

Review Article

A Historical Review of Medical Robotic Platforms

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This paper provides a brief history of medical robotic systems. Since the first use of robots in medical procedures, there have been countless companies competing to develop robotic systems in hopes to dominate a field. Many companies have succeeded, and many have failed. This review paper shows the timeline history of some of the old and most successful medical robots and new robotic systems. As the patents of the most successful system, i.e., Da Vinci® Surgical System, have expired or are expiring soon, this paper can provide some insights for new designers and manufacturers to explore new opportunities in this field.

1. Introduction

Due to technological advancement, research and development of medical robots has revolutionized the way medical procedures take place, including surgical operations. This tremendous progress can be attributed not only to technological advancement, including actuators, sensors, control systems, and materials but also to the growth of imaging systems for medical applications such as higher resolutions and magnetic imaging [1]. Widespread acknowledgment of medical procedures that have been successfully performed with the aid of robotic systems has led to an increase in the number of individuals willing to undergo a procedure performed either solely by a robot semi-autonomously or a robot-assisted procedure. This in turn leads to the rapid advancement of the field of medical robotics.

Robots are generally defined as machines that can be programmed to perform a specified set of simple or complex tasks, with or without human assistance. One advantage of using robotic assistance is the capability to program for performing tasks that require high-speed motion with a focus on precision and accuracy. Robots may also perform tasks that require strength application without becoming worn out. Some of the disadvantages associated with the use of robotic systems include their high price, large space required to operate, need for

frequent maintenance, and need for properly training operators such as doctors and clinical staff prior to use [2–4]. Despite these disadvantages, the positive impact of medical robotic systems can be observed in surgery, where the achievement of an acceptable improvement in precision and accuracy levels results in the enhancement of procedures such as tissue manipulation. Research and clinical studies have reported significant improvement in outcomes of surgical operations [5–7], including a reduction in trauma experienced by patients [3, 7, 8] and post-procedure recovery of patients [1, 9]. Some of the major fields of medicine have been greatly impacted by the introduction of robotic systems, such as the Renaissance® System introduced in 2011 [10], which has been proven to increase the accuracy rate by a factor of 85% to 100% [1, 2] and is extensively accepted for use in spinal surgeries [10]. MAKO, one of the leading robotic systems for orthopedic procedures, was launched in 2015 [11] and provides accuracy and precision that eliminates the need for manual instruments [3, 12]. The most widely known robotic system, the Da Vinci® Surgical System [5, 13], is primarily used for performing minimally invasive surgery (MIS). Being a “master-slave” system, the Da Vinci® platform helps surgeons perform tasks in which there is the possibility of failure to operate smoothly, through the use of advantageous features like the filtering of tremors

