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COMPARATIVE ANALYSIS OF CHEAP SINGLE-BOARD COMPUTER FOR OPTIMAL PERFORMANCE IN NINTENDO WII EMULATION

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Abstract
This research paper provides a comparative analysis of Single-Board Computers (SBCs) within a price range of $125 for optimal Nintendo Wii emulation performance. The objective is to identify the most suitable and cost-effective SBC capable of running Nintendo Wii games with high emulation performance and smooth action. Through installation, configuration, and testing using the Dolphin emulator on multiple platforms (Windows, Android, iOS, macOS, and Linux), it was determined that the Orange Pi5B with 4GB of memory provided the best performance, enabling smooth emulation of the majority of Nintendo Wii games. This research will aid vintage gaming enthusiasts and researchers in selecting a high-performance SBC for Nintendo Wii emulation within a reasonable budget.
Additionally, benchmarking metrics will be developed to uniformly assess each SBC's performance. The capacity to handle resource-intensive games is one of these measures, along with average frame rates, minimum and maximum frame rates. Through surveys and user testing, user experience and feedback will be obtained, taking into account elements like simplicity of setup, user interface, and general satisfaction.
We offer useful insights and suggestions for players, console producers, and system designers looking to enhance gaming experiences on the Nintendo Wii emulation through this review. The results of this study are an invaluable tool for making well-informed choices about hardware upgrades, system customization, and upcoming developments in gaming technology. We support the continued development of game emulations and the improvement of gaming experiences by dissecting the complexity of these SoC architectures.

Keywords: SBC; Nintendo Wii, Emulation, Dolphin Emulator.

Introduction

Single-board computers (SBCs) have revolutionized computation and digital entertainment since their introduction. These portable and flexible devices provide a cost-effective solution for a variety of applications, including retro gaming. The resurgence of interest in classic gaming consoles such as the Nintendo Wii has made the emulation of such systems a popular activity among enthusiasts and gamers. However, obtaining optimal performance in Nintendo Wii

emulation on SBCs is difficult due to the console's complex hardware and stringent requirements. (1)

Released in 2006, the Nintendo Wii introduced a revolutionary gaming experience with its motion-based controls and vast library of immersive games. As the console has aged, many users have sought to rekindle their nostalgia by emulating Wii games on contemporary hardware. With their compact size and adequate processing capacity, SBCs have emerged as a viable option for emulating Wii games.

This research paper's primary objective is to conduct a thorough comparative analysis of various SBCs for attaining optimal performance in Nintendo Wii emulation. By evaluating a variety of SBCs, we hope to determine the most suitable platform for handling the emulation requirements of Wii games. This analysis will take into account critical factors such as processing power, graphics capabilities, memory, and overall performance to determine the SBCs that offer the greatest potential for immersive and pleasurable gaming.

To accomplish our research objective, we will employ the Dolphin Emulator, a widely recognized and highly esteemed Nintendo Wii game emulator. Dolphin Emulator is renowned for its compatibility and capacity to replicate the original console's functionality. We will evaluate the performance of a selection of SBCs in terms of frame rates, graphical fidelity, audio quality, and overall gameplay stability by evaluating them with Dolphin Emulator. We will also evaluate the compatibility of each SBC with Wii titles, focusing on the emulation of Wii-specific features such as motion controls and Wii Remote functionality.

In addition to performance testing, we will establish benchmarking metrics in order to consistently evaluate SBCs. These metrics will consist of average frame rates, minimum and maximum frame rates, and the ability of SBCs to manage resource-intensive games. User experience and feedback will also be collected via surveys and user testing in order to gain insight into factors such as setup simplicity, user interface, and overall satisfaction.

Retro gaming enthusiasts, aficionados, and developers will gain valuable insights into the performance capabilities of various SBCs for Nintendo Wii emulation as a result of this research. By comprehending the advantages and disadvantages of various SBCs, individuals can select the gaming platform that best meets their requirements. In addition, the findings of this study can contribute to the growth of the retro gaming community by encouraging the development of enhanced and immersive gaming experiences on SBC platforms.

