|  |  |
| --- | --- |
| Group 27 | Item Tracker |
| Major: | Team members: |
| CS | Mohammad Aljagthmi |
| EE | Ryan Ly |
| CEG | Jake Manser |
| CS | Donald Taylor |

HW/SW Design Trade

Hardware/software design choice to be made (include its identification within your system architecture):

Controller - Size

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Design Options for Microcontroller | | | |
| Criteria | Raspberry Pi Zero W | Arduino MKR WiFi 1010 | Adafruit Feather M0 WiFi – ATSAMD21 + ATWINC1500 | Adafruit HUZZAH ESP8266 breakout |
| Constraint 10 | 5 mm | ####  We know it is well under 2 cm | 8 mm | 5 mm |
| Constraint 20 | 30.5 mm | 25 mm | 22.8 mm | 25 mm |
| Constraint 30 | 66 mm | 61.5 mm | 53.65 mm | 38 mm |
| Constraint 40 | 9.3 g | 32 g | 6 g | 5 g |

Controller – Wi-Fi Compatibility

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Design Options for Microcontroller | | | |
| Criteria | Raspberry Pi Zero W | Arduino MKR WiFi 1010 | Adafruit Feather M0 WiFi – ATSAMD21 + ATWINC1500 | Adafruit HUZZAH ESP8266 breakout |
| Requirement 1.0 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 |
| Requirement 2.0 | ####  Depends on SW development | ####  Depends on SW development | ####  Depends on SW development | ####  Depends on SW development |
| Requirement 3.0 | ####  Comms via Wi-Fi | ####  Comms via Wi-Fi | ####  Comms via Wi-Fi | ####  Comms via Wi-Fi |
| Constraint 70 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 |
| Standard 10 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 | ####  Commercial products adhere to IEEE 802.11 |

Controller - Controller

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Design Options for Microcontroller | | | |
| Criteria | Raspberry Pi Zero W | Arduino MKR WiFi 1010 | Adafruit Feather M0 WiFi – ATSAMD21 + ATWINC1500 | Adafruit HUZZAH ESP8266 breakout |
| Constraint 60 | #### | #### | #### | #### |
| Constraint 160 | ####  Depends on Ryan’s performance | ####  Depends on Ryan’s performance | ####  Depends on Ryan’s performance | ####  Depends on Ryan’s performance |
| Constraint 180 | #### | #### | #### | #### |
| Standard 40 | #### | #### | #### | #### |
| Standard 90 | ####  Depends on Ryan’s performance | ####  Depends on Ryan’s performance | ####  Depends on Ryan’s performance | ####  Depends on Ryan’s performance |
| Standard 100 | #### | #### | #### | #### |

Lighting – Size/Power consumption

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Design Options for Microcontroller | | | |
| Criteria | Raspberry Pi Zero W | Arduino MKR WiFi 1010 | Adafruit Feather M0 WiFi – ATSAMD21 + ATWINC1500 | Adafruit HUZZAH ESP8266 breakout |
| Constraint 60 | ####  Does not have integrated LED | ####  Does not have integrated LED | ####  Does not have integrated LED | ####  Has integrated LED |

We chose to use the Adafruit HUZZAH ESP8266 breakout because it fits the size constraints while having the required Wi-Fi and microcontroller functionality. Wiring constraints and Wi-Fi usage are dependent on other parts of the design.

Power Source - Size

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Design Trades for Power Source | | | | |
| Criteria | 4 AAA Batteries in Series | 6V NiMH Battery pack | Solar cells | 2 3V button cell batteries in series | Hamster wheel and hamster |
| Constraint 10 | 178 mm | 72 mm | 145 mm | 24.5 mm | 342.9 mm |
| Constraint 20 | 10.5 mm | 50 mm | 145 mm | 24.5 mm | 304.8 mm |
| Constraint 30 | 10.5 mm | 15mm | 2.5 | 10 mm | 127 mm |
| Constraint 40 | 46 g | 141.748 g | 80 g | ~25 g | 997.903 g |
| Standard 40 | #### | #### | #### | #### | #### |

Power Source – Voltage output

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Design Trades for Power Source | | | | |
| Criteria | 4 AAA Batteries in Series | 6V NiMH Battery pack | Solar cells | 2 3V button cell batteries in series | Hamster wheel and hamster |
| Voltage Output | 6V | 6V | 6V | 6V | To Be Determined |

We chose to use the 2 3V button cell batteries in series implementation because it is the smallest choice that can supply the required voltage to the microcontroller.

Case – Damage resistance

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Trades for Case | | |
| Criteria | Tupperware | Wrap plastic cling wrap | Wrap in Aluminum foil |
| Requirement 18.0 | #### | #### | #### |
| Requirement 19.0 | #### | #### | #### |
| Requirement 20.0 | #### | #### | #### |
| Requirement 21.0 | #### | #### | #### |
| Allows Wi-Fi Through | #### | #### | #### |

We chose to use plastic cling wrap because it is the most form fitting external material that a Wi-Fi signal can still pass through.

