Sensor Buoy for Environmental Monitoring

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Motivation

Background:
The concerns about environment are escalating, and it is expected that the water quality and the condition of underwater structures such as bridge pillars and sheet pilings should be constantly monitored.

Requirements:
1. Lower the maintenance cost by deploying buoy since it is too costly and time-consuming to send out divers to do the measurements.
2. Find energy harvesting solutions which have higher power density than solar harvester and energy-aware task scheduling.

Project Goals:
- Explore different energy harvesting solutions.
  1. Wind Energy Harvester
  2. Wave Energy Harvester

Wave Energy Harvester

Background:
Current energy harvesting techniques such as wind and solar are very much dependant on their environment. Unreliability and maintenance due to pollution and corrosion are real problems. The goal was to build an energy harvester, to fit inside the buoy and use the vertical wave movement to generate enough energy to power the sensors without being exposed to the environment.

Simulation:
To be able to get a rough estimate of the necessary spring constant as well as magnet mass, we built a Matlab Simulation.

Prototype:
A prototype was built using a transparent PVC pipe and springs with different spring constants, which originated from the simulation. 10 cylindrical magnets were used (combined weight of 300g). This prototype was then connected to a testbed to simulate excitation of different wave frequencies as well as various amplitudes. Due to the timing constraints, we were not able to measure the output power of the coil yet.

Riot OS and Scheduler

- Riot OS:
  1. Open source operating system designed for low end embedded IoT systems.
  2. Memory requirement in Riot OS is low.

- Challenges concerning the Software implementation:
  1. Underestimated the complexity of existing code
  2. Issues setting up RiotOS
  3. Underestimated the time required for the whole software part

Conclusion and Future works

- Currently, the wind turbine rotation is tested for a single generator. Further we can perform simulation using different generators to find the most efficient generator.
- The wave energy harvester produces possibly sufficient magnet movement at the typical wave frequencies and amplitudes found at the harbor. Therefore, this prototype could definitely be used to further analyze if the power output is sufficient as an alternative energy supply for the buoy. Possible improvements would include the addition of more (magnet) weight as well as different spring constants.
- Implement the task scheduler according to the existing algorithm. The existing code should be scrapped off and rewritten using the libraries provided by RiotOS.