In the following sections, we will delve into the methodology used for testing and evaluating the SBCs, discuss the concept of Nintendo Wii emulation, examine the features and requirements of the Dolphin Emulator, and provide a literature review pertaining to SBCs and retro gaming emulation. Through this investigation, we hope to provide a comprehensive resource for those who wish to optimize their Nintendo Wii emulation experience on SBC platforms.

SBCs are comprehensive computer systems constructed on a single circuit board. They combine essential components such as a central processing unit (CPU), memory, storage, input/output terminals, and other peripheral interfaces onto a single circuit board. SBCs are designed to be small, energy-efficient, and affordable, making them suitable for a variety of applications.

SBCs typically incorporate a processor, which can range from low-power options such as ARM-based processors to more potent x86 processors. Depending on the model and intended

application, the quantity of memory available on an SBC can range from several hundred megabytes to multiple gigabytes.

In addition to the CPU and memory, SBCs typically include graphics capabilities for display output. They may include HDMI, VGA, or additional video interfaces for connecting to monitors or displays. Some SBCs offer expansion slots or connectors to accommodate peripherals such as USB devices, Ethernet ports, Wi-Fi modules, and audio interfaces.

SBCs are flexible and can operate a variety of operating systems, including Linux distributions, Android, and specialized embedded operating systems. This versatility enables their use in a wide variety of applications, including robotics, Internet of Things (IoT) projects, digital signage, home automation, and, in this instance, vintage gaming emulation.

Due to their diminutive size, deferent cost, and sufficient processing capacity to run emulation software, SBCs have gained popularity in the retro gaming community. They offer a convenient platform for operating emulators such as Dolphin, enabling users to play games from older consoles such as the Nintendo Wii.

As a result of advances in SBC technology, more recent models feature enhanced processing power, graphics capabilities, and connectivity options. This allows them to support more demanding emulation requirements and provide a more fluid gaming experience.

In the context of this study, the objective of the comparative analysis of SBCs for optimal performance in Nintendo Wii emulation is to identify the most appropriate SBC platform for effectively emulating Wii games. By evaluating various SBC options, we can determine the hardware that offers the optimal balance of processing power, graphics capabilities, memory, and overall performance to provide retro gaming enthusiasts with an immersive and pleasurable gaming experience.

Single-Board Computers (SBCs) are selected for use in the research based on their availability, compatibility with the Dolphin Emulator, and performance capabilities, among other considerations. Nevertheless, the following popular SBC models could be evaluated for their efficacy in Nintendo Wii emulation, the below table include the selected SBCs price with their chips and other equipment's types.

TABLE I: SBCS CHIPS TYPES AND PRICE COMPARESTION

Item	Raspberry Pi 4	Nvidia Jetson Nano	Orange Pi5B	ODROID N2L	Khadas VIM3
Chip	Broadcom BCM2711	Tegra X1 T210	Rockchip RK3588S	Amlogic S922X	Amlogic A311D
CPU Type	Quad core Cortex-A72	Quad Core Cortex-A57	Quad Core Cortex-A76, and Quad Core Cortex-A55	Quad Core Cortex-A73, and Dual Core Cortex-A53	Quad Core Cortex-A73, and Dual Core Cortex-A53
Memory Type	LPDDR4	LPDDR4	LPDDR5	LPDDR4	LPDDR4X
GPU Type	Boardcom VideoCore VI	128-core NVIDIA Maxwell	ARM Mali-G610 MP4	ARM Mali-G52 MP6	ARM Mali-G52 MP4
Storage Type	Micro SD	eMMC 5.1	eMMC	eMMC	eMMC
Price	$57	$149	$90	$69	$160

The Raspberry Pi4 is a popular and extensively utilized Single-Board Computer. It features a quad-core ARM Cortex-A72 CPU operating at up to 1.5 GHz, providing a significant increase in processing capacity over previous Raspberry Pi models. The Raspberry Pi 4 is offered with RAM configurations ranging from 1GB to 8GB, providing flexibility based on the needs of the user. It also incorporates a VideoCore VI GPU, which supports graphics processing hardware acceleration. Multiple USB interfaces, Ethernet connectivity, HDMI output, and wireless connectivity options make the Raspberry Pi 4 a versatile SBC suitable for a variety of applications. (2)

