ONR Sea Otter

N00014-09-M-0228

Rapid Mobile Geotechnical Measurement System for Amphibious Operations

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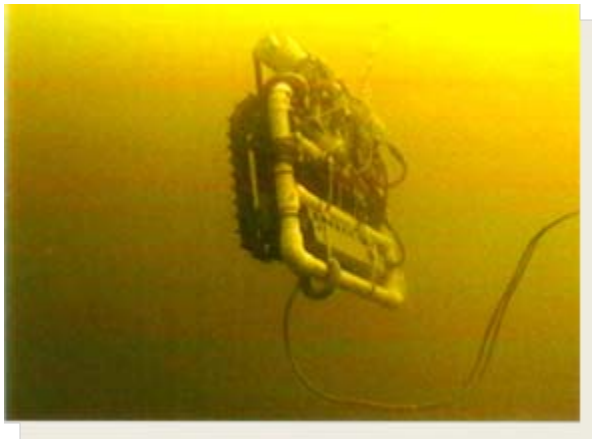
Problem & Approach

- Establish and map trafficability in hostile near shore, estuarine, and riverine amphibious terrain
- Alternatives:
  - Single point probes only good for uniform beaches, susceptible to drop error
  - Drifters are unpredictable
  - Hyperspectral cannot penetrate murky or turbulent water
  - SEAL teams are exposed and require considerable logistical support
- Bottom crawlers can cover large areas, obtain continuous data.

Advantages of the Sea Otter

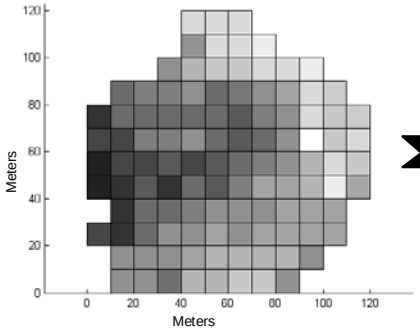
- Wide track capable of traversing weak soils
- Operates in high current environments (tested to 4kts)
- Independent of surface conditions
- Close and constant contact with sols for range sensitive instruments (e.g. magnetometers)
- Can operate tethered or non tethered
- Instrumentation can be mounted externally or internally
- Operates at 3 km/hr (though slower is better)
- Covers large area
- Easy deployment form surface craft, beach



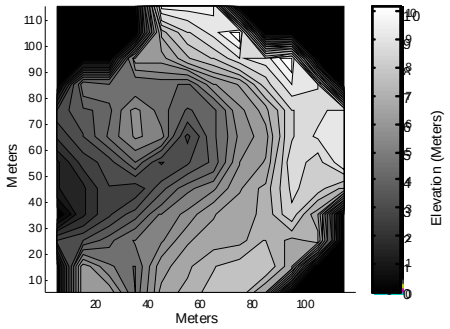
Sea Otter Output Data

- Penetration resistance
  - scaled CBR, CI, RCI relates to NATO trafficability model
  - Continuous measurement to 18-in depth
- Continuous measurement identifies channels, bars, other invisible features
  - Shear strength, draw bar pull or tractive effort
  - Ground slope (contour)
  - Surface ground roughness
  - Water depth
  - Current speed and direction
- Simple to include visual reconnaissance, turbidity, comms surveys

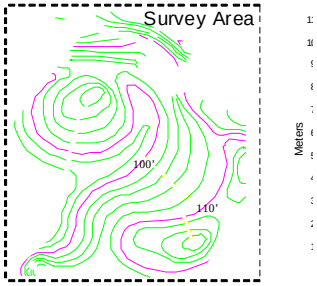
Contour maps generated by vehicle mounted barometer and tilt. Slope and obstacle alarms shown in red.



Raw altitude data

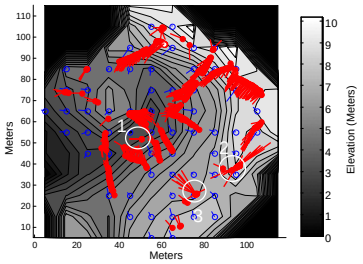


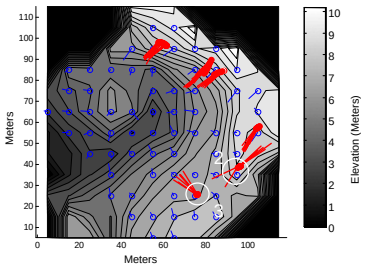
Contour map generated from raw data

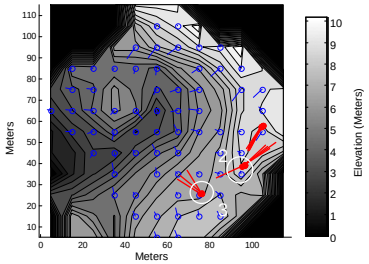


Actual contour map (USGS)

