Raspberry Pi-Powered Arcade Machine with RetroPie

Cagri Goksu Ustundag

IT Project Volunteer

Digital Inclusion A.S.B.L.

1, Dernier Sol, Bonnevoie, L-2543

September 2025, Luxembourg

Table of Contents

List of Figures

1 Introduction

Arcade gaming remains a popular form of entertainment, combining nostalgia with interactive fun. This project demonstrates how to recreate an arcade machine using modern hardware and software, providing both a practical guide and a complete playable system.

1.1 Project Overview

This project focuses on building a fully functional arcade machine using a Raspberry Pi and the RetroPie platform. It combines classic arcade controls such as joysticks and buttons with modern hardware and software to recreate the arcade machine system. The system is designed to run on a compact setup, with games loaded from an SD card.

1.2 Objectives

The main goal of this project is to deliver a complete, working arcade machine that blends hardware assembly with software configuration. It aims to demonstrate how to integrate physical controls with a Raspberry Pi, set up and manage pre-made images of RetroPie efficiently across different operating systems. Beyond just building the machine, the project also seeks to provide a clear, reproducible guide so that others can replicate the setup, customize their controls, and maintain the system, ensuring reliable functionality and usability.

2 Hardware Components

This chapter outlines the essential hardware components needed to build a fully functional arcade machine using a Raspberry Pi and RetroPie. From the display to the input controls, each piece plays a critical role in delivering the project.

2.1 General Hardware Components

The core of the arcade machine on Raspberry Pi relies on a few key hardware elements that bring the system to life.

- Raspberry Pi 3B+
- Screen (Raspberry Pi 3B+ supports HDMI)
- 5V-3A micro-USB power supply (to power Raspberry Pi)
- SD card (to store RetroPie and game ROMs)
- Input devices (keyboard, joystick, and buttons)
- Speaker (3.5mm audio jack, preferably USB-powered, optional)

2.2 Input Controls

The core of the arcade machine lies in its input controls, which give the ability to configure the system and play the games. The joysticks, mounted securely to the control panel, enable precise directional input to navigate menus and gameplay. The arcade buttons are arranged to handle actions such as jumping, shooting, or selecting options. A USB encoder connects these controls (joystick and buttons) to the Raspberry Pi, translating physical inputs into digital signals that RetroPie can interpret. The keyboard input is used solely to configure the machine.

3 SD Card Preparation

Before the arcade machine can run, the Raspberry Pi needs a bootable SD card with the RetroPie image. This chapter explains how to extract an image from an existing SD card for backup and how to write a new image to an SD card. Instructions are provided for both Windows and Linux-based systems (e.g., Ubuntu, Debian, ...).

3.1 Extracting Images from SD Card

Extracting an image from an SD card creates a complete backup of the system. The extracted image can be written to an SD card in order to run the games on multiple arcade machines. This method is also useful to keep a copy in case of corruption.

3.1.1 Windows

On Windows, the simplest tool for extracting SD card images is **Win32 Disk Imager**.

1. Download and install Win32 Disk Imager.
2. Insert the SD card into your computer using an SD card reader.
3. Open the program and select the drive letter that corresponds to your SD card.
4. Choose a location and filename for the image file (`.img`).
5. Click **Read** to copy the SD card contents into the image file.

3.1.2 Linux

On Linux-based systems, SD card images can be extracted using the `dd` command.

1. Insert the SD card into your computer.

2. Identify the device name using `lsblk` (e.g., `/dev/sda`). **Note:** device name can be different than `/dev/sdX` depending on your operating system

3. Run the following command in a terminal:

```
sudo dd if=/dev/sdX of=~/backup.img bs=4M status=progress
```

Replace `sdX` in `/dev/sdX` with the correct device name, and then wait for the process to complete. In case of an interruption during the process, retry step 3.

3.2 Writing Images to SD Card

Writing an image to the SD card installs the RetroPie system. This process erases all data on the card, so ensure that any important files are backed up before proceeding.