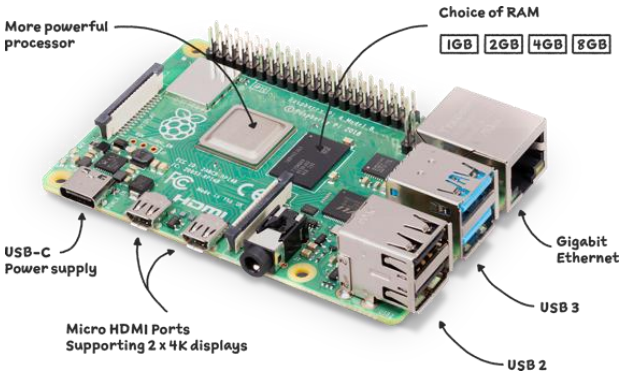

Image 1 – Raspberry Pi 4B SBC

The Nvidia Jetson Nano is a developer-oriented Single-Board Computer designed for artificial intelligence and robotics applications. It is equipped with a powerful quad-core ARM Cortex-A57 CPU and an Nvidia Maxwell GPU with 128 CUDA processors. This configuration offers exceptional computational performance for a variety of duties, including graphics-intensive applications. The Jetson Nano features four gigabytes of LPDDR4 RAM in addition to USB, Ethernet, HDMI, and wireless connectivity options. It offers a dedicated hardware video decoder and encoder, which can improve the efficacy of video playback for emulation purposes. (3)

The Orange Pi5B is a powerful Single-Board Computer (SBC) with an outstanding price-to-performance ratio for retro gaming and other applications. It has a Rockchip RK3588S SoC with a Quad Core Arm Cortex-A76, and Quad Core Arm Cortex-A55 CPU and ARM Mali-G610 MP4 GPU. The SBC has 4GB of LPDDR4 memory, which is sufficient for demanding duties such as Nintendo Wii emulation. In addition, it features Gigabit Ethernet, USB 3.0 interfaces, HDMI output, and an SD card slot. The Orange Pi5B is an attractive option for retro gaming enthusiasts due to its remarkable processing power, graphics capabilities, and comfortable price. (4)

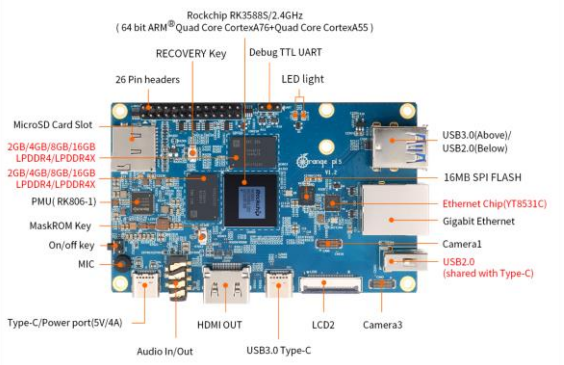

Image 2 – Orange Pi5B SBC

ODROID N2L: is a noteworthy Single-Board Computer that provides dependable performance for a variety of applications, including Nintendo Wii emulation. It is equipped with an Amlogic S922X SoC that includes a quad-core ARM Cortex-A73 CPU, a quad-core ARM Cortex-A53 CPU, and an ARM Mali-G52 MP6 GPU. The ODROID N2L's 4GB of LPDDR4 memory is sufficient to perform the computational requirements of Nintendo Wii games. In addition, it features Gigabit Ethernet, USB 3.0 interfaces, HDMI output, and an SD card slot. The ODROID N2L provides adequate Nintendo Wii emulation performance, albeit with some limitations in comparison to more powerful SBCs. (5)

The Khadas VIM3 is a versatile Single-Board Computer with remarkable performance and a small form factor. It is propelled by an Amlogic A311D SoC with a quad-core ARM Cortex-A73 CPU, a dual-core ARM Cortex-A53 CPU, and an ARM Mali-G52 MP4 GPU. The Khadas VIM3's 4GB of LPDDR4 memory price is 160$, it is out of our target budget but we put it because provides substantial computational resources for Nintendo Wii emulation, as well as for better competition with the others, in addition to check Amlogic A311D capability. The SBC offers multiple connectivity options, such as Gigabit Ethernet, USB 3.0 interfaces, HDMI output, and an SD card slot. The Khadas VIM3 provides commendable performance for Nintendo Wii emulation, making it a viable option for fans of vintage video games. (6)

