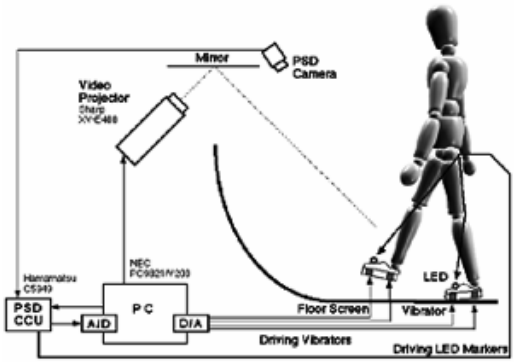
Projects of Akihiko SHIRAI

Fantastic Phantom Slipper [1997-1998]

The first project of the "Interactive Floors" series. Most virtual reality systems use upper body parts, such as eyes, ears, arms and hands, for the interactions, and much information is concentrated into them. This situation is caused by some restrictions of current interface devices. People should be able to move and act freely in virtual environments as they do in the real world. People usually move with their legs and feet in the real world. We believe that they should be able to move freely with their legs and feet in virtual worlds.

From this viewpoint, we have developed a multimodal interface using human feet. Feet movements of the users are measured by a real-time optical motion capture system. The feedback information is transmitted to the users through tactile sensation on the feet, namely to the soles. These functions are realized by specially developed slippers. The only device the user should wear is a pair of slippers, and he/she can move and act freely. Since we are accustomed to wear shoes, wearing such slippers, do not cause psychological/physical discomforts. Utilizing key technologies we developed, we constructed an interactive amusement system using a foot interface, the "Fantastic Phantom Slipper".



[Fantastic Phantom Slipper]

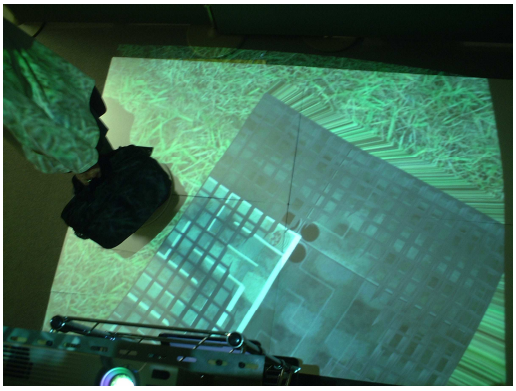
The system has been realized with a real-time optical motion capture system using PSD and Infrared-LEDs. In the system, two LEDs are fixed on each slipper. The locations and directions of slippers on the floor are measured in real-time. Since feet are usually on the floor, two dimensional measurement is sufficient for this application.

The another key technology is the "Phantom Sensation", a special psychophysical phenomenon on human skin. When two mechanical stimuli of the same intensity are applied to different locations of skin surface with appropriate spacing, the two stimuli are fused and one sensation is perceived. When the intensity of one stimulus increases, the location of fused sensation shifts to the location of stronger stimulus. This psychophysical phenomenon has been known as phantom sensation, which was found by Bekesy, a Novel Prize Winner in 1961. This project was realized before the rumblepad of game controllers.

When people walk, various kinds of information, such as pressure, ruggedness and inclination of floors, are perceived through the skin sensations of their soles. We employ phantom sensation to transmit such kinds of information. In order to elicit phantom sensation, we use tiny vibration motors. The vibrators are set in the sole of the slippers. Two vibrators are set in each sole. Fused sensation can be moved two-dimensionally around the feet, by controlling the intensities of the four vibrators appropriately.

Fantastic Phantom Slipper is shown at VRSJ'97 (Virtual Reality Annual Conference in Japan) and SIGGRAPH'98 Enhanced Reality.

"the Labyrinth Walker": A step-in-place interface for walktrough VR[2002-2003]



[the Labyrinth Walker]

"The Labyrinth Walker" is the second project of the "Interactive Floors" series. It is a demonstration system to explain a new hardware that can detect user's stomps with four pressure sensors. The system also has a motor under the device for rotating the user to keep facing to the front. When the user steps, the sensors detect the direction by estimating the center of gravity between the steps, after which the motor corrects the orientation automatically.

