OPEN ACCESS Freely available online

International Journal of Physical Medicine & Rehabilitation

Short Communication

# Effectiveness of Rehabilitation Robotics using Combined Sensors

**Keisuke Kubota[1*], Toshiaki Tsuji[2]**

[1]*Graduate Course of Health and Social Services, Saitama Prefectural University, Saitama, Japan;* [2]*Graduate School of Science and Engineering, Saitama University, Saitama, Japan*

## ABOUT THE STUDY

Robotics system using sensors may be categorized as passive mechanisms, Robotic manipulanda or Robotic exoskeletons. Many studies have demonstrated the effectiveness of rehabilitation using these sensor-based robots. In recent years, various computer technologies have worked together in collaboration in order to obtain better results. The development of sensor-based rehabilitation using machine learning technology can be useful for the accurate evaluation and therapeutic intervention in sensor-based rehabilitation. Thus, sensor-based robotics is evolving into highly accurate and more effective devices. Sensor-based robots could provide better information for building evidence in the rehabilitation field.

### Robotics systems of rehabilitation

Robotics system using sensors may be categorized as passive mechanisms, Robotic manipulanda or Robotic exoskeletons [1]. Some of the devices are introduced below:

### Passive mechanism

The passive mechanism is fitted with a range of sensors and often augmented with a virtual environment in the form of a game-like challenge to guide the patients through the training phase [1]. Through instrumentation such as built-in position sensors and software, the Armeo Spring can be engaged as an input device for the accomplishment of meaningful function tasks that are simulated in a virtual learning environment on a computer screen, with the provision of auditory and visual performance feedback during and after practice [2].

### Robotic manipulanda

The robot manipulanda controls the motion at the end-effector of the robot. These systems have a variety of sensors for the measurement of hand motion and/or interaction forces [1]. A typical end-effector type device is the MIT-MANUS. The MIT-MANUS can move, assist or perturb the movement of a subject's or patient's upper limb and can record motion and mechanical quantities such as the position, velocity, and force applied [3].

### Robotic exoskeletons

These are powered robotic mechanisms that regulate force and motion at the joint space of the subject's limbs [1]. The Locomat is an exoskeleton robot combined with a treadmill and a trunk suspension system to become a body-weight supported passive gait robot [4]. The robot does not require voluntary movement by the patients but can achieve lower limb joint movement during gait with actuators and a treadmill. The ARMin is an upper limb exoskeleton robot that aids the patients to enforce their own movement trajectory for reaching movements, while the robot supports their efforts in order to complete the task [5].

### Other systems

Sensor-based rehabilitation is not limited to systems that are integrated with robots. IMU can be attached to various parts of the body to acquire acceleration information. Nuesch, et al. have reported the RehaGait system, which includes seven IMU and joint angle calculations software, is similar in calculation accuracy to a motion capture system [6]. Moreover, IMU has been applied in combination with other devices. Milosevic, et al. proposed a system of motion tracking systems at home which combined IMU and video-based motion capture systems [7]. Wittmann, et al. developed a system using a therapy game and its assessment-driven target selection algorithm are implemented on the ArmeoSenso systems, a novel; IMU based virtual reality system for the training of upper limb function [8]. Many studies have demonstrated the effectiveness of rehabilitation using these sensor-based robots. On the other hand, effectiveness is limited and depends on the patient's symptoms, amount of training and type of treatments. Therefore, caution is needed in interpreting the results which has also been reported [9]. In recent years, various computer technologies have worked together in collaboration in order to obtain better results.

**Correspondence to:** Dr. Keisuke Kubota, Graduate Course of Health and Social Services, Saitama Prefectural University, Saitama, Japan, Tel: 818043340528; E-mail: 2091006z@spu.ac.jp

**Received:** 21-Dec-2022, Manuscript No. JPMR-22-12701; **Editor assigned:** 24-Dec-2022, PreQC No. JPMR-22- 12701 (PQ); **Reviewed:** 07-Jan-2022, QC No. JPMR-22-12701; **Revised:** 11-Jan-2022, Manuscript No. JPMR-22- 12701(R); **Published:** 18-Jan-2022, DOI: 10.35248/2329-9096-22.10.621.

**Citation:** Kubota K, Tsuji T (2022) Effectiveness of Rehabilitation Robotics using Combined Sensors. Int J Phys Med Rehabil. 10:621.

