Further Analysis of the R-V Dynamics Illusion on Sense of Weight

Satoshi Hashiguchi, Yuta Kataoka, Fumihisa Shibata, and Asako Kimura

Ritsumeikan University, 1-1-1 Nojihigashi, Kusatsu, Siga 525-8577, Japan

Keywords: Mixed Reality, Sense of Weight, Visual Stimulation, Psychophysical Influence

ABSTRACT

In mixed reality space, we can change appearances of a real object (R) and virtual object (V). In this study, we visually change movements of the real and virtual objects and observe the influences of the virtual object’s dynamics on the sense of the weight of the real object.

1 INTRODUCTION

In the mixed reality (MR) environment, the appearance of touchable objects can be changed by superimposing a computer-generated image (CGI) onto them (we call this “MR visual stimulation”) [1]. Using this specialty of MR technology we have studied the influence between the visual and haptic sensations. For example, we focused on the perception of the center-of-gravity (COG) and examined what could happen when superimposing a virtual object onto a real object which has different COG position. As a result, we confirmed that COG perception can be influenced by superimposed virtual objects, and we named this illusion the “Shape-COG Illusion” [2]. In the experiments of “Shape-COG Illusion,” we only focused on the rigid object for both real and virtual stimulation whose COG position is clear for the subject. However, through the experiments, new question has raised. That is, if real and/or virtual objects are non-rigid (deformable or having movable portion in it), how are they perceived?

In previous study, we firstly focused on a situation in which a virtual object that has movable portion is superimposed on a real rigid object, and confirmed that weight perception can be changed under this condition though the weight of real object is not changed [3].

As the next step, we conducted more detailed experiment to analyze influence of movement of a virtual object. In this paper, we explain this experiment, its results and discussion.

2 PURPOSE AND PREPARATION

2.1 Purpose

The aim of the experiment was to examine the effect of virtual object’s movement, acceleration in particular, of virtual liquid on R-V Dynamics Illusion. In this experiment the objective evaluation and subjective evaluation were conducted separately.

2.2 Experimental Environment

As with the previous experiments [1], we adopted an MR system with a video see-through mechanism that visually merges the real and virtual worlds (Fig. 1). Wearing a head-mounted display (HMD) (VH-2002, Canon Inc.) with a pair of built-in video cameras, the subject viewed the stereoscopic images that are computer-generated images (CGIs) in the scene in front of his/her eyes. Head position and position of real object were constantly tracked within six degrees of freedom (6-DOF) by a magnetic sensor (3SPACE FASTRAK, Polhemus Inc.), which allows the subject to move his/her head freely.

2.4 Real Object

The real rigid object used in the experiment was a plastic case (165 mm width × 90 mm height × 80 mm depth) with the handle (Fig. 2). The weight of the plastic case was adjusted to 750 g, which was the weight of a case filled with water up to the level of 45 mm (50 % of the case height).

2.5 MR Visual Stimulation

The size of virtual object used for MR visual stimulation was the same as the real object (Fig. 3). In the virtual object, water colored virtual liquid was filled. We employed a simplified model that mimics the swaying of the liquid, without a detailed representation such as...
waves or splash (Fig. 4). C is a value affecting the acceleration of the liquid. The viscosity of liquid is...