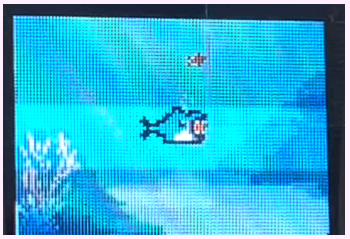
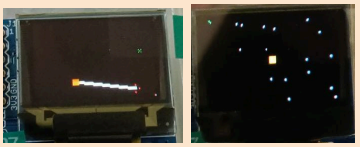
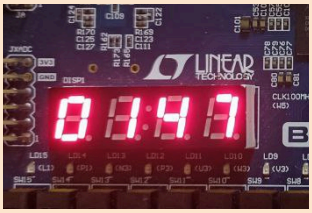
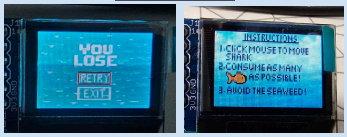
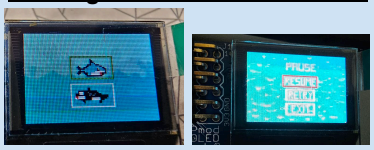
PERSONAL AND TEAM IMPROVEMENTS		
Student and Improvement Name	**Improvement Description**	**Images/Photos**
Team S1_12 “Famished Fish”	<u>Controls</u> btnU / btnD -> Scroll Menu Options btnC -> Choose Selected Menu Option btnL -> Previous Menu btnR -> Pause Game Mouse L/R-> Set Target Location For Shark to Swim To Middle Mouse Button -> Activate Shark Nitro **SW[3:0] Must be on for the game to start** <u>Intro</u> Our project is largely inspired by the Hungry Shark mobile game series. In Famished Fish, the player controls a shark displayed on the OLED to consume as much fish as possible before its satiety bar becomes empty. The player must continuously eat fish to replenish the bar. If satiety(all LED turns off) hits zero, the shark dies instantly, and the game ends. If the shark collides with seaweed at the bottom of the screen, the player is taken to a separate screen to “battle” the seaweed. Failing this challenge will end the game.	  
Student A: **Zhang Yijian** Cursor/Shark Control, Fish Spawn System, Shark Collision Mechanics, and Score Display	The target location is set using the left/right mouse button. Once a target location is chosen, the **shark will navigate towards the target location automatically** at a speed that is based on its current position and speed. **The target can be set dynamically even before the shark reaches the target location**, and the shark’s movement will be updated accordingly to match the new target location. The path the shark takes is indicated by the white line drawn on the screen. The ‘nitro’ feature allows the shark to move at 150% speed by adjusting various game timers. However, using ‘nitro will also decrease the satiety bar 150% faster. **There are three scenes in the game which the shark can traverse into.** The shark starts in the middle scene. If the shark reaches the border, it will be sent to the adjacent scene if it exists. If there is no adjacent scene (e.g. no scene to the left of the leftmost scene), the shark will remain at the border of the scene. **The fish spawn system uses a LFSR to randomise fish spawn locations at a set frequency.** Fish movements are handled at every game tick, **where a linear search is used to track all existing fish and move them down by one pixel.** A collision area (hit-box) was made for both the shark and the fish spawned to detect collision. The seven-segment display was also programmed to show the score, which increments whenever the shark successfully consumes the fish.	 Shark Pathing / Fish Spawn (Raw)  Shark Pathing / Fish Spawn (With Graphics)  Score Display

