

Thus, the chosen approach, based on a combination of threshold segmentation and contour analysis, is well-founded for the task of structure segmentation in computed tomography images and ensures the required level of accuracy whilst maintaining high computational efficiency.

**Keywords:** medical image segmentation, computed tomography (CT), 3D modelling, custom prosthetics, stump socket, digital anatomical models, medical image processing.

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UDC 615.849.11

## **ROBOTIC MECHATRONIC PLATFORM FOR A HEALTHCARE FACILITY**

*Klotchko T.R., Rozumnyak R.L., Zhiglyi D.V.*

*National Technical University of Ukraine “Igor Sikorsky Kyiv Polytechnic Institute”,  
Kyiv, Ukraine*

*E-mail: [t.klochko@kpi.ua](mailto:t.klochko@kpi.ua)*

A modern medical institution, in particular a clinical one, requires increased efficiency of work, speed of response of personnel to complex challenges, which are characteristic of functioning of complex medical technologies of surgical

intervention, treatment and rehabilitation. One of technical options for solving this problem is development and application of robotic mechatronic platform. Actual tasks are delivery of medicines to patients, as well as timely disinfection of premises of various functional purpose, in particular surgical, stationary and rehabilitation profile and office premises.

First, there is a growing need to improve the efficiency and optimize the work of medical staff. A significant part of the time of nurses and support staff is spent on logistical tasks, such as transporting medicines, instruments and consumables. Automating these processes allows to reduce the workload on staff and focus their attention directly on patient care.

Secondly, the relevance is further reinforced by the need to ensure a high level of infection safety in healthcare facilities. The spread of hospital-acquired infections remains a serious problem. The use of robotic systems for regular disinfection of premises (particularly through the use of UV radiation or the spraying of disinfectants) makes it possible to improve the quality of sanitation and reduce the risk of infection for both patients and medical staff.

Thirdly, the experience of pandemics (particularly COVID-19) has demonstrated the need to minimize direct human contact in hospitals. Robotic platforms are capable of delivering medications and essential supplies without human involvement, thereby helping to reduce the risk of infection transmission.

The implementation of mechatronic systems aligns with modern trends in the digitalization and automation of healthcare. Such platforms can be integrated with hospital information systems, operate autonomously or semi-autonomously, and use sensors for navigation and obstacle avoidance, thereby increasing the overall efficiency of healthcare facility operations.

An equally important aspect is the economic factor: although the initial investments required for implementing robotic solutions may be significant, in the long term they make it possible to reduce operating costs, optimize resource utilization, and improve the quality of patient care.

Thus, the development of a robotic mechatronic platform for drug delivery and disinfection of premises is a relevant, socially significant and promising task that meets the modern needs of the medical industry and contributes to increasing the level of safety, efficiency and quality of medical services.

The robotic platform is one of the promising areas of development of modern medicine in a medical clinical institution, combining automation, artificial intelligence and engineering solutions to improve the quality of patient care and staff safety. In the context of the increasing burden on medical institutions, as well as increased requirements for infection control, such systems are becoming not just an innovation, but practically a necessity.

One of the key functions of a robotic platform is the delivery of medications directly to the patient. Traditionally, this process has relied on medical staff, which requires significant time and increases the risk of human error. Robotic systems can optimize this process by automated transportation of medications between the

pharmacy, warehouse and wards. Equipped with navigation sensors such as lidars, cameras and ultrasonic sensors, robots can safely navigate the clinic corridors, avoid obstacles and interact with the building infrastructure, for example, automatically call elevators or open doors.

In addition, such platforms can be integrated with hospital information systems. This allows you to automatically receive data on the doctor's prescription, form a delivery route and monitor the correctness of the dispensing of medications. For example, each container with medication can be equipped with an identification system (RFID or QR codes), which guarantees the accuracy of delivery to the patient for whom the drug is prescribed. This reduces the risk of errors and increases the overall level of treatment safety.