3.2.1 Windows

On Windows, tools like **balenaEtcher** or **Win32 Disk Imager** can be used.

1. Download and install balenaEtcher (recommended for simplicity).

2. Insert the SD card into your computer.

3. Open balenaEtcher and select the RetroPie image file (`.img` or `.zip`).

4. Select the target SD card.

5. Click **Flash** and wait for the process to finish.

3.2.2 Linux

On Linux-based systems, an image can be written with the `dd` command.

1. Insert the SD card into your computer.

2. Identify the device name using `lsblk` (e.g., `/dev/sda`). **Note:** device name can be different than `/dev/sdX` depending on your operating system

3. Use the `dd` command:

```
sudo dd if=retropie.img of=/dev/sdX bs=4M status=progress conv=fsync
```

Replace `retropie.img` with the image filename and `/dev/sdX` with your SD card device. Once the process completes, safely eject the SD card. This SD card is ready to be used to boot up the Raspberry Pi with RetroPie.

4 Arcade Machine Setup

This chapter explains how to assemble the arcade machine hardware and install the software needed to run RetroPie on the Raspberry Pi.

4.1 Hardware Assembly

The hardware assembly stage involves preparing and connecting all physical components of the arcade machine. This includes mounting the joysticks and buttons, wiring them to the USB encoder, and linking the encoder and other peripherals to the Raspberry Pi.

4.1.1 Installing Joysticks and Buttons

Mount the joysticks and buttons onto the arcade panel, securing them firmly with screws or mounting plates. Ensure that the buttons are arranged in a comfortable layout for gameplay. While the layout can be adjusted to personal preference, this project follows the configuration shown below.

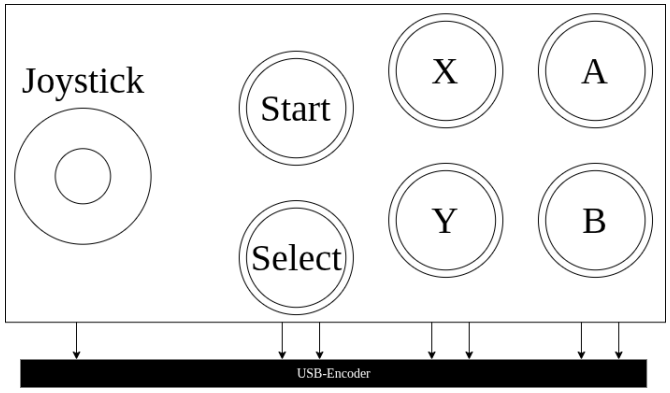

Figure 4.1: Joystick and button layout.

4.1.2 Connecting USB Encoder

Attach the button and joystick wires to the USB encoder according to Figure 4.2. The encoder converts physical inputs into signals recognized by the Raspberry Pi over USB. Note that the joystick uses 5-pin, arcade buttons use 3-pin cable for connection.

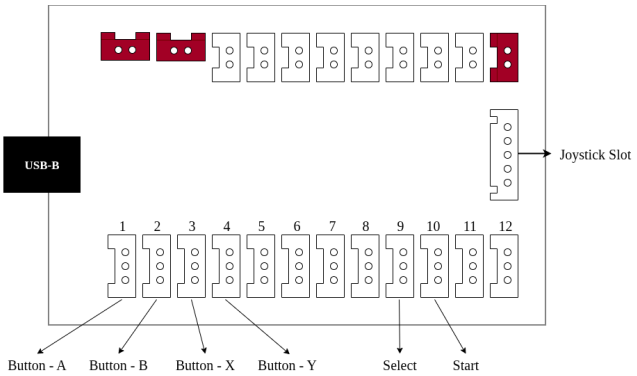

Figure 4.2: USB-encoder wiring schema.

