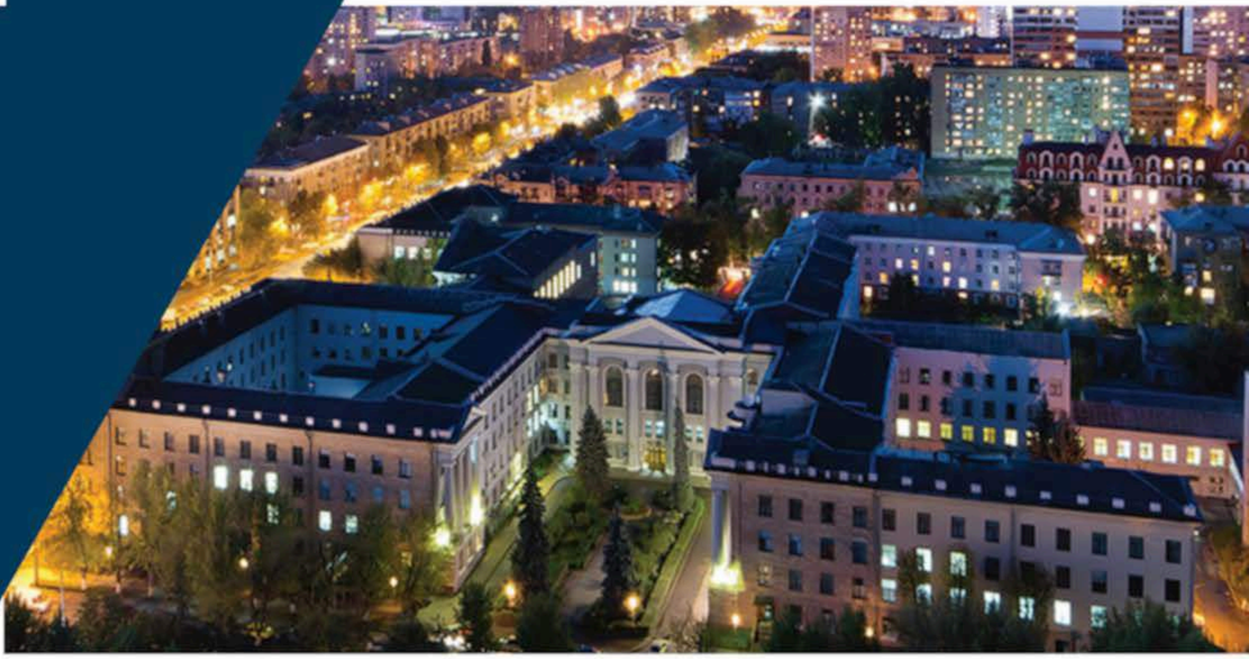
МІНІСТЕРСТВО ОСВІТИ ТА НАУКИ УКРАЇНИ

ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ РАДІОЕЛЕКТРОНІКИ

МАТЕРІАЛИ XXVII МІЖНАРОДНОГО МОЛОДІЖНОГО ФОРУМУ

РАДІОЕЛЕКТРОНІКА ТА МОЛОДЬ У XXI СТОЛІТТІ



2023

ТОМ 1

ХАРКІВ

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ХАРКІВСЬКИЙ НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ
РАДІОЕЛЕКТРОНІКИ

МАТЕРІАЛИ 27-го МІЖНАРОДНОГО МОЛОДІЖНОГО ФОРУМУ

«РАДІОЕЛЕКТРОНІКА І МОЛОДЬ
У XXI СТОЛІТТІ»

10-12 травня 2023 р.

Том 1

КОНФЕРЕНЦІЯ
«ЕЛЕКТРОННА, ЛАЗЕРНА ТА БІОТЕХНІЧНА ІНЖЕНЕРІЯ»

Харків 2023

27-й Міжнародний молодіжний форум «Радіоелектроніка та молодь у XXI столітті». Зб. матеріалів форуму. Т. 1. – Харків: ХНУРЕ. 2023. – 142с.

В збірник включені матеріали 27-го Міжнародного молодіжного форуму «Радіоелектроніка та молодь у XXI столітті».

