Ping Pong: A Networked Multi Player Game

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1 INTRODUCTION

We plan to design and develop a networked multiplayer Ping Pong game that will be played on a desktop machine. The game will have maximum four players where each player guards her wall from the ball(s) using sliders. If the ball touches the player's wall 3 times, the player is deemed as dead and her paddle is removed from the game board.

This is a continuous game, even if a player misses the ball, the ball continues to move on the game board. Some players in the game can be manual, and some can be backed by the computer with different difficulty levels as easy, medium, hard. The player who remains alive at the end of the game is deemed as the winner.

There are some special kinds of modes which the players may want to play in viz. multiple balls mode, blinking ball mode, obstacles mode.

In between the play different kind of powers can pop up at random position on the board, which if consumed by any user (by hitting the ball so that it passes over the pop up), can yield a positive as well as negative result for the player. e.g. bat/ball size increase/decrease, multiple balls emerge, ball speed increase/decrease, extra life for the player, one life wasted, sticky ball etc.

There is friction between the bat and the ball, hence players can spin the ball as per their will. Moreover the surface between the ball and the game board, so the speed of the ball will not decrease due to friction. Since the bat can be moved

in vertical direction as well, the speed of the ball can be changed by the players to some extent. To increase the speed

2 SCOPE OF THE GAME

2.1 Special Modes

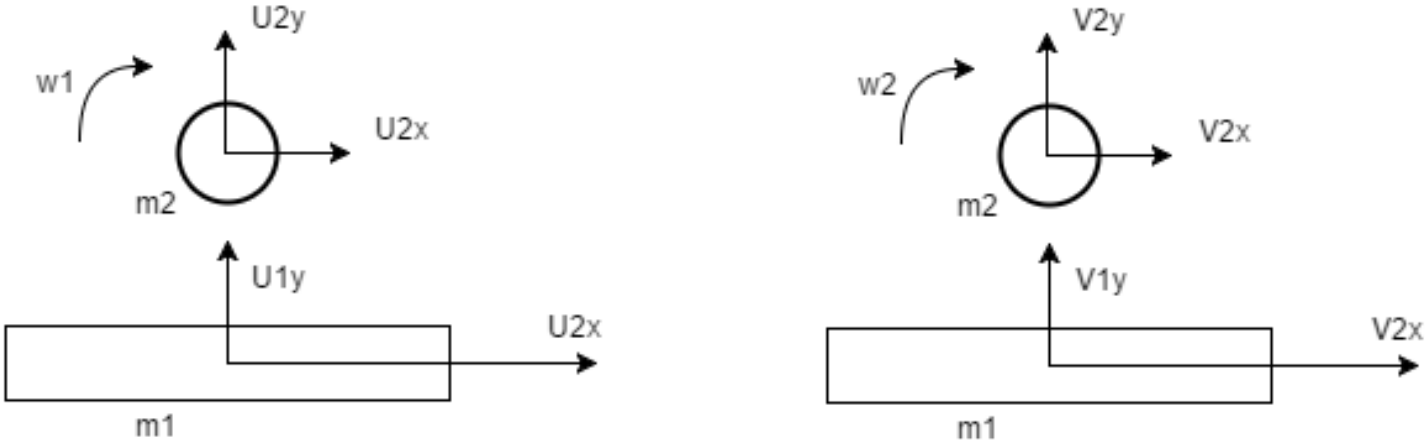
- ***Multiple Balls Mode :*** More than one balls will be in the play. Each player will have 5 lives in this mode. Players can also select the no.s of balls with maximum limit of 4.
- ***Obstacles Mode :*** There will be rigid obstacles of arbitrary shape lying in the game board so there the ball can bounce from it in an unexpected direction post collision.
- ***Blinking Ball Mode :*** The ball will become invisible periodically while moving in its normal path to make things interesting for the players.
- ***High Spin Mode :*** The ball will spin 2x to 3x times than it normally spins, to make things interesting for the players.

