A Gait and Balance Training System for Patients Suffering from Parkinson’s Disease

Zhaocheng Zhou, Sihui Liu, Mingsong Shi, Ningbo Yu*
College of Artificial Intelligence
Nankai University
Tianjin, China
nyu@nankai.edu.cn

Yang Yu, Jialing Wu*
Department of Neurorehabilitation
Tianjin Huanhu Hospital
Tianjin, China	tjhuanhu@163.com

I. INTRODUCTION

Parkinson’s disease (PD) is a neurodegenerative disease, mainly due to the progressive loss of dopamine. The incidence of PD is rapidly increasing as population aging. Manifested movement symptoms of PD, such as bradykinesia, postural instability, etc., seriously affect the patients’ life quality. Exercise training can promote the release of dopamine, and has proved effective in improving the movement capability of PD patients [1].

II. REQUIREMENTS ANALYSIS

Due to the deterioration of motor learning ability, more sensory information and motor guidance are necessary for PD patients in rehabilitation training [2]. Robot-assisted rehabilitation can provide a lot of repetitive training, which can strengthen the neuronal circuit of lower limb movement and improve the patient’s motor output function [3]. Meanwhile, gait training with oblique perturbation is more effective than on a single plane, which can be reflected in the patient’s walking ability without assistance [4].

We propose a series-parallel hybrid rehabilitation system for training of gait and balance function, as depicted in Fig. 1. It is composed of a linkage mechanism, parallel mechanism, and virtual reality (VR) module.

III. THE LINKAGE MECHANISM FOR WALKING

The linkage mechanism is based on the Chebyshev linkage and parallelogram mechanism. We recorded the walking trajectory of healthy subjects with the Vicon V16 motion capture system. The linkage mechanism was designed in such a way that it can well approximate the recorded walking trajectory. The linkage on the left or right side is driven by a single motor for planar movements, and the two linkages are in line with the phase difference of human walking cycles.

IV. THE PARALLEL MECHANISM FOR BALANCE

The 3-SPR parallel mechanism with two degrees of freedom is rigidly connected to each of the end effectors of the two linkage mechanisms. The length of the branch near the forefoot is fixed. The movable platform can rotate around the sagittal axis and the coronal axis, which can fit the orientation adjustment of the ankle joint.

V. SYSTEM INTEGRATION

This system is required to provide different virtual scenes through the VR module, which can be meaningful specifically for PD patients. For example, a narrow door scene may induce freezing of gait. With the linkage and parallel mechanism, various terrain can be simulated. For mild PD patients, the system will provide more controllable balance disturbance during the gait training with the parallel mechanism.

REFERENCES