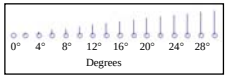
Vehicle generated contour map







Legend



1: 3” dia. Log

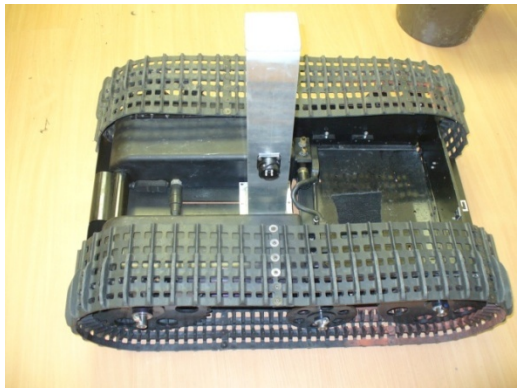
2: 8” dia. Log

3: 6” high Rock

Phase 1 Test Sites selected for worst case low bearing strength soil conditions

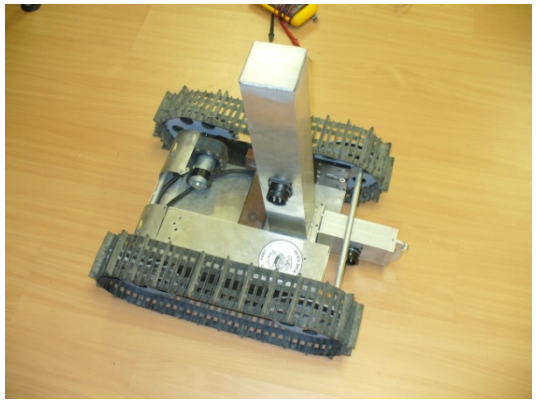
- Coastal plain Taunton clays with high plasticity
- Sandy silts
- Silty sands
- Organic silts

