FPGA Dino Run

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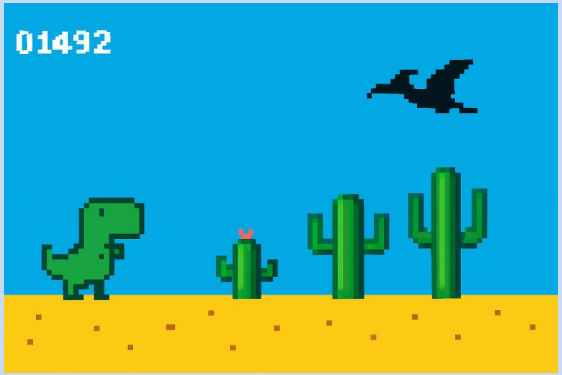
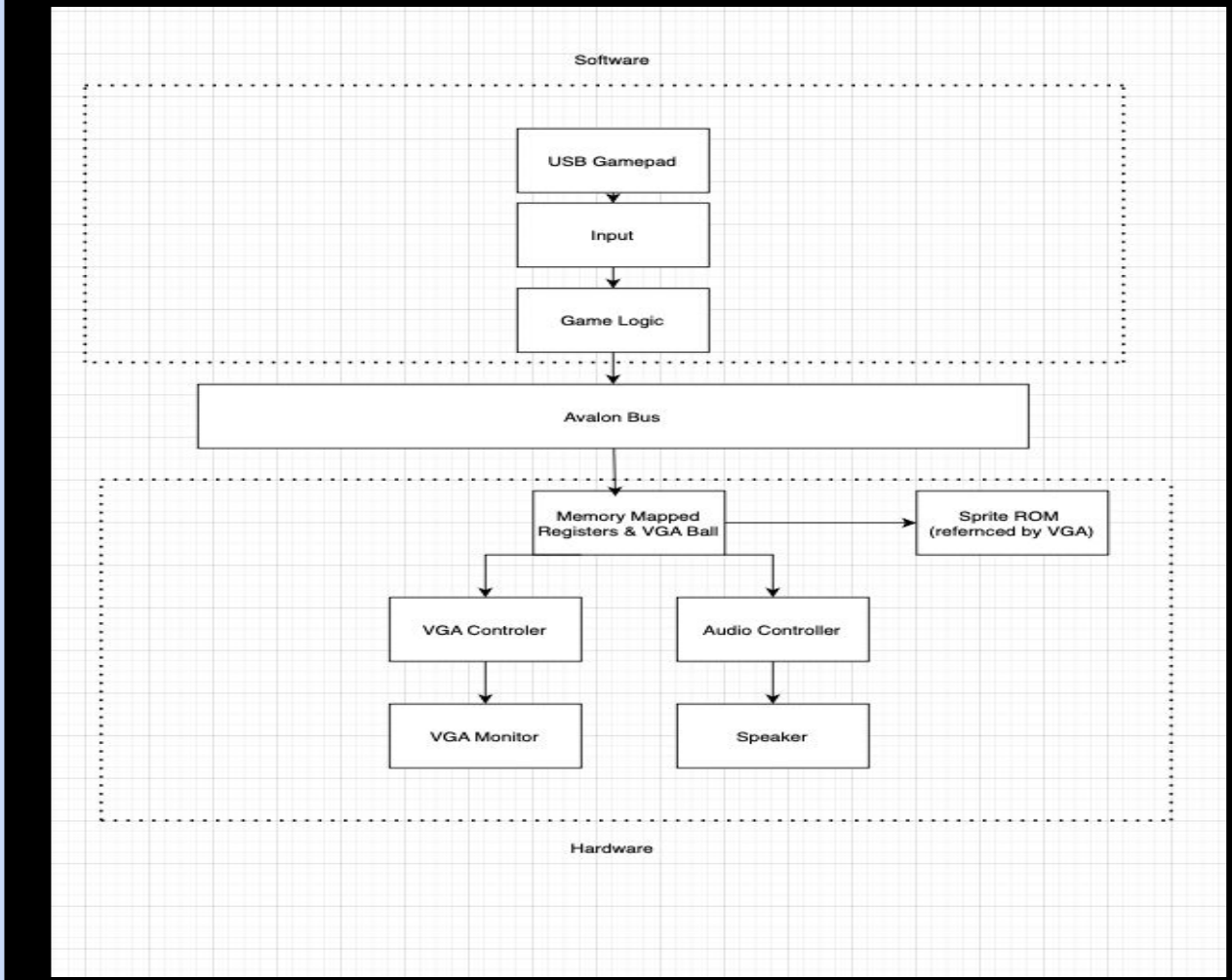
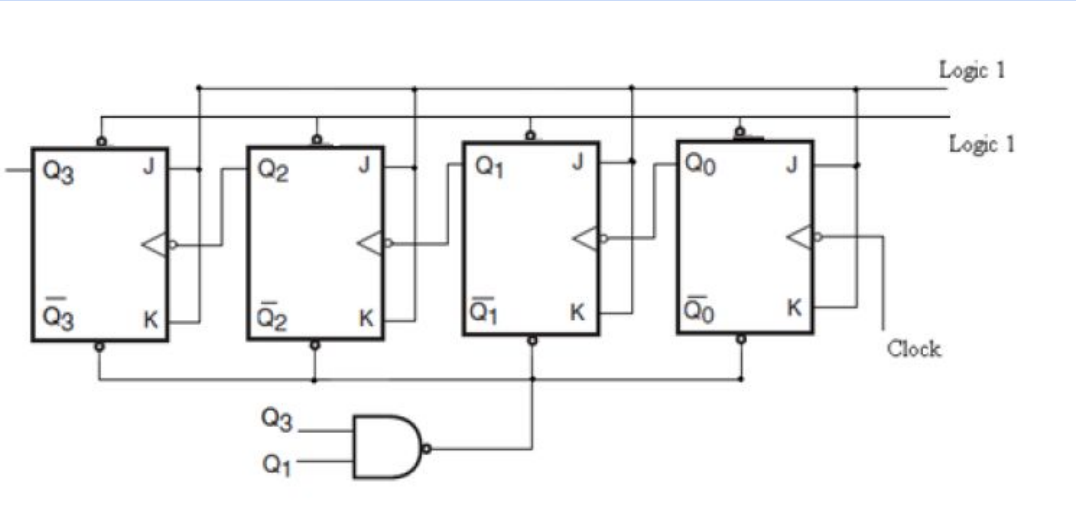


