MistFlow:

A Fog Display for Visualization of Adaptively Shape-Changing Flow

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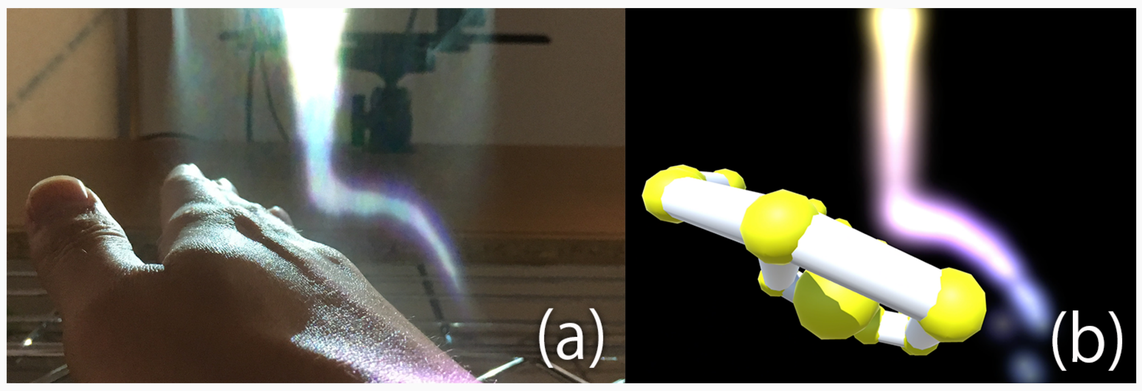
Introduction

Conventional fog displays realized interesting interaction focusing on touching motion to aerial images, there is no expression explicitly taking advantage of the relationship between the physical flow of the screen and a projected image associated with it.

Mistform [Tokuda et al. 2017] proposed to predict the shape of the screen. However, it also does not detect the physically deformed shape of the screen by user's action explicitly.

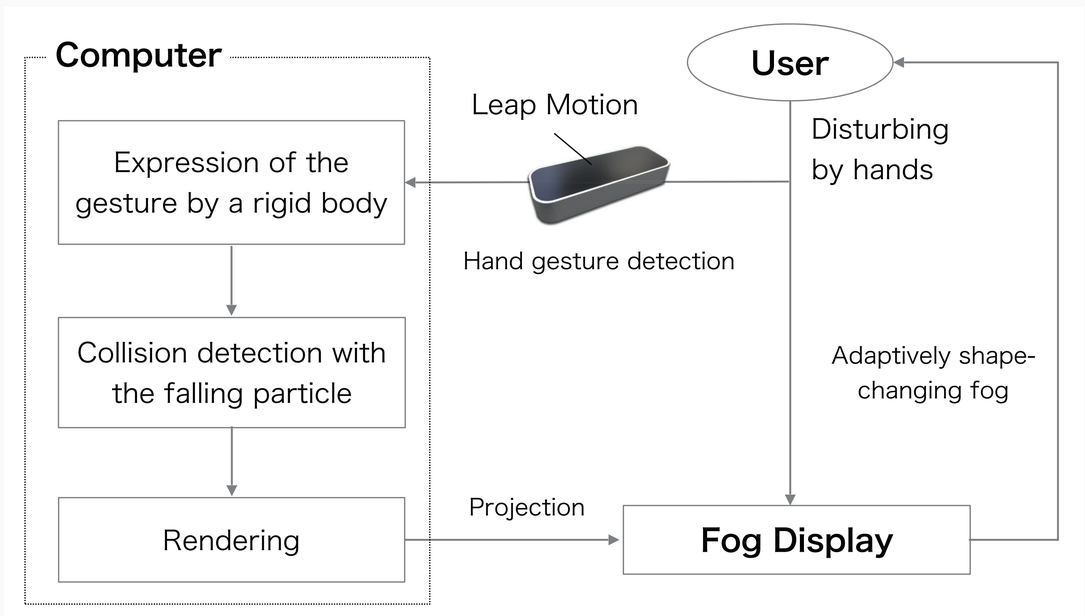
We propose a feed-forward approach to create pseudo-synchronized image contents with the deformation by users. In the proposed method, a sense of natural synchronization between the shape-changing screen and the projected image is provided by using hand gesture detection and a physical simulation of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