Another important function of robotic platforms is disinfection of premises, in particular with the use of ultraviolet (UV) radiation. Infection control is a critically important aspect of the work of any medical institution, especially in conditions of the spread of nosocomial infections. Robots equipped with UV lamps are able to effectively destroy bacteria, viruses and other pathogenic microorganisms on surfaces and in the air.

The advantage of using UV disinfection lies in its high efficiency and the absence of a need for chemical agents that may be harmful to people or cause allergic reactions. Robotic platforms can operate autonomously, performing disinfection at scheduled times, for example after a patient is discharged or during nighttime hours when the premises are empty. Integrated motion sensors and safety systems ensure the automatic shutdown of UV radiation if a person is detected within the operating area, thereby minimizing health risks.

In addition to their basic functions, modern robotic systems may include additional capabilities such as environmental monitoring (temperature, humidity, and air pollution levels), real-time video transmission, or even telemedicine features. For example, such a robotic platform may be equipped with a display and a camera to enable remote communication between a doctor and a patient, which is particularly relevant under quarantine restrictions (Fig. 1).

The block diagram (Fig. 2) illustrates the operating algorithm of the robotic platform, starting from system initialization and receiving a task from the medical facility's information system.

Each scenario includes route planning, navigation, and target actions.

Special attention is paid to the security subsystem, including monitoring the presence of people during ultraviolet disinfection. After completing the operation, the robot returns to the base station or moves on to the next task.

The implementation of robotic platforms also has a positive impact on the efficiency of medical staff. Relief from routine tasks, such as medication delivery or room disinfection, allows doctors and nurses to focus on direct patient care. This improves the quality of medical services and reduces the level of professional burnout.

