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# DESIGN AND IMPLEMENTATION OF AN AUTOMATED BLOOD COLLECTION SYSTEM WITH BIOMETRIC IDENTIFICATION

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***Abstract.*** *The study presents the development of a blood collection system with biometric identification, ABSS, designed to ensure the accuracy and safety of medical procedures. Automating patient identification processes using dynamic biometric data, such as heart activity signals, and static biometric data, such as fingerprint ridge lines, minimizes the risk of errors and improves the quality of laboratory research. The ABSS system enhances the efficiency of medical procedures and the quality of patient care while ensuring the reliability of medical data and optimizing document workflows.*

***Key words:*** *static and dynamic biometric identification, operational algorithm, automated blood collection system, electrocardiogram ECG, photoplethysmogram PPG, fingerprint ridge lines.*

***Анотація.*** *У даній статті представлено алгоритм роботи системи забору крові з біометричною ідентифікацією, ABSS для забезпечення точності та безпеки медичних процедур. Автоматизація процесу ідентифікації пацієнтів з використанням динамічних біометричних даних, таких як сигнал роботи серця, а також статичних біометричних даних як папілярні лінії пальців, дозволяє мінімізувати ризики помилок та покращує якість лабораторних досліджень. Система ABSS забезпечить підвищення ефективності медичних процедур та якості обслуговування пацієнтів, водночас забезпечуючи надійність медичних даних та оптимізацію документообігу.*

***Ключові слова*** *статична і динамічна біометрична ідентифікація, алгоритм роботи, автоматизована система забору крові, електрокардіограма, фотоплетизмограма, папілярні лінії.*

## Introduction.

The efficiency of medical research and procedures directly depends on the accuracy and reliability of the collected biological data. Errors occurring during medical research are conventionally divided into three stages [1,2]: pre-analytical, analytical, and post-analytical errors.

Pre-analytical errors are defined as mistakes that arise from the physician's order to the analytical phase and include the request for analysis, patient identification, collection, transportation, and preparation for analysis. Analytical errors occur during testing and involve equipment malfunctions, sample mix-ups, interferences, undetected quality control errors, and failure to follow procedures. Post-analytical errors occur after the test is completed and include reporting inaccuracies, errors in analytical data

verification, incorrect data entry, and excessive processing time.

Automating medical research processes can optimize workflows and reduce the risk of errors. A study conducted between 2004 and 2015 [2,3] indicates that most errors (48–70%) occur during the pre-analytical phase of blood collection. These include ordering incorrect tests, patient misidentification, test mismatches, loss of test records, improper sample collection, or inadequate patient preparation, such as incorrect tube labeling and errors in sample transportation.

**Integration of biometric identification into an automated blood collection system**

This study presents the development of an automated blood collection system with biometric identification. The system is designed to eliminate errors that occur during patient identification and depends on various critical aspects of the identification process, such as labeling and deliberate fraud. The proposed automation aims to eliminate the mistakes that most frequently arise during the pre-analytical phase, ensuring the accuracy of medical research.

The patient presence block (Fig. 1) represents the implementation of biometric identification in the automated blood collection system. This system consists of two modules for dynamic biometric identification: an electrocardiogram (ECG) sensor and a photoplethysmogram (PPG) sensor. A biometric identification module also scans the patient’s fingerprint and compares the fingerprint ridge lines with the database.

In the software system, the "Start Patient Identification" button initiates the identification process (Fig. 2a), which sequentially activates the research modules in the following order: electrocardiogram, photoplethysmogram, and fingerprint scanning module. If the patient is successfully identified, the next stage of the process, "Screening Procedure," becomes accessible (Fig. 2b).

