

Excel PONG Tutorial #4

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- combining kinematics with collision events

3D PINGPONG

- In this tutorial (which is a continuation of part#3) the kinematics of the ball is further analyzed.
- three different of collision effects are introduced. These effects are the wall collision effect, the bat collision effect and the bat miss effect
- These effects play an important role in the play, scoring and sound effects involved in the game



25. Create a new copy of the worksheet and macros

- Copy the last worksheet into a new one. Rename the new worksheet "Pong_Tutorial_4".
- Insert a new module, Module3, using the VBA editor
- Copy both macros from Module2 into the new module (including the RunPause variable declaration)
- Change the name of the macros:
 - “Serve_3” => “Serve_4”
 - “Play_Tutorial_3” => “Play_Tutorial_4”
- Reassign the new macros to the buttons in the new worksheet

```
Dim RunPause As Boolean
```

```
Sub Serve_4()
```

```
Range("R28:Y30").Clear
```

```
Range("R28:U28") = Range("R23:U23").Value
```

```
End Sub
```

```
Sub Play_Tutorial_4()
```

```
RunPause = Not RunPause
```

```
Dim Pt0 As POINTAPI
```

```
Dim Pt1 As POINTAPI
```

```
GetCursorPos Pt0
```

```
Do While RunPause = True
```

```
DoEvents
```

```
GetCursorPos Pt1
```

```
[S6] = [P8] * (-Pt1.Y + Pt0.Y)
```

```
On Error Resume Next
```

```
Range("R28:Y29") = Range("R27:Y28").Value
```

```
Loop
```

```
End Sub
```

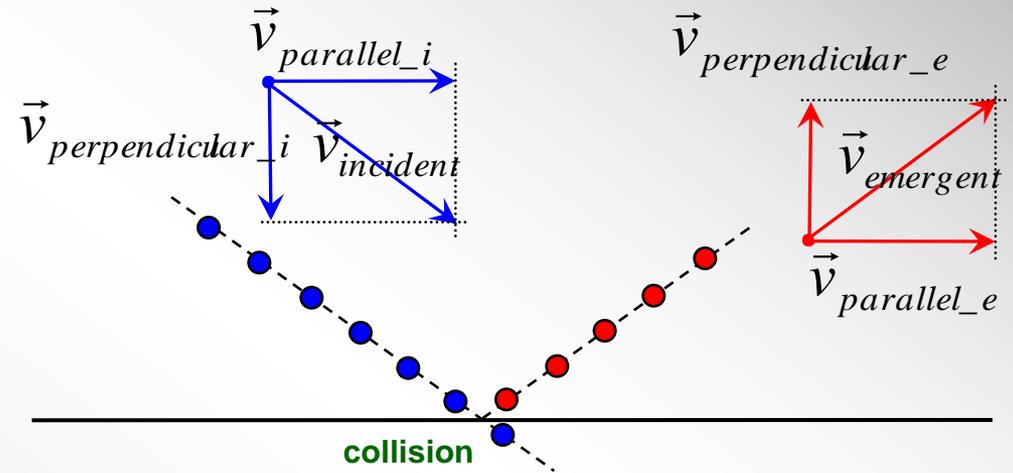
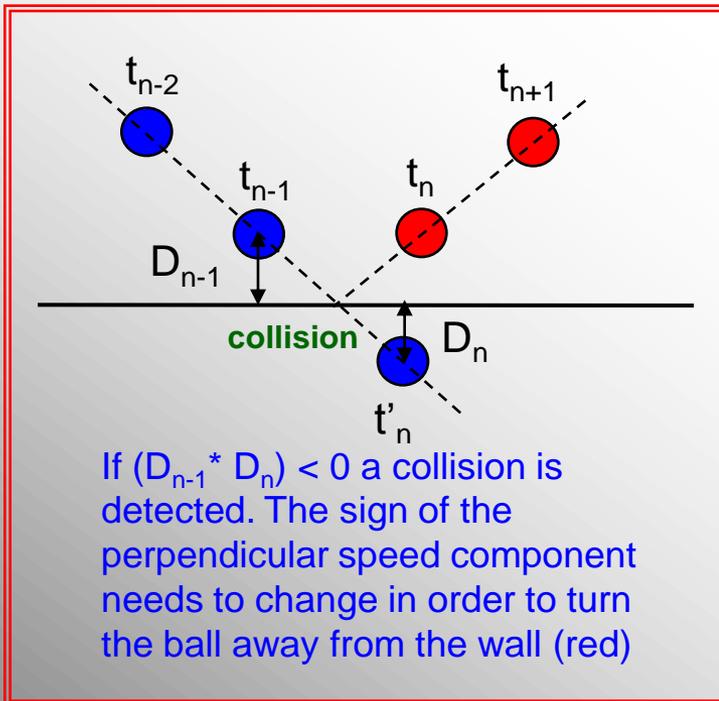
26. Inserting the "collision event table"

