| **Group** 13 | *Spring 2024 Design Challenge* |
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| **Major:** | **Team members:** |
| *ITC* | *David Kajuna* |
| *CEG* | *Joshua Andrews* |
| *CS* | *Jason Bynum* |
| *ITC*  *CS* | *John Armlovich*  *Kennedy Eziolise* |

**System Design Trades***.*

**Hardware design trades**

1. **Power Supply**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Input Voltage* | *120VAC 60Hz* | *Typical outlet Power* |
| *Output Voltage* | *5V, 2.5A* | *minimum* |
| *Variable voltage control* | *1-5V* | *Testing Purposes* |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |

1. Hardware Components are provided.
2. **USB Drive**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Data Transmission* | *5 Gbit/s,* | *5 Gbit/s data transmission, contains all 100 images* |
| *Image Storage* | *minimum 30MB* |  |
| *Communication Interface* | *USB 2.0 or USB 3.0* |  |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |

1. Hardware Components are provided.
2. **Empire Lab Raspberry Pi**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Disk Space* | *5 GB* | *At minimum 5 GB* |
| *RAM* | *4 GB* | *At minimum 4 GB* |
| *Frequency* | *1GHz* | *At minimum 1 GHz* |
| *Number of GPIOs* | *Minimum 8* |  |
| *Communication Interfaces* | *USB 2.0, USB 3.0, Micro SD* |  |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |
| *Output Power* | *3.3V at 50mA, 5V at 750mA* |  |

1. Hardware Components are provided.
2. **Rebel Raspberry Pi**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Disk Space* | *5 GB* | *At minimum 5 GB* |
| *RAM* | *4 GB* | *At minimum 4 GB* |
| *Frequency* | *1GHz* | *At minimum 1 GHz* |
| *Number of GPIOs* | *Minimum 8* |  |
| *Communication Interfaces* | *USB 2.0, USB 3.0, Micro SD, USB-C,* |  |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |
| *Output Power* | *3.3V at 50mA, 5V at 750mA* | *Rated for Raspberry Pi 4* |

1. The Rebel Raspberry Pi component was chosen to keep logic consistent between the Empire Lab transceiver module, and the transceiver module outside of the lab. This would not be possible without a similar Raspberry Pi in comparison to other controllers.
2. A Raspberry Pi allows for code to be shared between the two modules which would not be possible if connected to a different microcontroller or the rebel server.
3. Research done on other hardware components in our system recommends using a Raspberry Pi for implementation over other options.
4. **Li-Fi Transceiver System**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Data Transmission* | *5V, directional* | *400-650 nm laser* |
| *Data Reception* | *6V Solar Cell* | *minimum 5V solar cell* |
| *Communication Interfaces* | *USB 2.0* |  |
| *Cooling system* | *5V, 0.2A* | *30mm x 30mm x 8mm electric fan.* |
| *Number of Inputs* | *minimum 7* | *7 inputs from the device controller* |
| *Input Power* | *6V, 80mA* | *minimum power requirements are 6V, 80mA* |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |

1. A 400-650 nm laser would be better for this system than an LED set-up due to the need for a minimum of 5-meter distance between each transceiver.
2. A 400-650 nm laser is low cost, with easier access to obtain.
3. A 5V solar cell is preferred as the lowest power needed, but a 6V solar cell is more available.
4. A 5V cooling fan is optimal due to its small size and low power requirements. This is due to the need to be covert.
5. **Android Mobile Device**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *C++ Programming language* | *GCC 6.8. 0-1* | *Software coding language* |
| *Wi-Fi Capabilities* | *802.11ac* | *Typical University Wi-Fi* |
| *Disk Space* | *5 GB* | *At minimum 5 GB* |
| *RAM* | *4 GB* | *At minimum 4 GB* |
| *Frequency* | *1GHz* | *At minimum 1 GHz* |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |

1. An Android mobile phone will be used due to the ease of development that comes from being able to program in a common language in comparison to other mobile devices. Also, C++ is the most compatible language for Android compared to other languages.
2. An Android phone will be used because a group member personally owns an Android device with the needed specifications.
3. **Rebel Server**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Wi-Fi Capabilities* | *802.11ac* | *Typical University Wi-Fi* |
| *Disk Space* | *5 GB* | *At minimum 5 GB* |
| *RAM* | *4 GB* | *At minimum 4 GB* |
| *Frequency* | *1GHz* | *At minimum 1 GHz* |
| *Operating Temperature Range (°C)* | *16 to 27* | *Ambient* |

1. A hardware system is provided.

**Software design trades**

1. **Death Star Image Evaluation application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Python Programming Language* | *Python 3.7.6* | *Software coding language* |
| *Image Evaluation Libraries* | *pillow, Tensorflow, ImageIA, NumPy, Matplotlib, Keras* | *Libraries to be used in conjunction with each other* |
| *File I/O* | *.png, .txt processing* |  |

