3-Dimensional Pong Proposal Draft

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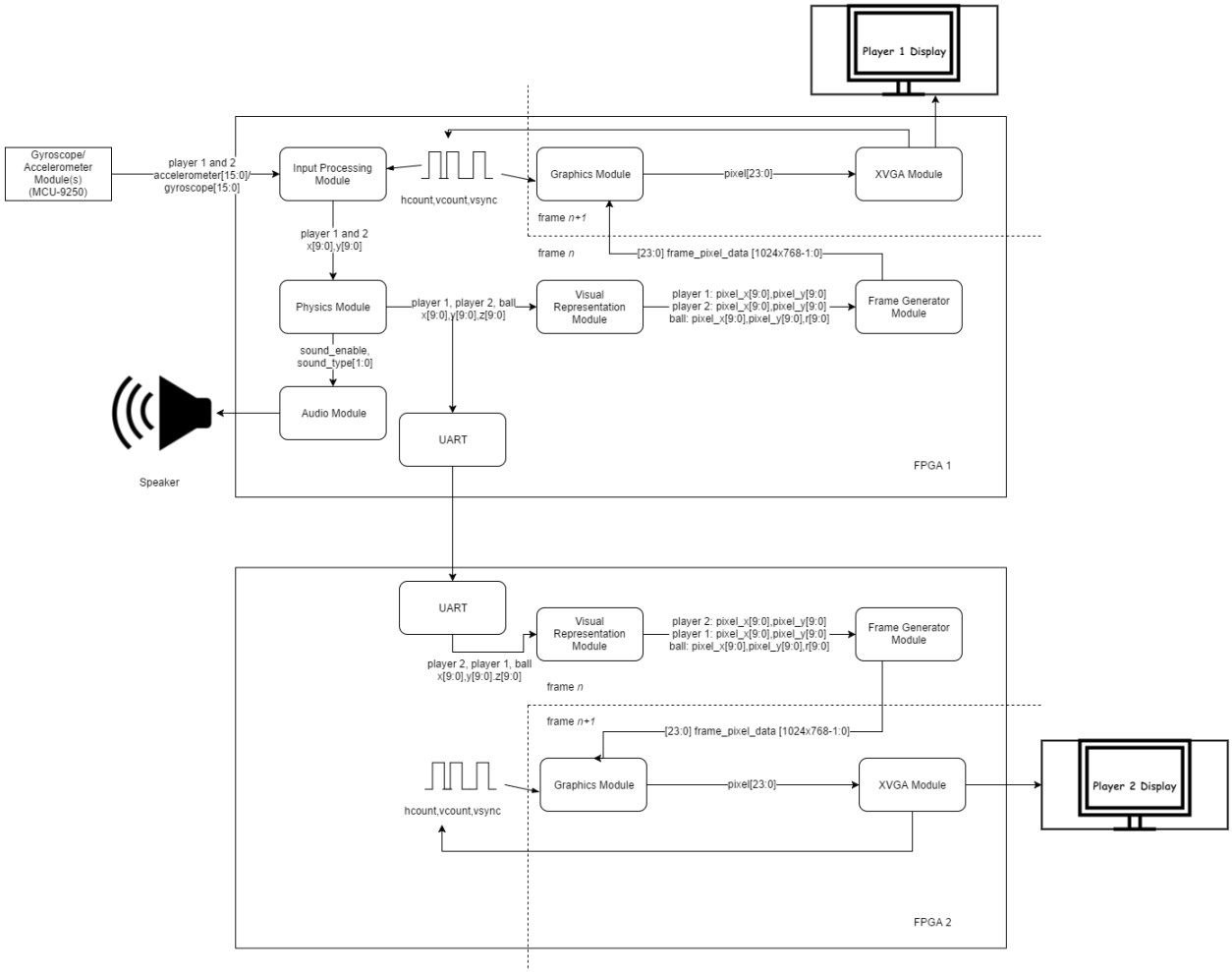
The project is inspired by the simple 2-D pong game from Lab 3. We aim to enhance the player experience by adding a third dimension to the game. The player will be able to either play against a second player, or against a computer. The project features a simple artificial intelligence engine that allows the computer to play against a human at various preselected skill levels, on which the computer's paddle accuracy and reaction speed would depend. For two-player mode, the game would be set up on two monitors such that each player can see the movement of both their paddle and their opponent's paddle. Additionally, extra hardware would be used to take in analog signals that control each player's paddle. An accelerometer will be used to control paddle movement across two dimensions, vertically and horizontally. A gyroscope will be used to control paddle angle whenever a player wishes to change the pong ball's direction upon striking.

