AquaMote: Ultra Low Power Sensor Tag for Animal Localization and Fine Motion Tracking

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Localization to Track Animal Behavior

- Sensor tags reveal nuanced animal behavior and ecosystem dynamics
- Localization is key to understanding animal context
- Design objectives:
  - Provide frequent, accurate and fine-grained location
  - Have a long life and be extremely small

AquaMote Tag

Inertial Measurement Unit
- IMU data gives information on the actions and behaviour of the animals.
- Timestamped by using the real time clock of the Microprocessor.
- Time is synchronized opportunistically with the absolute time from GPS.

Flash Memory - NAND Flash
- Preferred over an SD card because it’s much smaller physically.
- Has much smaller read/write current.
- At the given voltage level, NAND Flash has limited storage capacity.
- Sensor rates might be reduced to allow more lifetime in the field.

GPS
- Time to First Fix is reduced to less than 6 seconds by storing valid Satellite Ephemeris and Almanac data in the GPS RAM.
- GPS is turned on only when the animal surfaces based on the reading from the pressure sensor which helps in saving power.

Bluetooth Low Energy
- Facilitates data retrieval to a host (Laptop/Smartphone).
- Allows erasing the data and tweaking calibration parameters.
- Permits communication between known anchors and other sensor tags.

Software Work Flow

1. **Turn on**
   - BLE Advertising for 10 secs
   - Connected?
     - Yes: Data Retrieval
     - No: BLE Switched off

2. **Data Collection**
   - IMU, Pressure, GPS
   - Mem. Full?
     - No: Write to buffer
     - Yes: Page Write to Flash

**Power Analysis**

- Measured using Keithley source meter with accuracy of 0.6 μA
- Board supply voltage: 1.8V

**Future Work**

Localization is difficult as accelerometer, gyroscope, and magnetometer are noisy.
- Better accuracy can be achieved with higher data collection frequency.
- Using virtual gyroscope mitigates use of power hungry gyroscopes. With 20% sampling, rest of the values can be estimated using neural networks.
- GPS can provide accurate location, time, and ground truth.

**REFERENCES**