- In the range R15:T19, create a table with logical collision information formulas
- We need this information later in the Kinematics formulas to see when and how we need to take trajectory change decision
- In later models there will be various sounds triggered by the collisions
- Populating this table with formulas will be explained in the following pages

	Q	R	S	T	U
12					Bat_OverSize
13					
14		Collision Events:			Ba
15		Horizontal wall collision		FALSE	
16		Collision with Bat #1		FALSE	
17		Missed Bat #1		TRUE	
18		Collision with Bat #2		FALSE	
19		Missed Bat #2		FALSE	
20					
21		Initial Ball Conditions (Serve)			
22		Init_X_Ball	Init_Y_Ball	ServeSpeed_X	ServeSpeed_Y
23		240	0	-0.908957706	-0.416888341
24					
25		Kinematics			
26		X_Ball	Y_Ball	Speed_X_ball	Speed_Y_ball
27	t0	-4.3157346	94.62463644	-0.932502804	0.361162735
28	t-1	-3.3832318	94.26347371	-0.932502804	0.361162735

27. Horizontal (upper or lower) wall collision formulas

- The ball movement is created by changing the position of the ball in time. Therefore the ball trajectory is a string of dots.
- A natural way to detect collisions is finding “wall straddles” of the ball trajectory, which means looking for two consecutive points along the ball trajectory when the ball is on one side of the wall at a certain time and on the other side of the wall in the next time step.
- When this condition occurs we will use it to revert the sign of the perpendicular (to the wall) speed component while leaving the speed component parallel to the wall unchanged.



$$\vec{v}_{perpendicular_i} = -\vec{v}_{perpendicular_e}$$

$$\vec{v}_{parallel_i} = \vec{v}_{parallel_e}$$

Let's see how we write the collision detection formula taking into consideration the width and length of the court and the present (x_0, y_0) and past (x_{-1}, y_{-1}) coordinates of the ball (BR stands for ball radius):

$$\left(-\frac{\text{length}}{2} < x_0 < \frac{\text{length}}{2} \right) \text{and} \left(|y_0| > \frac{\text{width}}{2} - BR \right) \text{and} \left(|y_{-1}| \leq \frac{\text{width}}{2} - BR \right) = \text{TRUE}$$

The ball must be within the court horizontal boundaries

The absolute value of the current y-coordinate of the ball exceeds half of the width of the court minus the ball radius

The absolute value of the past y-coordinate of the ball is less than half of the width of the court minus the ball radius

The above formula works well because the system of coordinate is placed exactly in the center of symmetry of the court (both x and y). We also assumed that the x-axis of this system of coordinates is parallel to the length of the court and the y-axis is parallel to the width of the court. Translated in spreadsheet formulas the above expression becomes:

T15: `"=AND(R27>-V9/2,R27<V9/2,ABS(S27)>V10/2-V11,ABS(S28)<=V10/2-V11)"`

28. Ball-bat collision formulas

- A similar logic applies to the ball-bat collision formulas
- In this case however, there are two different event detections:

1. The ball is hit and it must bounce back into the court reversing the sign of the horizontal speed component (the "collision with bat" event)
2. The ball is not hit and it must continue its flight - one party wins a point (the "missed bat" event)

How do we write the **ball-bat collision** detection formula for **Bat #1** taking into consideration the length of the court, the distance of the bat from the x-end of the court (Players_in), the ball radius (shorthand BR) the present (x₀,y₀) and past (x₋₁,y₋₁) coordinates of the ball?

$$\left(y_{bat_1} - \frac{Bat_size}{1.8} \leq y_0 \leq y_{bat_1} + \frac{Bat_size}{1.8} \right) \text{and} \left(x_0 \leq -\frac{length}{2} + Players_in + BR \right) \text{and} \left(x_{-1} \geq -\frac{length}{2} + Players_in + BR \right) = TRUE$$

The ball must be within the vertical boundaries of the bat (with an added 10% bonus – without that it would just be Bat_size/2. By playing it I found out that 10% over-extension gives the player a better feel for the game)

The current x-coordinate of the ball exceeds the coordinate of Bat#1 (in the negative direction) plus the ball radius

The past x-coordinate of the ball is within the coordinate of Bat#1 plus the ball radius