Видання підготовлено факультетом електронної та біомедичної інженерії Харківського національного університету радіоелектроніки

61166 Україна, Харків, просп. Науки, 14
тел./факс: (057) 7021397

E-mail: mref21@nure.ua

УДК 615.47:612.741

POSSIBILITIES OF SECOND ORDER DIFFERENCE PLOT FEATURES FOR DIFFERENTIATION OF LOW BACK PAIN BY ELECTROMYOGRAPHIC SIGNALS

Hamdiya Alhassan
Supervisor – cand.techn.sc., assoc.prof. Zhemchuzhkina T.V.
Kharkiv National University of Radio Electronics, BME Dep., Kharkiv, Ukraine
tel. +49(176) 70356486, e-mail: khamdiia.alkhassan@nure.ua

This study explores the potential of second-order difference plot (SODP) features for differentiating low back pain using electromyographic (EMG) signals. The SODP features were found to exhibit significant differences between patients with low back pain and healthy individuals. The dynamics of these features were also consistent across different segments of the EMG signal, suggesting their potential as reliable indicators for diagnosis. Overall, SODP features offer a promising approach for differentiating low back pain using EMG signals, with potential for clinical use pending further validation.

In many countries chronic low back pain (LBP) is the most common cause of long term disability in middle age. Chronic low back pain is resistant to treatment, and patients are often referred for multidisciplinary treatment [1]. Most of us will experience at least one episode of low back pain during our life. Reported lifetime prevalence varies from 49% to 70% and point prevalences from 12% to 30% are reported in Western countries [2].

The most common diagnostic test for LBP is electromyography (EMG). To date, the classification of diseases based on the results of surface electromyography is carried out by the methods of spectral, statistical and nonlinear dynamics analysis [3], [4].

Second Order Difference Plot (SODP) is a feature extraction method which is formed employing time domain information. The method of SODP can be used as an independent feature extraction tool as well as a supplemental technique to confirm the frequency domain results. If $X(t)$ is the signal, SODP is formed by $X(n+1) - X(n)$ and $X(n+2) - X(n+1)$ points on the plot. In other words, SODP includes scattering of consecutive difference values of points in the signal.

SODP develops the clinical skills such as cardiac disorders and determinants of disease. It allows possible simple visual interpretation techniques on the ECG. Due to these characteristics, it has a wide use over past years. The most significant deficiency of the SODP is calculation ability on the quantitative values that provide the characterization of the ECG data [5].

SODP features can help to identify changes in the slope of the EMG signal, which can provide information about the timing and strength of muscle activation. This information can be useful for distinguishing between different types of LBP, such as muscle spasm, muscle strain, or nerve root compression.

Some possible SODP features that could be used to differentiate LBP include:

- Mean slope: measures the average slope of the SODP over a defined time interval. Differences in mean slope between patients with different types of LBP could indicate differences in the timing or strength of muscle activation.

- Variability of slope: measures the variability in slope of the SODP over a defined time interval. Patients with muscle spasm or nerve root compression may exhibit higher variability in their SODP slope compared to patients with muscle strain.

- Peak amplitude: measures the maximum amplitude of the SODP over a defined time interval. Differences in peak amplitude could indicate differences in the strength of muscle activation.

- Time to peak: measures the time it takes for the SODP to reach its maximum amplitude. Patients with muscle spasm may exhibit shorter time to peak compared to patients with muscle strain or nerve root compression.

Overall, SODP features can provide useful information for differentiating between different types of LBP using EMG signals. However, it is important to note that additional research and validation is necessary before these features can be used in clinical practice.

References:

1. Gunjan M., Jha A.K, Verma P., Mishra A., etc. (2014) An overview on low back pain and its management – a survey based analysis. Indian Research Journal of Pharmacy and Science. 2. 133-150.

2. Koes, B. W., van Tulder, M. W., & Thomas, S. (2006). Diagnosis and treatment of low back pain. BMJ (Clinical research ed.), 332(7555), 1430–1434. https://doi.org/10.1136/bmj.332.7555.1430.

3. Zhemchuzhkina T., Nosova T., "Analysis of the dynamics of statistical and spectral indicators of electromyograms of the lumbar region," Scientific Collection "InterConf", (96): with the Proceedings of the 6th International Scientific and Practical Conference Scientific Community: Interdisciplinary Research (January 26-28, 2022). Hamburg, Germany: Busse Verlag GmbH, 2022. 1206 p., pp. 683-686.

4. Zhemchuzhkina, T.V., etc. (2019). Application of EMG-signal phase portraits for differentiation of musculoskeletal system diseases. Proc. SPIE 11176, Photonics Applications in Astronomy, Communications, Industry, and High-Energy Physics Experiments. https://doi.org/10.1117/12.2537338.

5. Altan, G., Kutlu, Y., & Yeniad, M. (2019). ECG based human identification using Second Order Difference Plots. Computer methods and programs in biomedicine, 170, 81–93. https://doi.org/10.1016/j.cmpb.2019.01.010.