On the basis of their price, performance, processing capacity, graphics capabilities, and compatibility with the Dolphin emulator, these SBCs were evaluated. With its remarkable performance and reasonable price, the Orange Pi5B has become the recommended option for retro gaming enthusiasts seeking optimal performance in Nintendo Wii emulation on a budget of 125 USD or less, table 2 includes the selected SBCs performance that used in this article.

TABLE II: SBCS USED PERFORMANCE COMPARESTION

Item	Raspberry Pi 4	Nvidia Jetson Nano	Orange Pi5B	ODROID N2L	Khadas VIM3
CPU	4 x 1.5 GHz	4 x 1.43 GHz	4 x 1.8 GHz 4 x 2.4 GHz	4 x 1.8 GHz 2 x 1.9 GHz	2 x 1.8 GHz 4 x 2.2 GHz
RAM	4GB	4GB	4GB	4GB	4GB
GPU	500 MHz	921 MHz	1 GHz	800 MHz	820 MHz
Storage	16 GB	16 GB	16 GB	16 GB	32 GB
Display	4K @ 60fps	4K @ 60fps	8K @ 60fps	4K @ 60fps	4K @ 60fps

II. NINTENDO WII

The Nintendo Wii, a seventh-generation home video game console developed by Nintendo came with an IBM PowerPC Broadway @ 729 MHz CPU, Memory 24 MB 1T-SRAM @ 324 MHz (2.7 GB/s) + 64 MB GDDR3 SDRAM, and 512 MB storage (NAND flash memory), and ATI Hollywood @ 243 MHz, was unveiled in 2006 and became an international sensation almost immediately. The Wii, in contrast to its competitors, introduced a motion control system that revolutionized the way players interacted with video games. The console's innovative features and extensive game library helped make it one of Nintendo's best-selling consoles ever. (7)

Image 01 – Nintendo Wii Console (7)

The Nintendo Wii was designed to appeal to a diverse audience, including both avid enthusiasts and families and casual players. The Wii Remote, a motion-sensing controller that enabled players to interact with games through physical gestures, was the console's defining feature. The accelerometer and infrared sensors of the Wii Remote allowed for precise tracking of player movements, thereby introducing a new level of interactivity and immersion.

In addition, the Wii console debuted the Nunchuk, a secondary controller that added analog stick control and additional buttons to a variety of game genres. The combination of the Wii Remote and Nunchuk provided intuitive and engaging gameplay, making the system accessible to players of all talent levels.

In terms of software, the Nintendo Wii featured an extensive catalog of games spanning multiple genres, from family-friendly titles such as "Wii Sports" and "Mario Kart Wii" to more traditional games such as "The Legend of Zelda: Twilight Princess" and "Super Smash Bros. Brawl." The console's extensive library of games catered to a variety of interests and preferences, providing players with a diverse and pleasurable gaming experience.

The Wii also introduced the concept of "Wii Channels," which offered features and services outside of gaming. Channels like the Mii Channel enabled players to create customized avatars, while the Virtual Console provided access to a variety of classic games from previous Nintendo consoles. The Wii Shop Channel allowed users to download additional titles and content, thereby expanding the library of the console.

The success of the Nintendo Wii can be attributed to its innovative hardware, distinctive motion control system, and extensive library of engaging games. Its approach to accessibility and family-friendliness expanded the console's appeal beyond the traditional gaming audience, attracting the interest of casual users and non-gamers.

While the Wii console remains popular among retro gaming enthusiasts, the introduction of emulation on modern platforms has expanded the ways in which Wii games can be played. Emulators, such as the Dolphin Emulator, enable users to play Wii games on diverse hardware, such as SBCs, PCs, and even smartphones. This study intends to investigate the performance capabilities of SBCs for Nintendo Wii emulation, thereby contributing to the preservation and enjoyment of Wii games for future generations.