Vehicle mounted mast-penetrometer correlated to NATO mobility model

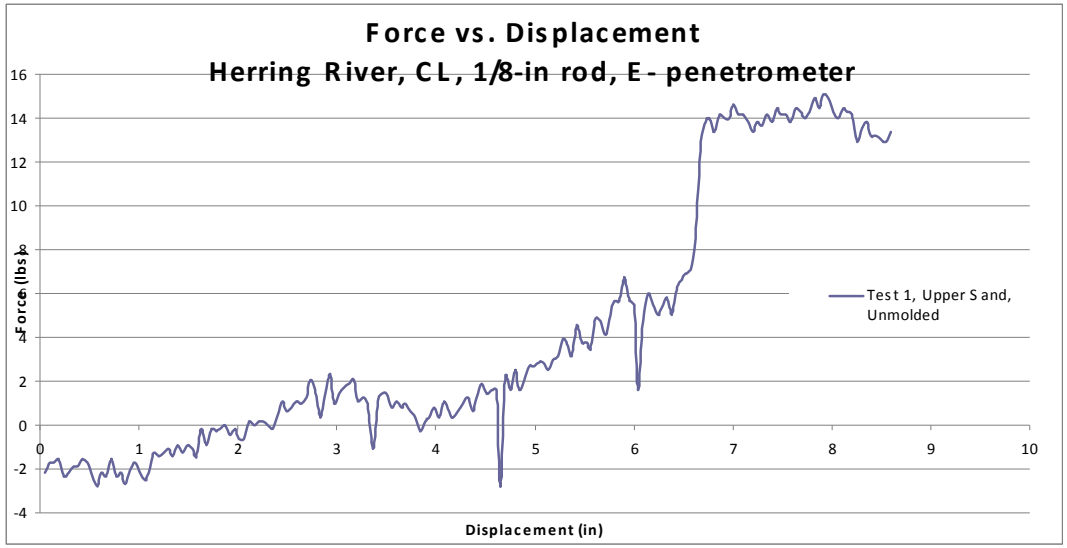


Mounted in Sea Talon class vehicle

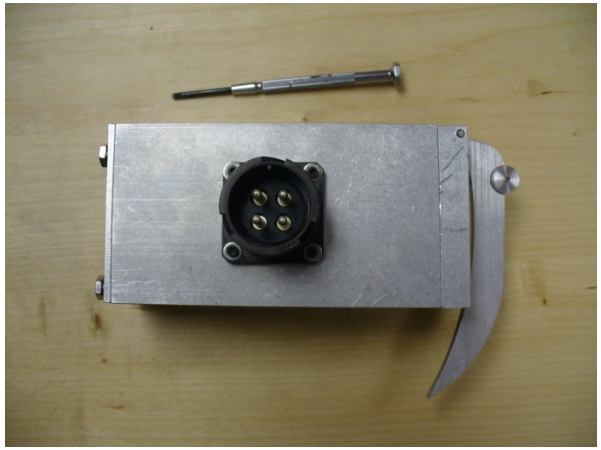
Data has greater sensitivity and reliability than impact based systems



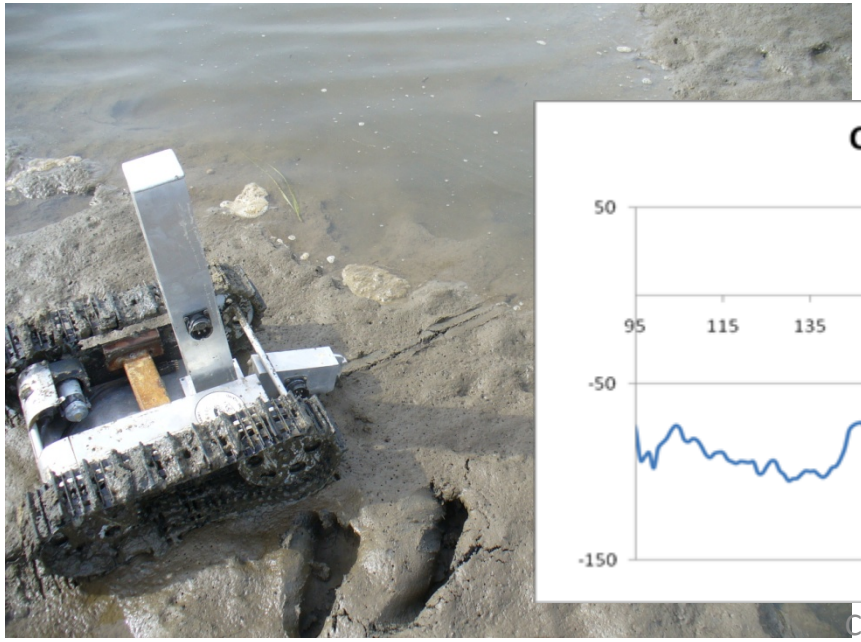
Mounted on Lemmings class vehicle

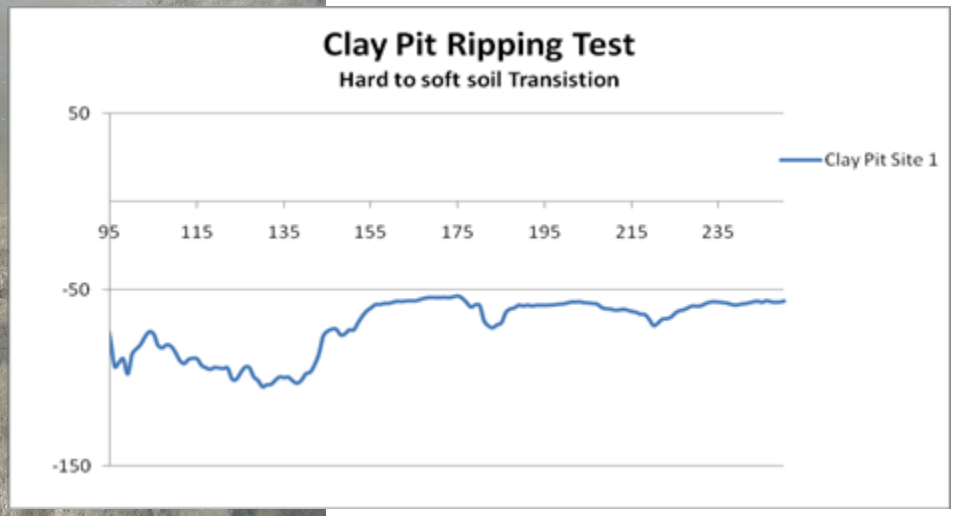


Ripper provides continuous soil strength data. Alarms when penetrometer data should be taken



- Indicates soil changes
- Newer self cleaning system designed
- Strength changes confirmed with penetrometer data



