# Phong, augmenting virtual and real gaming experience

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## ABSTRACT

This paper introduces a mixed reality pong game that bridges the gap between the real and digital worlds. The article first presents the game and how to play it. It further details the tangible interaction mechanisms and presents the problem of localization of objects on the game board, as a solution to augment the players' physical implication in the digital board. Finally the paper concludes with preliminary players' feedbacks and propositions of improvements.

**ACM Classification:** H5.2 [Information interfaces and presentation]: User Interfaces. - Graphical user interfaces.

**General terms:** Experimentation, Human Factors

**Keywords:** mixed reality, tangible user interfaces, gaming, localization

## INTRODUCTION

The goal of the Phong project, contraction for Physical Pong, is to implicate players physically in digital games and to join physical and digital worlds. Tangible user interfaces have proved to be an intuitive and natural mean of interaction [1], particularly useful to reduce the gap between digital and physical worlds, since objects can co-exist in both dimensions. A recent project, PingPongPlus [2], also dealt with an augmentation of a real ping pong game by projecting animations on the classic table. The purpose of Phong is to go further adding both physical elements to the virtual world and virtual elements to the real world, making it a good example of mixed reality system. We believe that mixed reality systems, combining multimedia outputs and tangible interactions, is particularly adapted to gaming and will increase the fun and sociable aspects of it. This article describes Phong game board and game play. It presents the various input and output devices and in particular details the localization module, based on RFID technology, used to interact directly on the virtual board with so called bonuses. Finally, the article concludes with players' feedbacks and propositions of extensions.

## DESCRIPTION OF THE SYSTEM

Phong's basic gameplay is inherited from pong, the most classic arcade game; each player moves his racket and tries to return the ball. Missing the ball makes the opponent

score. The main difference with pong is that the racket is no longer a virtual object, but becomes a real one. The interaction is thus primarily based on a physical paddle which directly represents the racket in the game. Besides, to extend the original pong gameplay, special actions can be triggered by bonuses collected by each player during the game. The first category of bonuses involves manipulating other physical controllers: a joystick, a push-button and a slider. These affect the virtual ball properties in an indirect way. A second category of bonuses allows players to place additional elements, which affect the behavior of the ball, on the game board in a direct way, by laying a stamp on the board where they want the modifier element to appear. Both categories of bonuses and related interactors will be described more precisely at the end of the section.
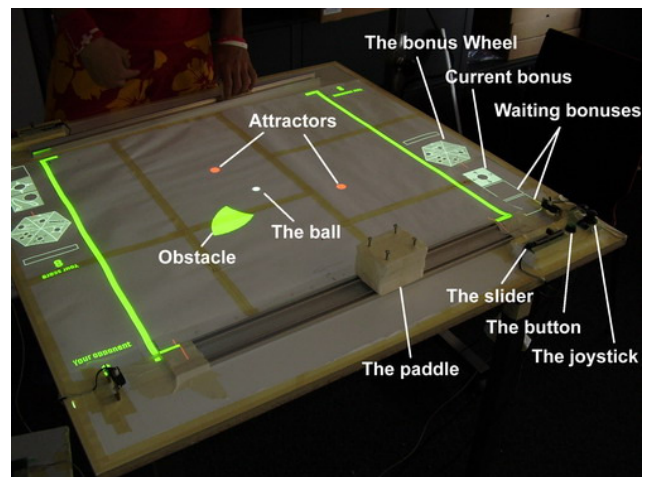


Figure 1: Overview of the Phong game board during a game

### Output Devices

There are two output devices. The first one is a beamer projecting virtual items of the game: walls, ball(s), scores, etc. The beamer is fixed on the top making the screen about 70cm wide and 100cm high. The second one is a speaker to play sounds during the game.

