National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського»

Міжнародна науково-практична конференція

СУЧАСНИЙ СТАН ТА ПЕРСПЕКТИВИ БІОМЕДИЧНОЇ ІНЖЕНЕРІЇ

присвячена 125-річному ювілею
Київського політехнічного інституту імені Ігоря Сікорського

International Scientific and Practical Conference

CURRENT STATE AND PROSPECTS OF BIOMEDICAL ENGINEERING

dedicated to the 125-anniversary of the
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МАТЕРІАЛИ КОНФЕРЕНЦІЇ

BOOK OF ABSTRACTS

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Сучасний стан та перспективи біомедичної інженерії : матеріали Міжнародної науково-практичної конференції, присвяченої 125-річному ювілею Національного технічного університету України «Київський політехнічний інститут імені Ігоря Сікорського» (13-14.12.2023, м. Київ) : ел.збірник / Упоряд.: О.І. Голембіовська – Київ : КПІ ім. Ігоря Сікорського, 2023. – 239 с.

Збірник матеріалів доповідей Міжнародної науково-практичної конференції «Сучасний стан та перспективи біомедичної інженерії», присвячена 125-річному ювілею КПІ ім. Ігоря Сікорського.
Розглянуто широке коло питань в галузі біомедичної інженерії, такі як: проблеми та перспективи біомедичної інженерії як освітньої та наукової галузі; клінічна інженерія, технології діагностики та лікування; медичне приладобудування і біомедична електроніка; регенеративна біоінженерія, біофармацевтична інженерія, медичні біотехнології; реабілітаційна інженерія, фізична терапія, ерготерапія; біомедична кібернетика, телемедицина, інтелектуальні системи в медицині.
Розраховано на наукових та науково-педагогічних працівників наукових установ, закладів освіти фармацевтичного, медичного, біологічного профілю, докторантів, аспірантів, студентів, співробітників підприємств та громадських організацій.

Current state and prospects of biomedical engineering: materials of the International scientific and practical conference dedicated to the 125th anniversary of the Igor Sikorsky Kyiv Polytechnic Institute (December 13-14, 2023, Kyiv) : electronic abstract book / Edited by: O.I. Golembiovska – Kyiv : Igor Sikorsky Kyiv Polytechnic Institute, 2023. – 239 p.

Collection of reports of the International scientific and practical conference "Current state and prospects of biomedical engineering", dedicated to the 120th anniversary of the Igor Sikorskyi Kyiv Polytechnic Institute. A wide range of issues in the field of biomedical engineering are considered, such as: problems and prospects of biomedical engineering as an educational and scientific field; clinical engineering, diagnostic and treatment technologies; medical instrumentation and biomedical electronics; regenerative bioengineering, biopharmaceutical engineering, medical biotechnology; rehabilitation engineering, physical therapy, occupational therapy; biomedical cybernetics, telemedicine, intelligent systems in medicine.
It is intended for scientific and scientific-pedagogical employees of scientific institutions, pharmaceutical, medical, and biological education institutions, doctoral students, postgraduate students, students, employees of enterprises and public organizations.

За виклад, зміст і достовірність матеріалів відповідальні автори.
Матеріали друкуються мовами оригіналу: українська, англійська.

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DIAGNOSTIC METHODS OF ELECTRONIC CONTROL BOARDS IN ARTIFICIAL LUNG VENTILATION DEVICES

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The peculiarities of the diagnosed electronic control boards in artificial lung ventilation devices include their great complexity and heterogeneity. Each of the component parts of the board does not function independently, but is connected with the other parts that affect each other, and when failures occur, the nature of these connections is difficult to analyze. For efficient diagnosis and prompt troubleshooting in such control systems, classical methods are most often ineffective. To optimize the process of setting up, adjusting and monitoring electronic control boards in artificial ventilation devices, it is necessary to have special methods and software and hardware that can minimize the labor costs associated with the search for a defect and recovery. Thus, the task of minimizing the diagnostic time of control boards in artificial lung ventilation devices is relevant [1, 2].

We propose to solve the problem of minimizing the diagnostic time of electronic control boards in artificial lung ventilation devices, as well as reduce the complexity of the diagnostic process by using special diagnostic modules for testing electronic control boards in artificial lung ventilation devices based on microcontrollers.

When choosing a diagnostic strategy, it should be noted that today there is a huge choice of both the strategies themselves and the equipment for their implementation.

Each of the methods has its own advantages, but also has certain disadvantages. For a more complete understanding, let's consider several directions separately, listing their main advantages and disadvantages [2, 3].

Functional testing is highly reliable: only with functional testing can we say with confidence whether the electronic module works or not. Relatively low cost of mastering new products: since testing is carried out through the edge connector, it does not require significant costs for the manufacture of adapters for connection. It may take from one week to several months to develop a test program for a single print module. The development period of the program will be determined by the complexity of the tested PCB, and in general, 2 people may need to work: an electronics specialist (to develop a testing algorithm) and a programmer (to directly write a test program). high costs for repair of a defective module. Due to the fact that the FT provides verification of the module through the edge connector, this method does not provide sufficiently complete information about the location of the defect, and its localization usually requires high qualifications from maintenance personnel, knowledge in the field of electronics, as well as experience. The average time to locate a defect can range from 30 minutes to several hours, depending on the complexity of the board and the type of defect. Incomplete test coating, part of the "hidden" defects is not determined. Here we are talking about those defects that do not affect the characteristics of the tested device during functional testing, but can affect operation [3, 4, 5].

In-circuit testing is high performance, the testing time takes several minutes. High functional reliability: a board that has passed in-circuit control is approximately 95% likely to be operational. High resolution: due to the fact that access is carried out to almost every component, it is possible to localize the defect with a high degree of probability. High costs for mastering new products: associated with the manufacture of a unique adapter for each module being tested. The higher the cost, the more complex the control boards in artificial lung ventilation devices. Storage and maintenance of test adapters is costly. In some cases, access to test points with needle probes is not possible.

Peripheral scanning does not require physical contact with test points, there is no need to manufacture adapters. High resolution, provides access to components for which physical contact is not possible. Generate test programs based on CAD files. Incomplete test coverage. Only those circuits that are connected to a chip that supports the JTAG standard are checked. To implement Boundary Scan tests, the tested product must be powered up. Only digital circuits are tested, an analog test (check of resistance, capacitance, etc.) is impossible. Dynamic defects, i.e. defects manifested during module operation, are not detected [5, 6].

Element-by-element diagnosis is a low cost of developing diagnostic support. Applicability when diagnosing any functional diagrams of systems, inoperable elements. A relatively large number of checks,

including with optimal defect search programs. Among the variety of methods presented, element-by-element diagnostics, focused on checking control boards in artificial lung ventilation devices, which significantly helps in solving the task we set, has a special specificity. The search for a defect using the method of successive element-by-element checks is carried out by monitoring the functional elements of the system according to one and according to a certain program. The defect search program is optimized, as a rule, according to the criterion of minimizing the average defect search time, based on the known values of the average time for checking the elements and the probability of system failures due to the failure of any of the n-elements [6, 7, 8].

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