical Sciences", professional direction 5.2. "Electrical Engineering, Electronics and Automation" (Application of the principles and methods of cybernetics in various fields of science (biomedicine).

In the competition announced for the needs of the section "Processing and Analysis of Biomedical Signals and Data" at IBFBMI, published in the State Gazette, issue 58/18.07.2025, on the basis of Art. 5.9. of the Regulations for the Application of the ZRASRB at IBFBMI, the only candidate participating is Senior Assistant Dr. Dobromir Petkov Dobrev from the same section.

1. Brief biographical data of the candidate

The candidate Dr. Dobromir Dobrev graduated from the Technical University - Sofia, Faculty of Electronic Engineering and Technology, specialty "Power Electronic Engineering and Technology" in 1995. From 1994 to 1997 he worked at CLEMA at the Medical Academy as a designer of electronic medical equipment. From 1997 to 2000 he was a designer of integrated circuits at Semkotek Engineering OOD and from 2000 to 2001 - at Silway Semiconductors AD, from 2001 to 2002 he was a designer of integrated circuits at Megaaccess Bulgaria EOOD. From 2002 to 2004 he was an electronic equipment designer at Jet Systems OOD, after which from 2004 to 2009 he was an integrated circuit designer at Melexis Bulgaria OOD, and from 2009 – at Facit OOD.

From 1997 to 2000 he was a doctoral student at the Central Laboratory of Biomedical Engineering and defended a dissertation for the ONS "Doctor" in the scientific specialty 02.21.07 "Automated systems for information processing and control (in medicine)" on the topic "Methods and electronic devices for monitoring newborns". In 2006 he completed an intensive training course on "Low noise IC design" at EPFL, Lausanne, Switzerland. Since 2011 he has been a chief assistant at IBFBMIE.

2. General description of the submitted materials

According to Appendix 2 of the Regulations for the implementation of the Act on the Development of the Academic Staff in the Republic of Bulgaria at the Institute of Biophysics and Biomedical Engineering at the Bulgarian Academy of Sciences, which sets out the minimum requirements for holding the academic position of "Associate Professor" in area 5. "Technical Sciences", I determine the following ratio between the minimum requirements and the grades of the materials submitted by the candidate:

Group of indicators	Indicator	Minimum required points for associate professor	Candidate points
A	1. Dissertation for the award of the educational and scientifi degree "Doctor"	50	50

Б	2. Dissertation for the award of the scientific degree "Docto Science"	x	x
В	4. Habilitation thesis - scientific publications in publications that are referenced and indexed in world-renowned databases of scientific information	100	340
Г	7. Scientific publication in publications that are refereed and indexed in world-renowned databases of scientific information 8. Scientific publication in non-refereed journals with scientific review or in edited collective volumes	200	292
Д	12. Citations or reviews in scientific publications, refereed and indexed in world-renowned databases with scientific information or in monographs and collective volumes	50	100

It is evident that the candidate exceeds the requirements for holding the academic position announced in the competition.

3. **Impact of scientific materials in the scientific community**

To participate in the competition for the academic position "Associate Professor" in the section "Processing and Analysis of Biomedical Signals and Data" at the Institute of Biomedical Signals and Data - Bulgarian Academy of Sciences, the candidate submits a total of 36 scientific papers as follows: - articles in journals with an impact factor - 8 pcs (total IF = 15.73), - articles in publications with SJR rank - 2 pcs., - publications in other publications indexed in WoS, Scopus, ERIH+ - 5 pcs., - publications in publications not indexed in WoS, Scopus, ERIH+, including proceedings of international and national scientific forums - 21 pcs. Of the total number of 36 scientific papers submitted for participation in the competition for the academic position "Associate Professor", in 4 the candidate is an independent author, in 29 he is the first author. Here I should recall that the field of biomedical engineering, in which he works, is multidisciplinary and practically requires teamwork, which limits the publication of production by a single author. However, in all the materials presented, the personal participation of the candidate is visible in the published circuit solutions and/or algorithms for signal processing and analysis.

4. General characteristics of the candidate's activities

In summary, the candidate's research concerns:
registration and filtering (removal of network interference) of various biosignals - mainly electrocardiographic (ECG), but also heart rate registration via photoplethysmographic signals, respiration registration via impedance plethysmogram and piezosensors,
ECG from capacitive electrodes.

5. The main contributions with a significant scientific component and scientific-applied nature are systematized in more detail as follows:

Two-electrode recording and amplification of biosignals

Publications in this scientific direction cover developments for recording ECG signals with amplifiers without a reference electrode. The proposed solutions are applicable for recording ECG signals without a reference electrode in two-electrode applications such as defibrillators, ambulatory monitors, etc. The proposed solutions can also be used for other biosignals obtained with electrodes from the body surface, such as: electromyogram (EMG), electroencephalogram (EEG), electrooculogram (EOG), etc.

An innovative circuit solution of a differential amplifier of biosignals without a reference electrode with current generators at both inputs, controlled by the in-phase signal, has been developed. The solution represents a significant contribution to the circuitry of two-electrode bioamplifiers.

An innovative circuit solution of a differential amplifier of biosignals without a reference electrode has been developed, having a standard high-frequency characteristic of the first order and tolerating high DC input voltages, in absolute value close to the supply voltage of the circuit.

