Immersive 3D World

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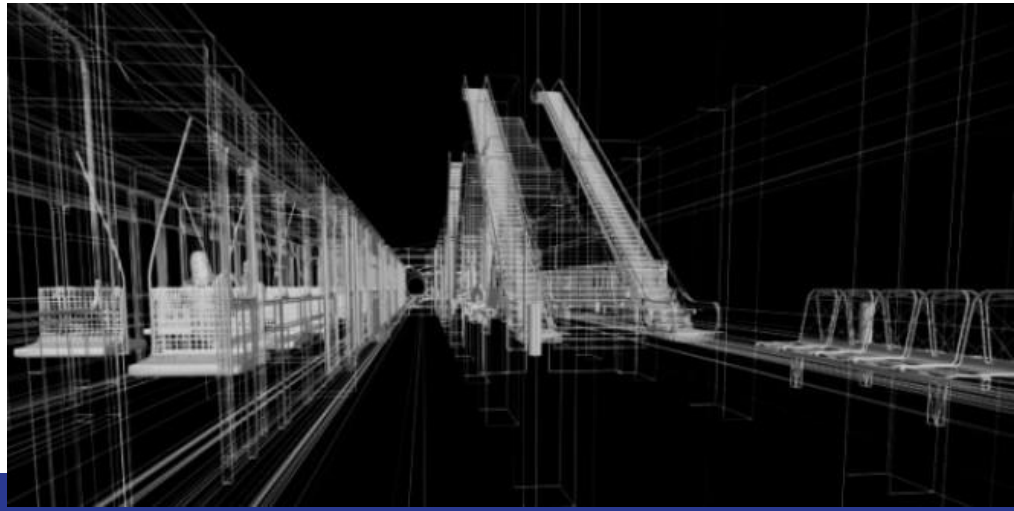
Project Overview

- **3D world for exploration** (actual game as reach objective)
- **Game controller for walking around**
- **Headphones with gyroscope for looking around**
- **Footstep sound through headphones**
- **FPGA controls game FSM, hardware logic, audio generation, etc.**

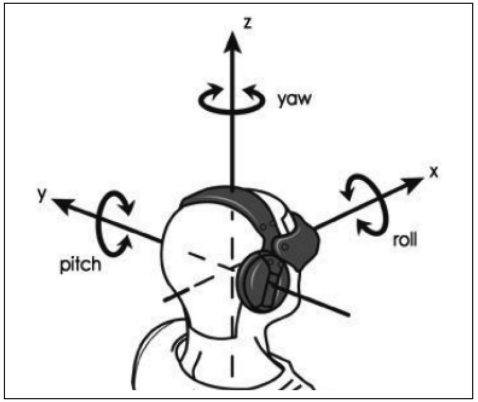


3D Graphics Module

- Static World with changing perspective
- Virtual “camera” position and orientation as inputs
- VGA output to screen
- Triangle (Polygon) Graphics
- Triangles compute in parallel while pixels compute in series
- Each triangle module involves a change of coordinates, interior testing, and depth interpolation