Student B: **Brian Chan** Main Menu, pause, end screen, guide, character design and control logic, LED Health Bar.	To access the main menu from the dynamic loading screen, you have to **enter a password which is "SW0 to SW3".** For the main, pause and end menu, **scroll up** and **down** the options using **btnU** and **btnD**. **Selection of the submenu** is done by pressing **btnC**, and **btnL** is reserved for **backtracking**. Debouncing was implemented for the menus. Highlighting of the box was done using the if else statement, based on x and y coordinates of the boundary. For character selection, when **on the character**, the box will be **red**. When a character is selected (by pressing **btnC**), it will be **green**. Control logic for characters is done by **outputting 1** into **a register**(select_shark/hammer) which is passed into the animation module, controlling the character selected. Created the initial logic for **pause and retry page (btnC to select, btn L backtrack)**, which was refined and integrated by Zhan Hao. LED health bar takes in 4 MAIN inputs, game_start, game_active, shark_eat_trigger, as well as y_pixel. Health Bar **starts at full** and **resets every game**. **Y_pixel** determines the **speed that LED turns off**. Consuming a fish **(shark_eat_trigger)** will **decrease the count (turn LED on)**. When **below 50% health**, the LED health bar will **flicker. When LED health bar is off,** game is over**(enter end screen)**	 **Health Bar**  **End screen and Instruction**  **Loading screen and main menu**  **Character selection and pause menu**
Student C: **Cai Jiali** Game Animation, Map design and LUT control	The visual elements in the main game were carefully designed to accommodate the OLED's low resolution, ensuring **clear and smooth animations**. Actions like the **shark's eating** were animated to enhance user experience, and both sharks have **mirrored versions** to provide a more natural feel **when moving left or right**. The **three-scene underwater map** was created, featuring details like **bubbles rising and shrinking** due to pressure and a **brightening sky** toward the top, enhancing realism. Seaweeds were designed to vary in size and shape to enrich gameplay, with each plant **individually controlled** to support gameplay mechanics. **Memory** limitations were **carefully managed** by separating the storage of dynamic objects like bubbles and static objects like the maps and storing complex graphics, such as the map, in block memory, reducing LUT usage, and optimising speed of bitstream generation.	
Student D: **Hoe Zhan Hao** Seaweed, Reset, and Pause Logic	Upon **colliding with seaweed** at the bottom of the screen, the player enters a minigame **utilising mouse movement and left-click**. Four seaweed strands appear on the OLED, highlighted in a **randomised sequence** for the players to follow. The sequence is determined by an **LFSR** generating random numbers from 0 to 23. A **0.5-second input delay** is implemented to prevent accidental clicks. If the player cuts the seaweed in the **correct order**, they return to the game, with the collided **seaweed disappearing** to simulate the shark's escape. An incorrect sequence results in an instant loss. Clicking "exit" or "retry" on the pause or lose screen triggers a **scene transition and game reset**. "Exit" redirects to the main menu, while "retry" returns the player to the game. In both cases, the score, satiety bar, and seaweed are reset. The game remains **paused** while in the main menu or pause screen.	 Seaweed highlighted in sequence  Seaweed disappears once the minigame is won

References

Map design:
https://www.freevector.com/vector/sea-animal

Seaweed design:
https://opengameart.org/content/dancing-seaweed

Main Menu Design:
Pixel Art Ocean Images - Free Download on Freepik

Shark/Orca Design:
Orca Killer Whale Pixel Art Icon Stock Vector (Royalty Free) 1083427289 | Shutterstock
Premium Vector | Cute shark in pixel art style

Pause, End, Main Menu Background:
Pixel art water background. Seamless sea texture backdrop. Stock Vector | Adobe Stock

Loading Screen Background:
Pixel Art Shark Photos, Images & Pictures | Shutterstock

BRAM:
https://circuitfever.com/store-an-image-on-fpga-verilog#google_vignette
https://nandland.com/lesson-15-what-is-a-block-ram-bram/