Innovative circuit solutions of non-differential amplifiers of biosignals without a reference electrode have been developed: with a current generator controlled by a transimpedance amplifier, as well as with a transimpedance amplifier and an RC group for balancing the input common-mode currents.

Innovative circuit solutions of differential amplifiers of biosignals without a reference electrode have been developed, in which the increase in the input impedance for the useful signal is achieved with 100% positive bootstrap feedback. The increase in the input impedance through bootstrap feedback has also been applied to non-differential amplifiers of biosignals.

Registration and processing of biosignals from phototransducers, bioimpedance, signals from capacitive electrodes and sensors

A method and a circuit solution have been developed for simultaneous registration of a high-quality electrocardiogram (ECG) and bioimpedance (respiration). This has been achieved thanks to a specially designed measuring transducer with current-controlled inputs, providing low common-mode impedances of the current electrodes and at the same time high differential impedance between them, as well as between the voltage electrodes.

A phototransducer has been developed for registering a peripheral pulse from the forehead area. The device operates with a 3V lithium battery 2032, is controlled by a microcontroller, and is designed to generate an additional signal corresponding to cardiac activity, which is used in portable automated external defibrillators.

Innovative measuring transducers have been developed for capturing biosignals from sensors with capacitive output impedances, such as signals from capacitive electrodes or piezosensors. A significant contribution is the automatic determination of the operating point by means of active negative feedback, which achieves a low cut-off frequency of 0.05 Hz, allowing the recording of ECG signals for diagnostics.

A method and device have been implemented in which Correlated Double Sampling (CDS) (a widely used technique in the processing of sensor signals) is improved to Correlated Multiple Sampling (CMS) techniques.

Filtering of network interference from ECG signals

Averaging-based notch comb filters have been developed. The principle of operation of these filters is that when two discretes, spaced at half a period of the network interference, are added together, the interference is removed, i.e., a comb filter based on averaging is obtained.

Averaging-based notch comb filters have been developed. The principle of operation is that when two discretes, spaced at one period of the network interference, are subtracted, the interference is removed, i.e., a comb filter based on first difference is obtained.

Band-pass comb filters with a high quality factor have been developed for extracting network interference.

By correlated averaging of more than one first difference, spaced at multiples of the network disturbance, a notch comb filter with a linear phase

characteristic is obtained. The filter high-pass filters the signal and the filtered part can be recovered using a low-pass linear-phase filter with moving averaging.

A linearized model has been developed to determine the frequency response of an adaptive filter with incremental estimation. The filter synthesizes the fundamental harmonic of the disturbance as a sinusoid and subtracts it from the signal. The quality factor and the cutoff frequency are determined by coefficients that can change during operation and further adapt the filter's response to changes in amplitude and frequency.

Automatic balancing of electrode-amplifier impedances

The work in this direction includes the development of an innovative method and its application in various solutions for obtaining high-quality ECG signals, free of network interference, when registering them without a reference electrode. The method is based on the automatic balancing for common-mode signals of the impedance bridge formed by the electrode impedances and the input impedances of the amplifier. Network interference is removed by adding a part of the common-mode voltage, with automatically regulated amplitude and phase, to the useful differential signal. The advantage of the method is that the interference is removed at the hardware level, by adding a part of the common-mode to the differential signal, i.e. the interference is removed without affecting the spectrum of the useful signal.

Synchronous filtering of network interference

The work in this direction includes the development of an innovative method for synchronous filtering of network interference. Synchronous filtering involves quadrature demodulation of the network interference, integration of the detected components, subsequent quadrature remodulation of the interference and its subtraction from the input or output signal. Thus, synchronous filtering can be implemented in closed-loop or feed-forward systems.

6. Critical remarks

I have no significant critical remarks on the materials presented by the candidate in the competition. It is possible that the candidate's self-assessments could have avoided or been shorter descriptions of existing solutions by other authors, even if as a motivation for personal research. The candidate could in the future present a summary material on his research in the field of filtration methods for bioelectric signals.

7. Personal impressions

I know the senior assistant Dr. Dobromir Dobrev since 1994, when he started working at the Central Laboratory of Electromedical Equipment at the Medical Academy, then since 1997, from his very entry into the Central Laboratory of Biomedical Engineering and the successor after 2010 – the Institute of Biophysics and Biomedical Engineering, where he is a doctoral student, subsequently in the Section for Processing and Analysis of Biomedical Signals and Data. In the Section, he is distinguished by his precise work as a specialist, an authoritative colleague, with the skills to work in a team.

8. Conclusion

From the materials presented on the scientific, scientific-applied and implementation activity in the competition for the academic position of "Associate Professor" in the field of higher education 5. "Technical Sciences", professional direction 5.2. "Electrical Engineering, Electronics and Automation" (Application of the principles and methods of cybernetics in various fields of science (biomedicine) for the needs of the section "Processing and Analysis of Biomedical Data and Signals" at the IBFBMI, it is clear that Senior Assistant Professor Dr. Dobromir Dobrev has significant contributions and achievements, for which he is known to the professional community in our country and abroad. **Based on these grounds, I propose to the members of the scientific jury that Senior Assistant Professor Dr. Dobromir Petkov Dobrev be elected for the academic position of "Associate Professor" for the needs of the IBFBMI - BAS.**

Prof. Dr. Mihail Georgiev Matveev