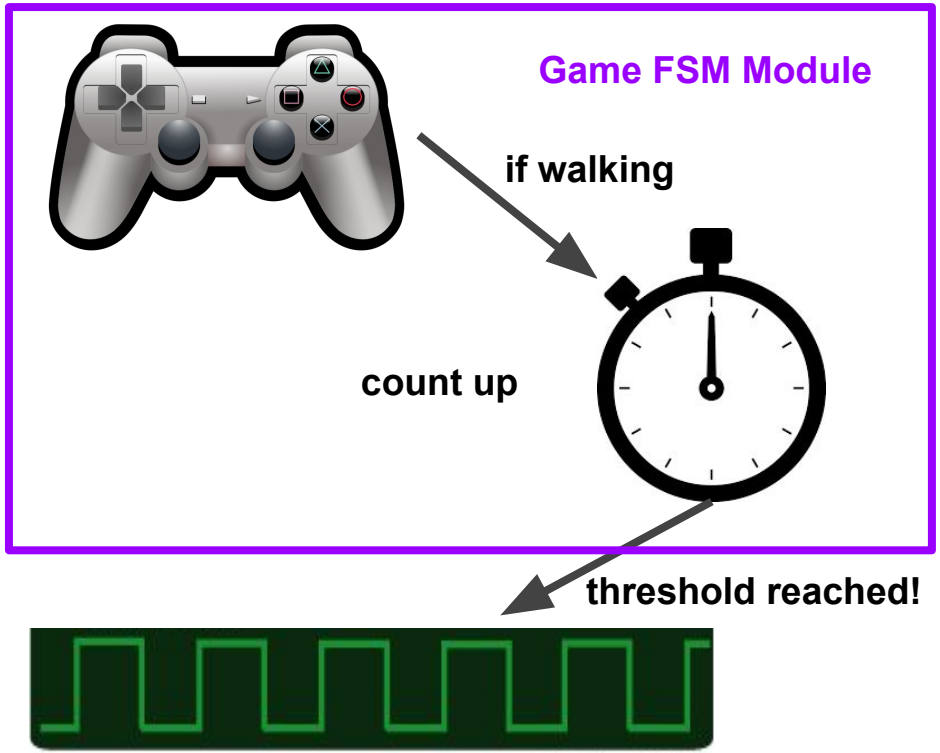
Gyroscope Coordinate Transform Module

- Gyroscope outputs three rotation values
- We only want two of them, but for the user's head, not for the gyroscope itself
- So we use a change of coordinates
- The parameters for this change of coordinates depend on gyroscope readings at fixed reference points at configuration time
- Robust against different use conditions



Audio Module

- Footstep -> bass square wave
- Sound is triggered by enable signal from FSM module
- In FSM:
  - Compute distance traveled each clock cycle
  - Increment counter by computed distance
  - At certain threshold, trigger audio module and reset counter

