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Project Research

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Contents

1 Introduction

Here I will specify my research that will help me determine what type of project I want to build and what functionality I want it to have.

2 Raspberry PI

By it's makers, the raspberry PI is a "Low cost, credit card sized computer". Essentially a micro-computer that allows for the functionality of a normal computer in a compact format with some additional unique features. The main feature that I will need is the GPIO (General purpose input/output) pins supplied on the board.

The mainstream conception of a raspberry PI's capabilities are limitless. The PI is often used as a server for paper printing processes, a home media centre with the capability to download and play any source of media without the hidden data farming that comes with most smart TV's [**cawley˙2020**]. The PI has also been known to be extensively used as a home security controller with many modular features such as motion detection photography sensors. The PI can be especially be put to good use here as it can upload the images off site to a cloud. This is vastly superior to traditional forms of camera security that store the information in removable storage such as high capacity hard drives which can be easily stolen or tampered with to allow an intruder to cover their tracks.

One of the most important aspects of the PI, is its capability to run a web server. To rent a web server can cost a lot of money and will not allow you to take complete control over all of the web servers features. Many of the better features will be included in more expensive packages which can go from an affordable package to an infeasible package fast. With the PI however, it is a one time purchase so are all the modular add-ons like disk space that you may want to add. The PI has a very low energy usage so this will not substantially impact your budget by your electricity bill, especially when compared to a traditional home server or leaving a PC run as a server and not turning it off. [**https://www.seeedstudio.com/blog/2019/09/29/top-20-best-r**

2.1 GPIO

The GPIO is crucial as it will be the tethering point between the sensors and the raspberry PI. Each sensor will come with a number of connector points that will say along side which part of the PI's GPIO port it will be connected to. Each sensor will require at least its own designated power port (3V3 / 5V), GND (ground) and a GPIO port to allow for the PI and the sensor to communicate. Due to each sensor needing their own independent port for the ports mentioned above, it will be impossible to have each sensor running concurrently. Due to this predicament, I know that I will only be able to run one sensor at a time.

2.2 Breadboard

A breadboard will be the intermediary between the sensors and the GPIO. A breadboard is for the prototyping of electronic circuits and is essential due to its plug and play design that involves no soldering. It will allow for easy testing of electronic circuits and for fast redesigning. To use the breadboard, you insert a GPIO extender from the PI and insert its connectors into the breadboard, now any connector inserted into the same row as for example a 3v3 pin will be able to connect/utilise that GPIO port.

2.3 PI operating S

With versatility being one of the PI's main selling points, it has to be able to handle the generic and the extreme in terms of built-in functionality. To change the PI's functionality is to change it's OS, essentially making it a completely different computer that one can find which OS works best for them with their project. There are two operating systems that I've seen countless times upon my research.

The main OS that I have seen is "NOOBS". NOOBS stands for New Out Of The Box Software and is an OS designed with user friendliness in mind as a way of helping a person who is just getting into Linux to learn it. The great thing about NOOBS is that it technically isn't an OS itself, it is a collection of OS's that allow you to pick one that best suits you. NOOBS allows for example, OpenELEC RPi2, this is a pre-built entertainment system OS, that will allow you to use the popular Kodi entertainment system. Noobs

allows you to access a Windows 10 IoT Core which allows you to build apps and devices for windows even though the PI works on Linux.

The most important OS that I've seen however is the Raspbian OS. Raspbian is based on the very popular Linux OS Debian. It's functionality is very similar to Debian but allows for the user to take full control of all the features of the PI such as the GPIO board which you wouldn't see on a traditional Linux computer. Raspbian also comes with over 35,000 packages that you can install that are specially designed for the PI. Raspbian was created by a small team of developers for the goal of educating people about the key card sized linux system.

2.4 PI Limitations

The PI itself is an excellent computer but its slim form factor and cheapness comes at a price. The PI's processing output has more in common with a phone than a general computer or a laptop. The biggest and most notable aspect of it is the central processing unit (CPU) can easily be compared to an off the shelf desktop CPU such as the Intel Pentium 2 300MH CPU from the late 1990s. The RAM is not modular on the PI as well, you have two different choices of 256MB or the larger 512MB with no room for expansion.

For limitations regarding the project however, digital signage is a huge factor in IOT security and would be a great aspect to implement to ensure tamper proof storage of any information the PI takes in. Setting up the PI for digital signage is a well known pain among the security crowd that use PI's. The PI has a very poor performance to price ratio for signage.

The PI can also only support 32GBs of storage through the SD card slot, this leaves little room for expansion. If you wanted to increase the capacity size you would need to purchase an external hard drive and the components needed to connect it to the PI. Using the cloud would also be another way of increasing storage capacity, however this does not come without it's own security concerns as this involves the transfer of data from the PI to another device. With signage being an issue with the PI, this could be an easy avenue for an attacker to take to manipulate the data in a malicious way.

2.5 PI Security

How can we protect against tampering. There's the basics when securing a device such as having a strong password to the admin account and root on the device. For our data that we're going to store on the device, from a cyber security aspect, it will need to be encrypted using a strong encryption algorithm that the PI will be able to handle in term of hardware performance. The data that we encrypt will also need to have a way for us to prove that it has not been tampered with e.g. door logs that we take cannot be manipulated to remove evidence.

