Autonomous Boat - Design Proposal

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1 Requirements

- Size Approximately 1.5m by 1m
- Fully self-sufficient
- Two-motor drive (for mechanical simplicity)

2 Hull and Superstructure

2.1 Requirements

3 Electronics

3.1 Requirements

- 100W solar supply
- Survive a whole day with no solar generation
- Able to drive continuously
- Routine telemetry updates via Satellite modem

Generation Capacity Main power is to be supplied by a 1.5x1m solar panel (see below), this size of panel is rated to about 100W generation capacity. In Perth, there's an approximate factor of 4.3 to go from a panel's rated power output to the daily generation capacity (in W-h), however this factor is calculated based on using an optimal panel angle. Since the panel will be (on average) flat, the factor will be reduced to about 85% **??**.

This available generation capacity must be sufficient to both power the boat during the day, and provide charging for during the night (and cloudy days). This requires that a minimum of 50% of the supply power must be reserved for charging (and ideally up to 70% to account for losses and recharging after cloudy days).

$$P_{\text{cont}} = 100 \times 4.3 \times 0.88 \times 0.70 \div 24 \approx 11W$$

Power Storage To be able to continue to run at full capacity in the absence of solar generation for a whole day, we need storage equivalent to 36 hours of continual drain.

$$E_{\text{storage}} = 11W \times 36\text{hrs} \approx 400\text{W-h} = 33\text{A-hr at 12V}$$

Control Drain The control logic (ArduPilot, GPS, logger, modem) have a constant drain that must be accounted for before the driving capacity is determined. A rough figure can be calculated by taking the peak current draw of each unit and converting that to drawn power.

- ArduPilot 203mW (calculated by summing peak current of all major chips and multiplying by 3.5V)
- GPS 105mW (peak, during active tracking)
- Data Logger 21mW (during write)
- Satellite Modem 75mW average (450mA peak, but only for approximately 2 mins per hour, and supply is 5V)

The above equals a total draw of 404mW

Driving Drain The design calls for two motors (avoids complexities of a rudder), so after subtracting the control draw, the available power must be split between both motors.

$$P_{\text{motor}} = (11W - 0.5W)/2 = 5.25W$$

3.2 Existing Parts

Controller: ArduPilot2.8 Controller Board

Modem: RockBlock+ Satellite Modem

3.3 New Parts

Battery Any 40A-hr 12V lead-acid battery will work, but using two batteries may be desirable to ensure a sane weight distribution.

Options

- 2x 12V 18Ah SLA Battery Total capacity 36Ah, distributed across both hulls `https://www.jaycar.com.au/12v-18ah-sla-battery/p/SB2490` Price: $80AUD (plus shipping)
- 1x Centry NS40ZLS Single unit, 40Ah capacity. Could be stored in the keel `http://www.batteriesdirect.com.au/shop/product/4424/ns40zlsmf.html` Price: $95AUD (TODO: Shipping)

Solar Panel 100W/12V solar panel, 1580mm by 808mm size.
`https://pethomeoutdoor.com.au/products/12v-200w-solar-panel-kit-home-generator-caravan-camping-p`
Price: $212AU (TODO: Shipping)

Low-Voltage Supply *Simple DC-DC converter to turn 12V battery/panel supply into 3.5V for boards to regulate down to 3.3V.*

GPS *Any TTL-based gps would work* "Adafruit Ultimate GPS Breakout" `https://core-electronics.com.au/adafruit-ultimate-gps-breakout-66-channel-w-10-hz-updates-version-3.html` Price: $70AU (incl. shipping)

Data Logger "SparkFun OpenLog" `https://www.sparkfun.com/products/13712` Price: $52.75 (incl. shipping)

Propulsion Still undecided, several options. We have a capacity of approximately 10W across both motors, this means that each will run at 5W constant, spiking up to 10W each (when at max turn)

Options

- Blue Robotics - T100 thruster
  Rated to 130W max draw, but max efficiency is at 6W draw. Price: $144USD (plus shipping of 35USD) per motor = $431AUD
- Custom build - Motor in hull
  Complex due to sealing requirements, but very easy to tailor to our needs (and minimum impact on hydrodynamics)
  - Prop 50mm diameter, 3 blade prop
    `https://hobbyking.com/en_us/50mm-3-blade-aluminum-cnc-boat-prop-p1-4-3x3.html`
    Price: AU$42 ea.
  - Motor 12V Brushless w/ ESC
    `https://littlebirdelectronics.com.au/products/brushless-dc-motor-with-encoder-12v-159rpm`
    Price: AU$42.90 ea
  - Shaft ??? (Custom?)
- Custom build - Motor outside hull
  Simpler than in-hull, but requires making a streamlined enclosure/mounting
  - Prop
    50mm diameter, 3 blade prop
    `https://hobbyking.com/en_us/boats/propellers/3-blade.html`
    Price: AU$42 ea.
  - Motor
    12V Bilge Pump
    `http://www.bcf.com.au/Product/TMC-Submersible-Pump-Mini-12V/116270`
    Price: AU$25 ea
  - Motor Controller
    10A 5-25V Dual Channel DC Motor Driver
    `http://www.robotshop.com/en/10a-5-30v-dual-channel-dc-motor-driver.html`
    Price: AU$30 (TODO: Shipping)
  - Shaft ??? (Custom?)

  Note: The bilge pump could also be used just as a pump thruster
- Low-power water pumps
  Relatively simple to set up, but ability to moderate output is unknown. Can place in-hull with two hoses (complex, but smooth), or external (more drag, simpler build).

4 Firmware

Firmware will be the `APMrover2` configuration of the open-source ArduPilot suite. However, to support telemetry updates via the Satellite modem, there will need to changes to the stock firmware.

References

[1] Optimum angle for solar panels in Australia `https://solarcalculator.com.au/solar-panel-angle/` Fetched 01-Apr-2017