Riverine Drifter

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LONG-TERM GOALS

The original long-term goal of this Small Business Innovation Research (SBIR) Program Phase II project was to develop a Surf Zone (SZ) bottom drifter measurement system that would be relatively invulnerable to effects of breaking waves and that would utilize near bottom currents to provide drifter locomotion without using its own power. Pressure sensor data would be processed with spectral filters to provide bathymetry and wave data. Using acoustic positioning, locations of bathymetric measurements would be known so that bathymetric data could be gridded for numerical modeling and military applications. Developing a riverine drifter variant had been proposed as an option. This variant would drift with currents at the surface and either profile up and down to measure depth and other parameters, or measure depths from the surface with a low-cost commercial "fisherman type" fish finder or depth sounder. Increased naval interest in the riverine variant developed. Considering the high cost of the SZ variant, the low cost of the riverine variant and the interest in the riverine variant, goals were shifted to developing a riverine drifter that initially would measure currents, water depths and water temperatures

OBJECTIVES

The objective is to develop a low cost, optionally expendable, riverine drifter to measure currents, bathymetry, and other data as it is transported by currents.

APPROACH

The approach is to design a drifter with the following general design goals:

- Size: 25 cm (10 in) diameter size or smaller
- Weight: 3 kg (7 lbs) in air or less
- Communications: Satellite
- Servicing: No user serving
- Charging: Inductive, no hull opening or replacing batteries
- Operating lifetime on one charge: 1 week or more
- Initial measured data: Position, surface current from positions, water depth, temperature
- Later measured data: salinity from conductivity, turbidity/visibility

Development is enabled by integration of the following low cost and small size components:

- Depth sounders / fish finders sold into the fisherman / consumer market
- GPS modules used in consumer electronics such as cell phones
- Thermistor based temperature measurements
- Inductive charging used in consumer products such as electric toothbrushes
- ARM microcontrollers for low cost computational power
- Satellite communications such as Globalstar
- Strong light weight hull materials such as Polycarbonite

The Lead Electrical Engineer is Radhika Dahale and the Lead Mechanical Designer is Bill Hughes.

WORK COMPLETED

The following overview of the SZ part of this effort describes this closed out work. Under an earlier Phase I effort, techniques were developed to track drifters using new micro Inertial Measurement Units (IMU's) with acoustic tracking updates considering SZ acoustic limitations such as noise and bubble attenuation. A preliminary design that considered size, weight and power limitations was developed. Preliminary data analysis methods to provide SZ bathymetry and wave information were programmed and tested with simulated drifter tracks using bathymetry from the Field Research Facility (FRF), Duck, NC. Simplified prototype drifters without tracking instrumentation, environmental sensors, and data relay capabilities were built. One was used successfully in the field at Eglin Air Force Base, FL. Before final designs were developed, it became clear that the system, while possibly suitable for research use, would be too expensive for operational use or purchases in reasonable quantities mainly due to the acoustic tracking instrumentation. This tracking also requires placement of two transponders on bottom mounts outside of the SZ. The cost of a five unit system with the transponders would be approximately $150,000. The cost of a ten unit system with the transponders would be approximately $210,000.

For the riverine drifter, comparisons between an ascending / descending drifter and a surface drifter using depth sounders / fish finders to collect bathymetric data showed major system simplifications, increased reliability, and much lower costs for the latter approach. In small quantities (<10), surface drifters could be produced for approximately $900-$1,000 each. In large quantities (> 100), surface drifters could be produced for approximately $500-$750 each.

A preliminary design was developed based on the following key components: electronics and transducer heads from flashlight sized depth sounders mainly used for ice fishing, a GPS module used in cell phones and Personal Digital Assistants (PDA's), low cost inductive charging electronics drawing on an open literature design, an Advanced RISC (Reduced Instruction Set Computer) Machine (ARM) microcontroller already being used in a Planning Systems air-deployed expendable wave buoy, Globalstar satellite communications, and sealed spherical hulls with durable strong materials (e.g., ABS plastic, Delrin, Polycarbonite). Inductive chargers have no direct electrical connection between the batteries being charged and the charger. Alternating Current (AC) power is transferred magnetically using a primary coil on the charger and a secondary coil in the unit being charged. The AC generated in the secondary coil is converted to Direct Current (DC) for charging batteries in the unit being charged. Data transfer for drifter setup would use the same coils used for inductive charging. Thus, drifters would be permanently sealed as durable units with no need for user internal access. A spherical drifter would minimize hanging up on debris or obstacles.

