

# Gait Enhancement through Illusory Pulling Sensations Induced by Asymmetric Vibrations

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**Abstract**—In this demonstration, we present a gait enhancement system that utilizes illusory pulling sensations induced by asymmetric vibrations. The illusory pulling sensation is a haptic illusion in which asymmetric vibrations applied to the fingertip create the perception of a pulling force. In our previous study, we demonstrated that such sensations can modify ballistic wrist movements. Building on this finding, the proposed system applies the same principle to arm swing during gait. Specifically, the illusion of being pulled in the direction of the arm swing is generated in response to its angular velocity, which is detected by an inertial measurement unit (IMU). This vibrotactile feedback increases the amplitude of the arm swing, potentially enhancing physical movement with minimal perceived effort.

**Index Terms**—Illusory pulling cue, gait, arm swing.

## I. INTRODUCTION

In super-aged societies, extending healthy life expectancy is an important and urgent challenge. Regular physical activity is essential for maintaining health and preventing age-related decline. However, it is often difficult to continue voluntary exercise over the long term. To address this issue, we propose a system that enhances physical movement with a reduced sense of effort by utilizing illusory pulling sensations. Our previous study revealed that when illusory pulling sensation is applied in the direction of ballistic wrist movement, the motion is unconsciously amplified by the user's own muscular effort [1]. At the same time, the subjective sense of effort is reduced. This finding suggests a dissociation between sensory and motor. In this study, we adapt this phenomenon to arm swing during gait. The aim is to increase the amplitude of arm swing with less conscious effort, thereby supporting more effective and sustainable physical activity. In this demonstration, we present a prototype of the proposed system.

## II. DEMONSTRATION

Fig. 1 shows an overview of the prototype system. The system consists of a voice-coil vibrator (639897, Foster Electric Co., Ltd.) and a control box that contains an IMU (MTi-7,

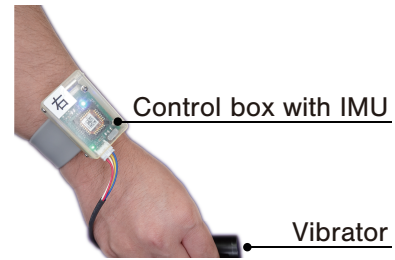


Fig. 1. Overview of prototype system

Movella Inc.), a Li-Po battery (400 mAh, DTP502535, Data Power Technology Ltd.), and a printed circuit board. The angular velocity of the arm swing is measured by the IMU, and a microcontroller (ESP32C3, Seeed Technology Co., Ltd.) with a DAC (AD5664, Analog Devices, Inc.) generates the signal required to induce the illusory pulling sensation.

In the demonstration, the user wears the devices on both arms and performs arm-swinging movements. The demonstration includes two conditions: with and without the illusion, allowing users to experience the perceptual difference. Since the devices are battery-powered, users can move around freely while wearing them.

## ACKNOWLEDGMENT

This work was supported by the JST PRESTO Grant No. JPMJPR24I7, and JSPS KAKENHI Grant No. 24K02969.

## REFERENCES

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