Hardware Design Final Project

**FPCAT – Battle Cat on FPGA**

Team 01

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# 1. Introduction

## 1.1 Motivation

一張含有 文字, 螢幕擷取畫面, 軟體, 網站 的圖片

自動產生的描述The Battle Cats has been my favorite mobile game since I was in elementary school.

▲ Figure 1.1: one of my Instagram post, kind of old

The stage and character designs are absolutely top-tier, even by today’s standards. To share the fun of playing The Battle Cats with more people, we plan to create our own version of the game using FPGA. By showcasing this project on our GitHub account, we hope to demonstrate the game's appeal.

## 1.2 Overview

We name our game by “FPCATS”, simply combine “FPGA” and “CATS”. Our game requires players to use mouse to operate. As for screen signals transmissions, we use VGA standard. At the start, the game begins with a **start scene**. After pressing the **start button**, the game transits to the **stage selection menu**. Players can choose from three stages, each with designated enemies assigned to them.

In the **game scene**, players will have access to buttons for **cats**, **tower**, **purse**, and **pulse(a button on FPGA)**. To **summon cats**, players must accumulate enough money, which can be earned over time. The **tower** can emit air cannon after it finishes charging. Players can also spend money to expand the **purse capacity** andspeed up **money’s accumulation**.

The goal is to destroy the enemy tower using the player’s cats. If the player’s cats succeed, the player wins. If the enemy destroys the player’s tower, the player loses.

After triggering the **win scene** or **lose scene**, players can return to the **stage selection menu** by clicking mouse.

//TODO: Top module

# 2. Game Interface and Workflow

## 2.1 Start and Menu Scene

一張含有 文字, 字型, 螢幕擷取畫面, 圖形 的圖片

自動產生的描述 一張含有 文字, 螢幕擷取畫面, 字型, 數字 的圖片

自動產生的描述▲ Figure 2.1.1: Start scene ▲ Figure 2.1.2: Menu scene

## 2.2 Play Scene

一張含有 文字, 螢幕擷取畫面, 卡通 的圖片

自動產生的描述 一張含有 文字, 螢幕擷取畫面, 卡通 的圖片

自動產生的描述

▲ Figure 2.2.1: play scene demo 1 ▲ Figure 2.2.2: play scene demo 2

## 2.3 Win and Lose Scene

一張含有 文字, 螢幕擷取畫面, 字型, 卡通 的圖片

自動產生的描述 一張含有 文字, 螢幕擷取畫面, 字型, 卡通 的圖片

自動產生的描述

▲ Figure 2.3.1: Win scene ▲ Figure 2.3.2: Lose scene

# 3. Game Material Design (Johnny)

## 3.1 Character Design

- each 6 pics, statistics

因為我們的FPGA板memory capacity不大，所以在設計角色之前，我們就先花了一些時間思考如何解決空間不夠的問題，最後我們想出來的解法有:

1. 減少顏色數量，以節省coe檔案每個value的bit數，之後用Mux選擇要渲染的顏色
2. 減少圖片的長寬pixel數，之後在取addr時再根據放大倍率決定每個addr重複取幾次

在實際執行的部分，

- IPs for enemy queue

# 4. Game Engine

- Display Time & Blanking Time

## 4.1 Storage Protocols

## 4.2 Character FSM

## 4.3 Game State FSM

# 5. Graphics Rendering

## 5.1 Rendering Module Architecture

- scene change, tint technique

## 5.2 Layer Implementation

### 5.2.1 Statis Objects

### 5.2.2 Characters

# 6. Conclusion

## 6.1 Gameplay Demonstration

## 6.2 Comparison with Original Game

## 6.3 What We Learned

# A. Appendix

## A.1 Contribution

## A.2 Python Tool - PNG to COE