Usage of ChatGPT for miscellaneous tasks

pic2pixel.py: code for conversion of image to verilog code (framework generated by ChatGPT)

```
from PIL import Image

# Load the image
image = Image.open('image.png')

# Convert the image to RGB mode
image = image.convert('RGB')

# Get pixel values
pixels = image.load()
width, height = image.size

# Prompt the user for starting positions i and j
i = int(input("Enter the starting X position (i): "))
j = int(input("Enter the starting Y position (j): "))


# Convert RGB to 16-bit binary format (5:6:5 format)
def rgb_to_16bit(r, g, b):
    r_5bit = (r >> 3) & 0x1F  # Convert red to 5 bits
    g_6bit = (g >> 2) & 0x3F  # Convert green to 6 bits
    b_5bit = (b >> 3) & 0x1F  # Convert blue to 5 bits
    return f'{r_5bit:05b}{g_6bit:06b}{b_5bit:05b}'

# Function to output color ranges while traversing the image
def print_color_ranges(output_file):
    current_color = None
    x_start = None
    y_start = None
    prev_x = None
    prev_y = None


    for y in range(height):
        for x in range(width):
            r, g, b = pixels[x, y]  # Get RGB values of the current pixel

            # Skip the pixel if it matches the excluded color
            if rgb_to_16bit(r, g, b) == '0000000000000000':
                continue

            shark_color = rgb_to_16bit(r, g, b)  # Convert color to 16-bit binary

            # Check if this pixel continues the same range (same color and consecutive pixels)
            if current_color == shark_color and prev_x == x - 1 and prev_y == y:
                # Extend the current range
                prev_x = x  # Update the end of the range

            else:
                # If the color changes or it's not consecutive, finalize the previous range
                if current_color is not None and current_color != '0000000000000000':
                    if y_start == prev_y:
                        # Single row range
                        output_file.write(f"else if ((x >= i + {x_start} && x <= i + {prev_x}) && (y == j + {y_start})) oled_color <= 16'b{current_color};\n")
                    else:
                        # Multi-row range
                        output_file.write(f"else if ((x >= i + {x_start} && x <= i + {prev_x}) && (y >= j + {y_start} && y <= {prev_y})) oled_color <= 16'b{current_color};\n")

                # Start a new range
                current_color = shark_color
                x_start = x
                y_start = y
                prev_x = x
                prev_y = y

        # At the end of each row, we still need to finalize the current range
        if current_color is not None and current_color != '0000000000000000':
            if y_start == prev_y:
                # Single row range
                output_file.write(f"else if ((x >= i + {x_start} && x <= i + {prev_x}) && (y == j + {y_start})) oled_color <= 16'b{current_color};\n")
            else:
                # Multi-row range
                output_file.write(f"else if ((x >= i + {x_start} && x <= i + {prev_x}) && (y >= j + {y_start} && y <= {prev_y})) oled_color <= 16'b{current_color};\n")

# Save the output to a text file
with open("color_ranges_output.txt", "w") as output_file:
    output_file.write(f"Generating Verilog code with starting X (i) = {i} and starting Y (j) = {j}...\n\n")
    print_color_ranges(output_file)

print("The output has been saved to 'color_ranges_output.txt'.")
```

pic2coe.py: code for conversion of image to .coe file for BRAM (framework from the open source stated in reference and ChatGPT)

```
from PIL import Image

def rgb_to_16bit(r, g, b):
    """
    Convert RGB values to a 16-bit integer in 5:6:5 format.

    Args:
        r (int): Red component (0-255).
        g (int): Green component (0-255).
        b (int): Blue component (0-255).

    Returns:
        str: A 16-bit binary string representation of the color.
    """
    r_5bit = (r >> 3) & 0x1F  # Convert red to 5 bits
    g_6bit = (g >> 2) & 0x3F  # Convert green to 6 bits
    b_5bit = (b >> 3) & 0x1F  # Convert blue to 5 bits
    return f"{r_5bit:05b}{g_6bit:06b}{b_5bit:05b}"

def png_to_coe(png_file_path, coe_file_path, radix=16):
    """
    Convert a PNG image file to a .coe file with memory initialization for Vivado.

    Args:
        png_file_path (str): Path to the input PNG file.
        coe_file_path (str): Path to the output .coe file.
        radix (int): Radix for the memory values (16 for hexadecimal).
    """
    # Open the PNG image and convert it to RGB mode
    image = Image.open(png_file_path).convert('RGB')
    width, height = image.size

    # Prepare the header of the .coe file
    coe_content = f"memory_initialization_radix={radix};\n"
    coe_content += "memory_initialization_vector=\n"

    # Collect the RGB values as 16-bit data in 5:6:5 format
    color_data = []
    for y in range(height):
        for x in range(width):
            r, g, b = image.getpixel((x, y))
            # Convert RGB to 16-bit binary format (in 5:6:5 format)
            if radix == 16:
                color_data.append(f"{int(rgb_to_16bit(r, g, b), 2):04X}")  # Hexadecimal format
            else:
                color_data.append(rgb_to_16bit(r, g, b))  # Binary format

    # Join all pixel data with commas and add a semicolon at the end
    coe_content += ",\n".join(color_data) + ";\n"

    # Write to the .coe file
    with open(coe_file_path, 'w') as coe_file:
        coe_file.write(coe_content)

    print(f"Conversion complete! The .coe file is saved as {coe_file_path}")

# Usage example:
png_file_path = "settings.png"  # Replace with your PNG file path
coe_file_path = "settings.coe"  # Desired .coe file path
radix = 16  # Set radix as 16 for hexadecimal (Vivado usually uses hexadecimal)

png_to_coe(png_file_path, coe_file_path, radix)
```