4.1.3 Wiring to Raspberry Pi

In order to complete the setup, all connections must be completed before running Raspberry Pi. Connect the USB encoder to the Raspberry Pi using a standard USB cable. Also connect a keyboard to Raspberry Pi using USB port. A display must be connected to HDMI port. Connecting a speaker is optinal. These steps provides all the necessary connections to complete the hardware assembly, except power supply. Once micro-USB power is inserted to the Raspberry, the system will start up. Figure 4.3 shows the fully-connected system schema.

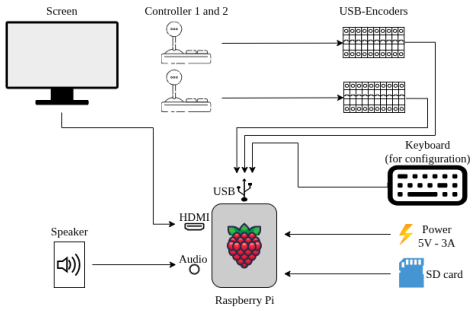

Figure 4.3: Fully-connected system schema.

4.2 Software Installation

Raspberry Pi doesn't have any storage unit than the SD card. It requires a SD card with a system image to boot up. In this project, RetroPie image in the SD card runs on the Raspberry Pi.

4.2.1 Booting from SD Card

Insert the prepared SD card with the RetroPie image into the Raspberry Pi and power it on. On first boot, the system will expand the filesystem and load into the RetroPie setup screen, where initial configuration and controller mapping can be completed.

5 Configurations

After assembling the arcade machine and installing RetroPie, it is necessary to configure inputs and interface settings to ensure proper operation. This chapter explains how to map keyboard and joystick inputs, adjust UI modes, and manage game visibility.

5.1 Emulator Input Mapping

Input mapping allows the emulator to recognize user actions correctly, whether from a keyboard or physical arcade controls. Proper mapping ensures that commands, movements, and hotkeys work as intended. Input mapping is configured through the "Configure Input" menu. When you first connect a controller or arcade buttons, EmulationStation will automatically prompt you to assign each button and joystick direction. This menu also allows to define hotkeys for system commands, such as exiting a game or opening the RetroPie menu.
The menu is accessible in RetroPie screen, by pressing the assigned `Start` button to enter the main menu and selecting `Configure Input`.

5.1.1 Keyboard

Keyboard inputs are mainly used for configuration and system navigation. To set up keyboard controls:

1. From the RetroPie main menu, navigate to **Configure Input**.
2. Follow the on-screen prompts to assign keys for system functions, hotkeys, and navigation.

5.1.2 Joystick and Buttons

Joystick and button mapping is used exclusively for gameplay. RetroPie automatically detects new controllers on startup. To configure:

1. Navigate to main menu, and then **Configure Input**.
2. Follow the on-screen instructions to map each direction and button to the corresponding arcade control.

5.2 Emulator UI Settings

RetroPie allows customization of the user interface to control visibility, accessibility, and navigation. These settings help secure configurations and make the arcade machine user-friendly.

5.2.1 UI Mode Settings

RetroPie supports three UI modes: Full, Kiosk, and Kid mode. To configure:

1. From the main menu, go to **RetroPie → Configuration → UI Settings**.
2. Choose the desired mode:
   - **Full Mode** – Complete access to all menus and settings.
   - **Kiosk Mode** – Simplified interface hiding advanced menus.
   - **Kid Mode** – Restricts access to configuration screens to prevent accidental changes by gamers.
3. To temporarily return to Full mode while in Kid mode, press Up, Up, Down, Down, Left, Right, Left, Right, B, A buttons in this order.

5.2.2 Game Settings

Game metadata determines which games are visible in each UI mode:

1. Navigate to **RetroPie → Configuration → Game Settings**.
2. Edit metadata such as genre, rating, or tags to categorize games.
3. Only games tagged appropriately for Kid mode will appear when the arcade is running in that restricted mode, ensuring children access approved games.
4. Full mode will display the complete library for administrative purposes.