MistFlow:

A Fog Display for Visualization of Adaptive Shape-Changing Flow

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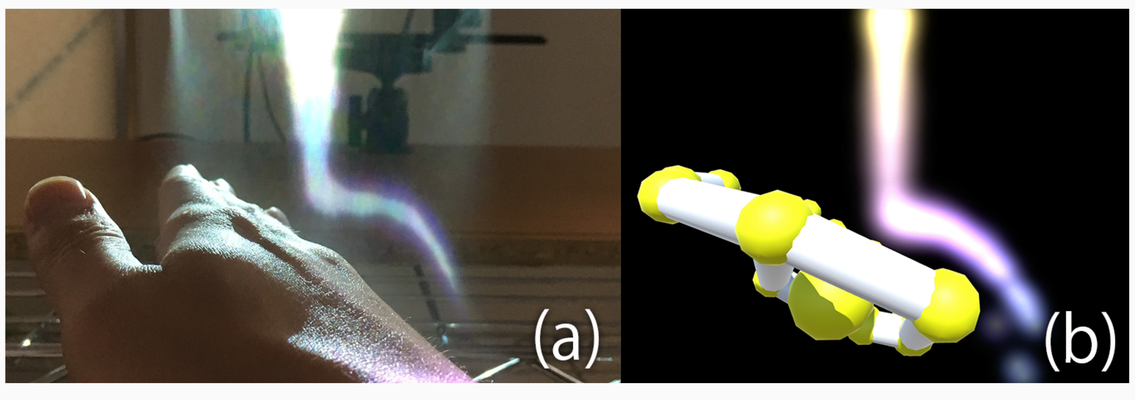
Introduction

Conventional fog displays realized interesting interactions between a touching motion and aerial images, there has not yet been an experiment that explicitly takes advantage of the relationship between the physical flow of the screen and the projected image associated with it.

Mistform [Tokuda et al. 2017] proposed a machine-learning-based method to predict the shape of the fog screen, and enable projection onto the shape-changing screen.

We propose a feed-forward approach to create pseudo-synchronized image contents with the deformation by users. In the proposed method, a sense of natural synchronization between the shape-changing screen and the projected image is provided by using hand gesture detection and a physical simulation of collision between falling particles and user's hands.

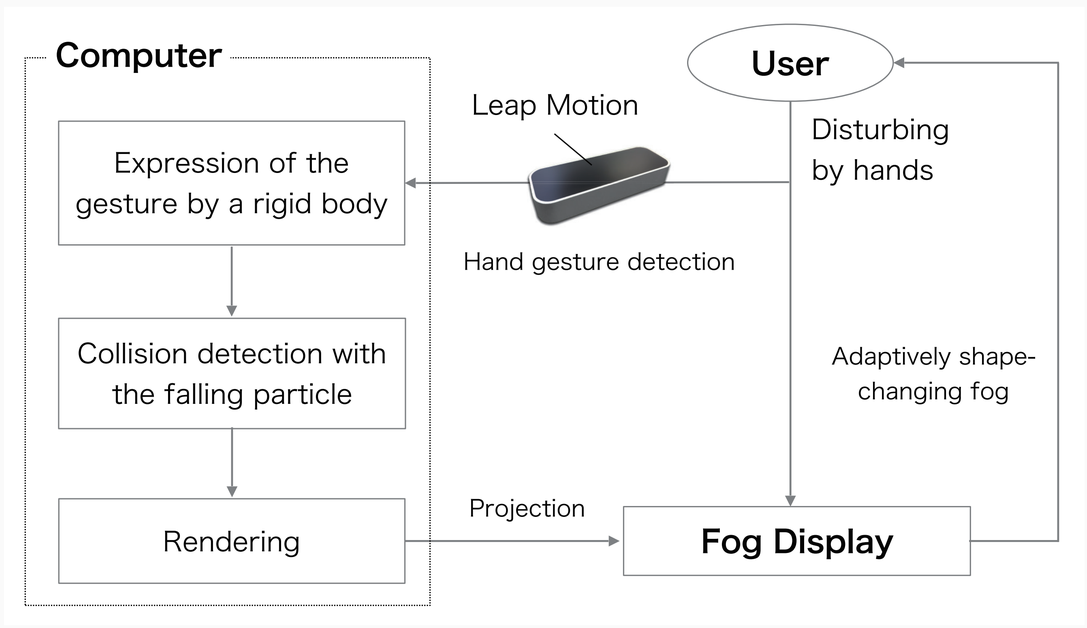


System Overview

The key point of the proposed method is to use a feed-forward calculation approach that approximately simulates the collision between falling particles and a detected user's hand in a virtual world.

Simulation by physical engine
To simulate the shape-changing flow of the fog screen, we implemented a particle system with the physical engine included in Unity. The particle system consists of both Emitter and Particle. Emitter reproduces the position of the nozzle of the fog screen and generates the particles. Particle is a set of small primitive spheres and has physical parameters such as mass, friction, restitution, etc.