Altogether, the project will be split up into eight modules, described in detail below

Diagram:



Modules:

Sensor Module:
Velocity readings from the accelerometer and angular velocity readings from the gyroscope are recorded in this module. The module ensures that data is properly fed through the physical sensors themselves. We anticipate wiring the sensors to the FPGA, in order to eliminate problems that are well associated with wireless connections.

Input Processing Module:
The input processing module takes as input the readings from the gyroscopic/accelerometer sensors and “cleans” this sensor data, into such a format that is conducive for calculations in the physics module, which will perform sequences of manipulations in 3-dimensional abstract space. Most of the “clean-up” involves discretizing the continuous analog data that is fed into the system by the sensors. Discretized data is then relayed over to the Physics module, described in further detail below.

Physics Module:
The physics module takes as input the output of the “Input” module and determines the absolute positions of the ball in 3-dimensional space. The physics module is distinct from its successor, the visual representation module, in that the physics module performs computations on an abstract 3-dimensional space, whereas the visual representation module performs the job of translating the data in abstract space to the 2-dimensional space of the screen.

Visual Representation Module:
Given the paddles and ball positions for this frame, this module computes the visual representation for the frame. The visual representation consists of pixel coordinates for the ball and paddles sprites (their true location on the screen), as well as scaling parameters for the sizes of the sprites. The visual representation will then be given to the Frame Generator Module.

Frame Generator Module:
Given the pixel coordinates and scaling parameters for the ball and paddle sprites, this module computes the frame data for the next frame. The frame data consists of 24 bit pixel values for each of the 1024x768 pixels on the screen. The Frame Generator would use the Memory Module to store this data and output it to the graphics module.
Graphics module - The graphics module takes the output of the frame generator module, and generates the data for rendering the graphics on the XVGA display. The output of the graphics module serves as the input for the XVGA module.

XVGA Module:

The XVGA module is an essential piece in the implementation of the 3-dimensional pong game. The XVGA is similar to the one in Lab 3, and will generate XVGA display signals that will be output to a monitor with an appropriate screen resolution via the VGA port on the FPGA.

Memory Module:
In order to ensure high performance, in that the game information can be fully computed on each rising edge of the hsync signal, we envision a scheme where on each step, the information needed to draw the next frame will be cached in memory. This is done to pipeline the implementation; at each following step, computing the data for a new frame and drawing the previous frame from the data in memory can occur in parallel.

Audio module:
To ensure that the game is realistic, we will incorporate an audio module which will add sound to the game. This was a feature that was not included in the 2-dimensional pong implementation in lab 3. We don't foresee this as a difficult module, but in terms of functionality, it is certainly valuable to have.

Splitting Work:

Our team consists of three members. Each member has different strengths in terms of hardware or software based experiences. Thus far, we foresee the work being proportioned as follows:

Hardware-based gyroscope and accelerometer/input data processing/Audio - Paul Kalebu
Physics, Graphics, XVGA - Louis Tao
Frame generator, Visual representation module - Miguel Rodriguez

Potential reach goals:

This is a project with many potential directions to go in, in terms of the input, graphics, physics, and playability of the game. We anticipate the following functionalities to be reach goals for this project:

- **Playability.** To enhance the playability of the 3-dimensional pong game, we will develop an AI which plays against the 1st player instead of just having two players play at once.

- **Graphics.** To make for a more entertaining gaming experience, the basic background of the game will be a grid of boxes that get smaller the further away they are from the front of the screen. If time and resources permit, these grids could be enhanced to light up whenever the ball is within a given grid.

- **Physics.** Given that the game is now three-dimensional, the game will involve gravity to control how the ball moves. The game will also have an option to adjust the gravitational

pull to determine the gaming experience. If time permits, we could perhaps include spin based on how the paddle makes contact with the ball.

External Components:
Outside the FPGAs, the project will require a set of two paddles, one for each player, a gyroscope for each paddle, an accelerometer for each paddle, and wires to connect the sensors on the paddles to the FPGAs. Since the wires are available in the lab, all that's left to obtain is the accelerometers and gyroscopes. We intend to purchase the sensors off Sparkfun with a total cost of about $80, but will also speak with the course instructors beforehand to get advice on more cost effective options.