### Input Devices

The most important input device is each player's paddle (see Figure 1), that the player can move horizontally in front of him and which offers the main direct and physical interaction with the virtual ball. Its position is detected by two IR distance sensors, one on each side. In order to make the virtual ball collide correctly with the physical paddle,

the position of the latter must be as precisely detected as possible, reason why two IR distance sensors are used simultaneously. Three input devices, placed on the right side of each player, can be seen at the bottom right of Figure 1 and are dedicated to bonuses. The slider controls the ball speed, the button launches the ball at the beginning of the game or launches an extra ball, and the joystick controls the direction of the ball. Of course, the player cannot use these devices anytime during the game; he must have activated the proper bonus before being allowed to use one of them. Each of these physical interactors has been chosen because its manipulation offers the best resemblance with the action determined by its associated bonus.
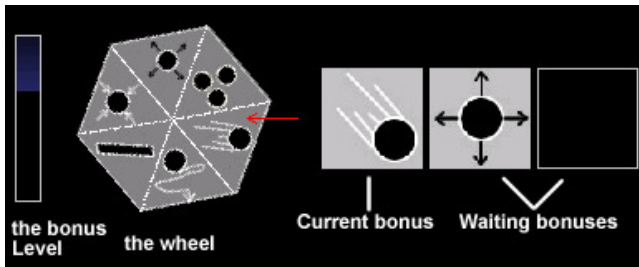


Figure 2: Section of the bonuses in the graphical interface

### Localization

Certain bonuses, like obstacles or attractors that modify the trajectory of the ball, are called localization bonuses. They must be put on the game board, within one of the 25 areas that can be seen on the right side of Figure 3. The player uses a stamp to place a modifier directly onto the game board. This kind of action is very intuitive. No mouse or keyboard is needed to set the location of the bonus; instead it is placed on the board in a direct way.
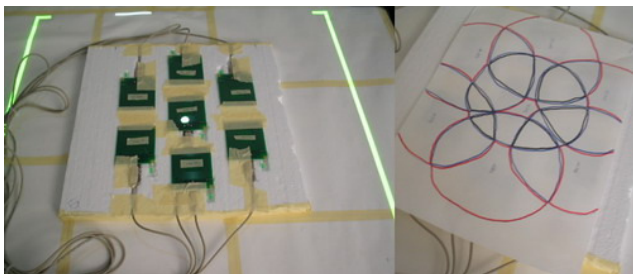


Figure 3: Seven RFID readers are devoted to the detection of localization bonuses' placement.

The localization works with seven little RFID readers. To detect where the stamp is, an intersection is made between the readers which detect it. The detection radius of the readers can be seen on the right of Figure 3. Their intersections create 25 distinct areas. The precision of the detection is acceptable in our setup, even if the detected area is slightly shifted from time to time. Moreover, as the readers do not work when they are too close to one another, they are switched on and off sequentially. Of course, this generates a short delay for the detection of the stamp, but this problem does not interfere much with the game.

### Bonuses

When the bonus wheel (see Figure 2) rotates, a bonus can be caught. To stop the wheel, the player must push the button. The selected bonus is then put in the bonus boxes that are under the wheel. A maximum of three bonuses can be accumulated in the stack of boxes, which follows a "last in, first out" rule. A bonus can only be activated if it is on top of the stack, in the "current bonus" box. All bonuses last for a limited time, except extra ball that is not limited. The first category of bonuses, extra ball, speed and direction, do not need localization, but only the devices on the right side of the player. To use these bonuses, the player has to push the button that is located on his right side to load them during the game. After that the player may manipulate, if necessary, the appropriate physical device to apply the bonus. If extra ball is activated, another ball will be sent simply by pushing the button. If the speed bonus is selected, the slider will be activated, allowing changing the speed of the ball. At last if the direction bonus is loaded, the joystick is activated to control the direction of the ball for a short period of time. To use the second category of bonuses, called the localization bonuses, namely attractors, expulsors and obstacles, the player has to load the current bonus in the stamp. This action is simple, he only needs to put the stamp on the virtual bonus box and wait for the sound that validates the transfer. Then he can stamp the game board where he wants the localization bonus to appear. If it is an attractor or an expulsor, the ball will be deviated from it. If it is an obstacle, the ball will behave like on a wall.

### CONCLUSION

This paper introduces Phong, an augmented pong game with tangible interactors, allowing players to physically interact directly with digital elements. This interaction style puts the players between reality and virtual world. At this time preliminary user evaluations, in the form of satisfaction questionnaires, have shown encouraging results; players are enthusiastic because they can directly manipulate and act on the digital world. In the near future, a usability evaluation will be set up to test the game play, i.e. playability, and system reactivity. Another user evaluation will be set up to compare a digital-only pong with Phong, aiming at measuring how Phong improves players' experience.

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