newconverter.py: code for conversion of image to OLED data (Refined by ChatGPT)

```python
from PIL import Image

# Convert a 16-bit RGB value to the Verilog format (5-bit Red, 6-bit Green, 5-bit Blue)
def rgb_to_verilog(r, g, b):
    # Scale RGB values to their respective bit-widths
    red = (r >> 3) & 0b11111     # 5-bit Red
    green = (g >> 2) & 0b111111   # 6-bit Green
    blue = (b >> 3) & 0b11111     # 5-bit Blue

    # Combine into a 16-bit number
    verilog_color = f"16'b{red:05b}_{green:06b}_{blue:05b}"
    return verilog_color

# Convert image to 16-bit color parameters
def image_to_color_parameters(image_path):
    img = Image.open(image_path)
    img = img.convert("RGB")  # Ensure RGB mode
    img = img.resize((96, 64))  # Resize to 96x64 pixels
    width, height = img.size

    color_data = []

    # Iterate over each pixel and convert to Verilog 16-bit format
    for y in range(height):
        for x in range(width):
            r, g, b = img.getpixel((x, y))
            color_data.append(rgb_to_verilog(r, g, b))

    return color_data, width, height
```

```python
# Generate Verilog assignments for the OLED data array
def generate_verilog_assignments(color_array):
    verilog_assignments = []
    for i, color in enumerate(color_array):
        verilog_assignments.append(f"image_data_fin[{i}] = {color};")
    return '\n'.join(verilog_assignments)

# Example usage
image_path = 'C:\\EE2026\\pausepagefinal.png'  # Replace with your image path
color_array, img_width, img_height = image_to_color_parameters(image_path)

# Generate the Verilog assignments
verilog_output = generate_verilog_assignments(color_array)

# Write the Verilog output to a file
with open("verilog_output.txt", "w") as f:
    f.write("module image_data;\n")
    f.write("  reg [15:0] oled_data[0:6143];\n")  # 96x64 pixels = 6144 entries
    f.write("  initial begin\n")
    f.write(verilog_output + "\n")
    f.write("  end\n")
    f.write("endmodule\n")

print("Verilog output written to verilog_output.txt")
```

```
        color_data.append(pixel_to_color(r, g, b))

    return color_data, width, height

# Generate Verilog assignments
def generate_verilog_assignments(color_array):
    verilog_assignments = []
    for i in range(len(color_array)):
        verilog_assignments.append(f"oled_data[{i}] = {color_array[i]};")
    return '\n'.join(verilog_assignments)

# Example usage
image_path = 'C:\\EE2026\\famishedfish2.png'  # Replace with your
image path
color_array, img_width, img_height =
image_to_color_parameters(image_path)

# Generate the Verilog assignments
verilog_output = generate_verilog_assignments(color_array)

# Write the Verilog output to a file
with open("verilog_output.txt", "w") as f:
    f.write("module image_data;\n")
    f.write("  reg [15:0] oled_data[0:6143];\n")  # Adjust for the new size
    f.write("  initial begin\n")
    f.write(verilog_output + "\n")
    f.write("  end\n")
    f.write("endmodule\n")

print("Verilog output written to verilog_output.txt")


can you change this code to include ALL SPECTRUMS OF COLOUR
THAT CAN BE FORMED WITH 16 BITS thank you
```

```python
    img = img.convert("RGB")  # Ensure RGB mode
    img = img.resize((96, 64))  # Resize to 96x64 pixels
    width, height = img.size

    color_data = []

    # Iterate over each pixel and convert to Verilog 16-bit format
    for y in range(height):
        for x in range(width):
            r, g, b = img.getpixel((x, y))
            color_data.append(rgb_to_verilog(r, g, b))

    return color_data, width, height

# Generate Verilog assignments for the OLED data array
def generate_verilog_assignments(color_array):
    verilog_assignments = []
    for i, color in enumerate(color_array):
        verilog_assignments.append(f"oled_data[{i}] = {color};")
    return '\n'.join(verilog_assignments)

# Example usage
image_path = 'C:\\EE2026\\famishedfish2.png'  # Replace with your image path
color_array, img_width, img_height = image_to_color_parameters(image_path)

# Generate the Verilog assignments
verilog_output = generate_verilog_assignments(color_array)

# Write the Verilog output to a file
with open("verilog_output.txt", "w") as f:
    f.write("module image_data;\n")
    f.write("  reg [15:0] oled_data[0:6143];\n")  # 96x64 pixels = 6144 entries
    f.write("  initial begin\n")
    f.write(verilog_output + "\n")
    f.write("  end\n")
    f.write("endmodule\n")
```