Attachment Method – Secure attachment

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Trades for Attachment Method | | |
| Criteria | Rubber Bands | Hook-and-Loop Fasteners | Epoxy |
| Requirement 4.0 | #### | #### | #### |
| Standard 20 | #### | #### | #### |

Attachment Method – Removable

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Trades for Attachment Method | | |
| Criteria | Rubber Bands | Hook-and-Loop Fasteners | Epoxy |
| Requirement 4.1 | #### | #### | #### |

Attachment Method – Capable of reattachment

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Trades for Attachment Method | | |
| Criteria | Rubber Bands | Hook-and-Loop Fasteners | Epoxy |
| Requirement 4.2 | #### | #### | #### |

We chose to use the hook-and-loop fasteners (Velcro ©) because it can be removable and reusable. We chose hook-and-loop fasteners over rubber bands because it is faster to remove and reattach with hook-and-loop fasteners than with rubber bands. Rubber bands also have the added disadvantage of adding extra strain and stress on the tracker’s external case.

GUI – Programming Language

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Design Options | | | | |
| Criteria | Option 1  Java | Option 2  C++ | Option 3  Swift | Option 4  Python | Option 5  JRuby |
| Requirement 3.0 | Used for mobile app development | Used for mobile app development | Used for mobile app development | Used for mobile app development | Used for mobile app development |
| Requirement 7.0 | Is Multi-Platform | Is Multi-Platform | Is IOS exclusive | Is Multi-Platform | Can be used on Android devices |
| Familiarity with language | All team members have experience | Some team members have experience | No experience | Some team member have little experience | No experience |
| Has Wi-Fi Tracking Library Tools | Yes | Yes | Yes | Yes | No |
| Portable | Yes | No | No | Yes | Yes |
| Database API Tools | Yes | No | Yes | Yes | Yes |

We chose to use Java due to the reason for this is mainly group familiarity with the language as well as it has all of the tools that we need to complete the application.

GUI – Platform for Delivery

|  |  |  |
| --- | --- | --- |
|  | Design Options | |
| Criteria | Device Local | Remote Server |
| Constraint 190 | ### | #### |
| Time to Develop | Low | High |
| Complexity | Low | High |

We have chosen to develop a device local application in order to minimize the time required to develop as well as the complexity.

Database - Language

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Design Options | | | |
| Criteria | Postgres | SQL | MySQL(Room) | Firebase |
| Requirement 7.0 | No | No | Yes | Yes |
| Constraint 190 | Free | $1800 per core | Free | Free |
| Hardware Profile Requirements | High | High | Low | Low |
| Additional Tools Included | No | No | No | Yes |

We have chosen Firebase as it meets all requirements that we have for a database, as well as, includes a number of useful additional tools in Android that will prove useful in the development process.

Background Services – API

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Options | | |
| Criteria | Celery[Redis] | Lettuce[Dory] | WorkManager[Firebase] |
| Requirement 7.0 | No | Yes | Yes |
| Hardware Profile Requirements | High | Low | Low |
| Runs without Application in Memory | Yes | Yes | Yes |

We have chosen to use the java library of WorkManager as it allows us to have asynchronous tasking for Firebase database loading and monitoring per the software block diagram without the need for the application to be running.

OS Communication – API

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Options | | |
| Criteria | Kotlin | Java | Firebase |
| Requirement 7.0 | Yes | Yes | Yes |
| Team Familiarity | None | All | Some |
| Ease of Interface | Medium | Medium | Easy |

We chose Firebase as it offers an easy to use API and is already incorporated into the project in other ways so we have no need to learn additional tools or methods.

OS Communication – Communication to External Services

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Options | | |
| Criteria | Kotlin | Java | Firebase |
| Requirement 7.0 | Yes | Yes | Yes |
| Team Familiarity | None | All | Some |
| Ease of Interface | Medium | Medium | Easy |

We chose Firebase as it offers an easy to use API and is already incorporated into the project in other ways so we have no need to learn additional tools or methods.

Tracker - API

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Options | | |
| Criteria | Arduino 1.8.7 | Javascript | Python |
| Compatible with Adafruit HUZZAH ESP8266 breakout | #### | #### | #### |
| Compatible with Raspberry Pi Zero W | #### | #### | #### |
| Compatible with Arduino MKR WiFi 1010 | #### | #### | #### |
| Compatible with Adafruit Feather M0 WiFi – ATSAMD21 + ATWINC1500 | #### | #### | #### |

We chose Arduino 1.8.7 to interface with the Tracker as it is the only option which is compatible with the microcontroller.

Tracker – Communication Methodology Protocol

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Design Options | | | | |
| Criteria | TCP | UDP | HTTP | FTP | SSH |
| Requirement 1.0 | Yes | Yes | Yes | Yes | Yes |
| Requirement 3.0 | Yes | Yes | Yes | Yes | Yes |
| Constraint 70 | Yes | Yes | Yes | Yes | Yes |
| Standard 10 | Yes | Yes | Yes | Yes | Yes |
| Complexity | Requires listener for two way communication | One way communication | Limited by ports, requires webserver and web-browser decoding | Port Listener | Port listener, requires authentication |

We chose UDP as our data transmission protocol as it fulfills all of our needs for simple, intermittent communication.

Tracker – Structure of Data Transmitted

|  |  |  |  |
| --- | --- | --- | --- |
|  | Design Options | | |
| Criteria | JSON | String | Custom Object |
| Requirement 1.0 | Yes | Yes | No |
| Ease of Parsing | Easy | Medium | Easy |
| Compatible with Chosen Protocol | Yes | Yes | No |

We have chosen to structure the data in JSON as it offers the most flexibility as a payload which will be easily parsed into the database once received by the listeners.