POSTER:Development of Virtual Goldfish Scooping Using Haptic Device

Ken-ichi Kobori kobori@is.oit.ac.jp
Takanori Hori hori@ggl.is.oit.ac.jp
Norihiro Nakamura nakamura@is.oit.ac.jp
Koji Nishio nishio@is.oit.ac.jp

Osaka Institute of Technology
1-79-1 Kitayama, Hirakata
573-0196,Osaka Japan

ABSTRACT

Goldfish scooping is one of the traditional Japanese play. In general, people scoop goldfish in a shallow water tank using a fragile water-thin dipper. In this paper, we describe virtual goldfish scooping system using haptic device and stereoscopic display.

Keywords

Virtual reality, Haptic device, Stereoscopy, CG

1. Introduction

A virtual reality technology has been in the spotlight, because the capability for processing three-dimensional CG has been increasing in recent years. Many studies in which traditional Japanese culture is realized in a virtual environment have been proposed [Ter01a], [Oka01a]. We took notice of goldfish scooping. It is one of the traditional amusement in summer festival. We have developed virtual goldfish scooping system to evaluate the difference between real goldfish scooping and virtual goldfish scooping. The sense of touch and real time display are very important to achieve virtual goldfish scooping system. A haptic device is used to get the sense of touch. We use a stereoscopic display to represent three dimensional objects such as goldfishes. In addition, we achieve natural motion of goldfishes by using the method of crowd animation [Kay01a].

2. Virtual goldfish Scooping

2.1 System configuration

The system consists of three hardware components, a three dimensional input device PHANTOM[Sen01a] made by SensAble Technologies, a Intel Xeon 2.4GHz×2, and a 17inches stereoscopic display. Figure 1 shows our system.

Figure 1: Setup of virtual goldfish scooping

2.2 Motion of goldfish

Each goldfish object has a circle area called personal space to avoid other fishes or obstructions when they approach. The position of a goldfish is the center point of its personal space as shown in Figure 2.

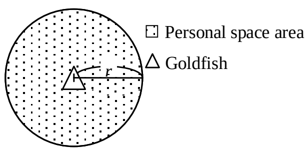


Figure 2: Personal space

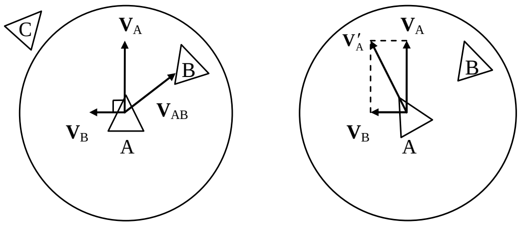
A goldfish avoids other fishes or obstructions using an avoidance vector as shown in Figure 3 when they break into its personal space area . First, goldfish 'A 'checks whether other fishes exist inside of the personal space of 'A' or not. Fish 'B' is an invader in Figure 3. Next, we calculate affect vector $\mathbf{V}_B$ that 'B' has influence on 'A'. The direction of affect vector $\mathbf{V}_B$ is perpendicular to $\mathbf{V}_A$ which is a velocity of gold fish 'A' when 'B' exists on the right side of 'A' shown in Figure 3(a). The length of $\mathbf{V}_B$ is given by equation (1). As the distance between 'A' and 'B' becomes short, the magnitude of $\mathbf{V}_B$ grows large. As a result, 'B' has big influence on the way of 'A'.

$$|\mathbf{V}_B| = |\mathbf{V}_A|(1-(|\mathbf{V}_{AB}|/r)) \quad (1)$$

$\mathbf{V}_{AB}$: Vector from position 'A' to 'B'

r:Radius of personal space

Composite vector $\mathbf{V}_A$' is calculated shown in Figure 3(b). Fish 'A' turns in the direction of $\mathbf{V}_A$'.



(a) (b)

Figure 3: Generation of avoidance vector

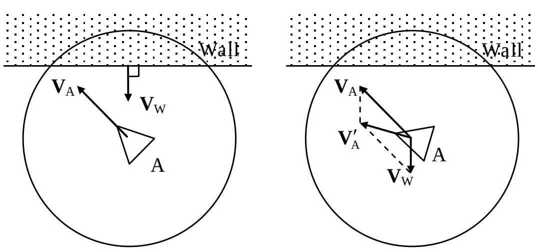
This process is also applied in the case that a fragile water-thin dipper invades the inside of the personal space area.

When fish 'A' gets close to a wall of the tank , affect vector $\mathbf{V}_W$ perpendicular to the wall is generated as shown in Figure 4(a). The length of $\mathbf{V}_W$ is given by equation (2).

$$|\mathbf{V}_W| = |\mathbf{V}_A|(1-(dist/r)) \quad (2)$$

dist : Distance between fish 'A' and the wall

Avoidance vector $\mathbf{V}_A$' is calculated shown in Figure 4(b).



(a) (b)

Figure 4: Affect vector V_W from the wall

2.3 Thin dipper

The thin dipper breaks easily because it is made of thin paper. We achieve this process that the paper of thin dipper breaks using the following two factors.

1) The damage that thin dipper sustains under the water.

2) The damage that thin dipper sustains when goldfish is caught.

