Vis-a-Vis: A physical user interface for mobile games

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Abstract
We describe the design and implementation of a novel physical user interface for a first-person perspective computer game in which a small tablet style personal computer and 3-axis orientation sensor is used to control the point of view within the game. By holding the tablet computer out in front of oneself, as if it were a window through which the game action can be observed, players are able to physically move their bodies in a full 360 degree circle in order to observe the entire game scene. We also describe an electronic version of the children's playground game, "Red Light, Green Light, Go!" which we designed specifically for this interface. Through this game and the interface, the project is designed to investigate the role that physical body movement can play in the design of new forms of electronic gaming.

Categories and Subject Descriptors
H5.2. User interfaces (input devices and strategies).

Keywords
3D gestures, spatial interaction, physical gaming, video games, game design, user interface.

General Terms
Experimentation, Human Factors

1. INTRODUCTION
Vis-à-Vis is a technical framework for experimenting with physical body movements to control the point of view in a first-person perspective computer game. The framework uses a TabletPC, held in the player's outstretched arms, to display the point of view one would normally see while playing a computer game. As the device is configured with a three-axis orientation sensor and digital compass, turning (yaw) or tilting (pitch) the TabletPC changes the player's point of view. The interface corresponds to sliding a computer mouse or tapping keyboard keys to change the point of view in a traditional game interface.

1.1 Technology design
The Vis-à-Vis prototype uses the Honeywell Magnetic Sensor Products' TruePoint sensor module.[3] The TruePoint measures roll, pitch and yaw angles using a combination of magnetic sensors and a three axis accelerometer. The device streams data over a conventional serial port interface. This serial interface is connected to a custom driver developed for the project. The driver is embedded within the game engine so that perspective changing interface action is mapped to the panning and tilting action of the sensor.

For our usage scenarios we used a Motion Computing LS800 TabletPC, chosen for its bright outdoor viewable display, small size and suitable processing and graphics rendering capabilities. We made a simple rig for mounting the TruePoint device to the back of the Motion Computing platform so that sensor readings corresponded to the panning and tilting movement of the TabletPC.

The game was designed using the Torque 3D Game Engine.[2] This engine provides an "available source" license which makes it suitable for modifying, including changing the conventional mouse and keyboard-based user input. We made modifications to the user interface code to read the sensor data from the TruePoint sensor.

1.2 The game
We designed and implemented a variation of the children's game "Red Light, Green Light, Go!" This game pits a player, who assume the role of a "traffic cop", against a phalanx of competing players who must respond to the traffic cop's instructions to either go (green light) or stop (red light.) The objective for the competing players is to be the first to tag the traffic cop player. The objective for the traffic cop player is to avoid being tagged for as long as possible by calling the opposing players "out" if they do not immediately obey the instruction to "stop." One by one, the competing players are called out and the traffic cop player yells the commands in as rapid a sequence as possible so as to "trip up" the other players and catch them making a false move.

Our implementation of the game makes a few variations to the one described above. In order to investigate the unique interface design's ability to explore the game world by panning, the opposing players are arrayed in a circle around the traffic cop. This provides an opportunity for the traffic cop to turn in a full-circle, panning with the tablet in their arms, to see the opposing players. Another variation is that we made all of the opposing players AI "bots" except for one. This one player is controlled by a human who manipulates the avatar through a network connected PC. The game has five bots, one of which is a human. The traffic cop player uses the Vis-à-Vis device, trying to identify which of the bots is actually controlled by the human player by noticing subtle distinctively "human" variations in the movement. In this way, the game is a kind of reverse Turing Test, forcing the traffic cop to figure out who is really a threat and who is not. The traffic cop player issues voice commands, either “red light”, “green light” or a number for the player they want to call “out.” The system uses a speech recognition application so that the AI "bots" "hear" the commands simultaneous with the real human player.