In this project, I used a simple physics graphics engine to create an infinite maze to be explored by users' foot steps. There is nothing to equip the users with. Just walking enables them to explore the world freely. It was demonstrated at SIGGRAPH2002 Emerging Technologies. And some museums had interest to apply this system to their exhibitions.

"Tangible Playroom" [2001-2003]

[Tangible Playroom]

Tangible Playroom is the third project of the "Interactive Floors" and also my doctoral theme. It was designed as a future entertainment system for infancy children. It can provide some Virtual Reality contents with a safe force feedback and a large floor image with realistic interactions thanks to a real-time physics engine. Players can interact with the world's contents using full body interaction. The player grasps a tangible (graspable, perceptible by touch) grip like a cork ball to the feel force feedback. It is linked to encoder motors by strings which can feed a 3D location to the system. When a player touches some virtual objects with their hand, the system calculates the correct force feedback using a real-time physics simulator. The player feels this force feedback via the strings and a tangible grip. Our system can provide a safe high quality force representation rather than using a metal linked arm system.

"Penguin Hockey" is a typical content demonstration. It is a simple 3D hockey game played with automotive penguins. The pucks are snowmen. To get points, players should throw snowmen to the enemy's goal. All characters have a real mass in the world. All actions of penguins are generated by AI engine. When a player child touches a penguin, the player can feel its weight and its direction of interest via a tangible grip.

During my doctoral research, the players' behaviors were analyzed with subjective and objective methods. Through some international demonstration and its evaluation, I had developed some new physical evaluation techniques for full body interaction systems. For example, players' interests can be measured by their playing time and seconds. Differences of players' activities can be visualized by tracing the data of their tangible grip. Also it is possible to compare difference in player activities when some Haptics parameters are changed.

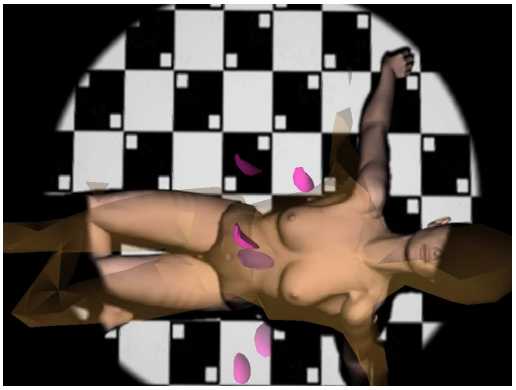
Tangible Playroom project was demonstrated at SIGGRAPH 2003 SigKids, Laval Virtual 2004 and an event for handicapped children. There were no accidents with our interactive "touchable" robotics systems. It was also given a lot of awards for project and its research activities.

"Dynamo" [2003]

Dynamo is a study for contents creation using SPRINGHEAD, a haptics VR development environment.

If an ideal Haptics interface can be expressed as a media, it could be explained as a human body. That was the motivation of this project.

To share the work with students, I had developed a text scripting environment to create contents with haptics interaction. As a result, if the creator would have liked to express a human body, Haptics modeling should be more florid than real shape. It was not enough if the model was exported directly. But Haptics feeling was to be designed with a simple method.



[Dynamo]

A Research for Photo-Realistic Virtual TV Sets [2003-2004]

This project was the foundation of researches for photo-realistic virtual TV sets. In this project, I had developed some practical systems like a global illumination engine and renderer "OptGI", interactive camera controlling system and a "virtual to real" shadow casting system.

I also worked at NHK research (which is a broadcasting institute) and it was very exciting to know how to promote research activities.

[Photo-realisitc Virtual TV sets]

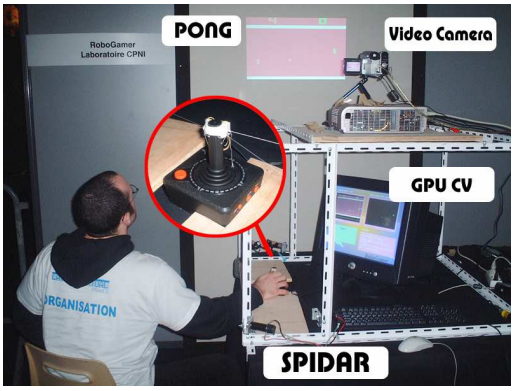
Lumina Studio [2004]

A new real-time vide composing using GPU. The system can make a complex video composing in real-time. The composing parameters are given by text file and color value of texture files.