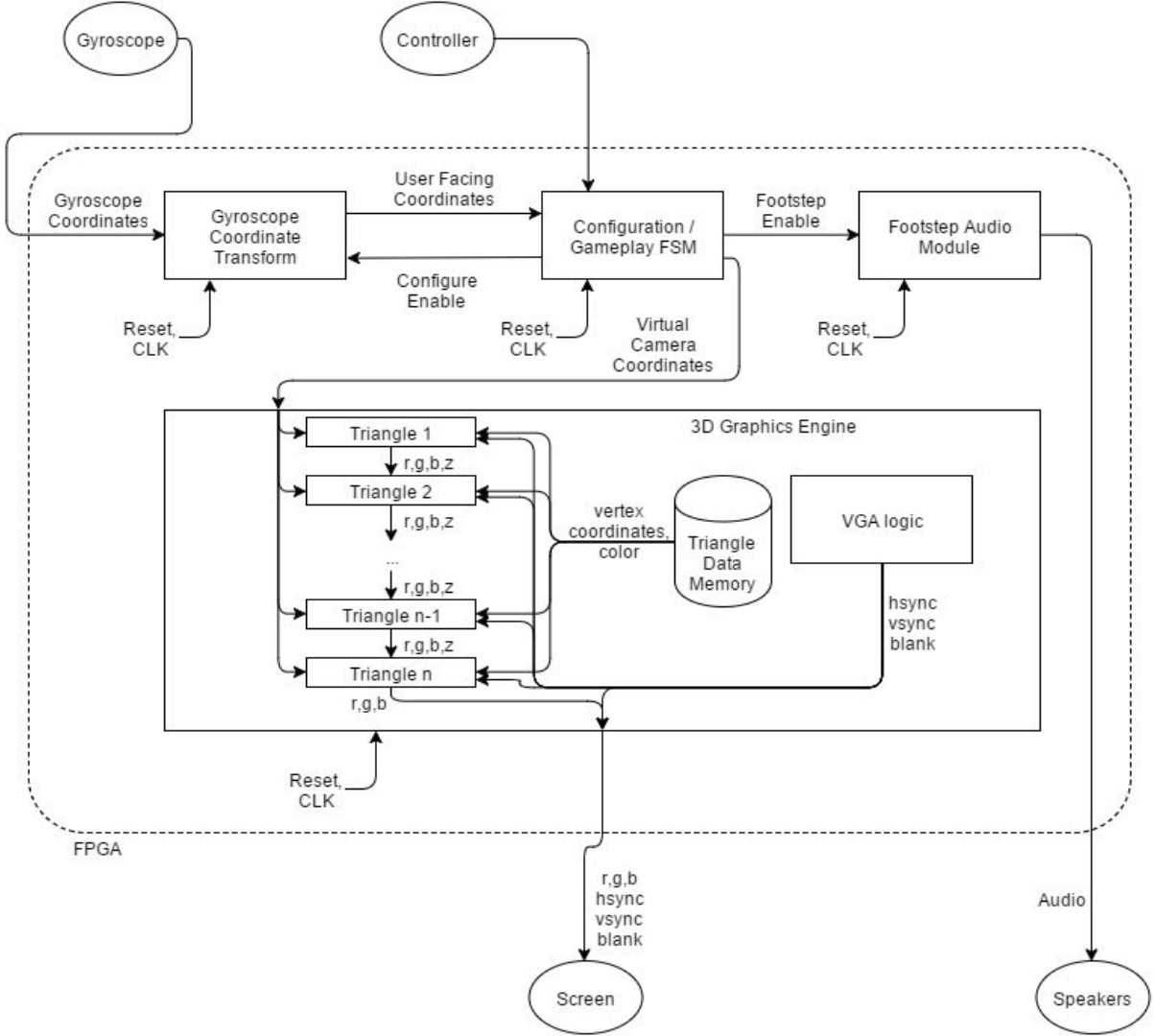


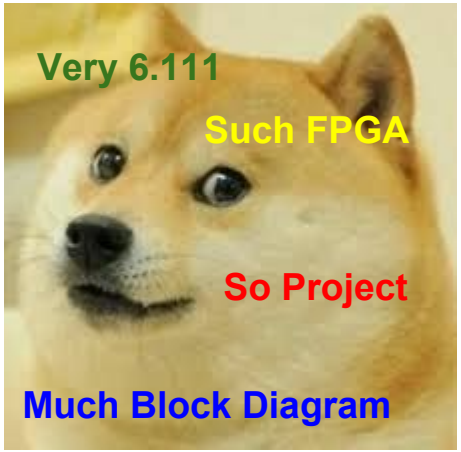
Game FSM Module

- Tie everything together
- Configure gyroscope coordinate transform module
- Store user coordinates in registers; update using input from controller
- Combine transformed gyroscope coordinates with user coordinates to get virtual camera coordinates for the graphics module
- Trigger footstep sound

Hardware Interface

- Several necessary parts outside of the labkit
- VGA out and headphone out: part of the labkit
- Gyroscope: external IC, interfaced with ADCs; attached physically to the headphones
- Controller: external component; synchronized in labkit


Gyroscope
Controller
Gyroscope Coordinates
Gyroscope Coordinate Transform
User Facing Coordinates
Configure Enable
Configuration / Gameplay FSM
Footstep Enable
Footstep Audio Module
Reset, CLK
Reset, CLK
Virtual Camera Coordinates
Reset, CLK
3D Graphics Engine
Triangle 1
r,g,b,z
Triangle 2
r,g,b,z
...
r,g,b,z
Triangle n-1
r,g,b,z
Triangle n
r,g,b
vertex coordinates, color
Triangle Data Memory
VGA logic
hsync
vsync
blank
Reset, CLK
FPGA
r,g,b
hsync
vsync
blank
Audio
Screen
Speakers


Very 6.111
Such FPGA
So Project
Much Block Diagram

Project Completion Timeline	Week of 11/2	Week of 11/9	Week of 11/16	Week of 11/23	Week of 11/30	Week of 12/7
1. Graphics and VGA interface, order parts						
2. Gyroscope and controller game logic						
3. Audio module SW						
4. Interface gyroscope and controller HW						
5. Test integration of modules						
6. Buffer week for testing and/or catch up						
7. Demo and Checkoff						