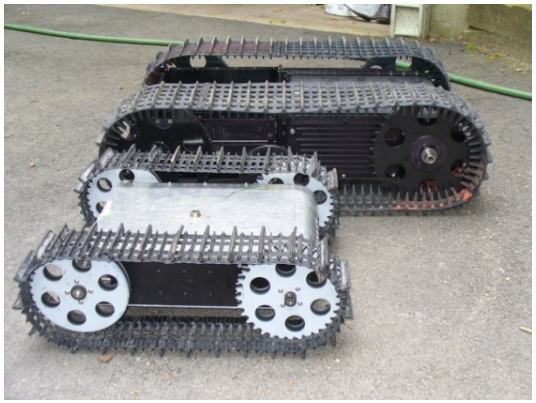


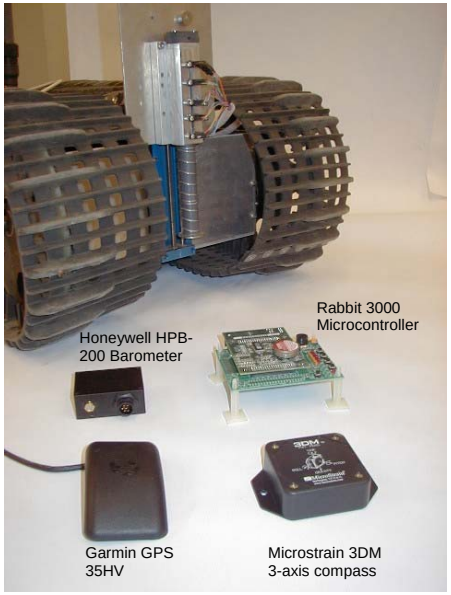
Testing performed on various vehicle chassis and correlated to standard soil mechanic instrumentation

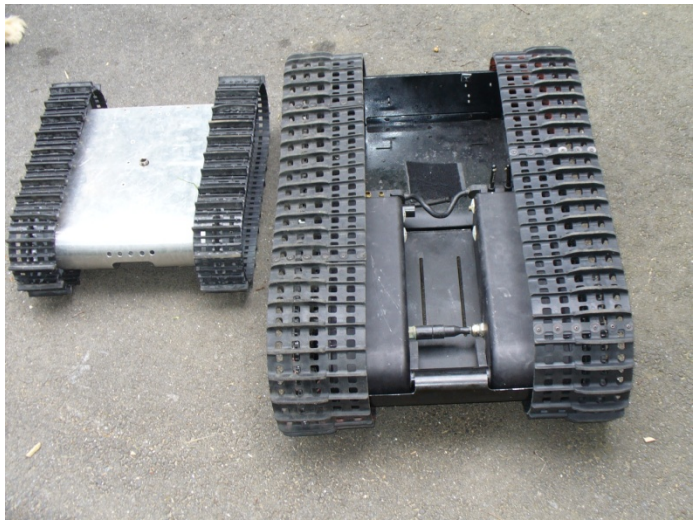
- Tested in weak saturated marine sediments
- Compared to proving ring and hydraulic manual penetrometers

