

# Presenting the sensation of flying with flapping virtual wings independent of the limbs

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Fig. 1. Flying with flapping virtual wings independent of the limbs

**Abstract**—Since ancient times, people have longed to fly in the sky. Actual flying involves risks and costs, but using a VR device makes it easy to experience flight. In this study, we propose a method of presenting the sensation of flying with flapping virtual wings independent of the limbs, such as a flying lizard. Unlike studies that presents the sensation of flapping wings by moving the arms, new applications that use the limbs during the flight experience can be expected by flying without moving the limbs. In this paper, we proposed a method of presenting the sensation of manipulating the wings without using the limbs and a method of transmitting the force acting on the wing to humans. We conducted experiments using these methods and obtained subjective evaluations. From the experiment, it was confirmed that the operation by static muscle contraction is also effective for operationing wings. It was also shown that the tactile presentation using EMS has a higher overall evaluation. Finally, we obtained the result that the body image expansion of the virtual wing which proposed in this study is possible.

## I. INTRODUCTION

Since ancient times, people have longed to fly in the sky. Until today, we have had a flight experience by using vehicles such as airplanes and hang gliders. However, actual flying involves risks such as crashes, costs such as fuel, and the skill to operate the equipment. By using Virtual Reality (VR) system, those risks and costs can be avoided, and makes it easy to experience flight.

Fig. 1 shows how they flying with flapping virtual wings independent of the limbs. In this study, we propose a method of presenting the sensation of flying with flapping virtual wings independent of the limbs as a reature with wings growing from the back of a human, as shown in Figure 1, using a VR system.

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## A. Background and purpose of the study

Many studies have been conducted to give a sensation of "floating" or "flying" using VR devices. Research on the sensation of falling generated by visual stimuli and a proposal for a flight experience device using a body assistance mechanism are examples.

Regarding research that gives a sensation of "flying with flapping", research has been conducted on a device that allows the user to board a large control device and experience a bird in flight. This method has disadvantages such as the need for a large scale device and the limitation of limbs movement.

In addition, there are still few studies on giving the sensation of flying with flapping one's wings. In general, studies on giving the sensation of flying by becoming a bird have been conducted, and studies on giving the sensation of flying by becoming a creature with wings independent of its limbs, such as a flying lizard, have not yet been focused on.

In this study, we propose a method to present the sensation of flying with flapping wings bymanipulating the wings that grow from the back without using limbs movements. By not using limbs movements, it is possible to use hands and feet during the VR flight experience, such as throwing an object while flying, which is expected to expand the range of the VR flight experience.

## II. BODY IMAGE EXPANSION

In this study, two elements are important: to make humans feel "wings" that do not originally exist (existence), and to present the sensation of "flying with flapping with one's wings" (movement). In order to present these sensations, we focus on the expantion of the body image.

### A. body image

Humans have the ability to perceive their own body shape, which is called body image. It allows us to ditinguish between ourselves and others.

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TABLE I  
AN EXAMPLE OF A TABLE

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Three	Four

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Fig. 2. Inductance of oscillation winding on amorphous magnetic core versus DC bias magnetic field

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## VI. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

## APPENDIX

Appendixes should appear before the acknowledgment.

## ACKNOWLEDGMENT

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