The Impact of Robotics in Healthcare: Rehabilitation and Patient Mobilization

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Abstract - The world's fast growing and ageing population demands for an extensive and efficient healthcare support as well as large financial investments. In Canada and the U.S. only, more than 700,000 strokes occur every year and over five million stroke survivors suffer from its side effects. The injuries caused by falling of the elderly constitute the second highest number of injury hospitalizations in Canada. These are only a few alarming examples to emphasize the dire need for more efficient health care practices and enabling technologies which can compensate for the predicted shortage of staff and financial resources. The robotics community is making great efforts to adapt their research and technological innovations to healthcare needs in attempt to realize more efficient and less invasive methods in diagnostic, therapeutic, and surgical procedures. In addition, the underlying robotic technologies are fast advancing, hence, accelerating its emergence as a viable dynamic field of research with great potentials to healthcare. In the last decade, several new medical robots have been proposed, prototyped, or commercialized. Some of the most well-known include the Da Vinci robot used in surgery, the Cyber knife used in radiotherapy, and the Locomat system used in rehabilitation.

In the first part of this talk, an overview is provided on the evolution of robotic systems and the gradual paradigm shift in the robotic community, from a focused research on traditional manipulator and mobile robotic platforms, to developing custom solutions for challenging applications such as healthcare. Particular attention will be given to the new medical robots, current status of rehabilitation robotics, and the challenges that are surrounding research and commercialization of medical robots. In the second part of this talk, the newest robotic systems developed at Carleton University's Advanced Biomechatronics and Locomotion (ABL) laboratory will be reviewed. Some of the most pressing issues related to rehabilitation robotics, assistive devices, and safe human-robot interaction are the core research areas highlighted. Damages to the central nervous system, caused by neural illnesses or injuries, may be only addressed via extensive and early rehabilitation conforming to the main principles of motor learning. As such, novel robotic systems capable of providing early and intensive gait therapy are under development, which also exploit virtual reality to ensure patient engagement. The research also includes the development of Omni-directional robotic support systems, capable of fall detection and prevention, to enable *early mobilization* - a standard practice for faster recovery of acute-care patients. Other novel devices and research results obtained at ABL are highlighted, spanning from sensing and biofeedback techniques for balance aid in elderly, interaction sensing and control for safer human-robot interactions, and assistance regulation techniques for assistive devices, to the general research on dynamics and learning of balance in bipedal walking.