Gushed Diffusers: Fast-moving, Floating, and Lightweight Midair Display

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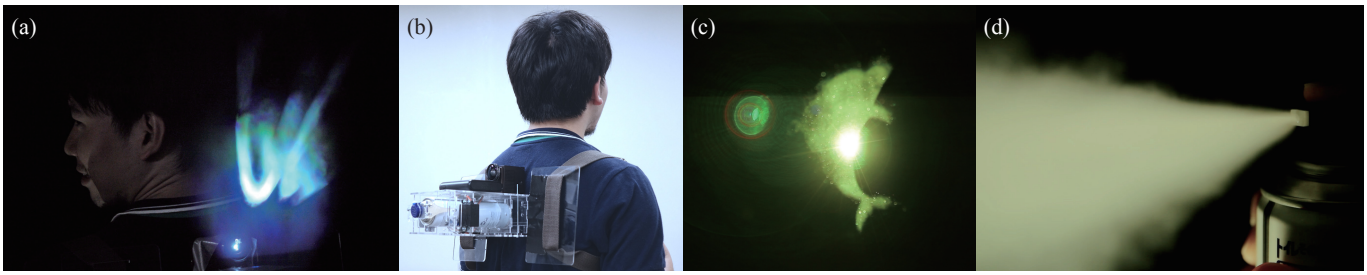

Figure 1. (a)(b) Wearable usage as an application example of our system. (c) Showing a dolphin. (d) We employ aerosol distribution from off-the-shelf spray as a fog screen.

ABSTRACT

We present a novel method for fast-moving aerial imaging using aerosol-based fog screens. Conventional systems of aerial imaging cannot move fast because they need large and heavy setup. In this study, we propose to add new tradeoffs between limited display time and payloads. This system employ aerosol distribution from off-the-shelf spray as a fog screen that can resist the wind, and have high portability. As application examples, we present wearable application and aerial imaging on objects with high speed movements such as a drone, a radio-controlled model car, and performers. We believe that our study contribute to the exploration of new application areas for fog displays and expand expressions of entertainments and interactivity.

Author Keywords

Display; fog screen; multicopter; entertainment; communication.

ACM Classification Keywords

H.5.1. Information Interfaces and Presentation: Multimedia Information Systems

INTRODUCTION

Numerous approaches of midair image-projection have been investigated. In these techniques, the screen is usually filled with small objects of a material that can passively reflect projected or environmental light. The fog screen [2] uses fog generated by fog machine. Han and Perlin [1] use dust-like particles. Tanikawa and Suzuki [3] use falling water drops. These studies aimed to realize large, and long time projection. However, their system can not be installed on drone or wearable usage and used in moving situation because they tend to be large and heavy.

In this paper, we employ aerosol distribution from the off-the-shelf spray as diffusers (Figure 1 (c)(d)). We propose to add new tradeoffs between limited display time and payloads. Using aerosol distribution from spray has two merits.

- Because of its high distribution speed, the system and projected image can be moved, and has high wind-tolerance.
- We enable the whole system to be lightweight and compact because our system consists of several small components.

Furthermore, we present applications that utilize benefits of our aerosol-based display: high refresh rate (approximately raise time 0.5 s, disappearance 0.4 s), small size and lightweight (approximately 600 g all package), high tolerance for wind (approximately 10 m/s).

SYSTEM OVERVIEW

Figure 2 (left) illustrates the overview of our basic setup system and data-flow diagram. This setup includes the off-the-shelf aerosol spray, the laser portable-projector, servomotors for operating the spray, embedded computers, a mirror controlled by the servomotor, a battery, and a frame on which these components are mounted. The minimum weight of whole system is around 600 g (when we use balsa woods for frames). The frames of our display systems were fabricated with a laser cutter. Assembled system of basic setup is shown in Figure 2 (middle). System setup is changed depending on the application.

