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RESEARCH ARTICLE

ROBOTIC ASSISTED THERAPEUTIC TECHNOLOGICAL AIDS (RATTAA) AS AN ALTERNATION TO PHYSICAL THERAPY FOR LOCOMOTOR DISABLED: A REVIEW

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ABSTRACT

Robotic devices can be used by physical therapists in conjunction with traditional physiotherapy methods. The use of robotic devices holds great promise to enable persons with disabilities to achieve and maintain their functional independence. The goal of therapy robotic aid is to help patients recover from different forms of accidents and maladies. Robotic systems are classified into two categories: Physical therapy training robots and Robotic aids for people with disabilities. Rehabilitation robotics is highly motivating field for locomotor disabled as technology developed will directly help people who are limited in major life activities.

INTRODUCTION

Disabilities occur throughout the entire age spectrum and the incidence of disability increases with age. The use of robotic devices holds great promise to enable persons with disabilities to achieve and maintain their functional independence (Hoffman A.H). Age-related disabilities put disabled people at risk and increase the need for institutionalization when there is no viable home-based solution. Personal robots, robotic therapy, smart prostheses, smart beds, smart homes and tele-rehabilitation services have accelerated in the past years and will need to continue a pace with the ever-increasing ability of health care to allow people to live longer through the repression of diseases. Rehabilitation robotics, although only a 40-year-old discipline is projected to grow quickly in the coming decades. Physical therapy have benefited from robotic assistance by movement therapy, enabling communication for children with autism and enabling education for children with cerebral palsy and other developmental disabilities. Robotic systems are classified into two categories: Physical therapy training robots and robotic aids for people with disabilities. The goal of therapy training robots is to help patients recover from different forms of accidents and maladies.

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On the other hand, assistive robots are mainly to support persons with disabilities in activities of daily living (ADL) and professional life. Assistive robots are further classified depending on the type of target users, namely fix manipulation aids, wheelchair-mounted manipulator systems, mobile autonomous and wheelchair navigation platforms, walking assistants and cognitive aids (Grigorescu *et al.,* 2011). Robotic devices can be used by physical therapists in conjunction with traditional physiotherapy methods. These robotic devices would assist the rehabilitation of these patients by assisting to restore bimanual coordination when one hand has been disabled (Lum *et al.,* 1993). A robot may be a good alternative to a physical therapist for the actual hands-on intervention for several reasons:

- An automated exercise machine can consistently apply therapy over long periods of time without tiring.
- The robot's sensors can measure the work performed by the patient and quantify, to an extent perhaps not yet measurable by clinical scales, any recovery of function that may have occurredwhich may be highly motivating for a person to continue with the therapy.
- The robot may be able to engage the patient in types of therapy exercises that a therapist cannot do such as magnifying movement errors to provoke adaptation.
- Robotic technologies are becoming more prevalent for treating neurological conditions in clinical settings.

Common neurological causes of immobility in the adult population include stroke, spinal cord injury (SCI), traumatic brain injury (TBI) and progressive neurological diseases such as multiple sclerosis or Parkinson disease. Neurological injuries and diseases often result in physical impairments that interfere with a person's ability to walk. Loss of walking function often creates dependency on a wheelchair or other restrictive assistive mobility device (Tefertiller *et al.,* 2011).

Robotic aids

Robotic Mobility aids are divided into electric wheelchairs with navigation systems and mobile robots that act as smart, motorized walkers, allowing people with mobility impairments to lean on them to prevent falls and provide stability. The following interventions may also be used in addition to walking practice:

- Cueing of cadence.
- Mechanically assisted gait (via treadmill, automated mechanical Robotic device.
- Joint position biofeedback and virtual reality training.
- Constraint-induced movement therapy with robot assisted training device.

Cognitive aids: Assist people who have dementia, autism or other disorders that affect Communication and physical well-being. These aids typically involves small, pet-like, toy-like, approachable devices that do not physically interact with the patient, but exist primarily to engage the patient in an effective way that promotes personal health, growth and interaction. There has recently been increased interest in using robots as motivational and educational agents during rehabilitation therapy (Machiel H.F and Reinkensmeyer D.J) .