### The combination of machine learning

Rehabilitation using sensors has shown greater effectiveness in precise measurements and more objective assessment of the patient's progress. Moreover, the quantified sensor information can be connected to the internet to autonomously collect evaluation results [10]. Creating a database of patient's rehabilitation information affords numerous benefits. For example, by creating a database that contains information on various physical functions of patients, similar cases can be searched from the database. Tsuji, et al. proposed a motion matching technique for searching similar cases, which uses position and force information as a feature value [11]. The development of such database-based motion matching technology can be useful for the accurate evaluation and therapeutic intervention in sensor-based rehabilitation. Furthermore, quantified sensor information is combined with machine learning technology. Sekiya, et al. showed that the endpoint of the lower limb using end-effector type robot with a force sensor can estimate lower limb muscle strength with high accuracy from force date obtained from the endpoint of the lower limb [12]. Also, Wang, et al. proposed an algorithm using IMU combined machine learning techniques [13]. This system can estimate kinetic data during gait at knee osteoarthritis patients with data collected from IMU. Essentially, it is necessary to use a motion capture system and force plate to calculate the kinetic data during dynamic tasks but by using machine learning, it could be estimated from the IMU data. In this way, by simultaneously measuring multiple parameters in advance, it is possible to estimate various latent information from only one parameter.

## CONCLUSION

Rehabilitation using sensor-based devices can provide accurate information for patient treatment effectiveness. Also, this technology enables highly accurate autonomous rehabilitation in a variety of situations. Furthermore, recently, with the development of computer technology, sensor information is being combined with machine learning to appropriately handle huge amounts of patient data. Thus, sensor-based robotics is evolving into highly accurate and more effective devices. Sensor-based robots could provide better information for building evidence in the rehabilitation field.

## REFERENCES

1. Zhou SH, Fong J, Crocher V, Tan Y, Oetomo D, Mareels I. Learning control in robot-assisted rehabilitation of motor skills: A review. J Control Decis. 2016;3(1):19-43.
2. Cimolin V, Vagnini A, Germiniasi C, Galli M, Pacifici I, Negri L, et al. The Armeo spring as training tool to improve upper limb functionality in hemiplegic cerebral palsy: A pilot study. Int Forum Res Technol Soc Ind. 2016;16450768.
3. Krebs HI, Hogan N, Aisen ML, Volpe BT. Robot-aided neurorehabilitation. IEEE Trans Rehabil Eng. 1998;6(1):75-87.
4. Colombo G, Wirz M, Dietz V. Driven gait orthosis for improvement of locomotor training in paraplegic patients. Spinal cord. 2001;39(5): 252-255.
5. Mihelj M, Nef T, Riener R. A novel paradigm for patient-cooperative control of upper-limb rehabilitation robots. Adv Robot. 2007;21(8): 843-867.
6. Nüesch C, Roos E, Pagenstert G, Mündermann A. Measuring joint kinematics of treadmill walking and running: Comparison between an inertial sensor based system and a camera-based system. J Biomech. 2017;57:32-38.
7. Milosevic B, Leardini A, Farella E. Kinect and wearable inertial sensors for motor rehabilitation programs at home: State of the art and an experimental comparison. Biomed Eng Online. 2020;19(1): 1-26.
8. Wittmann F, Lambercy O, Gonzenbach RR, van-Raai MA, Höver R, Held J, et.al. Assessment-driven arm therapy at home using an IMU-based virtual reality system. IEEE Int Conf Rehabil Robot. 2015;707-712.
9. Mehrholz J, Platz T, Kugler J, Pohl M. Electromechanical and robot-assisted arm training for improving arm function and activities of daily living after stroke. Stroke. 2009;40(5):e392-e393.
10. Yokoo T, Yamada M, Sakaino S, Abe S, Tsuji T. Development of a physical therapy robot for rehabilitation databases. In 2012 12th IEEE International Workshop on Advanced Motion Control. IEEE. 2012;1-6.
11. Tsuji T, Kaneko T, Sakaino S. Motion matching in rehabilitation databases with force and position information. IEEE Trans Ind Electron. 2015;63(3):1935-1942.
12. Sekiya M, Sakaino S, Toshiaki T. Linear logistic regression for estimation of lower limb muscle activations. IEEE Trans Neural Syst Rehabilitation Eng. 2019;27(3):523-532.
13. Wang C, Chan PP, Lam BM, Wang S, Zhang JH, Chan ZY, et.al . Real-time estimation of knee adduction moment for gait retraining in patients with knee osteoarthritis. IEEE Trans Neural Syst Rehabil Eng. 2020;28(4):888-894.