III. RETRO GAMES

Retro games are video games that were developed and released during earlier periods of gaming history, typically between the 1970s and the beginning of the 2010s. The Atari 2600, Nintendo Entertainment System (NES), Sega Genesis, Super Nintendo Entertainment System (SNES), PlayStation, and Nintendo Wii are frequently associated with these titles.

Retro games are distinguished from modern games by their distinct graphical designs, limited color palettes, pixelated graphics, and limited audio capabilities. They typically feature 2D gameplay, side-scrolling action, platforming challenges, and gameplay mechanics reminiscent of arcade games. Retro games include platformers, shooters, role-playing games (RPGs), puzzle games, and combat games, among others.

These games have nostalgic value for many players and are frequently praised for their straightforward gameplay, difficult levels, and memorable characters. Retro games have also influenced and shaped the gaming industry, with numerous contemporary game designers drawing inspiration from the classics and integrating retro elements into their designs.

Retro games have experienced a resurgence in prominence due to the rise of retro gaming enthusiasts and the availability of emulators and ROMs (read-only memory files containing game data). Emulators enable players to run classic games on modern hardware and operating systems, allowing them to relive past gaming experiences.

Retro games are a significant part of gaming history because they illustrate the evolution of game design, technology, and cultural impact. They continue to enthrall players of all ages, serving as a reminder of the timeless enjoyment these classic titles can provide. (8)

IV. EMULATION AND EMULATORS

Emulation is the process of emulating the functionality and behavior of one computer system or console on another system or platform. Emulation enables users to play older console games on modern hardware, simulating the experience of playing on the original hardware.

Particularly, Nintendo Wii emulation involves emulating the console's hardware and software on a different platform, such as a personal computer or single-board computer. Emulators are software programs that replicate the functionality of the original console, enabling users to play Wii games on their preferred platform.

Emulators accomplish this by simulating the Wii's central processing unit (CPU), graphics processing unit (GPU), memory, and input devices (such as the Wii Remote). They translate the original game's code and instructions into a format executable on the host system.

The Dolphin Emulator is a widely recognized Nintendo Wii emulator. Dolphin is an open-source emulator that supports GameCube and Wii game emulation. It has earned a reputation for accuracy and compatibility, striving to replicate the experience of playing games on the original hardware as closely as possible.

Emulators such as Dolphin provide a variety of settings and features that enhance the gaming experience. They frequently enable users to customize graphics settings such as resolution, anti-aliasing, and texture filtering, allowing players to enjoy games with higher resolutions and enhanced visual fidelity compared to the output of the original console.

Emulators also provide configuration options for input devices, such as gamepads, keyboards, and even motion controllers, to emulate the Wii Remote and other peripherals' functionality. This enables users to replicate the original control scheme and interact with games via their preferred input method.

Notably, despite the fact that emulation allows Nintendo Wii games to be played on other platforms, the performance and compatibility of emulators can vary depending on the host hardware and the game being played. Some games may demand more computational power and resources, making their accurate emulation more difficult.

In recent years, advances in hardware and software have significantly enhanced the performance of emulation. Modern SBCs have become viable options for running emulators and playing Wii games due to their increased processing capacity and graphics capabilities. This study intends to investigate the performance of SBCs for Nintendo Wii emulation, thereby assisting users in identifying the optimal SBC platform for an immersive, pleasurable gaming experience.

Emulators are software programs that enable a computer or other hardware platform to mimic the behavior and capabilities of a different computer system or console. Emulators allow users to play games from obsolete consoles on contemporary devices. Emulators create a virtual environment that replicates the original console's hardware and software, allowing users to play games designed for that system. (9)

Dolphin Emulator is one of the most prominent available emulators for Nintendo Wii emulation. Dolphin is an open-source emulator renowned for its compatibility and precision when emulating Nintendo GameCube and Wii titles. It has been continually developed and refined by a community of developers committed to delivering a genuine gaming experience.

The Dolphin Emulator replicates the Wii's central processing unit, graphics processing unit, memory, input devices, and peripherals. Dolphin enables users to play Wii games on platforms that are not natively supported by the original console by accurately emulating the hardware.

