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Abstract. In this paper, we present an underwater exploration game called Wave Touch, designed specifically for a category of devices known as, interactive tabletops. The game provides users with a fun way to learn about important historical artifacts. An emphasis is placed on making Wave Touch entertaining to the user, a goal which is satisfied through the use of interactive tabletops and realistic water simulation. We also present the techniques we used to enable real-time water simulation effects in the game.

Keywords: tabletop, water simulation, educational entertainment, multi-touch

1 Introduction

As a way of demonstrating the powerful potential of interactive tabletops for the entertainment domain, we developed an educational game called Wave Touch. Briefly, Wave Touch teaches players about significant historical artifacts pertaining to Korean culture. We also incorporated realistic water simulation effects to provide an exciting dynamic to the game environment. This captivating visual feedback mechanism can also serve to increase user enjoyment while playing Wave Touch.

Many researchers have dealt with tabletop technologies for entertainment purposes. In [1], Kaltenbrunner et al. presented reacTable, a tangible interface on an interactive tabletop, for musical performances. Tse et al. demonstrated a multimodal interface using a combination of hand gestures and verbal utterances for playing games on tabletops [2]. In [3], Gross et al. designed and evaluated a multi-touch tabletop interface, which supports cooperative and competitive gaming.

These days, a few researchers have shown interest in real-time fluid simulation. Bridson et al. [4] presents the curl-noise method for procedural fluid flow and added interesting fluid motions by using simple vector calculus. Thurey et al. [5] presents a new method for enhancing water simulations using overturning waves. This method can simulate large bodies of water in real-time. Yuksel et al. [6] introduces a novel method for real-time simulation of fluid surface waves. This method is very simple, fast, and unconditionally stable. It can simulate large bodies of water in real-time.

2 Interactive Tabletop

One of the most crucial elements for interactive tabletops is the touch sensing technology, particularly multi-touch, because they usually don't provide any peripheral devices for interaction (e.g. mice, keyboards). Interactions involving touch gestures tend to provides for a visceral user experience. Users feel much more engaged with the interface and derive more enjoyment out of the experience than with other conventional devices. There are a myriad of possible approaches for multi-touch detection, the two more well known approaches are capacitive [7] and optical-based [8]. We have developed novel optical multi-touch sensor to apply to Wave Touch.

3 Water Simulation

The Saint-Venant equations are a generalized version of the N-S equations. These equations reduce the problem of a 3D fluid motion to a 2D description with a height-field representation. The conservative Saint-Venant equations can be written as

$$\frac{\partial h}{\partial t} + \frac{\partial hu}{\partial x} + \frac{\partial hv}{\partial y} + \nabla \cdot (hU) = 0 \qquad \frac{\partial hu}{\partial t} + \frac{\partial hu^2}{\partial x} + \frac{\partial huv}{\partial y} = -\frac{\partial}{\partial x}\left(g\frac{h^2}{2}\right) \qquad \frac{\partial hv}{\partial t} + \frac{\partial huv}{\partial x} + \frac{\partial hv^2}{\partial y} = -\frac{\partial}{\partial y}\left(g\frac{h^2}{2}\right)$$

Where h is the height of the fluid above zero-level, U is the velocity of the fluid in the horizontal plane, u and v is each component of the velocity of the fluid U, and g is gravity. The Saint-Venant equations are commonly solved using the CPU, but solving the Saint-Venant equations on the CPU is very slow and not suitable for real-time applications. Therefore, we solve these equations using graphics hardware instead of the CPU, which significantly improves simulation performance and allows simulation to be performed on high resolution grids in real-time.

4 Wave Touch Game

The main goal of Wave Touch is to search and find hidden treasures (Fig. 2a) that are scattered throughout the underwater environment. As users navigate throughout the environment, these treasures will appear and disappear randomly. When a user finds and selects a treasure item, the game will pause momentarily and an information panel (Fig. 2b) will appear about that treasure. Each treasure found will award the user with a certain number of points. The game ends when all treasures have been found, and the player with the most points will win.

(a) (b) (c) (d)

Fig. 2. (a) Treasures (b) Information Panel (c) Multi-touch Interaction (d) Zoom-out gesture

Since Wave Touch is played on an interactive tabletop, players play the game by directly touching the tabletop interface. Navigation throughout the game environment is accomplished by using various single touch and multi touch gestures. The game world is presented in 2 dimensions so navigation consists of panning an overhead point-of-view or zooming in or out. To shift the point-of-view location, the player needs to swipe a finger across the interface. The scene will then move in that direction. To zoom in or out of the environment, the player needs to use a multi-touch pinch gesture, which entails bringing two contact points apart or together (Fig. 2d), respectively. When a player locates a treasure, they should directly touch that treasure on the screen in order to capture it.

5 Conclusion

We explored interactive tabletop technology and water simulation effects, particularly in regard to their contributive effects for entertainment related applications. A Series of user evaluation show that interactive tabletops are powerful devices for the entertainment domain due to the unique interaction modalities that are possible and the social nature of the device. Additionally, realistic water simulation effects provide applications with a type of visual feedback that is exciting and captivating, which can also improve user enjoyment.

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