Aerosol spray: An off-the-shelf aerosol spray which aims at cooling human's body is used as a projection medium in our basic setup. It consists of isopentane (47 ml) and liquefied

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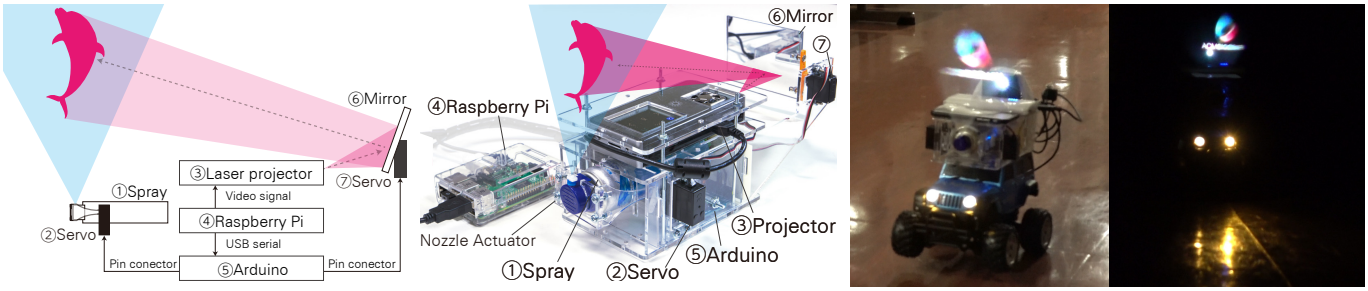

Figure 2. Left: System overview and data-flow diagram. Middle: System appearance of our basic setup (acrylic plates version). These parts were formed with a laser cutter. Right: Application example - a radio-controlled model car with our system.

Figure 3. Floating screen with projection (showing a morpho butterfly) under the drone (DJI Phantom 2; DJI Co., Ltd.).

petroleum gas (LPG). Because these are high-volatility ingredients, they do not remain on surfaces of objects like floors or walls. Many typical off-the-shelf sprays like antiperspirant sprays tend to include many ingredients and additives. Some of these ingredients remain on surfaces of objects and complicate the cleanup after using the system. Because audiences will experience unpleasant sensations in such case, we employ the spray for cooling human's body.

Spray actuator: Two servomotors are used to gush aerosol out automatically with a plate to push the spray nozzle. They are fixed on each side of the spray on the frame. The plate made of acrylic board is designed to push the nozzle down by fitting the form of the nozzle. This part is designed to be removable from the assembled state of whole system. Therefore, we can exchange the spray quickly and easily.

APPLICATIONS

Floating or fast moving midair display: We fabricated a prototype of the application installed on a drone, as shown in Figure 3. The system can be installed on a small drone easily because the weight of our system is around 600 g at the smallest including all components. Drone can compensate for the narrow viewpoint of our system by adjusting angles of display because the drone can move in any direction and rotate in the horizontal plane. If the drone is controlled depending on the position of observers, they can always see an image. Further, we also can install our system on a radio-controlled model car, as shown in Figure 2 (right). We can show an aerial image instantly by using our system. This will attract the attention of the viewers.

Wearable use and user interaction: We present wearable uses of our system as a proof of concept on advantages of the movability and lightweight. For the first example, we present entertainment uses. Our system could be installed on the back of the performer. If we use a conventional fog screen, the performer can not move swiftly, as it cause air movement which can distort the fog screen. A large 2D display may be used as a wearable display, however, it is too heavy to wear the display, and the results will be unsatisfactory. For another wearable example, we can communicate visually with other people using our system. People can project aerial images over their heads and communicate by using these images in the real world with others as shown in Figure 1 (a)(b). In a television program like a quiz-show, people can express their wonder with an overhead exclamation point image that is produced by our system. Conventional similar systems use only sound or fastened screens to express feelings. In contrast, we can send both various visual and audible messages. Therefore, we can evolve styles of communication in the real world.

DISCUSSION

The aerosol may get into a persons eyes or mouth directly depending on the style of use. In addition, the environmental impact of the system should be considered. Another problem regarding safety is that the spray is flammable. If our system is used in a fire scene, the spray could ignite or cause an explosion. Moreover, careful attention should be taken when using the system with real fire of stage effects, such as a flame machine.

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