

SVS-602 Next generation wave sensor

Tim Crandle, PhD SeaView Systems, Inc. tcrandle@seaviewsystems.com



The Internet of Things (IoT)...

- Worst acronym in history?
- The confluence of:
 - Readily available processing power and memory
 - Better sensors
 - Lower power consumption
- Driving new applications
 - Smart carpet, talking refrigerators, etc...
 - Technology transfer: often from mass market products where economies of scale drive massive research investments SEAVIE

The Smartphone Principle

If it's used in smartphones (game controllers, smart cars, etc...) well-capitalized companies will invest vast sums to try to make it smaller, faster, more accurate, and power efficient.

How will land based IoT developments spill over and enable floating/underwater things?



What does SeaView Systems do? Underwater/Oceanographic Technology Solutions

- Pipeline/Tunnel/Flooded Mine/Open Water investigations/ROV Survey/Inspection
- Sophisticated data presentation
- Innovative custom vehicles
- Remote Technology Products



Remotely Operated Vehicle Services





Innovative Data Visualization

CDL Tunnel Viewer





SeaView Developed Pipeline Viewer

NYCDEP: 3D point cloud survey

Point cloud used as basis for custom pipeline fitted plug

shaped" mechanical plag measures five feet across its widest diameter and is nearly exven feet tall and was designed with %" clearance on all sides during installation. It was machined from a series of stainless steel plates and is approximately four feet thick and weighs over 23,000 pounds. It features a mechanical seal and two grout actuated hydraulic seals and is exatifited with a series of restraining struts that are anchored along the walls of the shaft. Creves used a hydraulic lifting arm they dubbed "the claw" to precisely place different components of the play, some of which weighed over 500 pounds agiese. Operated remotely from the surface, this arm provided seven degrees of motion. A purpose built tool was used to push the plag, mounted on rollers, which allowed crews to place the plag exactly where it needed to go in the drift. This plag will allow the shaft to be dewatered and eutifited with nine submersible pumps (over 15.000 horsepower), which will serve to drain the



Plugautside of modiup



Shaft-6 Assembly Bulkhead Install





System in the building





Source: NYCDEP

Custom modifications





- Longer penetration
- Zero visibility ops
- Inertial Nav
- Dynamic Positioning



Innovative Vehicles

- Custom tool: "SmartGrapple" developed to remove debris from bottom of Shaft 19 Intake
- Inertial navigation and intelligent positioning system gives essential control
- Onboard visualization (if conditions permit)
- Over 1400 lbs of material removed for NYC DEP
- Tracks movement much like a wave sensing buoy in order to control position



Special Challenges drive Innovation



Source: NYCDEP



The Challenge

How to insert a vehicle, capable of performing a 15,000ft penetration in 1000ffw, with a full survey spread, through an 11 inch gap curving in two planes?





SeaView's Solution





Early concept drawing

Solid modeling drawing of concept vehicle passing through valve



Completed Chiton





Chiton (Extended)



Chiton (flexed)





Chiton (test deployment)







Vehicle Power Supply Units



SVS-10JB Smart Pressure compensated Junction Box

- RS-485 Control of switching and current monitoring
- Switching, Analog I/O, Digital
 I/O, PWM, Serial
- One cable in from central multiplexer bottle controls 10 devices
- Self contained with built in compensator No fuses, current controlled

- Delrin housing (zero corrosion and light weight)
- 2 motherboards/4 daughterboards
- View indicator lights through clear Lexan cover



SVS-109 Optical Multiplexer

- 3 Channels SD video
- 8-channels Serial
- Ethernet
- High speed triggers
- Form factor targeting ROV applications
- Plug compatible upgrade for legacy systems





Measuring Waves in the Age of MEMS Accelerometers

- Measurements getting better
 - Better sensor accuracy
 - More processing power
 - More memory
 - Less power consumption

 What are the possibilities (and prospects) for MEMS accelerometers for wave measurements?



Some Problems measuring waves with MEMS Accelerometers...

- How accurate is accurate enough?
 Small innaccuracies can integrate into big errors...
- Operational versus Scientific: Tradeoff between manipulating/consolidating data on-buoy for easy transmission versus thorough retrospective analysis of complete data set...



Some Solutions...

- Focus on wave stats rather than absolute values
- Work in frequency domain
 - It's where you go for many of the relevant representational wave statistics anyway...
 - Apply filters such as mean removal or noise removal (Lang 1987) to improve accuracy
- Add processing power on-buoy...
 - Opens possibilities for improved assessment/data manipulation/correction
 - New data manipulation innovations?



SVS-602 Wave sensor





SVS-602 Wave sensor

- MEMS based accelerometers
- Externalizable compass module
- Onboard microprocessor
 - Capable of performing FFT and noise correction on-board in near real-time
- Small 3.5 inch diameter PCB
- Low (371mW) power consumption



Proven Design...

- Deployed in both Great Lakes and near shore ocean environments
- Compares well with reference sensor







Reference: Brown and Meadows, 2011



Proving Accuracy...

 Windmill simulator with real time video monitor allows frame by frame accuracy check of rocking "buoy-basket" versus sensor output





SVS-602 Fits where others cannot go

- Much smaller buoys
- Smaller power budgets
- Other applications?: ROV's? Others TBD?
- We are looking for (and anticipating) many interesting applications... Do you have one?



SVS-602 Deployment Models

- Retrofit existing buoys
- Partner with buoy makers
- Partner with complete service providers
- Partner with research institutions



SVS-602 Wave sensor shortcomings

- Smaller? Lower power consumption?
- Only 6 degrees of freedom (DOF)
 - Can't fully account for pitch and roll
 - Requires mounting close to buoy roll center
- Temperature compensation would improve accuracy
- More powerful onboard processor?
 - Faster sampling?
 - More elaborate data manipulation?
- Nice to include raw data logging onboard?
- USB port?



Small gray box demonstration of next generation sensor...



Visiting SeaView Main office near Ann Arbor Michigan









Visiting SeaView Auxiliary Office

Conveniently located near a suitable body of water





SVS-602 and Beyond

How can we help you with the SVS-602 or other innovative electronics or services?

SeaView Systems: Solutions in Depth