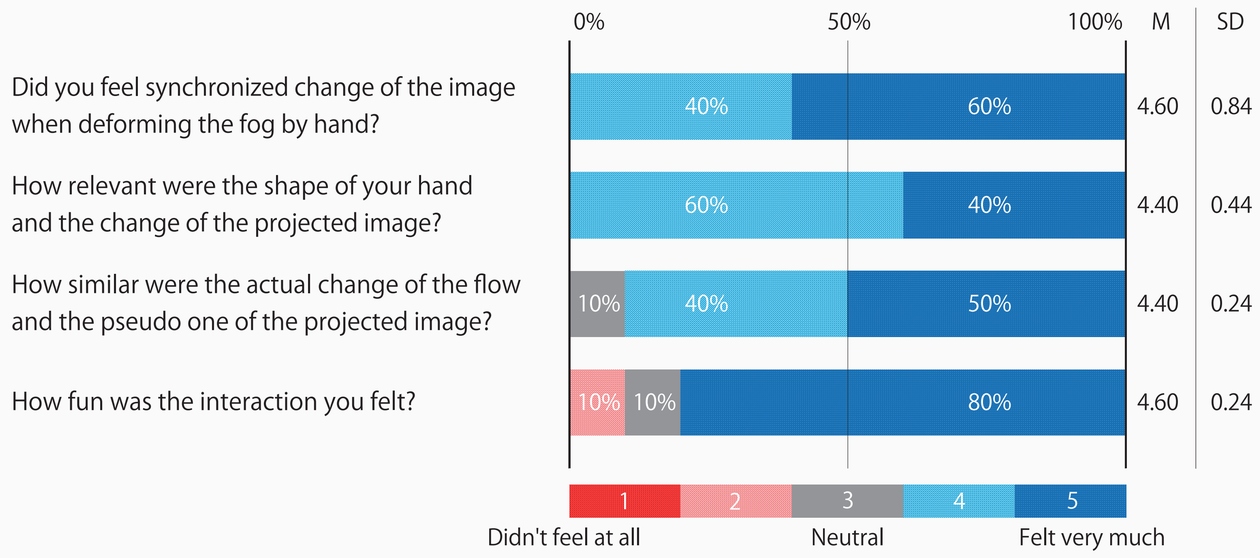
Simulation by physical engine
To simulate the shape-changing flow of the fog screen, we implemented a particle system with the physical engine included in Unity. The particle system consists of both Emitter and Particle. Emitter reproduces the position of the nozzle of the fog screen and generates the particle. Particle is a set of small primitive spheres and has physical parameters such as mass, friction, and restitution, etc.
Although the generated particle falls due to gravity, it collides according to the user's hand shape and bounces back.
This is consistent with the deformation of the real fog screen as shown in above Figs(a) and (b).



Result of User Study

We conducted a user study by 10 participants (7 males and 3 females, ages from teens to twenties). 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 some 5-grade evaluation and to free description.



The results were positive for all items.
Despite the approximated simulation with the rigid body model, almost participants felt a sense of natural synchronization between the shape-changing screen and the projected image.
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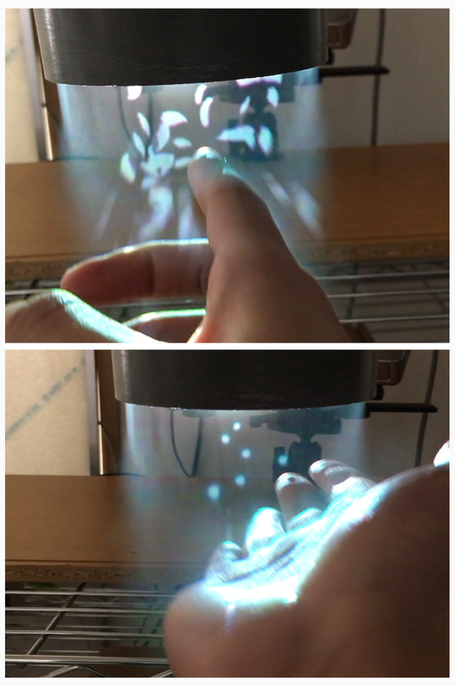
- We can experience natural interaction easily and intuitively.
- Strictly speaking, it is not accurate physical reproduction of the real flow.
- It was fun to actually touch and play.

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 to Interactive Art

We applied the proposed method to interactive arts to verify its effectiveness and applicability. Figures show a shower of 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 but also stirring the flow.



Future work is to synchronize the feel of the flow with the image contents by introducing a precise control of the blowing flow.