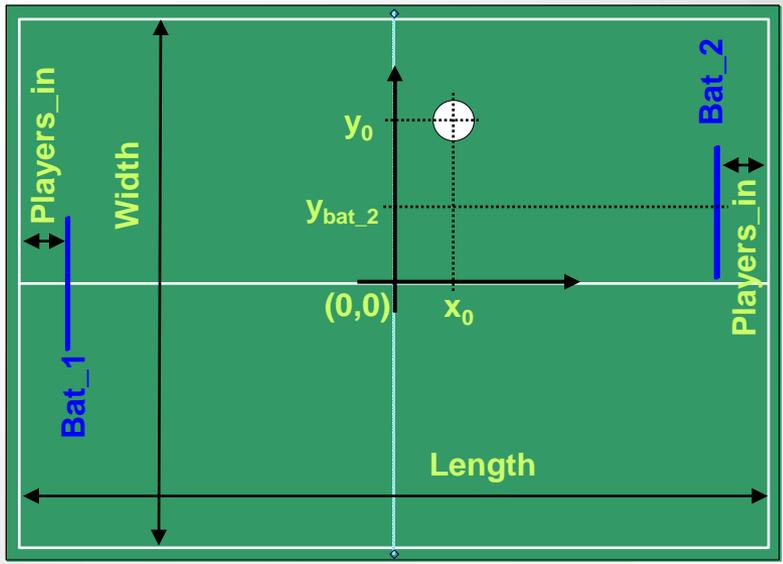
How do we write the **ball-bat collision** detection formula for **Bat #2** (which is located to the right of the court)?

$$\left(y_{bat_2} - \frac{Bat_size}{1.8} \leq y_0 \leq y_{bat_2} + \frac{Bat_size}{1.8} \right) \text{and} \left(x_0 \geq \frac{length}{2} - Players_in - BR \right) \text{and} \left(x_{-1} \leq \frac{length}{2} - Players_in - BR \right) = TRUE$$

Translated in spreadsheet formulas the above expressions become:

T16: “=AND(S5-P12/1.8<=S27,S27<=S5+P12/1.8,R27<=V9/2+V8+V11,R28>=-V9/2+V8+V11)”

T18: “=AND(S6-P12/1.8<=S27,S27<=S6+P12/1.8,R27>V9/2-V8-V11,R28<=V9/2-V8-V11)”



29. The missed-bat event formulas

– This event is important since it is a score changing event, moreover when the bat misses the ball there will be a special sound triggered by the Play macro

- How do we write the **missed-bat** event detection formula for **Bat #1** taking into consideration the length of the court, the distance of the bat from the x-end of the court (Players_in), the ball radius (shorthand BR) the present (x0,y0) and past (x-1,y-1) coordinates of the ball? It is very similar to the ball-bat collision event.

$$\left[\text{not} \left(y_{bat_1} - \frac{Bat_size}{1.8} < y_0 < y_{bat_1} + \frac{Bat_size}{1.8} \right) \right] \text{and} \left(x_0 < -\frac{length}{2} + Players_in + BR \right) \text{and} \left(x_{-1} \geq -\frac{length}{2} + Players_in + BR \right) = TRUE$$

The ball must be out of the vertical boundaries of the bat (with an added 10% bonus)

The current x-coordinate of the ball exceeds the coordinate of Bat#1 (in the negative direction) plus the ball radius

The past x-coordinate of the ball is within the coordinate of Bat#1 plus the ball radius

How do we write the **missed-bat** detection formula for **Bat #2** (which is located to the right of the court)?

$$\left[\text{not} \left(y_{bat_2} - \frac{Bat_size}{1.8} < y_0 < y_{bat_2} + \frac{Bat_size}{1.8} \right) \right] \text{and} \left(x_0 > \frac{length}{2} - Players_in - BR \right) \text{and} \left(x_{-1} \leq \frac{length}{2} - Players_in - BR \right) = TRUE$$

An outline of all the collision event formulas are presented below:

T16: “=AND(S5-P12/1.8<=S27,S27<=S5+P12/1.8,R27<=-V9/2+V8+V11,R28>=-V9/2+V8+V11)”

T17: “=AND(NOT(AND(S5-P12/1.8<=S27,S27<=S5+P12/1.8)),R27<=-V9/2+V8+V11,R28>=-V9/2+V8+V11)”

T18: “=AND(S6-P12/1.8<=S27,S27<=S6+P12/1.8,R27>V9/2-V8-V11,R28<=V9/2-V8-V11)”

T19: “=AND(NOT(AND(S6-P12/1.8<=S27,S27<=S6+P12/1.8)),R27>V9/2-V8-V11,R28<=V9/2-V8-V11)”