[Lumina Studio]

RoboGamer series [2005]

RoboGamer is a robotic system which is able to play a video game together with a human player. In previous computer game systems, the computers were always designed as enemies to the human. However, in this project, we realized a physically connected friendly computer player by a simple robotic system that is composed of a video camera, a wire based force feedback SPIDAR, a display and a program using GPU fast image recognition; without any modification of the original video game system. RoboGamer has three functions that are autonomous: play with augmented effects like force feedback and/or rich graphics for original old video games, collaboration play with A.I. and human player via force feedback on the joystick.

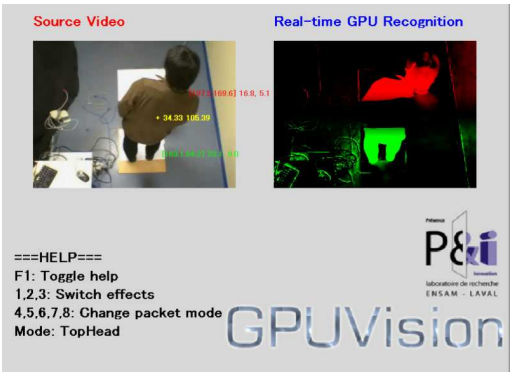


[RoboGamer]

GPUVision [2005-2006]

GPUVision project is a computer vision program that uses GPU (Graphics Processing Unit) for computer vision. "Faster but easy" is a concept of GPUVision. It supports normal Webcam, Digital Video Cam and media files like AVI, WMV and MPG to create vision based interaction easily.

Current GPUs have pixel shaders that can perform pixels with HLSL (High Level Shader Language) 8-16 times faster than CPUs. HLSL is a GPU programming language that is a C like language in a text file. Most parameters for tracking with GPUVision are obtained by HLSL and a texture file. Thus users does not need to recompile the main program. It also has a network connection function to send the tracking data to other program like Virtools. Thereby becoming a good solution to make interactive projects for students. It can perform over 600 fps for a simple color tracking at maximum. Four student projects have already used it.



[GPUVision]

AceSpeeder2 series [2006-]

"AceSpeeder2" is a high speed racing game product on PC platform. The player drives an anti-gravity vehicle on the circuit to get the fastest win in SciFi worlds. To show the new possibility of the computer game research, I have developed some special editions of AceSpeeder2.

On the "Laval Virtual ReVolution 2006 Special Edition", we had applied a marker less full body interaction human interface system using GPUVision. A player (120cm or higher, or an infancy child with a parent) can immerse themselves to the beautiful and high-speed computer graphics world and play by their full body action. The function was improved to a desktop version. Now players can try with a webcam using their face movements to direct the vehicle. The WiiMedia project (new utilization of Nintendo Wii's controller) was also applied to AceSpeeder2.

Besides this, I had tried to evaluate differences of human activities with several game interfaces without linguistic methods. When the players play the game, my logging system records the behavior of players. After the experiment, it was possible to use for human interface evaluation data to adapt difficulty and do a design evaluation for 3D models in the game.

This game project has been developed between Japan and France. I am currently working as an international coordinator and scientific researcher.

[Ace Speeder 2 series]

WiiMedia [2007-]

WiiMedia project is motion analysis methods and applications using Nintendo's consumer video game controller Wii Remote. Normally, consumer hardwares are closed to academic developers. Fortunately, we can connect to WiiRemote via BlueTooth on our PC. Basically, we may get some low level information from the Wii Remote like acceleration and 2D position of IR-LEDs. We thus tried to create several applications using a WiiRemote for several children's age groups. One example is "JaWii's Virtual Fencing" for 7-12 years old. It uses a sable fighting motion detecting system in which only the acceleration sensor of Wii Remote is used. A best paper award was given from Sandbox2007: An ACM SIGGRAPH Video Game Symposium for "WiiMedia: motion analysis methods and applications using a consumer video game controller". (http://sandbox.siggraph.org/about2.html)

[WiiMedia:JaWii's Virtual Fencing]