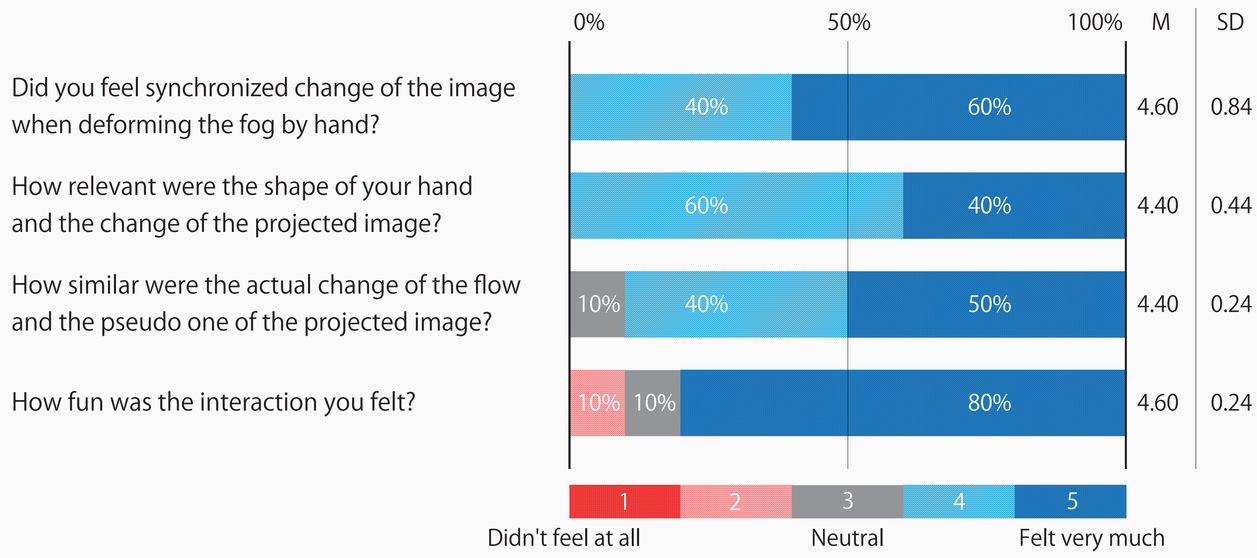
Although the generated particles fall according to a gravitational parameter, they collide in relation to the user's hand shape and bounce back. This is consistent with the deformation of the real fog screen as shown in Figs(a) and (b).



Result of User Study

We conducted a user study with 10 participants (7 males and 3 females, aged fifteen to twenty-five). The participants were instructed to stand in front of the fog display and to see how consistent the flow of the fog screen and that of the projected image were when disturbing the flow by hand.

After that, they were asked to answer to a five-tiered questionnaire and describe their experience in their own words.



The results were positive for all items.
Despite the approximated simulation with the rigid body model, almost all participants felt a sense of natural synchronization between the shape-changing screen and the projected image.

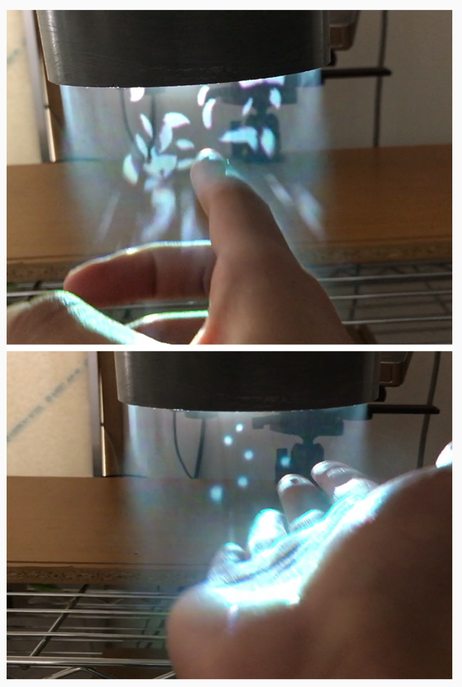
In the free description column, the following comments were obtained.

- We can experience natural interaction easily and intuitively.
- Strictly speaking, it is not accurate physical reproduction of the real flow.
- It was fun to actually touch and play.

Although physically accurate reproduction of the flow was not realized, the approximation produced a natural interaction between the fog screen and users' actions using the feed-forward approach.

Application and future work

We applied the proposed method to interactive arts to verify its effectiveness and applicability. Figure shows cherry petals (i.e. `Hanahubuki') and snowfall, respectively. The users can enjoy changing the behavior of those objects not only by touching and letting them pile up on the palm of their hands, but also by stirring the flow.



Our future work is to synchronize the feel of the flow with the image contents by introducing a precise control of the fog display's blowing flow.