Upon research, the AES encryption standard is secure and most commonly used today. AES-128 is where a 128 bit key is used to encrypt a message and it should be noted that not one AES-128 encryption cipher has ever been broken. The US government uses AES-128 encryption for 'Secret' level documents and AES-192 for 'Top Secret', so it is a definite secure encryption method.

A limitation of encryption on the raspberry PI would again come back to the PI's processing speed. To encrypt a big file with AES could potentially take a lot of processing power, while this would be ok for photos, video may be out of the picture.

For methods regarding tamper proofing, creating a hash of each file could be a possible avenue we can take.

2.6 Security devices already on the market

Motion (pi system). A very interesting product on the market right now that we could use for a door logging device would be a motion sensor. Motion sensors are cheap and somewhat easy to set up according to sources. The triggering of the sensor can be read, encrypted, hashed and then sent and stored in a secure location, making it an forerunner in the list of potential modules for the raspberry PI. The manufacturer Adafruit is a well known brand for GPIO modules for the raspberry PI. They sell both directional and omnidirectional motion sensors on their website and Amazon and have many projects detailed on the internet done with such devices.

Another similar project would be a motion sensor camera. From the various projects on the internet that I have found, many use the same motion sensor as mentioned above combined with a camera to give the motion sensor camera functionality. One project that I

was particularly interested in, sent the photos when taken straight to the Telegram app, an application similar to whatsapp that does not need a working sim card to function and is heavily focused on security. A potential aspect for the project could be to upload the photo to Telegram or to implement a from the ground up built feature to ensure no data tampering went on during data transit.

The PI can be used for less obvious security solutions such as taking control of your house's power grid. Depending on your setup, you can make the PI completely turn off the mains power in the house shutting everything off or you can select what to turn off individually. Upon my research, I have seen many projects involving powering on/off electronics around the house such as indoor/outdoor lights, washing machines and motion sensors.[**https://hometoys.com/raspberry-pi-projec**

2.7 PI Cameras

The raspberry PI has a multitude of different camera available on the market. The actual manufacturer of the raspberry PI sells their own Pi camera on the Pi website. It is a 12.3 megapixel Sony camera which you can scale the resolution down to ensure efficient data size storage. The camera also supports lenses which can be useful for photographing a wide angle such as the entire front of a house or an acute angle to focus on a doorway.

There are also infrared cameras available on the market to allow for a day and night photography capability. For a security camera this will be an essential functionality from my perspective as otherwise the project would be useless at night or in dark areas of the house without artificial light source. The IR flashlight included will be far greater than a traditional flashlight that can been seen by the human eye as it will allow the camera to stay somewhat incognito.

3 Python and necessary languages

3.1 Python

Python is a powerful and easy to use coding language that is almost essential in Raspbian based projects, especially ones that involve sensors. Python is known for how easily it is to learn compared to other means of programming like java or C++. Python itself is

an object oriented programming language and stands out due to its creators philosophy in the "zen of python". To quote Tim Peters, a long time python developer " Beautiful is better than ugly. Explicit is better than implicit. Simple is better than complex. Complex is better than complicated." With these mission statements, it is easy to see why python is so popular. With the many programming languages I'm experienced in, these promised attributes of python sound like a very welcome change and I have only worked with python for less than 50 hours in my life and I know that these are true.[**https://www.python.org/dev/peps/pep-0020/**]

Python on the PI is very easy to get started with. Raspbian comes with python 2 3 already pre-installed and comes with built in python IDE's, such as Thonny but I have also seen people run python script within the Linux Nano text editor. Similar to shell scripts, these python files can be used to cut down on time with tedious tasks such as batch renaming files or moving many folders worth of files. On the PI, you can also use python in conjunction with a web server to vastly improve its functionality, create specialised GUI's, control modular sensors or motors and even to create small sized databases. [**https://www.circuitbasics.com/how-to-write-and-run-a-pytho**

Python's value seems limitless and will be a for sure big aspect of the coming project.

3.2 Any other Potential languages

Although Python is the main language of the PI, there is still a lot more valuable languages that will be essential in making a good project.

HTML5 will have to be implemented in the project if I decide that the project will have a website interface. HTML 5 is the backbone of any website as it provides all the base functionalities of a website that are then built upon by use of CSS, SQL and PHP. HTML instructs your browser of how each page of your website is to be laid out and displayed. It also provides the functionality for a browser to embed links to allow a user to move to different pages on a website or to a different website altogether. With the latest version of HTML 5, it now allows for the embedding of audio and video into web pages and now has a much more user friendly design features when it comes to designing websites that run on phone browsers.

If I needed an alternative to python at any point, C++ would probably be the solution. I am already very familiar with the C++ coding language as I have spent the past two years writing programs in it. C++ is essentially a direct upgrade from the traditional, tried and true language of C. It has a countless number of real world applications such as hardware design, embedded software in mobile phones and desktop applications, graphical analysis applications and even programming video games. The main difference between C and C++ however is its object-orientated structure that makes it similar to programs like Java or Ruby.