

Letter to the Editor: Advancements in Digital Health Technologies

Kyrylo Malakhov^a  – malakhovks@nas.gov.ua

^a Microprocessor technology lab, Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine, Kyiv, Ukraine


Dear editor and readers of the South African Computer Journal,

We are pleased to provide an update from the research team at the Microprocessor Technology Lab, Glushkov Institute of Cybernetics, National Academy of Sciences of Ukraine. Our recent research endeavours are focused on enhancing the monitoring and rehabilitation of military personnel, particularly in response to the challenges posed by combat conditions, and post-traumatic stress disorder (PTSD). We invite researchers, and industry partners to collaborate on these groundbreaking initiatives, and encourage viewing our summary video featuring Illya Chaikovsky (Chaikovsky, 2024) for a comprehensive overview of our research. Led by scientific supervisors Oleksandr Palagin (Academician of the National Academy of Sciences of Ukraine, Doctor of Sciences in Technical Sciences, PhD, Professor, Honored Inventor of Ukraine, Deputy Director for Research of Glushkov Institute of Cybernetics of the National Academy of Sciences of Ukraine, Head of the Microprocessor Technology Lab), and Illya Chaikovsky (M.D., PhD multiple, FRMS, PMESC, Lead Researcher of Department of Sensory Devices, Systems and Technologies of Noncontact Diagnostics, Glushkov Institute of Cybernetics), our research team has made significant strides in understanding the psychophysiological state of servicemen, and developing innovative hybrid cloud solutions to support their well-being and operational readiness.

Our research has underscored the critical importance of monitoring the psychophysiological state of servicemen (Bocharov et al., 2023), especially in combat environments where success in tasks is significantly influenced by their mental and emotional condition. Drawing on insights from the combat experience of the Armed Forces of Ukraine, particularly in the face of large-scale aggression by Russia, we have highlighted the necessity of real-time monitoring, and processing to optimise training regimes, and ensure the readiness of servicemen for combat tasks.

The onset of war aggression and invasion has posed unprecedented challenges to the medical rehabilitation system in Ukraine, particularly in addressing the needs of individuals suffering from PTSD, and combat-related mental trauma. Recognising the urgency of this issue, both societal stakeholders, and the Ministry of Health of Ukraine have prioritised the development

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of rehabilitation strategies. Our research emphasises the integration of hybrid e-rehabilitation technologies, coupled with objective monitoring methods, to extend the reach of rehabilitation services, and provide personalised care to affected individuals.

In response to the limitations of traditional rehabilitation centers, we have developed a hybrid cloud-based platform – the patient-centered Smart system of telemedicine support for hybrid e-rehabilitation activities (Malakhov, 2022, 2023a, 2023b; Palagin, Malakhov, Velychko & Semykopna, 2022). This innovative approach features cutting-edge technologies such as remote patient monitoring via telemetry Internet of Medical Things (IoMT) devices, and cognitive support systems to deliver tailored rehabilitation interventions remotely. By combining these technologies with intelligent information systems, we aim to enhance the effectiveness and accessibility of rehabilitation services for military personnel, and other individuals in need.

Our research has culminated in the validation of portable hardware and software complexes for monitoring the psychophysiological state of military personnel. These validated methods offer commanders valuable insights into individual readiness levels, aiding in decision-making related to combat task execution. Moving forward, we remain committed to further refining these technologies, and expanding their application in supporting the well-being and performance of military personnel.

In addition to our ongoing efforts in monitoring and rehabilitating military personnel, we are excited to share insights from our latest research endeavors in the burgeoning field of digital health and the IoMT. Our team is currently focused on the development of groundbreaking information technology for computerised electrocardiography, representing a significant step forward in healthcare innovation. The primary objective of our research is to enhance the diagnostic capabilities of electrocardiography using IoMT devices to capture subtle changes (Chaikovsky et al., 2022) in cardiac signals that may go unnoticed during routine analysis. To address this challenge, we have pioneered an original method and software for scaling electrocardiograms (ECGs), and heart rate variability (HRV), enabling healthcare professionals to extract deeper insights from these vital physiological indicators (Chaikovsky et al., 2023).

By harnessing the power of IoMT devices, and advanced signal processing techniques, our innovative approach aims to transform the way cardiac data is analyzed and interpreted. Through precise scaling and analysis of ECG signals, we seek to uncover valuable diagnostic information that can inform personalised treatment strategies and improve patient outcomes. By bridging the gap between traditional diagnostic methods and cutting-edge digital solutions, we are paving the way for a new era of precision medicine that prioritises individualised care and proactive health management.

To provide a comprehensive overview of our research, we have recorded a short video featuring Illya Chaikovsky (Chaikovsky, 2024). In this video, Illya Chaikovsky succinctly summarises our findings and discusses the implications of our work in the field of digital health and IoMT. We encourage you to watch this video for a more in-depth understanding of our research, and its potential impact.

We gratefully acknowledge the support received from various funding sources, including grants from the National Research Foundation of Ukraine. These resources have enabled us to pursue transdisciplinary research initiatives aimed at addressing pressing societal needs. The results of these studies were obtained during 2017–2024:

- According to the scientific directions defined by the Strategic Defense Bulletin of Ukraine, put into effect by the Decree of the President of Ukraine of June 6, 2016 No. 240/2016. In particular, the research was carried out in the areas defined by Strategic Goal 5 “Professionalisation of the Defense Forces and the Creation of the Necessary Military Reserve” in part of Operational Goal 5.2 “Improving the system of military education and personnel training”.
- Grant contract of the National Research Foundation of Ukraine – “Trans-disciplinary intelligent information and analytical system for the rehabilitation processes support in a pandemic (TISP)” (Palagin, Malakhov, Velychko, Semykopna & Shchurov, 2022; Palagin & Petrenko, 2018), application ID: 2020.01/0245 (2020–2021, project was successfully completed).
- Grant contract of the National Research Foundation of Ukraine – “Development of the cloud-based platform for patient-centered telerehabilitation of oncology patients with mathematical-related modeling” (Malakhov, 2023b; Malakhov, 2024), application ID: 2021.01/0136 (2022–2024, project is still in progress).

Sincerely,

Kyrylo Malakhov (On behalf of the Institute’s research team),
Researcher, Full-stack Developer, DevOps engineer,
Microprocessor Technology Lab,
Glushkov Institute of Cybernetics,
National Academy of Sciences of Ukraine, Kyiv, Ukraine.

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