Each of the approaching bots are numbered. The traffic cop calls out which numbered bot they'd like to knock out of the game.

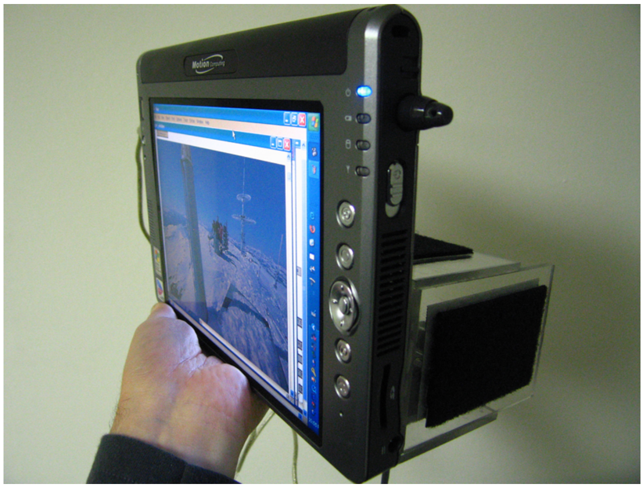

Figure 1. The TabletPC with the sensor rig mounted behind.

When a bot's number is called, the bot is spectacularly destroyed. The traffic cop has three guesses to determine which bot is the human. The game is networked so that the human player is able to play using their own screen, thus eliminating any cheating by the traffic cop player.

With access to the Torque game engine source code, we were able to make modifications so that the conventional mouse or joystick interface code used to change the first-person perspective was controlled by the TruePoint device. Thus, panning the TabletPC in the azimuth, or horizontal plane moved the first-person perspective left and right. Tilting the device in the vertical plane moved the first-person perspective up and down. (For this prototype, roll was not used to change any aspect of the first-person perspective.)

1.3 Creative motivation

This project is motivated by two creative issues. The first is to explore computer-user interfaces that more fully enable the use of the player's body movement. The second is experimentation with new kinds of game mechanics that draw more directly from traditional children's playground games.

The computer-user interface has remained largely fixed with the keyboard and mouse as the dominant input devices. Over time various other input devices have been developed, largely for specific usage scenarios. (3D mouse, speech recognition, visual motion tracking.) It is logical to consider the possibilities for broadening the user interface in the sense of including additional degrees of sensing beyond planar movement (the computer mouse) and state change (tactile keyboard buttons). First-person perspective games provide a natural framework for experimenting with tracking simple body movement and assigning that movement to the player's in-game avatar.

The use of computer games as a platform is well-suited to this experiment. Games are a variant form of computation where the expectations the user has for the activity and the way they engage that activity is open to exploration and new concepts. In computer or electronic games, these expectations for the kind of computing activity one engages has much more flexibility than traditional notions of desktop computing. The most prevalent understanding of computing is defined by the canonical user interface, which is based on issuing commands to the computer. These commands are rigid in their classification, and the "windowed" user interface is largely a facade around systems of software that poll for a command, execute the command, then wait for a subsequent command. The keyboard and mouse are the baseline interface for computing in this regard. Any new interface device only changes the style of the interaction, not the kind of computing. Exploring how gestures such as the one described here can be used for computing activity necessitates exploring other kinds of computing activities where these gestures are more resonant. These gestures are more resonant with games, particularly playground games, where body movement is integral to the activity.

Figure 2. An illustration of the basic game mechanic configuration.

2. RELATED WORK

The recent emergence of a variety of computer-human interfaces that employ tilt sensors, accelerometers, gyroscopes and proximity sensing offers new opportunities for considering how we interact with our devices. It is important to recall that this popularity is driven by a convergence of a variety factors, including diminishing costs for the technology. Early devices that used 3D motion sensing and broader movement gestures anticipated the possibility for the sort of user interfaces the Nintendo Wii and similar electronic games have made popular.