Block Diagram



Score



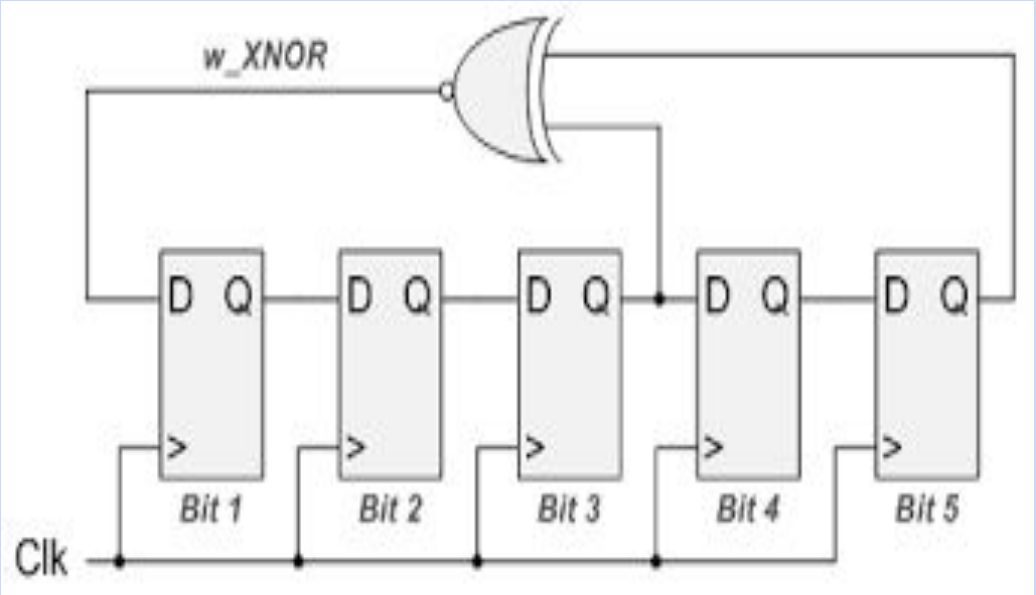

```
if (vcount >= SCORE_Y && vcount < SCORE_Y + 8) begin
  if (hcount >= SCORE_X && hcount < (SCORE_X + N_DIGITS * 8)) begin
    rx  = hcount - SCORE_X;
    idx = rx / 8;         // Each digit is 8 pixels wide
    cx  = rx % 8;
    ry  = vcount - SCORE_Y;

    if (idx < N_DIGITS && cx < 8) begin
      if (font_rom[bcd[N_DIGITS - 1 - idx]][ry][7 - cx]) begin
        a <= FG_R;
        b <= FG_G;
        c <= FG_B;
      end
    end
  end
end
```

Randomization of Order

6 bits

$x^6 + x^5 + 1$



Obstacle Movement

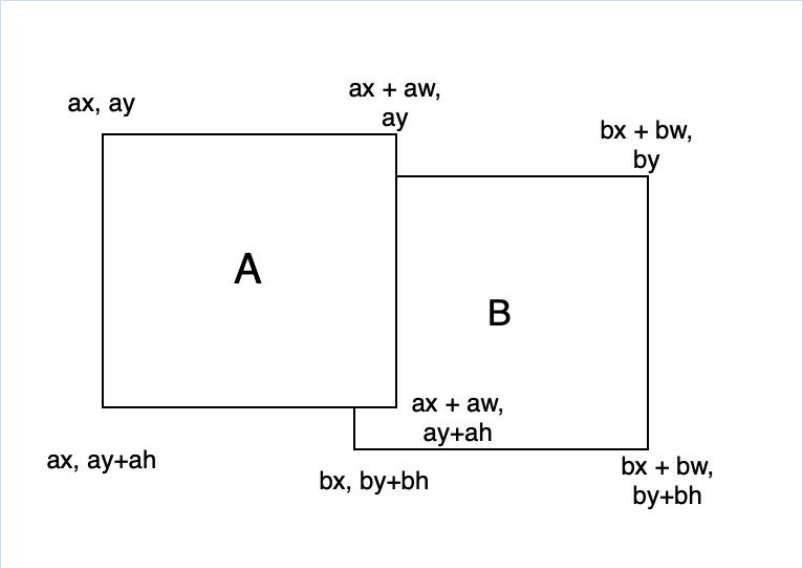
```
s_cac_x <= (s_cac_x <=
obstacle_speed)
        ? (HACTIVE + {lfsr, 4'd0})
        : s_cac_x - obstacle_speed;
```

{lfsr, 4'd0} = [b5 b4 b3 b2 b1 b0 0000]

Speed Increment

```
if (s_cac_x <= obstacle_speed || group_x <= obstacle_speed ||
    lava_x  <= obstacle_speed || ptr_x   <= obstacle_speed) begin
    passed_count <= passed_count + 1;
end
```