2.2 Extra powers

Extra Powers will be obtained from the pop up powers as follows

- Bat size can be increased or decreased.
- The ball will stick to the bat and player can release the ball at any time in any direction.
- One life added or deducted from the lives of the player.
- Ball size increased or decreased
- Ball speed increased

3 PHYSICS OF THE GAME



3.1 Friction

There is friction between the bats and the ball and not between the ball and game board. So the friction between the ball and the bat will play role in changing the component of velocity of ball in the direction parallel to bat surface on which collision is taking place.

3.2 Conservation of Momentum

Total Momentum of the colliding bodies (ball and bat) will be conserved in all the directions as there is no external force on the system of these 2 bodies. So if the initial velocities of the ball and the bat are U1, U2, let components of these in the direction parallel to the surface of the collision and perpendicular to it be U1x, U1y, U2x, U2y. Also let the masses be m1 and m2. Then to calculate the final velocities V1x, V1y, V2x, V2y we have the equations

$$m1 * U1x + m2 * U2x = m1 * V1x + m2 * V2x \ \textit{(Conserving in x direction)} \quad (1)$$

$$m1 * U1y + m2 * U2y = m1 * V1y + m2 * V2y \ \textit{(Conserving in y direction)} \quad (2)$$

Since elastic collision is taking place, coefficient of restitution is 1. Using it as follows

$$U1y + U2y = V1y - V2y \ \textit{(applied for y direction)} \quad (3)$$

Here assumed U1y in the downward direction and all other in upward direction. So relative velocity of approach is addition of the y components of initial velocities.

3.3 Impulse Momentum Theorem

Impulse applied on the body is equal to change in momentum that body. Let the impulsive normal reaction on the ball in the vertical direction be N, and coefficient of friction be between the surface of ball and bat. So there will be impulsive friction N in the x direction on the ball at the point of contact. The impulse in the y direction on the ball is N.dt and in the x direction N.dt . So the equations are

$$N.dt = m2 * (V2y - U2y) \tag{4}$$

$$N.dt = m2 * (V2x - U2x) \tag{5}$$

3.4 Angular Impulse Momentum Theorem

Applying about the centre of mass, the change in angular momentum about the centre of mass is equal to the angular impulse applied on the ball about the centre of mass. Let the moment of inertia of the ball about centre of mass be I, and radius be r, then the angular impulse on the ball about the centre of mass in the anticlockwise direction is r N.dt and the equation is

$$rN.dt = -w2 * I - (-w1 * I) \tag{6}$$

Taking w1 and w2 in the directions as shown in the diagrams.

Now we have 6 equations and 6 variables namely V1x, V1y, V2x, V2y, N.dt, w2 hence can solve to find the velocity and angular velocity of the ball post collision with the bat.

4 ALGORITHM FOR THE COMPUTER PLAYER

The computer player will come into action when either there are less than 4 users or during play one of the users gets knocked out or gets disconnected.

4.1 Aim

The aims of the computer player are :

- To hit the ball
- To prevent getting out and stay in the game
- Hit the ball in such a way so as to deduct a life of the other players

4.2 Algorithm

We wish to achieve the first task through a probability distribution function that would depend on the distance the pad has to move in order to hit the ball. Thus there would be a random chance that the computer hits the ball but the probability would depend inversely on the distance the pad has to move. Moreover, the probability function would also vary with the difficulty level of the computer player. The higher the level of the computer player, the higher would be the probability of it hitting the ball.

