3.007 TECHNOLOGICAL WORLD

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OUR PROBLEM:

Finding a power source that delivers sufficient power across one running session while maintaining a portable form factor

CONSIDERATIONS

1. Power draw:

- RPi Zero: 5V/100mA-350mA
- WS2812B 8x8 LED Matrix: 5V/1A-2A
- Neo 6M GPS module: 3.3V/40mA-67mA
- nRF24L01 RF Transceiver: 3.3V/ 13.5mA

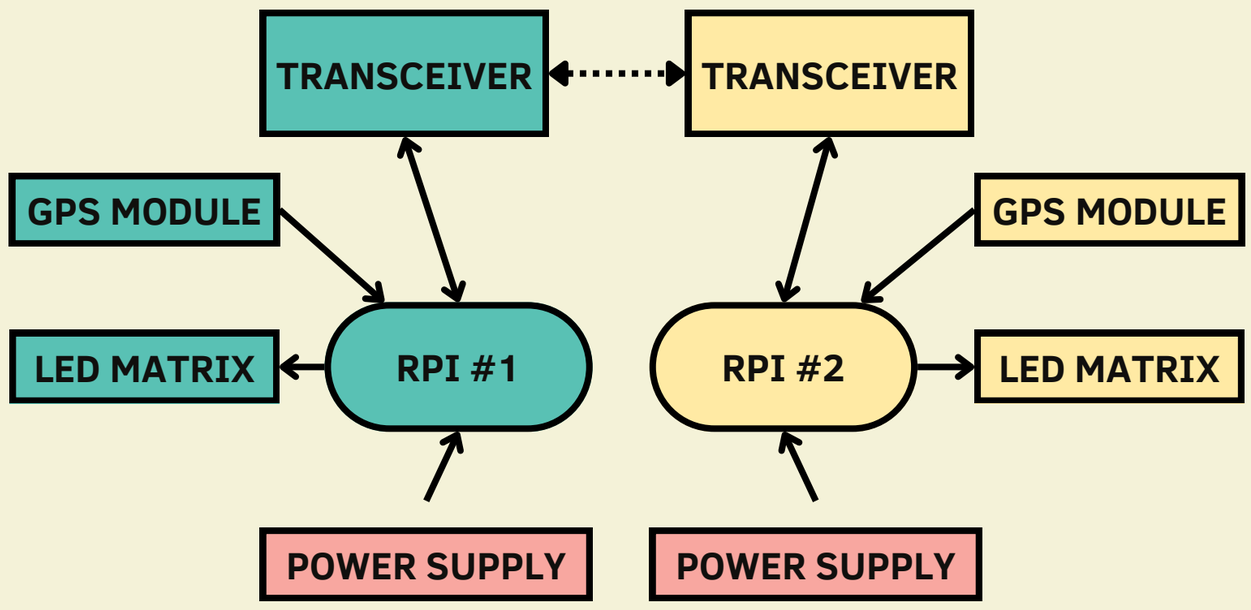
2. Power Requirements:

- Assuming the peak current draw in every component, this totals to **2430.5mA**.
- The power source utilised must have a minimum capacity of **2430.5mAh** at 5V to last at least an hour of usage. (generous estimate of time required for pairing and a complete run)