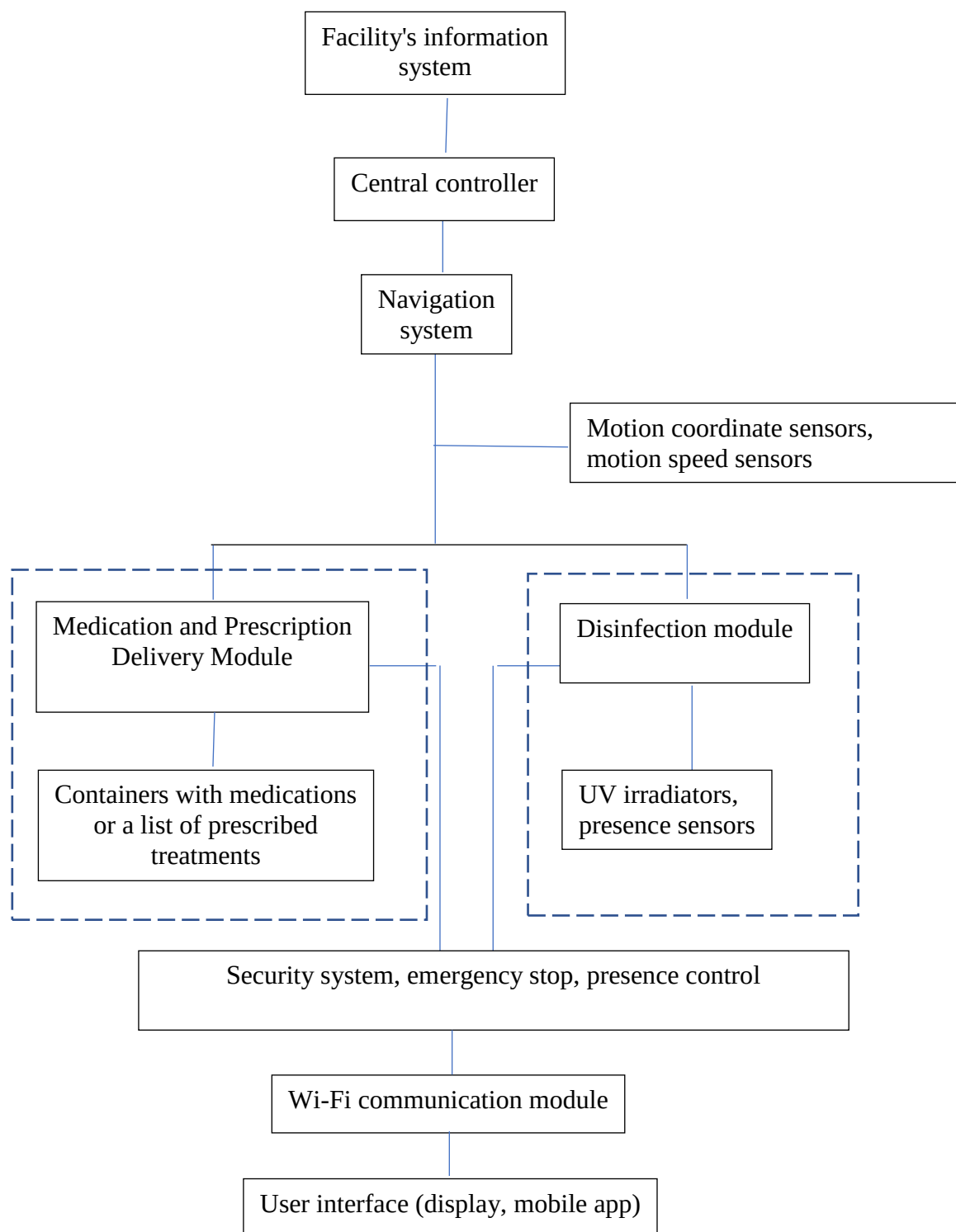


Fig. 1. Structural diagram of a robotic medical platform with integrated functions