Message ChatGPT

Using ChatGPT to refine debouncing:

```
  reg [3:0] btnU_count, btnD_count, btnC_count;
  wire btnU_debounced, btnD_debounced, btnC_debounced;
  parameter DEBOUNCE_THRESHOLD = 4'd15; // Adjust threshold
based on testing

  // Debounce
  always @(posedge clk) begin
    if (btnU && btnU_count < DEBOUNCE_THRESHOLD) begin
      btnU_count <= btnU_count + 1;
    end else if (!btnU) begin
      btnU_count <= 0;
    end

    if (btnD && btnD_count < DEBOUNCE_THRESHOLD) begin
      btnD_count <= btnD_count + 1;
    end else if (!btnD) begin
      btnD_count <= 0;
    end

    if (btnC && btnC_count < DEBOUNCE_THRESHOLD) begin
      btnC_count <= btnC_count + 1;
    end else if (!btnC) begin
      btnC_count <= 0;
    end
  end

  // Generate debounced signals
  assign btnU_debounced = (btnU_count ==
DEBOUNCE_THRESHOLD);
  assign btnD_debounced = (btnD_count ==
DEBOUNCE_THRESHOLD);
  assign btnC_debounced = (btnC_count ==
DEBOUNCE_THRESHOLD);
```

ChatGPT can make mistakes. Check important info.

If your debouncing logic is causing issues with skipping or unstable behavior, here's a simpler approach that should improve stability. This design works by counting stable clock cycles during which the button remains consistently pressed before confirming a valid press.

The following code uses two parameters, `DEBOUNCE_THRESHOLD` (to determine how many cycles a button press must be stable) and `RELEASE_THRESHOLD` (for ensuring the button is released fully before detecting the next press). This approach is often more stable, especially for slow or noisy button inputs.

verilog Copy code

```verilog
module button_debounce (
    input wire clk,
    input wire btn,     // Button input signal
    output reg btn_edge // Edge-detected output signal
);
    parameter DEBOUNCE_THRESHOLD = 16'd5000; // Adjust based on clock frequency
    parameter RELEASE_THRESHOLD = 16'd5000;  // Adjust as needed

    reg [15:0] debounce_count = 0;  // Counter for stable press duration
    reg [15:0] release_count = 0;   // Counter for stable release duration
    reg btn_stable = 0;             // Stable debounced signal
    reg btn_last = 0;               // Previous stable state

    always @(posedge clk) begin
        if (btn) begin
            // Button is pressed: increase debounce count, reset release count
            if (debounce_count < DEBOUNCE_THRESHOLD) begin
                debounce_count <= debounce_count + 1;
            end else begin
                btn_stable <= 1; // Button considered stably pressed
            end
            release_count <= 0;
        end else begin
            // Button is released: increase release count, reset debounce count
```

Message ChatGPT

ChatGPT can make mistakes. Check important info.