For example, Hinckley, et. al. reviews a variety of the human perceptual and ergonomic design issues that arise when designing computer interfaces that make use of 3D space.[7] Marrin describe some important early instances of how 3D space and gesture could be used for a unique interface for sensing the gestures of an orchestra conductor to control aspects of musical performance.[9] The device described prompted the researchers to

Figure 3. Split screen showing the traffic cop player on the left, the "human" player on the right, and the game view as seen by both. The game shows a vista with two of the five opposing players in the distance.

consider the more general purpose possibilities of sensing gestures and using the sensed movement for other usage scenarios.

Bolt's early work investigating arm gestures and voice response as command inputs to graphics display systems is pertinent.[6] Gesture and voice response are the two primary modes of input in the Vis-à-Vis system, although Bolt's primary interface setting was decidedly recumbent. Our system attempts to enforce engagement viscerally — the player is intended to stand or run in future versions, rather than sitting down.

Hinckley et. al. describes an experiment for measuring a variety of gestures one might find in typical interactions with a mobile device.[8] This research is important for its broad contributions to the consideration of gesture, particularly its multi-modal (tilt, direction, touch-sensing) and its consideration as to how contextual clues can be used for mobile device user interfaces.

The challenges remain for gesture input, particularly around how gesture fits into the "desktop computer" notion of what computation is, or can become. Recently, gesture as a computational interface has found some acceptance within the electronic game user interface. Payne et. al. provided a description of a platform developed to test how 3D gestures affect usability and "fun" for video game user interfaces.[10] We will briefly mention a few video game user interfaces that have informed the current project.

2.1 Warioware: Twisted

Warioware: Twisted is a game for the Nintendo Game Boy Advance. The Warioware: Twisted game cartridge includes a built in tilt sensor. The game uses the sensor in a variety of small, quick dexterity challenges wherein the player must physically tilt the game device in order to control certain aspects of the game. For instance, in one challenge, the player must help a cat walk across a tricky balance, or control a search light beam hunting for an escaping crook. These games are relevant in this context because they couple intuitive motion with an integral component of the game play.[4]

2.2 Nintendo Wii

The Nintendo Wii is one of the most popular examples of how broad-based body movement extends the conventional perception as to what a game user interface can be. The Wii's sensor is embedded in a hand-held game controller. The sensor uses a 3-axis accelerometer and IR sensor to measure motion, using an infra-red light reference to calibrate the motion relative to a fixed source.[5]

2.3 MobZombies

MobZombies is an electronic game played on a mobile computer, such as a mobile phone, that includes a sensor designed track the players translational and rotational movement.[1] The game display shows the player's avatar in the center of the screen. Attacking zombies chase the player's avatar and attempt to convert the player into a zombie. To avoid the zombies and survive, the player must physically move so that their avatar moves. Movement includes running forward and turning. This avoidance scenario forces the player to run serpentine in a suitably large and open space, such as a playground, while observing their current situation on the mobile computer. The game can be tuned to control the degree of physical movement required, but it is often quite broad, requiring the floor space of one or more hundred square meters. The player also has access to zombie bombs. One game strategy is to lure zombies to a central location and detonate one of the bombs. Occasionally, health packs appear. The player must navigate carefully to grab one and power up.

3. FUTURE DIRECTIONS

Through a number of experiments and informal user trials, we found that the interface design was compelling for users. It suggested a number of game design scenarios, including ones in which location, as derived by GPS, could play an integral part in a location-based electronic game design.

Advancing the game user interfaces is one avenue toward expanding game play and game genres. This project presents a relatively simple extension by coupling a relatively straightforward coupling of turning one's body to turning the point of view in the game world.

We see this experiment as an early indication of new ways in which games may be played. As the popularity of physical activity coupled with games increases — for example, Nameco's Dance Dance Revolution — the idea of a portable or mobile game that is similarly physical seems increasingly likely to occur.

4. ACKNOWLEDGMENTS

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