

Embedded Systems Project Proposal

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BameGoy Hardware Emulator

Summary

We aim to use the DE1-SoC development board to emulate a classic GameBoy capable of playing a multitude of games via ROM files uploaded via a User Interface on the monitor. It will be able to run any game made for the 1989 GameBoy.

Alongside the core CPU module, we will use a small speaker for audio, an NES controller for buttons, and a monitor for visuals. The diagram (Figure 1) illustrates a block diagram that we will attempt to model and use to guide our development.

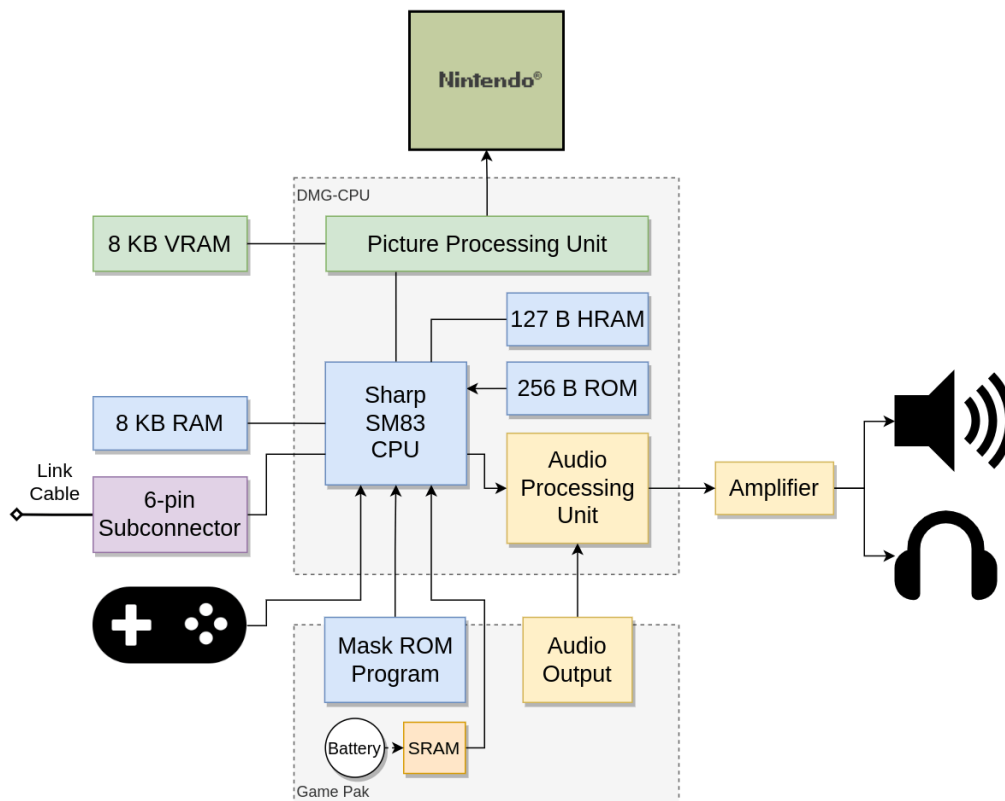


Figure 1: GameBoy block diagram

Hardware

The CPU will be modeled off of the GameBoy Sharp SM83 CPU (5). We will use a VGA connector for the PPU to translate to the monitor. In place of GameBoy game cartridges, we will use online ROM files to upload games. Audio output will be handled with a small speaker. Lastly, we will use a NES controller for user inputs to create a more holistic user experience.

The original GameBoy has a 16 bit address space, which maps to about 64KiB of memory. 32kiB of this is allocated to the cartridge; however, most games tend to be much larger than this. To circumvent this, the GB Cartridge implements a Memory Bank Controller to bank switch different parts of the ROM to the limited memory. We will have to emulate this memory bank controller in our FPGA.

To test, we will make Verilator testbenches and GTK wave to debug the various modules. In addition, we will complete the video modules earlier, in order to make debugging easier.

Software

The software will handle the uploading of the ROM to FPGA Block Ram, and the handling of the NES controller inputs. A general representation of the system architecture can be found in Figure 2, where we will handle ROM to FPGA in the absence of the game cartridge.

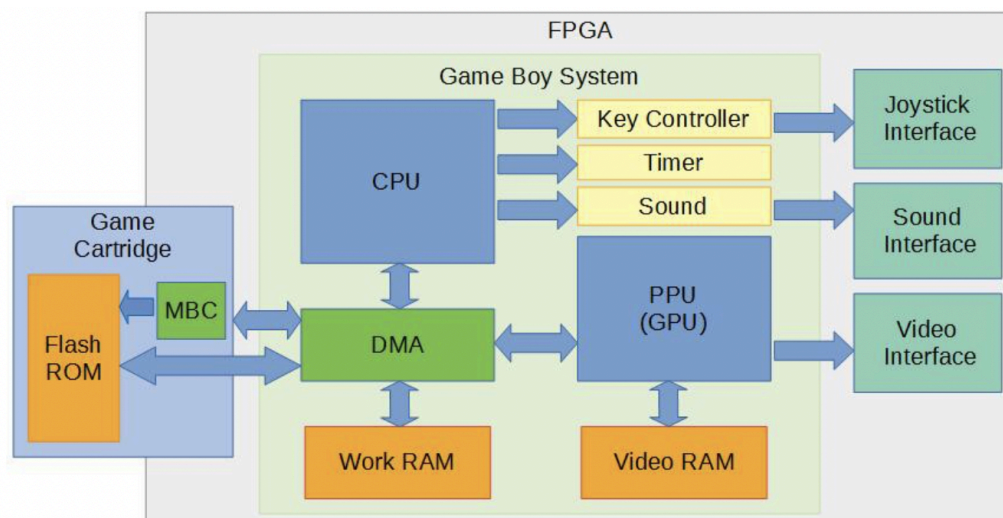


Figure 2: GameBoy system architecture

Milestones

1. March 31 - CPU module complete
2. April 12 - Video and Controller Interface complete
3. April 21 - Memory Bank Controller (loading ROMs) and audio complete

References

1. GameBoy block diagram - Figure 1:
<https://www.copetti.org/writings/consoles/game-boy/>
2. GameBoy system architecture - Figure 2:
<https://hackaday.io/project/57660-verilogboy-gameboy-on-fpga>
3. Open GameBoy Documentation Project <https://mgba-emu.github.io/gbdoc/#cpu>
4. GameBoy FPGA Project Notes:
<https://eli.lipsitz.net/posts/fpga-gameboy-emulator/#hardware-description-languages>
5. Game Boy CPU (SM83) instruction set (JSON): <https://gbdev.io/gb-opcodes/optables/>