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Title: Review and Considerations for the Raspberry Pi Zero W

Introduction:

The Raspberry Pi Zero W is a leading option for the microcontroller technology to be used in The Original BUSCA's project. The project aims to report study space availability across the Georgia Tech campus through a mobile app front-end by collecting data from devices placed underneath tables that monitor and sense table usage. The Pi Zero W has a GPIO header, Bluetooth, and Wi-Fi capability while being low-cost and relatively low power for an off-the-shelf solution. It will be used to power and read data from a sensor as well as send the data to a server. All in all, the Pi Zero W can complete the required tasks and meets the design specifications for the project. [1]

Market Technologies:

Little commercial products use the Raspberry Pi Zero W in their design due to it being sold on a single unit basis as well as facing licensing issues. However, there are many products that use other Pi devices, one of which being Raspberry Shake. This company uses a Raspberry Pi 3B, which has all the functionality of the Pi Zero W plus more computing power, and has it read data from very accurate accelerometers to detect earthquakes. They have been able to create an accurate seismograph that has very comparable readings to a high-grade seismograph while marketing at a hundredth of the cost. Their device is also capable of sending data to a server on which they have built a clean UI for customers to access and use the data and analytics. All the Raspberry Shake models function in a similar fashion to the proposed project. The device communicates with the sensors over GPIO pins, and it communicates with the data server using an onboard Wi-Fi chip.[2]

An example of a Raspberry Pi enabled product that uses the Pi Zero W is the Octocam. This device is sold by Pimoroni as a hobbyist kit. Its purpose is to give hobbyists a low-cost Wi-Fi enabled camera with a creative housing design. The Pi Zero W enables the device to record video via a 5MP camera using the onboard hardware decoder and send video over Wi-Fi using the onboard Wi-Fi chip. Pimoroni recommends running motionEyeOS on the Pi Zero W to allow the user to easily setup their own CCTV system. This product accentuates the Pi Zero W's ability to offer simple and advanced functionality via GPIO devices and the onboard Wi-Fi chip.[3] Kits like the Octocam as well as guided DIY projects are extremely numerous. The Pi Zero W can be used to perform many tasks, ranging from a tiny game console to tagging sea turtles. [4] **Operation and Specs:**

The Raspberry Pi Zero W has technical specifications that make it ideal for simple projects with connectivity options via Bluetooth and Wi-Fi. It has a very small form factor at only 65mm × 30mm × 5mm. The processor is an ARM 11 1GHz single-core CPU. This is bundled into the Broadcom BCM2835 SoC. With this and 512MB of RAM, the Pi Zero W can handle IO device control easily. It also contains a MicroSD card slot that is used for the OS and filesystem. The Bluetooth and Wi-Fi functionality make the Raspberry Pi Zero W capable of functioning as an IoT device. It supports Bluetooth Classic 4.1 and Bluetooth LE for Bluetooth connections and 802.11 b/g/n for Wi-Fi. The Pi Zero W also has a Micro USB output, 1080P HD video and stereo audio via mini-HDMI, a 40-pin GPIO, and a Camera Serial Interface. All of this is powered by a 5v power supply over a micro USB connection.[5]

The Raspberry Pi Zero W has a host of options for connecting devices and configuring them. It has a 40-pin GPIO header complete with PWM, SPI, I2C, and Serial functions. It has multiple 5v and 3.3v voltage outputs, and configurable pullup and pulldown resistors depending on the pin used.[6] Python is the primary way to configure and program the GPIO pins and communicate with external devices, but there are other options, like C++, available as wrappers.[7]

Raspberry Pi devices run Linux-based operating systems to support all their functionality. The company themselves have developed a few distributions specifically for this purpose called Raspbian. They support lightweight versions of this OS to encourage low-power consumption. However, there are third party operating systems developed for the Pi family of devices that are more minimal than Raspbian-lite. One of the smallest is piCore at only 35MB. This OS, in its smallest version, is little more than the basic Linux kernel.[8] This allows the user to use the Pi Zero W for very minimal applications, like in the case of The Original BUSCA's project where a minimal MCU is necessary. Any OS on a Raspberry Pi allows the programmer to enable and disable various features on the board that are unnecessary. For example, there are many cases where the HDMI output on the Pi Zero W will go unused and can be disabled to save power. The necessity of an OS is a double-edged sword as it does allow the programmer lots of included functionality making it easier to use, but this comes at performance and power costs.

Low-power consumption is a very important design specification for any IoT application. The Raspberry Pi Zero W idles at 120 mA while connected to Wi-Fi. It also drains 20-30 mA while powered off, unless it is physically disconnected from the power source.[9] Unfortunately, this means that the Pi Zero W is not suitable for long term battery applications. For example, a small 1200mAH battery would only power the Pi Zero W in an idle state for about seven hours. This information stresses the need for efficient programming to optimize the program to reduce the non-idle CPU cycles. This is done by using

commonly known code optimization techniques, like loop unrolling and passing structures by reference. It has been proven that these considerations and techniques are effective on the Raspberry Pi family of devices. [10]

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