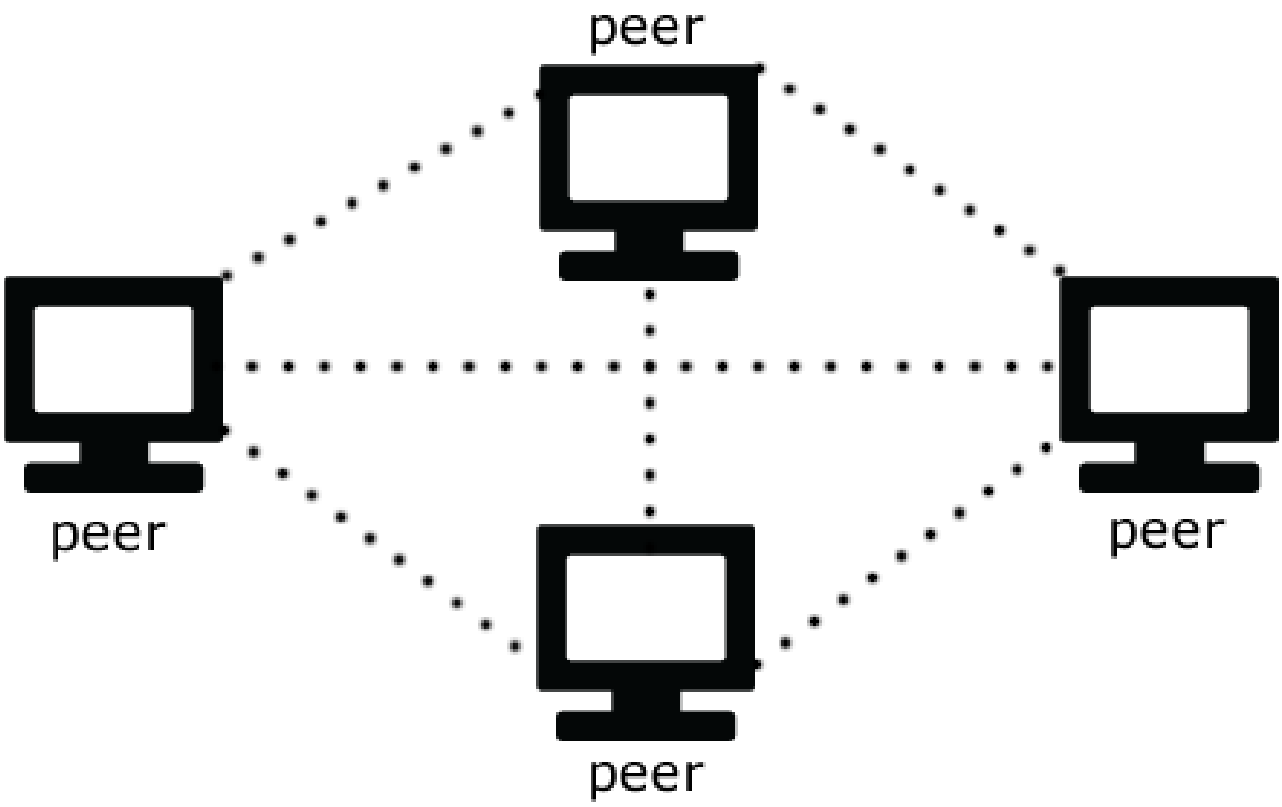
For the second task, the only way for any user to influence the path of the ball is by varying the pad speed to induce spin in the ball. Therefore, the more advanced computer players will be more efficient in hitting the ball with appropriate pad speed(taking in mind the current spin) so as to hit the ball in the desired direction.

Also, a random function will decide whether the computer player wishes to take a power up or hit for scoring a point. But there will be check that would ensure that if there is a high chance for scoring a point, the computer would go for the point.

The computer player will run on all machines in a distributed fashion so that when a user gets disconnected the game continues smoothly.

5 NETWORK COMMUNICATIONS

In peer to peer approach, there is no central entity and every peer controls its game state. In a peer-to-peer (P2P) approach, a peer sends data to all other peers and receives data from them



5.1 Overview

Every peer must control its own game state, communicating any changes and important actions to the others. As a consequence, the player is able to see these scenarios simultaneously viz. his paddle moving according to his input, a simulation of all other paddles controlled by the opponents and balls in the game and the position of special powers popping up.

The player's paddle's movement and actions are guided by local input, so the player's game state is updated almost instantly. For the movement of all the other paddles, the player must receive a network message from every opponent informing where their paddles are. The position of ball and powers will be saved on every system and will be updated instantly.

If the game has four players - say A, B, C and D - player A is the only one able to inform where paddle A is, if it has moved or if player has lost connection or player loses and so on. All other players will receive messages from A informing

about his actions and they will react accordingly. As a consequence, each player will see all other paddles according to the received messages.