Collision



$$ax < bx + bw$$
$$ax + aw > bx$$
$$ay < by + bh$$
$$ay + ah > by$$

Power Up

```
if (collide(dino_x, dino_y, powerup_x, powerup_y, 32, 32, 32, 32)) begin
    godzilla_mode <= 1;
    godzilla_timer <= 0;
    powerup_x <= 2000; // move off screen
end
          //Godzilla destroys
if (godzilla_mode) begin
    if (collide(dino_x, dino_y, s_cac_x, s_cac_y, 32, 32, 32, 32))
        s_cac_x <= 2000;
    if (collide(dino_x, dino_y, group_x, group_y, 64, 32, 32, 32))
        group_x <= 2000;
    if (collide(dino_x, dino_y, lava_x, lava_y, 32, 32, 32, 32))
        lava_x <= 2000;
    if (collide(dino_x, dino_y, ptr_x, ptr_y, 32, 32, 32, 32))
        ptr_x <= 2000;
end
```

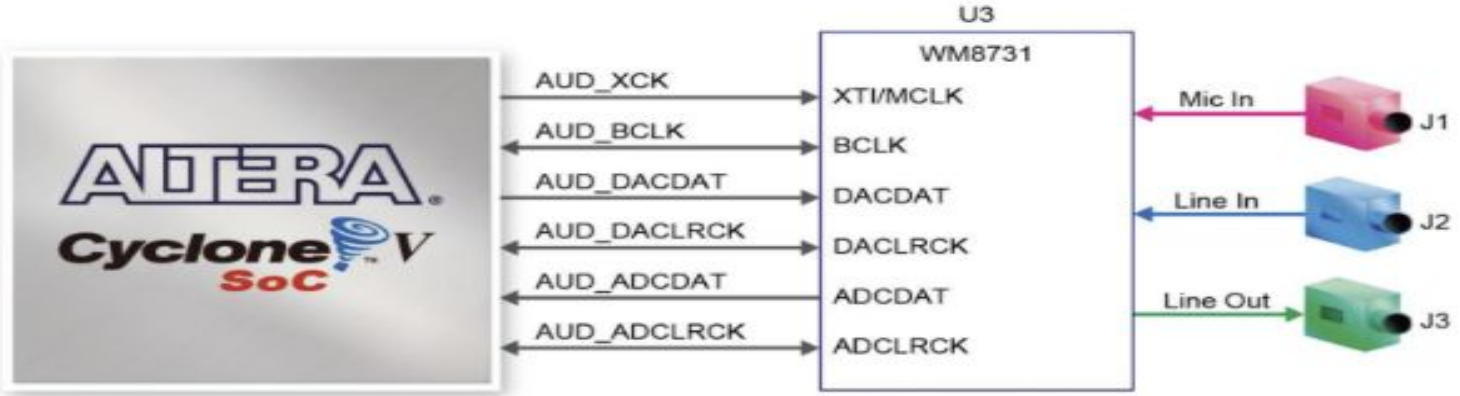
Sprites

Category	Graphics	Size (bits)	Number of images	Total size (bits)
Dino		32*32*16=16,384	3	49,152
Dino Jump		32*32*16=16384	1	16384
Dino Duck		32*32*16=16384	1	16384
Small Cactus		32*32*16=16384	1	16384
Cacti Together		64*32*16=32768	1	32768
Lava		32*32*16=16384	1	16384
Powerup		32*32*16=16384	1	16384
Pterodactyl		32*32*16=16384	2	32768

Sprites

Godzilla		**32*32*16=16384**	**1**	**16384**

Audio



	Size	Samples	Total size (bits)
Background Music	**16**	**9660**	**16*9660 = 153600**
Total			**153600**

Controller Logic

9'd0: dino_x <= writedata[9:0];
9'd1: dino_y <= writedata[9:0];

Register Address Mapping

Address	Name	Size	Description
0	dino_x	10 bits	X position of the dino
1	dino_y	10 bits	Y position of the dino
13	ducking	1 bit	Set duck mode
14	jumping	1 bit	Set Jump mode
19	replay_button	1 bit	To trigger replay state