The thin dipper has the power of endurance and the power reduces according to these damages. The paper of the dipper breaks when its power runs out.

2.3.1 The damage that thin dipper sustains under the water

The damage D_W under the water is given by equation (3)

$$D_W = s_w(\mathbf{V}_S \cdot \mathbf{V}_N) \quad (3)$$

where $\mathbf{V}_S$ is a velocity of the dipper and $\mathbf{V}_N$ is normal vector of the dipper shown in Figure 5. s_w is a damage coefficient under the water.

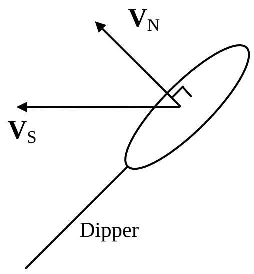


Figure 5: Relation between $\mathbf{V}_S$ and $\mathbf{V}_N$

2.3.2 The damage in catching goldfish

The damage depends on the position on the dipper where goldfish is caught by. The damage is biggest when the fish is caught on the center of the dipper.

The damage D_S is given by equation (4)

$$D_S = s_k(1-(len/r)) \quad (4)$$

Where s_k is a damage coefficient in catching goldfish and *r* is the radius of the dipper. *len* is the length between the center of the dipper and the position of the caught fish shown in Figure 6.

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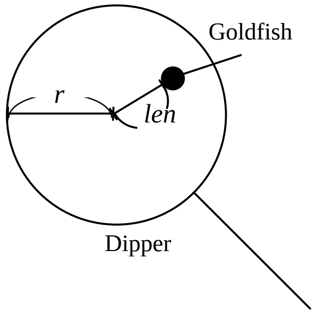

Figure 6: Position of goldfish on the dipper

2.4 Sense of touch

We have achieved the following the touch of sense.

1) Water resistance

2) Sense of touch when a goldfish is caught

2.4.1 Water resistance

Water resistance is caused when we move the dipper under the water. Water resistance F[N] is given by equation (5)

$$\mathbf{F} = k\left(\frac{\mathbf{V}_S \cdot \mathbf{V}_N}{|\mathbf{V}_S||\mathbf{V}_N|}\right)\overline{\mathbf{V}}_S \qquad (5)$$

where k is water resistance coefficient and is set to 0.3 in this experiment. $\overline{\mathbf{V}}_S$ is the opposite vector of velocity of dipper. Water resistance depends on an inclination of the dipper under the water.

2.4.2 Sense of touch when goldfish is caught

The caught goldfish jumps up and down on the dipper. The arm of PHNTOM vibrates up and down to achieve the feeling of jumping fish. The force F_y is given by equation (6)

$$\mathbf{F}_y = a\sin(t \times x) \qquad (6)$$

where a is amplitude of vibration and x is the number of vibration. t is the elapsed time after a fish is caught. The value of a and x depend on the size of a goldfish. The amplitude of vibration is in proportion to the size of a goldfish and the number of vibration is in inverse proportion to it.

2.5 Animation of goldfish

Sight information is important to improve reality of the motion. A goldfish swims while bending the body. In order to realize animation of goldfish, the system displays five images shown in Figure 7 from the left to the right in turn.

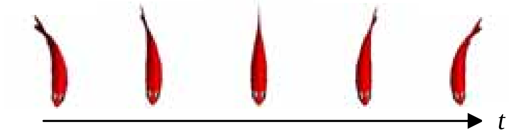

Figure 7: Five images to animate goldfish

2.6 Execution of the system

Figure 8 shows an example of CG image on the screen. The portion of paper is broken because of the damage from water.

Figure 8: Screen image of the system (without stereoscopy)

3. Experimental results

We experimented on a subjective judgment to verify the following 6 items of the system and evaluated these items by five grades (5: excellent,….,1: poor). In the subjective judgment, total average score for 13 test subjects was 4.3.

Evaluation items and the average score are as follows;

1) Motion of goldfish: 4.7

2) Handling feeling of the dipper under the water: 4.4

3) Sense of touch when goldfish is caught: 4.1

4) Realty of breaking paper dipper: 3.5

5) CG image quality by stereoscopic display: 4.3

6) Performance of real-time: 4.8

Generally, each score is high. However, the score in item 4) is slightly low. Several test subjects reported that they could not recognize when the paper of the

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dipper tore. Figure 9 shows the state of the experiment.

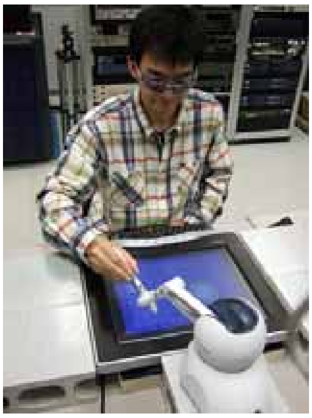

Figure 9: Experimental picture

4. Conclusions and future work

We proposed virtual goldfish scooping system using haptic device and stereoscopic display. Experimental results show that proposed system is same as the real goldfish scooping as for the sense of touch and reality of the goldfish. The score of item 4) is lower than the total score. We intend to improve the process of breaking paper dipper. We are also working on the improvement in representation of thin paper of dipper to imitate to real dipper.

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