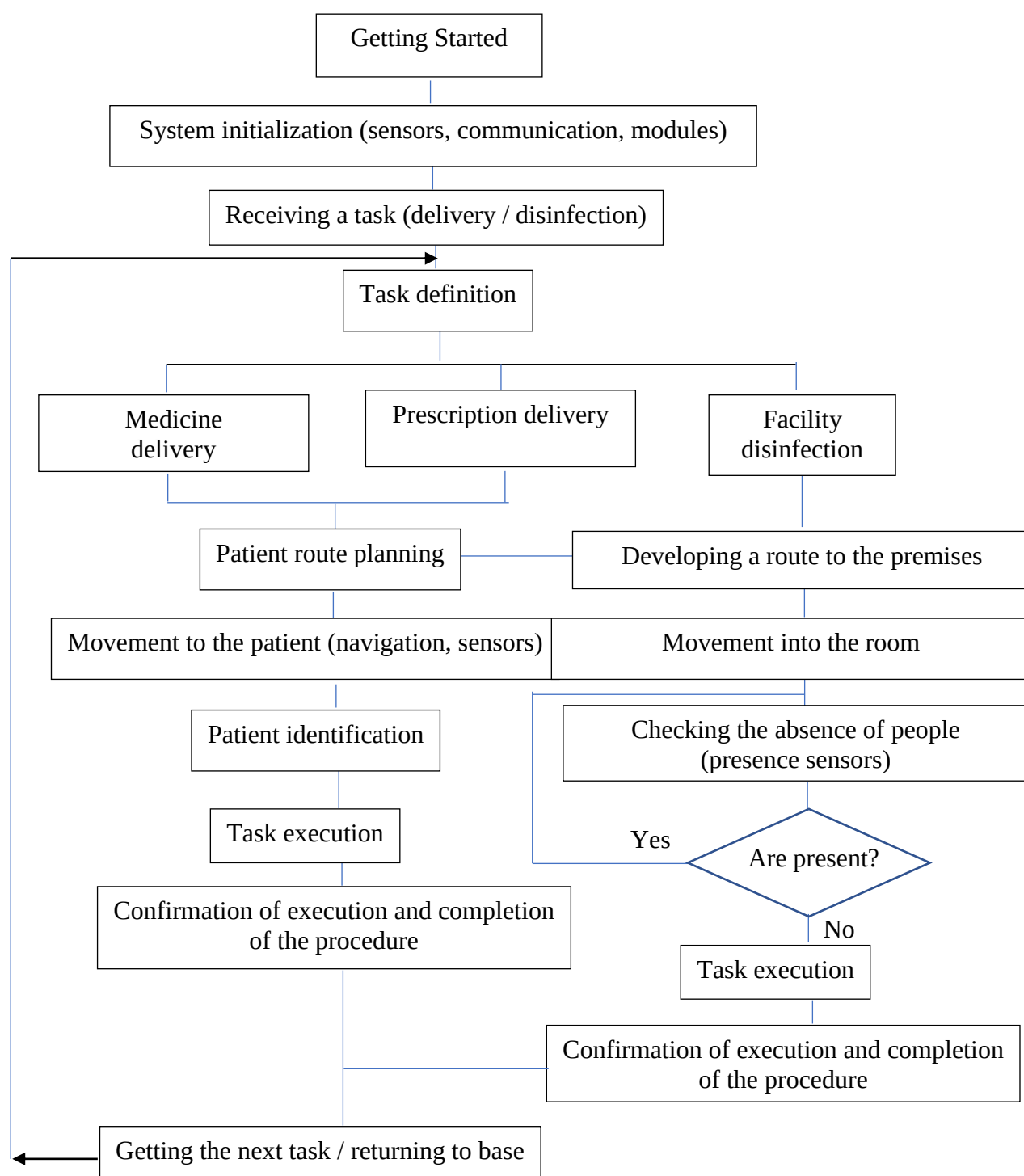


Fig. 2. Block diagram of the functioning of the integrated robotic platform

At the same time, there are certain challenges associated with the implementation of such systems. These include the high cost of equipment, the need to adapt the facility's infrastructure, as well as training staff to work with new technologies. However, in the long term, these costs may pay off through increased efficiency, a reduction in the number of errors, and improvements in sanitary and epidemiological conditions.

Therefore, a robotic platform for a medical clinical facility is an innovative solution that can significantly improve the quality of medical care. The functions of delivering medicines and disinfecting premises, including using ultraviolet light, make such systems an important element of a modern hospital.

Further development of technologies and their integration into medical practice open up new opportunities for creating a safe, effective, and high-tech environment for patient treatment.

**Keywords:** mechatronic robotic platform, disinfection system, clinical facility, monitoring.

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УДК 617:615.849.19

### **АВТОМАТИЗОВАНА СИСТЕМА КОНТРОЛЮ ФОКУСНОЇ ВІДСТАНІ АПЛІКАТОРА ЛАЗЕРА**

<sup>1)</sup> Цвігун М.Б.,<sup>1)</sup> Терещенко М. Ф.

<sup>1)</sup> КПІ ім. Ігоря Сікорського, м. Київ, Україна,

E-mail: [tsvignmarkiyan04@gmail.com](mailto:tsvignmarkiyan04@gmail.com), [agfarkpi@i.ua](mailto:agfarkpi@i.ua)

Апаратна лазерна медицина в сучасному світі є одним із найпоширеніших засобів лікування та діагностики завдяки широкому спектру та гнучкості застосування [1]. Вона використовується в більшості медичних напрямів та має свої унікальні переваги. Наприклад, точність, неінвазивність та ефект фотобіомодуляції (ФБМ) у терапевтичній галузі; здатність до коагуляції, стерильність та надзвичайну точність в хірургії; високі діагностичні можливості в томографії, що в сукупності роблять цей метод одним із найефективніших [2]. При цьому фізичне та термічне навантаження на організм пацієнта є мінімальним, а ризик побічних ефектів, таких як термічні опіки, є значно нижчим порівняно з медикаментозним чи хірургічним втручанням [3]. Саме це зумовлює високу популярність лазерних терапевтичних апаратів у клінічній практиці та постійний попит на їх удосконалення з боку медичної галузі [4].

Сучасний напрямок розвитку технологій апаратної медицини направлений в сторону автоматизації, роботизації та впровадження комп'ютерно-інтегрованих технологій в них, це відбувається в зв'язку з набагато вищою