Research Project
for
Raspberry Pi Zero 2 W

Authors: Reece Clem, Nasir Mendez, Marquise Allsup
Date submitted: 10/14/2024

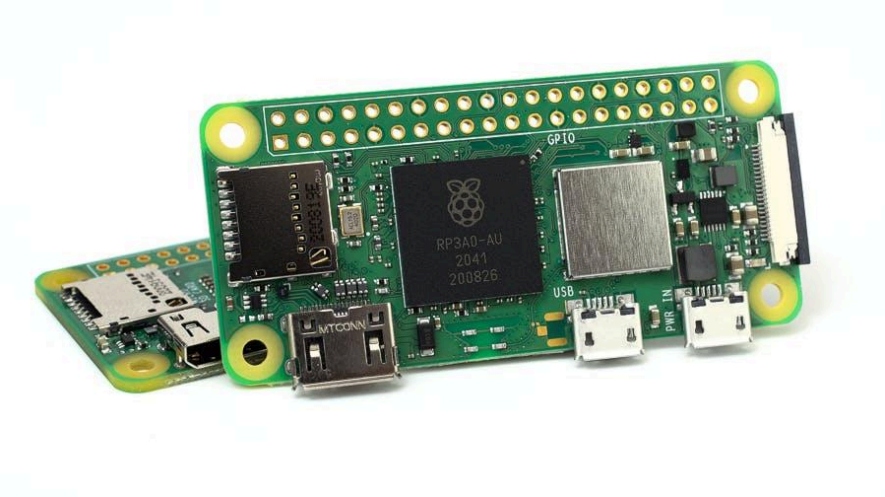

Table of Contents

1. Introduction

We chose to use the Raspberry Pi Zero 2 W as our computer for this project. The benefits of this computer is its cost to performance ratio, offering low cost with high performance. In this research paper, we will go in depth on potential operating systems, memory, and communication capabilities of the Raspberry Pi Zero 2 W. This will help us gain the best understanding of how we can use this device to its full capabilities. The paper will cover relevant sections such as background information, literature review, analysis of memory, operating systems, and communication methods for the Raspberry Pi Zero 2 W.

1.1. Background Information

The Raspberry Pi Zero 2 W was released in 2021 as part of the Raspberry Pi series. This computer features a quad-core ARM cortex-A53 CPU. It is often used in projects that requires wireless communication due to its built-in Wi-Fi and Bluetooth. Its strength is its affordability combined with its power and diverse use cases.

2. Literature Review

2.1. Overview

There has been a lot of previous research made about the Raspberry Pi Zero 2 W and its uses in different systems. Research has been done on its performance and how it handles various operating systems. A lot of research has also been done on its memory efficiency when running resource intensive applications.

2.2. Advances and limitations

In terms of advances that were made with the Raspberry Pi Zero 2 W, improvements were made in processing power with the introduction of a multi-core processor. This makes the Zero 2 W more capable of handling complex tasks than its previous iterations. Notably, the Raspberry Pi Zero 2 W is 5 times as fast as the Raspberry Pi Zero.

The main limitation that the Zero 2 W has is a small memory capacity. The computer is capable of storing 512MB of data. This limits its capability to run memory-intensive applications and will influence our choice of operating system.

2.3. Research question

The main question for us will be the following. How can we best optimize the use of our memory and select the best operating system to ensure we have an adequate amount of memory for our project while maintaining efficiency and full functionality?

2.4. Problem statement

While the Raspberry Pi Zero 2 W is a very capable computer, it has a limited memory and its selection of operating systems pose a challenge when determining the optimal setup for our purposes.

3. Memory

3.1. What does Raspberry Pi use for memory?

When the system is processing sensor readings from the GPIO pins, the RAM is used to temporarily store data and run code. This allows the alert system to function smoothly and effectively by allowing the Raspberry Pi to generate alerts based on proximity measurements and the microSD card to store the required files and historical data.

3.2. Our choice

Normally, the Raspberry Pi Zero 2 W has 512MB of LPDDR2 SDRAM, but it can have more storage by adding a microSD card. For best results, we will use a Class 10 or UHS-I microSD card with at least 8 GB of storage. This is because the microSD card acts as the primary storage for the operating system (such as Raspberry Pi OS) and stores log data and configuration files for the proximity alert system.