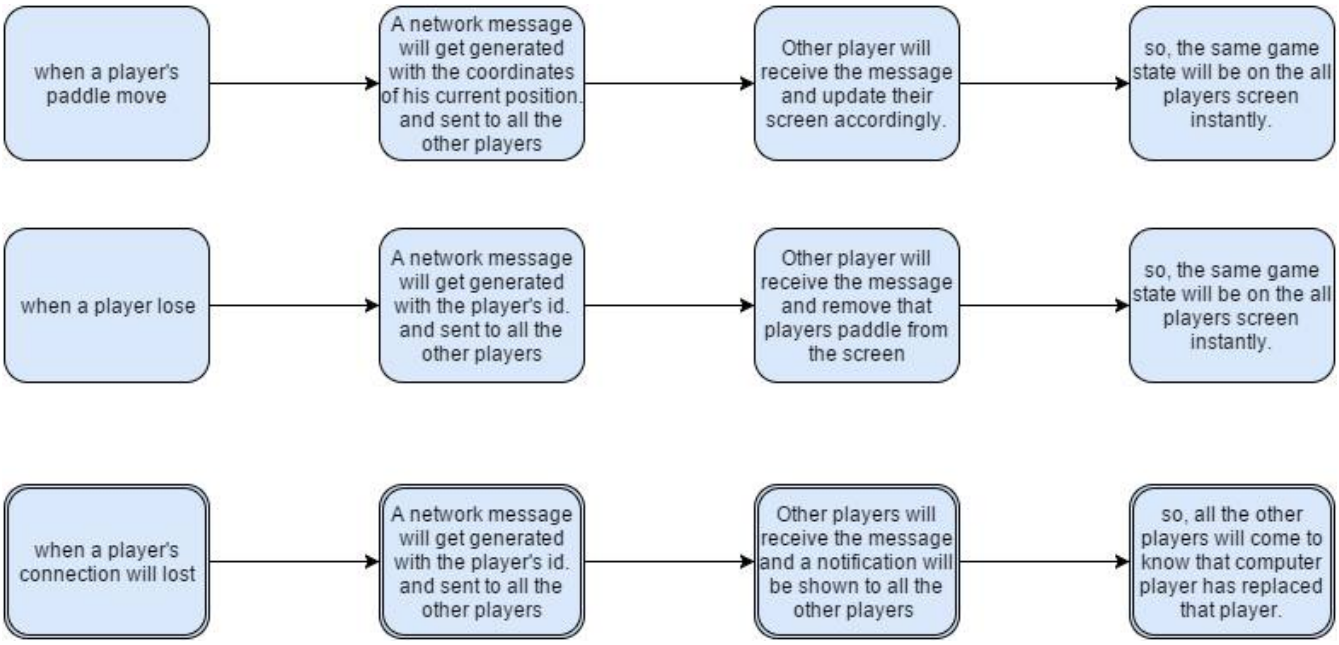
5.2 Actions

In our game, the important actions are:

- ***Changing the position of paddle(x,y):*** This message will be sent when the position of the paddle will change. Her x, y represent the current coordinates of the paddle. Other players will receive the data and update their screen according to the message.
- ***If player loses:*** If player loses the ball three times then he will lose and his paddle will be removed. This information will be sent to all the players and their screen will remove the lost player paddle.
- ***If player connectivity is lost:*** If player's connectivity is lost, a new computer player will start playing in his position but this information will be sent to all the other players, so that they come to know that the computer has started playing on that player's place.

For computer players all the data for computer player will be stored on each player's computer, the position of ball and power will be also on all computers. So, no data communication will be required. By this method, all the players will see the same game state at a time.

When a player lose his connection, the computer player algorithm will start for that player. and all the players will be informed of this event.


when a player's paddle move
A network message will get generated with the coordinates of his current position. and sent to all the other players
Other player will receive the message and update their screen accordingly.
so, the same game state will be on the all players screen instantly.
when a player lose
A network message will get generated with the player's id. and sent to all the other players
Other player will receive the message and remove that players paddle from the screen
so, the same game state will be on the all players screen instantly.
when a player's connection will lost
A network message will get generated with the player's id. and sent to all the other players
Other players will receive the message and a notification will be shown to all the other players
so, all the other players will come to know that computer player has replaced that player.