Gait rehabilitation modalities: Different modalities of gait rehabilitation are used in the domain of neurological rehabilitation such as manually assisted over-ground training and manually assisted treadmill training. Studies with neurological patients such as with stroke or incomplete SCI showed that subjects improved their ability to walk on a treadmill and over-ground (Swinnen *et al.,* 2010).

Driven gait orthosis (DGO): Driven gait orthosis training offers a promising treatment option for improvement of walking abilities in children with cerebral palsy. Training has been found effective in improving walking abilities in adult patients with stroke and spinal cord injury (SCI). Recently, robotic-assisted locomotion training has been introduced and found to be a feasible and promising therapeutic option in the paediatric settings (Heim *et al.,* 2009).

Body weight–supported treadmill training (BWSTT): is a task-specific rehabilitation strategy that has been shown to enhance functional locomotion in patients following neurological insult such as stroke and spinal cord injury (SCI). BWSTT is based on practicing a normal physiologic gait pattern, with attention to the ideal kinematic and temporal aspects of gait. To replicate a normal gait pattern, 2 to 3 physical therapists are needed to safely conduct the task-specific training sessions to control or assist with trunk and limb kinematics (Winchester *et al.,* 2005] .Use of robotic locomotor training devices in the rehabilitation setting could potentially augment recovery of ambulation in people following neurological injury by increasing the total duration of training and reducing the labor-intensive assistance provided by physical therapists (Hornby *et al.,*2005).

Roboticlocomotor devices: enable delivery of locomotor training to much larger patient populations. There are a number of robotic locomotor devices used in research and in clinical studies including the Pelvic Assist Manipulator (PAM), the Lokomat, Mechanized Gait Trainer (MGT) operates the patient's limbs in a similar way while strapped into the device, are driven through a stepping pattern by computer controlled robotic actuators. In upper limb stroke rehabilitation, robots are frequently integrated without feed forward execution of a recorded pattern, but by engaging the patients with low impedance interactive games and virtual environments. Upper limb rehabilitation robot i.e telerobots can be used to administer force/motion plans to the impaired limb while maintaining low impedance control. The motion plan is formulated and executed by a human directing the master device, while the slave device drives the impaired limb. A fully realized self-assist apparatus for clinical locomotor rehabilitation would likely entail a multi-joint exoskeleton powering ankle, knee, and hip assistance. Such devices involve complicated multi-degree of freedom motions and would require intricate engineering design and construction (Danek, 2008).

Robotic masks: Assisting facial expressions with robotic technology is a unique problem that require designing of a novel solution. It's unique because assisting facial expressions require either assisting skin movements or muscle actions which is different from assisting limbs or joints forces. Use of robots or robotic technology increases the movement repeatability and also provides additional tools to assess the progress and effectiveness of rehabilitation process. The Robot mask is the non-invasive wearable device which we have developed to realize expression assistance of facial paralyzed patients. It is portable, can be worn unaided, lightweight and standalone with no necessity of additional peripherals. Facial neuromuscular re-education requires isolating muscle contractions and reducing muscle activities of abnormal patterns of movements such as synkinesis. Repeated attempts to smile as much as possible, as a part of the rehabilitation program, can abnormally lengthen the partially or completely paralyzed ipsilateral side smiling muscles. By using the Robot mask and assisting the ipsilateral side according to intention of the patient and at the exact timing, facial nerve palsy can be cured (Jayatilake *et al.,* 2013).

Aids for ADLs: A robotic aid called Handy 1 is a rehabilitation robot designed to enable people with severe disability to gain/regain independence in important daily living activities such as: eating, drinking, washing, shaving, teeth cleaning and applying make-up. Similarly, children with severe physical disabilities are not offered opportunities to develop and exercise their skills of distance judging, creation and spatial awareness. A pre-prototype "Artbox" is being developed to provide persons with disabilities an outlay for their creativity and to help children with physical disabilities to gain and consolidate their skills of spatial and three-dimensional awareness (Topping and Smith, 2002).

Humanoid robots: In recent years, the field of developmental robotics in paediatric rehabilitation has expanded in different directions to improve the activity and participation levels of children with disabilities and their families. Humanoid robots such as dolls and pets are designed to promote social, emotional, communicative, imitative and interactive behaviours in children with cognitive and physical impairments. Autonomous mobile robots in the form of toys aim at engaging children in active play behaviours or learning activities. Robotic-assistive devices are used to improve independence and quality of life of children with severe physical disabilities. Mobile robots may provide assistance in self-feeding; in reaching, grasping and manipulating toys or objects; and in self-mobility (Larin *et al.,* 2012).