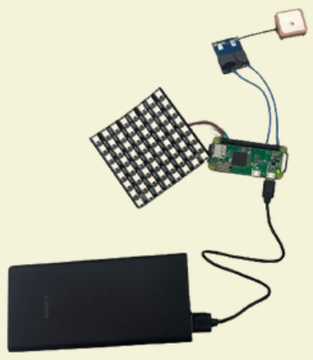
3. Compact and lightweight

- To minimise hindrance to the users' physical activities

FUNCTIONAL DIAGRAM



INITIAL SETUP

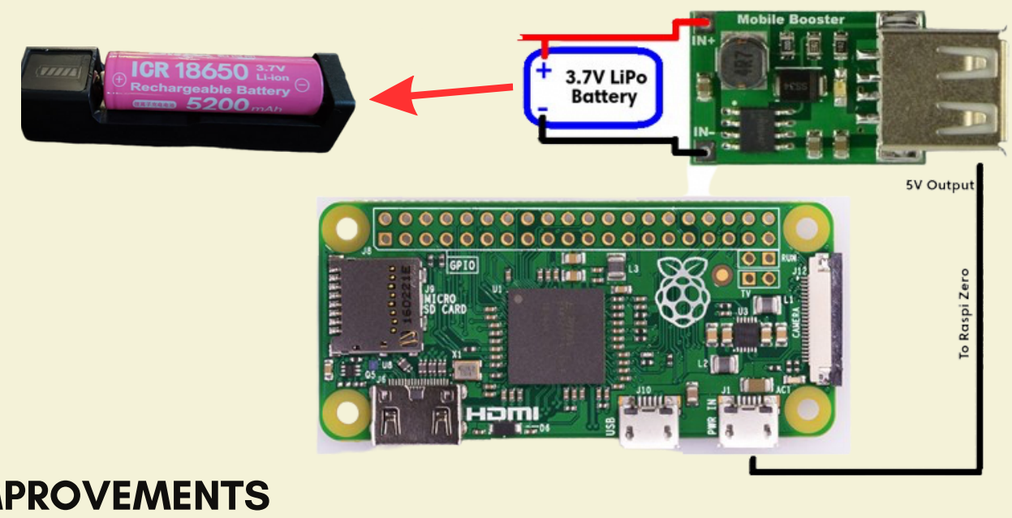


5000mAh power bank with power output of 5V/2A, connected via USB

LIMITATIONS

Too bulky and heavy to be placed within the visor, needs to be attached elsewhere.

OUR REVISED SETUP



IMPROVEMENTS

Use a smaller battery (boosted to 5V using a boost module) as our power source to reduce size and weight

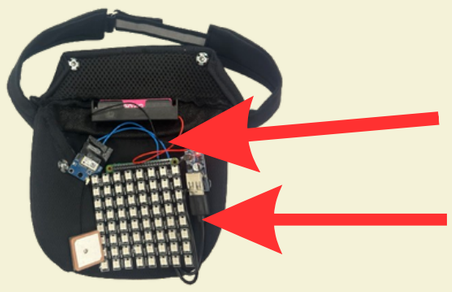
THEORETICAL RESULTS

The theoretical run times of different battery types with the boost module are calculated and tabulated below:

Battery used	18650 battery	AA battery	AAA battery	Rechargable AA
Battery Voltage (V)	3.7	1.5	1.5	1.5
Boosted Voltage (V)	5	5	5	5
Boost Ratio (from P=IV)	1.351351351	3.333333333	3.333333333	3.333333333
Reduced Current (A)	0.444	0.18	0.18	0.18
After 15% efficiency loss (A)	0.3774	0.153	0.153	0.153
Stated Battery capacity (Ah)	5.2	2.85	1.2	2.9
Run time (hour)	5.451333333	1.21125	0.51	1.2325
Reason of elimination	Enough current for our setup	Current is too low for the RPi	Run time is too short to fulfil minimum criteria	Current is too low for the RPi

We performed our calculations using the max current draw shown below. This is to ensure that we have enough runtime, even if we were to power our LEDs at maximum brightness only.

State of the RPi	Just RPi (Ampere)		Revised setup (Ampere)	
Boot	0.15	avg	0.15	avg
	0.2	max	0.2	max
Idle	0.1	avg	0.2	avg
	0.16	max	0.26	max
Max usage	0.23	avg	0.4	avg
	0.35	max	0.6	max (capped out by boost module)



18650 battery and holder

Boost module

VALIDATING OUR THEORETICAL RESULTS

To validate our calculations, we performed a real-world test of our 18650 battery. On our Pi, we ran the same programs that we would deploy in our final prototype, and monitored the time it took before we observe abnormal behaviour due to low battery voltage.

Tested Battery Life on Full Charge:

4 hr 24 minutes

Conclusion:

The actual battery life is 24% lower than the theoretical battery life from our calculations. However, it is still greatly surpasses our minimum requirements for run time and form factor. Thus, we decided on using the 18650 battery to power our prototype.