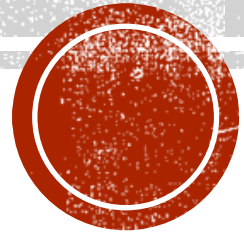
BATTERY POWER SYSTEM MANAGEMENT



Robotic Hardware Systems : Week 8

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TYPE OF BATTERIES

- Primary (non-rechargeable)
- Secondary (rechargeable)

PRIMARY BATTERIES

- A primary battery is a convenient sources of power for portable electronics and devices.
- Inexpensive, lightweight, and convenient to use with no maintenance and can not be recharged.
- Primary Battery Types:

  Alkaline, Magnesium, Mercury, Lithium Cathode, Lithium Electrolyte, Silver, Zinc-Carbon.

SECONDARY BATTERIES

- Can be recharged and reused.
- Secondary batteries usually cost more than primary ones. But considering they're rechargeable, they can have a longer lifespan.
- Used for two applications:

  - energy storage devices

  - applications where the battery is used and discharged as a primary battery

- Major Types of Secondary Batteries:
  - Lithium-ion, Lithium-Polymer, Lead-acid, Cadmium, Metal Hydride.

HOW TO CHOOSE THE RIGHT BATTERY?

- We need to consider the following:
  - Primary or secondary
  - Energy or power
  - Shelf life
  - Energy efficiency and recharge rate
  - Battery life
  - Battery temperature

HOW TO CALCULATE NEEDED BATTERY CAPACITY

- Step 1- Back of the envelope

If the current drawn is x amps, the time is T hours then the capacity C in amp-hours is

C = xT. For example, if your pump is drawing 120 mA and you want it to run for 24 hours.

C = 0.12 Amps * 24 hours = 2.88 Amp hours

HOW TO CALCULATE NEEDED BATTERY CAPACITY

- Step 2- Cycle Life Considerations

It isn't good to run a battery all the way down to zero during each charge cycle. For example, if you want to use a lead acid battery for many cycles you shouldn't run it past 80% of its charge, leaving 20% left in the battery. This not only extends the number of cycles you get, but lets the battery degrade by 20% before you start getting less run time than the design calls for C' = C/0.8

- For the example above, C' = 2.88 AH / 0.8 = 3.6 AH

HOW TO CALCULATE NEEDED BATTERY CAPACITY

- Step 3: Rate of discharge considerations

For example, if your portable guitar amplifier is drawing a steady 20 amps and you want it to last 1 hour you would start out with Step 1:

C=20 amps * 1 hour = 20 AH

Then proceed to Step 2

C' = 20 AH / 0.8 = 25 AH

Then take the high rate into account

C''=25 /.5 = 50 AH

Thus, you would need a 50 Amp hour sealed lead acid battery to run the amplifier for 1 hour at 20 amps average draw.

HOW TO CALCULATE NEEDED BATTERY CAPACITY

- **Step 4.** What if you don't have a constant load? The obvious thing to do is the thing to do. Figure out an average power drawn. Consider a repetitive cycle where each cycle is 1 hour. It consists of 20 amps for 1 second followed by 0.1 amps for the rest of the hour. The average current would be calculated as follows.

  20*1/3600 + 0.1(3599)/3600 = 0.1044 amps average current.

HOW TO CALCULATE BATTERY RUNTIME

- `Battery life = capacity / consumption * (1- discharge safety)`
- **Capacity** is the capacity of your battery, measured in ampere hours. You can usually find this value printed on your battery.
- **Consumption** is the average current draw of your electronic device, expressed in amperes. (If you want to learn more about the electric current, make sure to check out the Ohm's law calculator!)
- **Discharge safety** is the percentage of your battery capacity that is never used. For example, if you use a LiPo battery to fly a drone, you should never discharge it below 20% - otherwise, it can be damaged. Our battery life calculator assumes a default discharge safety of 20%, but feel free to change it as you wish.