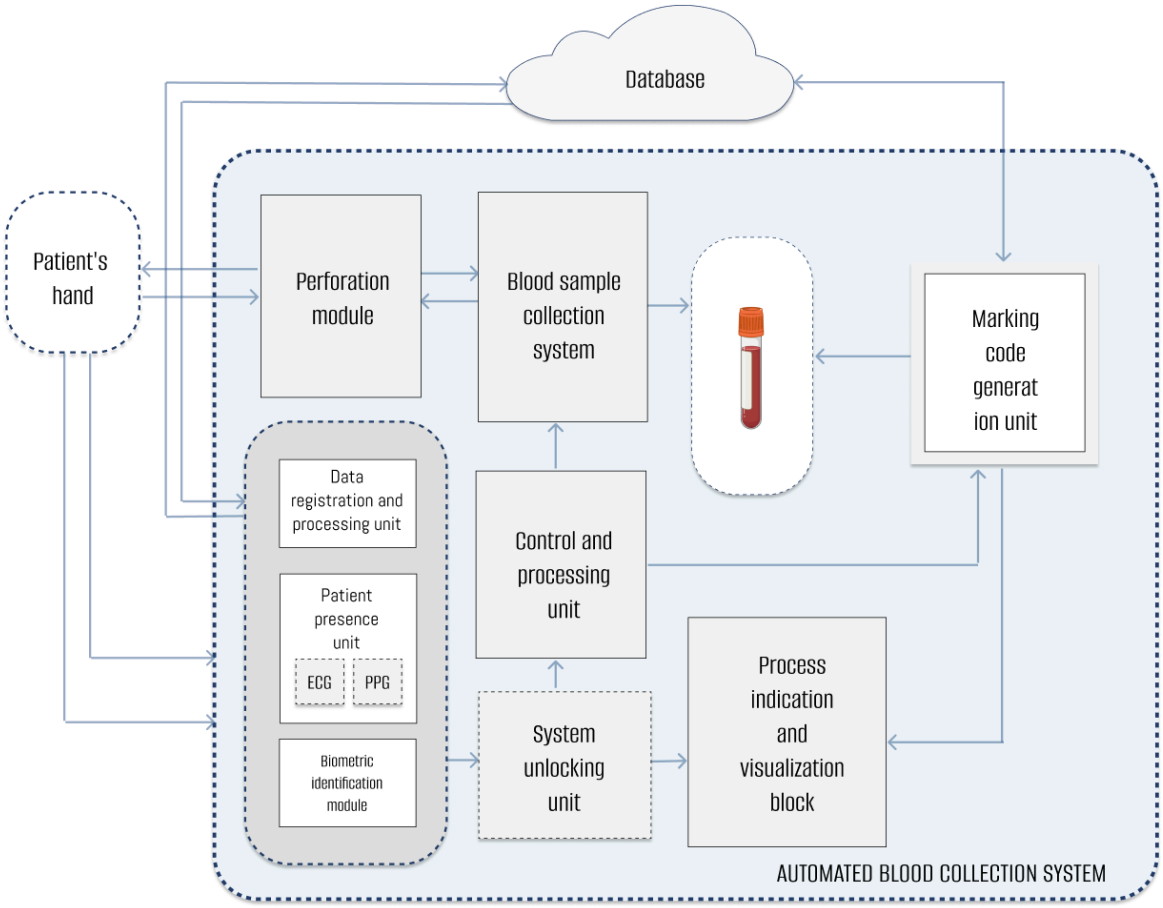
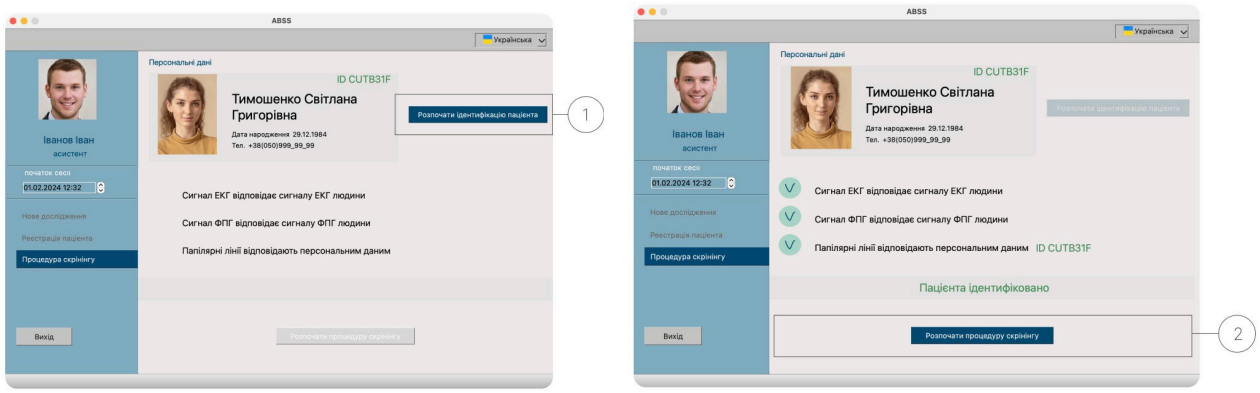



**Fig. 1. Generalized structural diagram of biometric identification implementation in an automated blood collection system**

*Source: developed by the authors*




a) b)

**Fig. 2. Interface of the program responsible for patient identification in the system (interface language: Ukrainian)**: ***a)*** *Identification start window:* ***1*** *– identification start button;* ***b)*** *Identification completion window:* ***2*** *– screening procedure start button.*

*Source: developed by the authors*

**Algorithm of the automated blood collection system with biometric identification**

This study presents the automated blood collection system algorithm with biometric identification, named ABSS. The system ensures high accuracy in patient identification and efficiency in blood collection processes through biometric technologies, such as fingerprint ridge scanning and analysis of biological signals (ECG, PPG) [4]. The software features a user-friendly interface, enabling medical staff to efficiently register new patients, log into the system, conduct studies, and process results. The system algorithm encompasses the entire process, from authorization to the completion of blood collection, including entering patient personal data, selecting studies, identifying patients, and generating reports on the results. The system is implemented to ensure the accuracy of medical analyses and enhance healthcare facilities' efficiency.

The automated blood collection system algorithm with biometric identification minimizes errors during patient identification, which depend on various critical aspects of the identification process, such as labeling and intentional fraud. This automation addresses errors that most frequently arise during the pre-analytical phase, ensuring the accuracy of medical research.

The proposed system simplifies the blood sample collection process and provides a high level of security through unique patient identification. This solution eliminates the human error factor, often occurring during manual data entry, and significantly reduces the time required for information processing.

Implementing integrated systems with biometric identification plays a key role in enhancing the efficiency of medical diagnostics. These technologies enable healthcare facilities to achieve high diagnostic accuracy and improved coordination between departments, ultimately contributing to better patient care.

The described system algorithm is advanced technologies that can optimize medical procedures and create a safer and more efficient environment for patients and healthcare personnel.

This system also facilitates the automation of document workflows, minimizing

the need for paper records and ensuring easy access to medical data. This significantly improves patient data management, allowing healthcare facilities to respond more quickly to patient needs and provide high-quality care based on accurate and up-to-date information.

**Summary and conclusions**

It can be concluded that the development of an automated blood sampling system with biometric identification will allow obtaining high-quality samples for successful blood testing and reliable and timely diagnostics.

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