Experiencing Shape-COG Illusion in Mixed-Reality Space

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ABSTRACT

Mixed reality (MR) is a technology that merges real and virtual worlds in real time. In MR space, visual appearance of a real object can be changed by superimposing a virtual object on it. Because it is well known that the sense of weight can be changed intentionally by providing the appropriate visual stimulation, we believe it has a similar effect in the case of presenting MR visual stimulation. If the behavior and extent of MR visual influence is well investigated, real objects can be differently perceived. In this study, we focus on the center-of-gravity (COG) and verify the influence of MR visual stimulation on the COG in MR environment. In this paper, we conducted experiments to examine the influence of superimposing virtual objects having different COG positions onto real objects. As a result, we confirmed that (1) the presence of COG can be changed by MR visual stimulation; (2) although COG differs in vision and force, the presence of COG can be represented by MR visual stimulation under certain conditions; (3) the influence of MR visual stimulation reduces when positions of COG of a real object and a virtual object are distant; and (4) COG perception can also be changed by varying the mass of the real object in MR space. We named this illusion the "Shape-COG Illusion."

KEYWORDS: Mixed Reality, Center-of-Gravity, Illusion, Psychophysical Influence, Visual Stimulation.

1 INTRODUCTION

This paper describes the influence of visual stimulation on center-of-gravity sense in mixed reality (MR) environment; We conducted experiments to analyze the influence of visual stimulation on COG perception in an MR environment. Specifically, we superimposed virtual objects of different shapes onto real objects having the same mass and volume in order to verify whether COG perception can be changed using MR virtual stimulation. In the experiments, we examined the changing aspect ratios of the virtual object, as well as the mass of the real object.

This study is inspired by the industrial application of MR technology in [1]. This can be summarized as **Fig. 1**. In [2] it is reported that visual stimulation affects tactual sense. Similar to our study, the influence in MR environment is investigated in [3].

2 EXPERIMENTAL ENVIRONMENT

In the following experiments, we adopted an MR system with video see-through mechanism that merges real and virtual worlds visually. Wearing an HMD and touching real objects, the user can see the computer-generated images (CGI) onto the objects with high geometric precision. As the real object used in the experiments, we employed a plastic case with the handle of a real attaché case (**Fig. 2(a)**). As virtual objects used in the experiments, we employed CG models such as the attaché case shown in Fig. 2 (b), which are available in many sizes and shapes.

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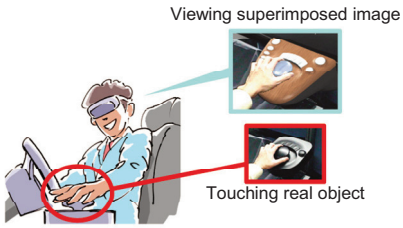

Fig. 1 Mixed reality presentation

(a) In Real space (b) In MR space

Fig. 2 Experimental scene

3 PRELIMINARY EXPERIMENT AND RESULT

In the preliminary experiment, to verify whether COG perception can be changed by superimposing virtual objects on real objects, we superimposed landscape- and portrait-oriented virtual objects onto real objects (Fig. 2(b)). Then, the subjects were asked in which position was the COG farther from their hand. As a result, the COG of real object was perceived in a different place than actual COG position by superimposing virtual objects. Therefore, we considered that COG perception can be influenced by superimposing virtual objects. For the results, we named this illusion the "Shape-COG Illusion."

4 EXPERIMENTS AND RESULTS

In experiment1, virtual objects with different aspect ratios were sequentially superimposed onto the same real object. As a result, the difference in the COG tended to be perceived by changing the aspect ratio of virtual object.

In experiment 2, the same virtual object was superimposed onto the real objects with different mass in order to study the influence of variation in mass. As the result, the perceived COG was changed by changing mass of the real object. Therefore, COG perception can also be changed by varying the mass of the real object in MR space.

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