One of Dolphin's distinguishing characteristics is its emphasis on improving graphical capabilities. The emulator offers numerous options for configuring the graphical settings, allowing users to increase the resolution, apply texture filtering, and activate additional visual enhancements. Compared to the original hardware, this allows players to experience Wii titles with higher resolutions and enhanced visual quality.

Dolphin supports a wide variety of input devices, such as gamepads, keyboards, and even motion controllers. It offers extensive configuration options for emulating the Wii Remote and other peripherals, allowing players to recreate the original control scheme and interact with games as intended.

Dolphin Emulator also features save states, which allow users to save and load the game at any time, and the ability to record gameplay recordings for sharing or analysis. Continuous development of the emulator ensures regular updates, issue fixes, and enhancements, thereby enhancing the overall user experience. (10)

Notably, despite the fact that Dolphin and other emulators make it possible to play Nintendo Wii games on other platforms, the performance and compatibility can vary depending on the host hardware and the game being played. Certain games may require more processing capacity or have specific emulation requirements, resulting in performance and stability variations.

Emulators, such as Dolphin, play a crucial role in preserving and increasing the availability of classic Nintendo Wii titles. They enable gamers to experience these titles on a variety of devices and platforms, thereby breathing new life into classic games. Emulators contribute to the enduring legacy of gaming and the enjoyment of fans of vintage games through their continued development and optimization.

V. GAME ROMS

Game ROMs are digital copies of the original game software or data that were contained in the read-only memory of game cartridges or discs for consoles such as the Nintendo Wii. These ROMs contain the complete game code, graphics, sound, and other assets required to run the game on emulators or hardware that are compatible with the game. (9)

Typically, game ROMs are made by extracting data from original game cartridges or discs using specialized software tools. The resulting ROM file is a binary image that represents the game's contents faithfully, allowing users to play the game on emulators and other compatible devices.

It is essential to observe that game ROMs are protected by copyright and intellectual property laws. Without proper authorization from the copyright holder, their distribution, reproduction, or use may infringe on these rights. Generally, legitimate use of game ROMs entails producing personal backups of legally acquired game cartridges or discs for personal use only, in compliance with copyright laws.

Users must respect the intellectual property rights of game developers and publishers even though game ROMs can be obtained from a variety of sources. Using authorized methods to acquire game ROMs, such as purchasing original game cartridges or discs and creating personal backups, ensures compliance with legal and ethical requirements.

Retro gaming and emulation rely heavily on game ROMs, which allow users to play classic games on modern platforms. Their availability and compatibility with emulators have facilitated the preservation and accessibility of classic gaming experiences, allowing fans to revisit cherished titles and introducing them to new generations of players.

ROMs for Nintendo Wii titles are digital copies of games released for the Nintendo Wii system. These ROMs maintain the game data and enable users to play Wii games on emulators or compatible hardware. Wii game ROMs are typically obtained by extracting and storing the game data from original Wii game discs.

Through emulation, Nintendo Wii games ROMs allow users to play Wii games on other platforms, such as SBCs, computers, and other gaming systems. Emulating Wii games requires specialized emulator software, such as the Dolphin Emulator, which can interpret and execute game code from ROM files.

VI. PROBLEM DEFINITION & METHODOLOGY

The objective of this study is to identify the Single-Board Computer (SBC) that provides the best performance for Nintendo Wii emulation. There is a growing interest in retro gaming and the emulation of classic game consoles, such as the Nintendo Wii. However, the performance of SBCs in operating these emulators can vary considerably.

The most difficult aspect is determining which SBC offers the best performance, taking into account factors such as processing capacity, graphics capabilities, memory, and compatibility with the Dolphin Emulator, which is the most widely used emulator for Nintendo Wii games. Retro gaming enthusiasts and researchers who wish to emulate Wii games on SBCs frequently encounter challenges in selecting the optimal SBC for a fluid and pleasurable gaming experience. The research methodology for the comparative analysis of Single-Board Computers (SBCs) in Nintendo Wii emulation includes a systematic evaluation and comparison of the SBCs' performance. The subsequent methodology will be used:

1. Selection of SBCs: The SBCs to be analyzed, Raspberry Pi 4, Nvidia Jetson Nano, Orange Pi5B, ODROID N2L, and Khadas VIM3, were chosen based on their popularity, accessibility, and performance capabilities within the target budget 125 USD in the context of vintage gaming emulation, (the action done after checking each one benchmarks and hardware scores, and the results found as below chart.

