Choice of electromagnetic actuators for assistive robots

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R. ZANIS, T.E. MOTOASCA, E.A. LOMONOVA. ***Choice of electromagnetic actuators for assistive robots.*** *Gerontechnology 2012;11(2):386;* doi:10.4017/gt.2012.11.02.235.00 **Purpose** Assistive robots such as exoskeletons that support the movement of physically impaired people and robots that are used for rehabilitation purposes need to closely interact with their (elderly) users. This gives rise to special requirements in the hardware design of such assistive robots, for instance a mechanical compliance or softness that significantly improves the safety level and provides more natural and lifelike sensation to the users. The mechanical compliance can be provided by actuators that may be based on electromagnetic (EM) principles, which in many cases favorably compare to the pneumatic- or hydraulic-based systems considering cost and implementation issues. In this work, the aspects of EM-based actuators for implementations in assistive robots are investigated. **Method** Three different EM-based actuators are compared in this work, namely a geared motor, a direct drive motor and a variable stiffness actuator (VSA)[1]. The geared and direct drive motors are each equipped with an impedance controller[2], which virtually renders a compliant mechanical behavior. The compliance of the VSA arises from two nonlinear mechanical springs[3] that are coupled with two geared motors, allowing both robot's joint position and compliance to be controlled. Experiments are performed to investigate the performance of each actuator in adjusting its compliance as well as its response to a sudden impact, which is done to evaluate the safety level of the actuator used in assistive robots. **Results & Discussion** The evaluation of the actuators in terms of cost and size can be done without use of experiments. The experiments attempt to define other comparison criteria of the actuators. The evaluation of a sudden impact with a rigid object is performed by speeding up the mechanical link (emulation of a robotic arm) attached to each actuator, towards a rigid force sensor. Another experiment is performed by keeping the mechanical link of each actuator in permanent contact with a force sensor while the compliance level of the actuator is changed over time. The measured force levels from both experiments reveal the capabilities of each of the actuators in absorbing impact energy as well as in adjusting its compliance. These findings give indications on the safety level of assistive robots with such actuators in interactive tasks with humans and the environment. In addition, it has also been shown that each actuator consumes a different amount of electrical power for performing the same experimental task. This can be an essential issue when one considers implementing a particular actuator in assistive robots having a limited energy supply (*Table 1*). The advantages and disadvantages as presented in the table could be used as a guideline in selecting actuators for implementation in assistive robots.

References

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Table 1. Comparison criteria of the actuators

Aspect	Geared	Direct drive	VSA
Cost	++	-	-
Size	++	-	--
Impact response	--	+	++
Manipulability of compliance	--	++	+
Electrical power consumption	++	--	+