1. Python has several relevant libraries that can be called upon to reduce the amount of coding needed to evaluate images for certain data points.
2. Python has much simpler file I/O manipulation than a language like C or C++.
3. **Empire Lab Pi Image Transceiving application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Python Programming Language* | *Python 3.7.6* | *Software coding language* |
| *C++/C Programming language* | *G++ 6.8. 0-1* | *Software coding language* |
| *PNG to binary converter* | *Python* | *Group Created, pillow 10.2.0* |
| *Data transmission* | *C* | *Group Created, Transceiving function* |
| *File I/O* | *.png, .txt processing* |  |
| *WiringPi* | *Open source, 3.0* | *Interface for Raspberry Pi GPIO pins* |

1. The PNG to binary converter is written in Python because it is easier to code with fewer lines than any other coding language.
2. The Data transmission application is written in C because the WiringPi library is designed to interface with C natively. Python or Java would require extra integration work by the team.
3. The Data transmission application will transmit .png images as binary data to work more easily with the partially pre-made transceiving application.
4. **Empire Data Verification Application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Bash* | *Debian* | *Shell OS system* |
| *OpenSSL* | *OpenSSL 3.1.0* | *Software for decryption and encryption* |

1. The Raspberry Pi contains a Debian operating system, allowing for Linux scripts to be used for data verification.
2. OpenSSL will be used for AES encryption and decryption due to its known security and ease of use.
3. **Rebel Data Verification Application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Bash* | *Debian* | *Shell OS system* |
| *OpenSSL* | *OpenSSL 3.1.0* | *Software for decryption and encryption* |

1. The Raspberry Pi contains a Debian-based operating system, allowing for Linux scripts to be used for data verification.
2. OpenSSL will be used for AES encryption and decryption due to its known security and ease of use.
3. **Rebel Pi Image Transceiving application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Python Programming Language* | *Python 3.7.6* | *Software coding language* |
| *C++/C Programming language* | *G++ 6.8. 0-1* | *Software coding language* |
| *PNG to binary converter* | *Python* | *Group Created, pillow 10.2.0* |
| *Data transmission* | *C* | *Group Created, Transceiving function* |
| *File I/O* | *.png, .txt processing* |  |
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4. **Raspberry Pi to Server Interfacing**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Bash* | *Debian* | *Shell OS system* |

1. A bash script will be used for this process to eliminate the possible human error from manipulating the files directly.
2. **Server Hosted Website using Nginx**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *Nginx* | *Version 1.25.4, Current version* | *Hosting Server* |
| *Bash* | *Debian* | *Shell OS system* |
| *HTML* | *html5, Current version* | *Website Programming Language* |
| *CSS* | *CSS3, Current version* | *Website Programming Language* |
| *Javascript* | *Javascript ES6, Current version* | *Website Programming Language* |

1. Nginx offers easy-to-use software that is widely used across the world to host web servers.
2. Nginx also works well with Linux which is our chosen operating system as opposed to other hosting software.
3. HTML and CSS work hand in hand, and are also the core languages to use for developing a website.
4. Javascript allows for making the said website more interactive to users.
5. Bash will be used to host the server to eliminate possible human error from starting the server directly.
6. **Mobile Download Application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *HTTP* | *HTTP Version 2.0* | *Data transfer protocol* |
| *C++ Programming Language* | *GCC-6.3.0-1* | *Software coding language* |
| *Android OS* | *Android 14-OneUI 6.0* | *Mobile Phone Specification* |

1. Android apps can be developed using C++ which is more widely used than Apple’s Swift.
2. C++ will be used as the application coding language because it is most comfortable for the developer group.
3. **Image Weakness Evaluation Application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *C++* | *GCC 6.8.0-1* | *Software coding language* |
| *Image Evaluation Software* | *OpenCV - 4.9.0* | *Coding Library for Image Evaluation* |

1. Android apps can be developed using C++ which is more widely used than Apple’s Swift.
2. OpenCV is an object detection software and works well when partnered with C++, so it offers great value compared to other object detection software.
3. **Data Organization and Display Application**

| *Attribute* | *Typical specification* | *Design notes – trades* |
| --- | --- | --- |
| *C++ Programming language* | *GCC 6.8. 0-1* | *Software coding language* |
| *Android OS* | *Android 14-OneUI 6.0* | *Mobile Phone Specification* |
| *Spreadsheet* | *LibXL, Excel* | *Coding Library for Excel read/write* |

1. C++ programming language was chosen over Python and Java because the team is proficient in C++ over the two languages as mentioned earlier.
2. LibXL is a library and will be used over other libraries for .csv or .xls creation and editing due to ease of use and examples available online for implementation.
3. Android apps can be developed using C++ which is more widely used than Apple’s Swift.