Robotic arm orthosis: Various orthotics, ranging from robotic arm orthosis to robot-assisted locomotor trainers have been used for persons with locomotor impairment (Howard, 2013).

Manipulation Aids: Common robots of this type are ADL and vocational manipulation aids and kitchen robots. In the US, the professional vocational assistive robot (ProVAR) is a re-search prototype based initially on a PUMA-260 robot arm mounted on a 1 m transverse overhead track that allows the robot to manipulate objects and operate devices on side shelves and the tabletop, bringing objects (like a drink of water or throat lozenge) to the robot's operator (Krebs *et al*). Robotic rehabilitation therapy can deliver high-dosage and high-intensity training, making it useful for patients with motor disorders caused by stroke or spinal cord disease. The use of robot-assisted therapy for improving motor function in stroke patients as an additional therapeutic intervention in combination with the conventional rehabilitation therapies. The purpose of assistive robots is compensation, whereas therapeutic robots provide task-specific training (Chang W.H and Kim Y.H 2013). Use of the ICARE, an Intelligently Controlled Assistive Rehabilitation Elliptical, as an adjunct to outpatient physical therapy by which balance, walking speed, and endurance was assessed in individuals with diverse medical conditions and the results indicate that the ICARE is a practical training device likely to benefit individuals with limited functional abilities receiving physical therapy (Yeseta, M.C *et al*).

ROVI: Robot for Visually Impaired is a device used to guide visually impaired people to dwell around. The main task of the ROVI will be to guide the blind person who holds the stick attached to robot to a target location along a street without colliding on any obstacles. The robot has three wheels with onboard sensor bank, encoders and batteries. The sensor bank has 9 ultrasonic sensors. The motors are driven by a microcontroller. A basic stamp microcontroller is utilized for programming the ROVI. The ROVI can avoid the obstacle along the path and is able to recalculate and realign its orientation to reach its target. It will also provide instruction to the wheels to return to the original path once the obstacle has been avoided. The feedback signals from the optical encoders attached to the wheels are important to determine the distance travelled by the wheels (Melvin *et al*., 2009). Robotics were incorporated into assistive devices to help the physically challenged accommodate their impairment. Orthotics and prosthetics may be considered as a category of assistive robotics. Rehabilitation robotics encompasses an emerging class of interactive, user-friendly, clinical devices designed to evaluate patients and also deliver therapy. Robots and computers are being harnessed to support and enhance clinician's productivity, thereby facilitating a disabled individual's functional recovery. This development represents a shift from earlier uses of robotics as an assistive technology for the disabled (Krebs *et al*). Various prosthetic systems are available for people with Cerebral Palsy, the applicability of which depends on the specificity of brain area damaged and the person's motor and intellectual abilities. These computer-based systems are based on a simple visual user interface, and often use haptic force feedback. They enable a level of communication which considerably increases the person's autonomy. Hearing aids and other amplification devices for people with hearing problems are another example of prosthetic devices (Kaliouby R and Robinson P).

DISCUSSION

Robot-assisted therapy aids are recent development used especially in the recovery of function of the upper and lower extremities. The therapy uses computer-based instruments with moveable parts which patients can manipulate, allowing them to reach, push or pull in an active, active-assisted or passive setting. With robot-assisted therapies, the patient can perform more intense repetitions and does not require the constant supervision of therapists. Some devices may assist the active movement of an isolated joint, whilst others move multiple segments to perform reaching-like movements. Alterations in therapy may be achieved by altering the force required for movement, decreasing the assistance or increasing the resistance given by the device and by altering the movement amplitude.

Conclusion

Rehabilitation robotics is a dynamic application in the field of rehabilitation and physical therapy. The field can be summarized as the development of robotic therapy devices, smart prostheses, orthoses, functional aids, Mobility aids, cognitive aids and aids for activities of daily living. Rehabilitation robotics is highly motivating field for locomotor disabled as technology developed will directly help people who are limited in major life activities. The field will continue to grow because of the dramatic aging of the populations of industrialized countries that is just beginning.

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