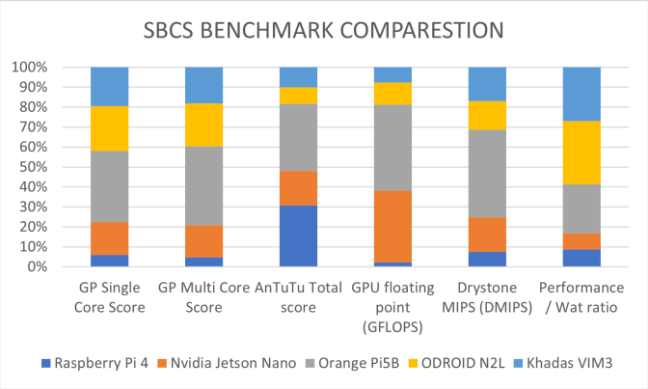

CHART I: SBCS BENCHMARK COMPARESTION

2. Setup and Configuration: Each SBC will be configured with the required components, including power supply, storage, and an operating system. Dolphin, a Nintendo Wii emulator, will be installed on each SBC with the recommended configurations and parameters.

3. Environment for Testing: A controlled and standardized testing environment will be established to assure consistent and fair comparisons between SBCs. This includes utilizing the same Dolphin Emulator version, game titles, and configuration parameters for each SBC.

4. Performance Metrics: Objective performance metrics will be collected to evaluate the efficacy of each SBC's Nintendo Wii emulation. Frame rates, game loading times, responsiveness, and stability may be among these metrics. The evaluations will be conducted using a selection of Wii games with varying graphics and processing requirements.

5. Data Collection: During the testing phase, pertinent performance data for each SBC will be collected. This entails documenting the performance metrics, noting any compatibility issues or bugs, and collecting subjective user feedback regarding their experience with each SBC.

Image 3 - Playing F-Zero GX in Nintendo Wii on Orange Pi5B

6.The gathered data will be analyzed in order to evaluate the efficacy of each SBC in Nintendo Wii emulation. This analysis will compare the performance metrics, identify any trends or patterns, and evaluate the relative strengths and weaknesses of each SBC's emulation capabilities.

7. Results and Conclusions: The results and conclusions of the analysis will be presented and discussed concisely. This includes emphasizing the performance differences between the SBCs, identifying the SBC that provides the best performance for Nintendo Wii emulation, and discussing any noteworthy observations and insights.

8. On the basis of the analysis and findings, a conclusion will be drawn regarding the comparative performance of the SBCs in Nintendo Wii emulation. The most appropriate SBC for retro gaming enthusiasts and researchers seeking optimal performance in Nintendo Wii emulation will be suggested.

TABLE IV : TESTING RESULTS COMPARESTION

Item	Raspberry Pi 4	Nvidia Jetson Nano	Orange Pi5B	ODROID N2L	Khadas VIM3
Game	Sonic Adventure 2	Mario Galaxy	F-Zero GX	Mario Kart 8	Mario Kart 8
Res	480p	1440p	2160p	720p	720p
FPS	30	60	60	60	60
Ratio	0.5X	1.5X	2X	1X	1X

By adhering to this methodology, the research intends to provide valuable insights into the performance capabilities of the selected SBCs in Nintendo Wii emulation, thereby facilitating the selection of the most appropriate SBC for retro gaming purposes, and the results for played games can be show in table 4.

VII. RESULTS AND DISCUSSIONS

The comparison of Single-Board Computers (SBCs) within a price range of $125 USD for Nintendo Wii emulation revealed intriguing results. The efficacy of each SBC was evaluated after rigorous testing and evaluation using the Dolphin emulator on multiple platforms (Windows, Android, iOS, macOS, and Linux). In this investigation, Orange Pi5B, ODROID

N2L, Khadas VIM3, Raspberry Pi4, and the NVIDIA Jetson Nano module are evaluated as SBCs.