4. Operating System

4.1. Operating Systems for Raspberry Pi

Raspberry Pi can operate using multiple different operating systems including:

- Ubuntu: A popular Linux distribution available for Raspberry Pi
- DietPi: A minimalistic OS designed to reduce memory load.
- Raspberry Pi OS: The official OS for Raspberry Pi, well supported with plenty of supporting documentation.
- Raspberry Pi OS Lite: A stripped down version of Raspberry Pi OS that is designed to be lightweight and optimized for performance in low memory environments. It is a Linux distribution, and focuses purely on command-line use.
- Windows IoT Core: A version of Windows 10 for IoT applications compatible with Raspberry Pi.

4.2. Comparison

- Ubuntu offers more capabilities with Linux, but it may be difficult to avoid going over our memory limit.
- DietPi is optimized to work in low resource settings, making it a considerable option for our low memory environment.
- Raspberry Pi OS is the most stable and well-supported option, but it is not designed to function in low memory environments.
- Raspberry Pi OS Lite is a good balance between the stability and support that Raspberry Pi OS offers while being lightweight and memory efficient.

- Windows IoT Core is relatively limited in its usability compared to our other options, especially in terms of supporting materials online.

4.3. Our choice

We are choosing to use Raspberry Pi OS lite for our project. We made this choice because this operating system offers great memory efficiency while having a lot of supporting materials online and avoiding some of the unnecessary bloat that comes with an operating system by operating using the command-line.

4.4. Installation Guide

- Step 1: Download the image for Raspberry Pi OS Lite from the official Raspberry Pi website.
- Use a tool like *Etcher* to write the OS image to a microSD card.
- Insert the SD card into the Raspberry Pi Zero 2 W and then power it on.
- Configure initial settings using the Raspberry Pi Imager tool or do it directly through the command-line.

5. Communication

5.1. How does Raspberry Pi communicate?

The Raspberry Pi Zero 2 W can be used to create a proximity alert system by first connecting the infrared or ultrasonic sensors to the device's GPIO ports. In order to measure distance, the Raspberry Pi Zero 2 W will first send a trigger signal to the sensors. It will then read the echo signal to calculate the proximity of surrounding objects. Depending on preset distance coding, the Raspberry Pi will generate various alert messages based on the detected distance, such as "Object is far away," "Object is getting closer," or "Warning: Object is very close!"

We will create these notifications that will be the outputs for the Raspberry Pi Zero 2 W in a number of ways, including through the use of an LCD screen, LED indicators, or a speaker for audio notifications. Furthermore, the system can be integrated with communication services for additional performance, allowing for the remote monitoring of proximity alarms by email or SMS messages. These activities can be handled more effectively because of the Raspberry Pi Zero 2 W's increased processing power and communication options.

6. Conclusion

While the Raspberry Pi Zero 2 W does have some important limitations for us to consider, we have found through our research that it is a good choice for our project. This is because it provides the necessary power along with a wide variety of applications which suit our project well. We also have a good way to somewhat overcome that limitation through the use of a microSD card for increased storage capacity. This computer proves to be lightweight and efficient when operating with our chosen operating system. For these reasons, we have chosen this device for our distance sensor project. More research may prove that with our memory solution a different operating system such as Raspberry Pi OS (non-lite) may be a better option. For now though, we are going to prepare to use the lite version just to be on the safer side, and because it is a good option regardless.

7. References

1. Raspberry Pi Foundation. (2021). *Raspberry Pi Zero 2 W Technical Specifications.* Retrieved from https://www.raspberrypi.org/products/raspberry-pi-zero-2-w/

2. DietPi. (2023). *DietPi: Lightweight Raspberry Pi Operating System*. Retrieved from https://dietpi.com/

3. Ubuntu. (2023). *Ubuntu for Raspberry Pi Documentation*. Canonical. Retrieved from https://ubuntu.com/download/raspberry-pi

4. Raspberry Pi Foundation. (2023). *Setting Up Your Raspberry Pi: Installation Guides*. Retrieved from https://www.raspberrypi.org/documentation/computers/getting-started.html

5. Microsoft. (2023). *Windows IoT Core on Raspberry Pi Zero 2 W*. Retrieved from https://docs.microsoft.com/en-us/windows/iot-core/

6. Copeland, R. (2023). *Raspberry Pi OS Lite: How to Install and Optimize for Low-Memory Systems*. Retrieved from https://www.hackster.io/news/raspberry-pi-os-lite-installation-and-setup-guide-abc123

7. Patel, S. (2023). *Which OS is Better for Low-Memory Raspberry Pi Projects? DietPi vs. Raspberry Pi OS Lite*. Retrieved from https://www.raspberrytips.com/dietpi-vs-raspberry-pi-os-lite/