Contactless Sensor System

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Background:

The US Navy employs a wide variety of sensor systems that must operate in harsh environments. Due to the extreme corrosive characteristics in some of these environments, exposed electrical contacts are not permitted. Removable hatches or covers installed in the sensor systems are undesirable since the system must be cleaned and mover to a clean environment before the device may be opened. Thus, contactless techniques must be employed in order to access the electronics inside the sensor.

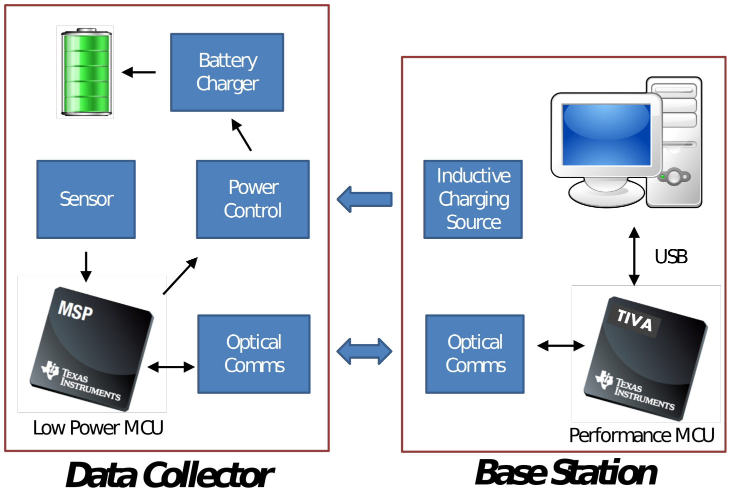
An additional concern with such a system is counter-detection. Radio Frequency (RF) communications such as Bluetooth and Wi-Fi are not permitted due to concerns about unintended enemy monitoring of data traffic, or even covertly extracting data from the sensor system. Even with advanced antenna techniques, directional RF communications will still leak detectable levels of RF energy into the surrounding environment. Such communications can be discovered and snooped at operationally significant ranges. An additional concern with RF communications is hijacking. RF signals are not line-of-sight; rather they travel through solid objects. This opens up the possibility of remote interrogation of the sensor system from an unintended source. To remain covert and secure, the data link with the sensor system must not use RF communications.

Both requirements, to remain completely sealed and communicate securely, can be solved using a variety of different techniques. This Capstone project will focus on inductive charging of a sensor's power source (LiPo/Li-Ion) and optical communications to program the sensor and extract data.

Project Details:

This project will contain two subsystems – a *data collector* and a *base station*. The data collector system will contain a battery, microcontroller unit (MCU), power controller, battery charger, and optical communications device. Electrical pickup circuitry will convert the electromagnetic (EM) fields generated by the base station into a regulated DC voltage to charge the battery and power the data collector system during communications with the base station. The data collector system will be programmed with some schedule for sampling the onboard sensor. Once the data collector is removed from the base station, the sampling scheduler initiates and collects data from the sensor at the proper intervals. It is important that the data collector be designed to consume as little power as possible to maximize system endurance.

The base station has a higher performance MCU that communicates with the data collector through the optical link. Through this link it sends commands to the data collector and receives sampled sensor data back from it. In addition, this MCU interfaces with a PC using USB. The PC provides a graphical user interface (GUI) to provide command control, status, and retrieve sensor data. In addition, the base station will contain the circuitry to generate the electromagnetic fields to power the data collector.



Operational Flow:

1. The data collector is placed in a cradle provided on the base station. The PC GUI alerts the user to the status of the battery, quantity of sensor data ready for download, and provides a means to program the sampling scheduler.
2. Once the battery is fully charged the data collector is removed from the base station cradle. The sampling scheduler starts and begins collecting sensor data. Data is collected continuously until the schedule is complete, the battery is completely drained, or the data collector is returned to the base station cradle.
3. The PC GUI allows the user to download the sensor data. The battery is recharged and the data collector is made ready for another sampling session.

Tasking:

- Electrical Engineer:
  - Develop/prototype EM field generation and reception circuitry for remote inductive powering
  - Identify battery and develop/prototype circuitry for battery charging
  - Link prototype circuits with sensor, optical communications, and MSP MCU evaluation board
  - Link TIVA MCU evaluation board with optical communications and work with Computer Engineer to verify data link.
  - If time permits, develop custom circuit boards for all circuitry.
- Computer Engineer
  - Develop data collector software to sample sensor, monitor battery, and communicate using custom data transfer protocol
  - Develop base station software to communicate using custom data transfer protocol and interface with PC GUI
  - Develop simple PC GUI to interface with base station
- Both:

    - Develop custom data transfer protocol for communications between data collector and base station
    - Work together to understand design tradeoffs and provide evidence for your design decisions

<u>Suggested Schedule:</u>

- Semester 1:
    - Identify all design parameters, develop data transfer protocol, demonstrate operation of individual prototype subsystems (battery charging, optical communications, sensor sampling, Tiva/GUI)
- Semester 2:
    - Link subsystems into a fully functional end-to-end demonstration system. If time permits, develop custom data collector circuitry and encase in urethane-based potting compound