Lemmings vehicle in background,
Sea Talon in foreground

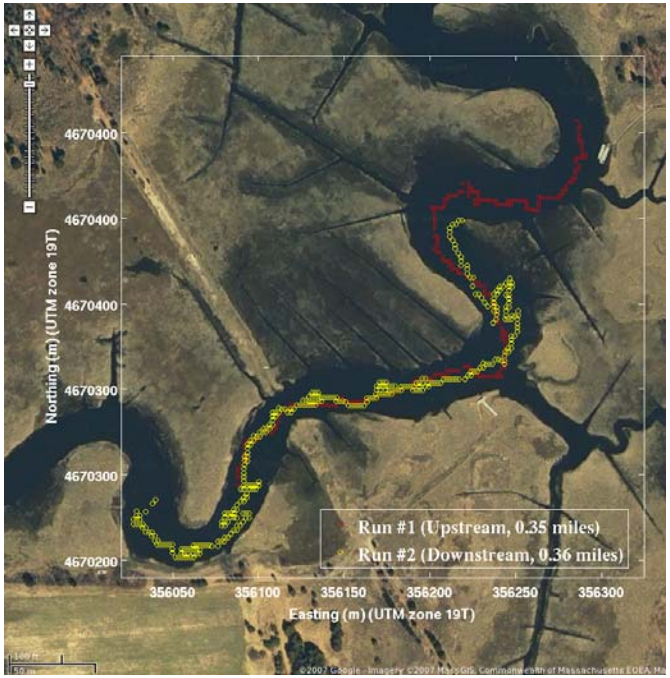
Test Vehicles







Autonomous Navigation: Herring River using Draper Labs algorithms

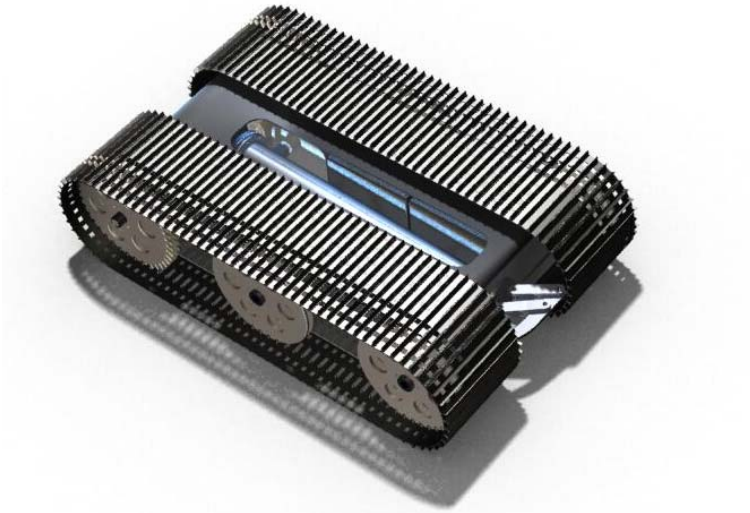


Tested radio based data exfiltration

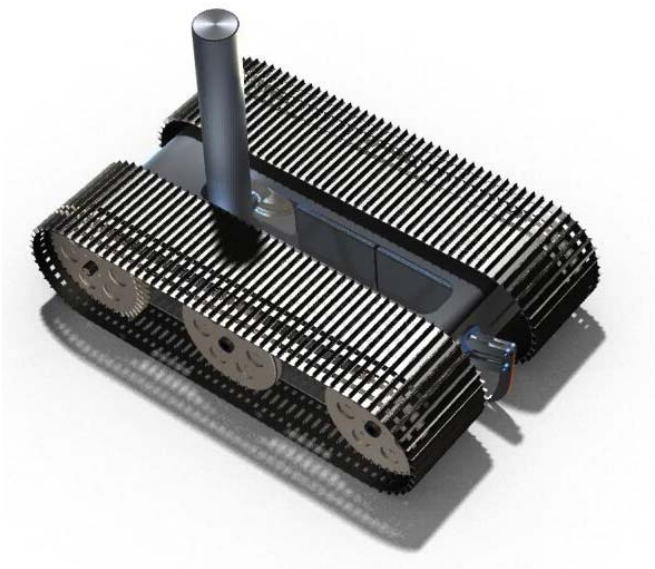
Approach	Non-US Operation (433 MHz ISM)	US Operation (915 MHz ISM)	Comments
ISM Transceiver based on AD7021	5 ft [Note 1]: 1.4 NM	5 ft: 0.8 NM	- 100 bps operation (provides very good sensitivity) - More external parts - Higher power consumption - More mature part - Has transmit capability from tag (growth path)
	20 ft: 2.8 NM	20 ft: 1.5 NM	
ISM Transceiver based on AD7023	5 ft: 0.7 NM	5 ft: 0.4 NM	- 1 kbps operation (pretty good sensitivity) - Fewer external parts - Power consumption offset by 'sleep' & 'wake-up' features - Very new part (preliminary data sheets) - Has transmit capability from tag (growth path) - Specifically designed for world-wide ISM operation
	20 ft: 1.5 NM	20 ft: 0.8 NM	
RKE Transmitter & Receiver, Receivers based on Melexis TH7111 (US Operation) & Linx RXM-433-LR (Non-US Operation)	5 ft: 0.6 NM	5 ft: 0.3 NM	- Very simple, low cost, low power RKE transmitter and receiver - Very few external parts - Will require two 'flavors' of radio, or two radios built together
	20 ft: 1.2 NM	20 ft: 0.6 NM	

COTS radio tested
Test site; shore to far shore

Transmitter antenna at 1 ft and receiver at
5 ft offers 1.4 NM range
20 ft receiver antenna offers 2.8NM range



Wide track with interior alley for smooth profile, low ground pressure



Mast and ripper extended

Wide track with external instrumentation mounts