

# Surgical Robots of the Next Decade

New trends and paradigms in the 21th century

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## KEYWORDS

surgical robotics; medical innovation; robotics 4.0; computer-integrated surgery; robot safety standards

## ABSTRACT

Robots in healthcare already have a stunning 40 years history, yet there is an unprecedented rise nowadays in new systems and clinical applications [1]. Surgical robotics is entering new domains, reaching new levels of integration, requiring highly sophisticated manipulation skills and decision making—on both the human and the mechatronic ends. The newest generation of robots does not only function as an agile extension of the human eyes and hands, but also becoming a skillful and smart co-worker of their MD counterpart [2].

Current trends include the seamless integration of pre-operative and intra-operative images along with the (limited) decision-support offered to the clinicians, both in terms of surgical planning and navigation. Employment of smart tools, in vivo direct and indirect diagnostic methods are also on the rise. Microsurgery applications have been empowered by stable robotic platform both for hands-on and teleoperational control modes. Some companies are already talking about the introduction of cognitive surgical robots, which may open the era of Surgery 4.0, where procedures are boosted by Surgical Data Science and supported by big data analytics and optimization. These and many other technological advancements are to be presented.

An emerging pattern is the cooperation of eminent research institutions, which is proved to benefit a lot the whole community. A great example of that is the Da Vinci Research Kit (DVRK) community, in which 25 outstanding labs (including the IROB at Óbuda University) synchronize their

research, and share the results in an open source platform, relying on the open architecture research version of the famous da Vinci Classic robot [3].

Legislation and standardization activities are gradually following the technical development, striving to establish a safe and reliable environment for Surgical Robots 4.0 [4,5]. Assessment of medical robot capabilities is of great importance: safety can only be ensured through rigorous testing and verification processes. Existing and new systems should be assessed and scaled along their Degree of Autonomy, as a new concept that will create a basis for objective comparison of functions and capabilities. As a next step, the standardization bodies are looking into developing complete test sequences and scenarios for practical benchmarking.

It is believed that the near future of medical robotics largely lies in cooperatively controlled systems, where robots and humans share the control, to exploit advantages of both. Humans will be able to benefit from the advantages of autonomous medical systems in the long term. The upcoming standards and test protocols should put emphasis on the evaluation and categorization of these systems [6]. The talk overviews the most important recent trends in the field, identifying some of the key enabling technologies and economic considerations. A critical analysis to the state of the art is also provided.

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