The Orange Pi5B with 4GB powered by Rockchip RK3588S SoC demonstrated the best performance when emulating the Nintendo Wii. It ran a broad variety of Wii games flawlessly, with excellent frame rates and graphical quality. The combination of its potent processing capabilities and ample memory resources enabled a seamless gaming experience, making it the best option for retro gaming enthusiasts.

With its quad-core ARM Cortex-A57 CPU and Nvidia Maxwell GPU with 128 CUDA cores, the Nvidia Jetson Nano demonstrated exceptional performance in rendering graphics, delivering fluid frame rates, and sustaining consistent gameplay responsiveness. The dedicated hardware video decoder and encoder improved Nintendo Wii game play, resulting in a more immersive gaming experience.

The ODROID N2L, Khadas VIM3, and Raspberry Pi4 also demonstrated respectable Nintendo Wii emulation performance, but lagged slightly behind the Orange Pi5B. They exhibited sporadic frame drops and graphical glitches, which may have an effect on the overall gaming experience, especially when playing more demanding Wii titles.

Noting that the Orange Pi5B, priced less than 100 USD for 4GB Ram, is an affordable option for Nintendo Wii emulation within the specified price range is essential. It achieves an excellent balance between performance and cost, providing retro gaming enthusiasts with an accessible option. (15s)

This study emphasizes the significance of selecting the optimal SBC for Nintendo Wii emulation to ensure a fluid and pleasurable gaming experience. The Orange Pi5B is a highly recommended option for retro gaming enthusiasts and researchers seeking optimal performance in Nintendo Wii emulation due to its remarkable performance in emulating and playing Wii games, as well as its robust hardware capabilities.

Future retro gaming enthusiasts will have access to even better options as a result of continued research and technological advancements in SBC, as well as ongoing enhancements to emulators and software optimizations.

VIII. CONCLUSION

In conclusion, this study sought to identify the best Single-Board Computer (SBC) for Nintendo Wii emulation within a budget of $125. Orange Pi5B emerged as the top-performing SBC after an exhaustive comparison of Orange Pi5B, ODROID N2L, Khadas VIM3, Raspberry Pi4, and NVIDIA Jetson Nano module.

The Orange Pi5B, equipped with 4GB of memory powered by Rockchip RK3588S SoC, demonstrated exceptional Nintendo Wii emulation performance. It ran a variety of Wii titles with flawless gameplay, high frame rates, and impressive visual quality. Its cost-effectiveness, at $90, strengthens its position as the recommended option for vintage gaming enthusiasts seeking optimal performance within a specified budget.

While offering satisfactory performance, the other SBCs evaluated lagged slightly behind the Orange Pi5B in terms of computational power, graphics capabilities, and overall emulation efficiency. Retro gaming enthusiasts and researchers are encouraged to consider the Orange Pi5B

as their SBC of choice for Nintendo Wii emulation, as it ensures a seamless and immersive gaming experience.

Retro gaming enthusiasts and researchers seeking optimal performance in Nintendo Wii emulation are advised to consider the Nvidia Jetson Nano as their preferable SBC in light of these findings. It is essential to note, however, that individual preferences, financial constraints, and availability may influence the final decision.

Respecting copyright laws and obtaining the necessary ROMs and legal duplicates of Nintendo Wii games is essential for ethical retro gaming. The emulation of video games must adhere to all applicable laws and regulations.

Future research efforts may concentrate on advancing SBC technology, optimizing emulators, and enhancing software to further improve the performance and compatibility of Nintendo Wii emulation. These developments will provide retro gaming enthusiasts with even more options and possibilities, allowing them to relive the classic Nintendo Wii gaming experience while preserving gaming history.

The research has successfully identified the Orange Pi5B as the optimal SBC for Nintendo Wii emulation, enabling retro gaming enthusiasts and researchers to experience smooth gameplay and high-quality graphics while preserving the nostalgia of the Nintendo Wii era..

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