RESULTS

The preliminary design shows that riverine drifters that measure currents, bathymetry, and water temperatures could be produced for approximately $500-$750 each in reasonable quantities (>100). There would be no user servicing or hull opening to change batteries due to use of inductive charging. There would be few user setup commands except for duration of data collection and the sampling rate. The interval between samples would likely be selectable between 1 s and 30 s to provide good spatial resolution at typical current speeds. An "automatic" setting could provide a reasonable spatial resolution [e.g., 2.5 m (8 ft)] based on measured current speeds. Figure 1 shows a cross-sectional schematic view of the riverine drifter. Figure 2 shows an exploded schematic view.

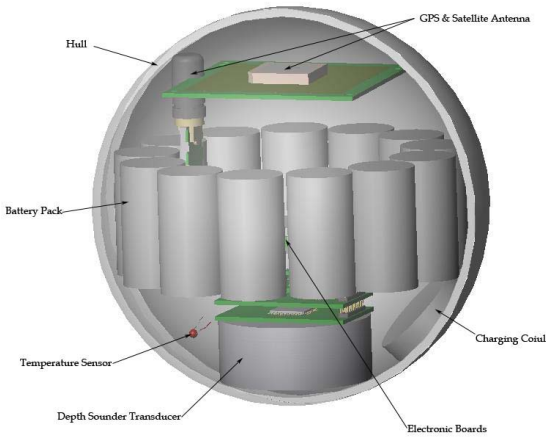

Figure 1. Cross-Sectional Schematic View of Riverine Drifter.

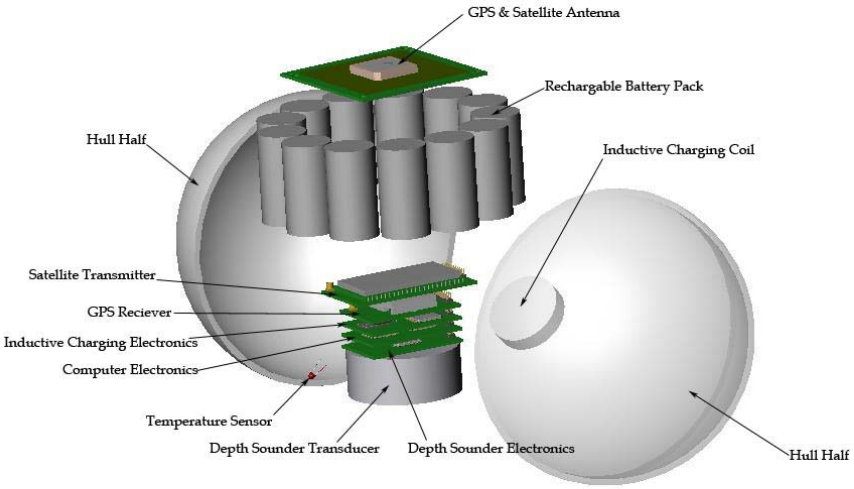

Figure 2. Exploded Schematic View of Riverine Drifter.

IMPACT/APPLICATIONS

A literature and Internet search indicated that there are apparently no similar technologies. There is increasing military emphasis on riverine operations for mobile Global War On Terror (GWOT) operations as well as more traditional military operations that increasingly require forces to rapidly move from shore to well inland. Knowledge about basic parameters, especially currents and bathymetry, is important for the rapid and safe conduct of these operations. Riverine drifters would provide this information without requiring extensive personnel time. A self-scuttling variant could be used as an expendable riverine sensor so that forces would be at minimal risk collecting data.

TRANSITIONS

Riverine drifters would directly support expeditionary forces in mobile GWOT operations as well as more traditional military operations. Forces would include traditional Marine Corps forces, Naval Special Warfare (NSW) Groups, special operations forces from all services under the Special Operations Command (SOCOM), and the array of diverse forces including Riverine Squadrons under the Naval Expeditionary Combat Command (NECC). In particular, the NECC has a mission to support joint force operations and logistics well inshore from the sea base of previous naval operations. Riverine drifters would have dual use applications for civilian hydrographic charting of river bathymetry.

RELATED PROJECTS

Development of the riverine drifter is a new concept with little or no related work.