NDBC’s BuoyCAM and Anti-Vandalism

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INMARTECH
11.20.2014
NDBC’s Ocean Observing Networks

115 Marine Weather & Ocean Observations stations (buoys)
51 C-MAN stations (fixed land sites near oceans & Great Lakes)
39 Tsunami Monitoring stations
55 Climate Monitoring buoys + 4 equatorial current profiler moorings

Tsunami

Weather

Tropical Climate

HIGH VANDALISM
NDBC’s BuoyCAM and Anti-Vandalism

- **Buoy Vandalism**: interference, damage or theft to observing platforms by human action, whether that action is unknowing, incidental to reckless activity, or malicious.

- Vandalism disrupts the vital data collected and reported by moored buoys, which place lives, property, and economies in peril.

- **Average cost of $100,000 per event**

On ieeexplore.ieee.org
See OCEANS 2009, MTS/IEEE Biloxi - Marine Technology for Our Future: Global and Local Challenges
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Mooring Cut
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From Start to Success in 36 Months

First Trail Cam “Catch”

NDBC Establishes Counter-Vandalism & Buoy CAM Objectives

First Trail Cams Deployed on TAO

The “Catch”

Enforcement!

Fishing License Suspension & Crew Education

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tr>
<td>2011</td>
<td>Aug 10</td>
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<tr>
<td>2011</td>
<td>Feb 16</td>
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<td>2011</td>
<td>May 20</td>
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<td>2012</td>
<td>May 24</td>
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<td>2014</td>
<td>Aug 6</td>
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Trail Cams

1 Trail Cam Recovered

7 Confirmed Lost at Sea
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Challenges

- Remotely Transmits Images
  - Instant knowledge and immediate response

- Low Power
  - Long term unattended operation at sea

- Wide View Angle
  - Panoramic to catch all view points

- Lens Fouling
  - Lens free of distortion from sea spray and precipitation
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Enabling Technology: NDBC’s Smart Module

Extremely low power

- Compact
- Low cost
- Wireless networking
- Two way Iridium short burst
- 32 GB file system
- GPS
- RS-232 serial ports
- Analog ports
NDBC’s BuoyCAM and Anti-Vandalism

- 5 Cameras
- Linux
- Smart Module

Images

- Iridium Modem
- Smart Module
- Batteries

Power
NDBC’s BuoyCAM and Anti-Vandalism

Submersion proof housing contains cameras, embedded Linux and NDBC Smart Module

• **Linux**
  • Uses “Angstrom” Linux that boots up in about 25 seconds
  • Runs NDBC software on boot up that utilizes OpenCV to take images and transfer them to Smart Module for transmission

• **NDBC Smart Modules**
  • Uses Wi-Fi to communicate with the Linux system
  • Extremely fast file transfers allow the system to shutdown after taking new images
  • Near zero sleep mode power
Iridium
- Data rates about 300 bytes per second and it takes about 2 minutes to send 40 KB image
- Camera can send photos from anywhere in the world

Battery Power
- NDBC Smart Module technology aims to reduce time Linux system is powered up.
- Linux system is only powered up and running about 8% of the time
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**Generation 1 Capabilities**

- 6 months of autonomous deployment
- 300° of vision
- Every 20 minutes: Take and store one image
- Every hour: Transmit one low resolution image
- Remotely request Hi resolution image
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Deployments in the TAO Array
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NDBC Counter Vandalism Program in Action!

NDBC MCC May 24 0800 CDT
NDBC’s BuoyCAM and Anti-Vandalism
BuoyCAM “Snap Shots” – Morning on July 8, 2014
NDBC’s BuoyCAM and Anti-Vandalism

22 Buoy Cameras deployed on climate, weather and tsunami buoys

Expanding Uses:
- Cloud study
- Wave height estimation
- Fog detection
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Generation 2 Capabilities

• Continuous autonomous deployment
• 360° of vision
• Every 5 minutes: Take and store one image
• Every hour: Transmit one low resolution image
• Remotely request Hi resolution image
• Includes AIS receiver
Plot of Station 0 95W (dm050a)
May. 21, 2013 12:30:00 to May. 28, 2013 12:00:00

095W TAO Pressure Sensor Shows “tugs” on Buoy

AIS positions ceased 5/19/13

AIS positions resumed during return to port 6/2/13

095W Camera captured events 5/24/13 & 5/26/13

2S95W Camera captured the same or nearly identical vessel 5/27/13 & 5/28/13

CAYUDE (Venezuela Flag) Purse Seine Fishing Vessel
Monitored in Real-Time Vandalizing a TAO Buoy
Working with NWS IA and U.S. State

NDBC MCC

BuoyCAM

NDBC 10/23/2013
NDBC Multi-Agency Counter Vandalism Program

The “Catch”

May 24 2013

Every “Event” Seen by NDBC Mission Control Center

Annual DBCP Report July 2013

Informational No Enforcement Action

High Confidence BV “Events”

ID?

Yes

No & Yes

Via HLS Information Network

USCG Field INTEL Rpt

Via DBCP-30 Vandalism Form

Inter-Agency Group

NDBC, NWS IA, NMFS, US STATE, DHS, USCG, INTERPOL

Western Pacific

Enforcement

International Regional Fishery Management ORGs

WCPFC

IATTC

IUU Fishing List

Fishing License Suspension & Crew Education

Policy Prohibiting Fishing on Data Buoys

C-05-07 Illegal Fishing 2005

C-11-03 Buoy Vandalism 2011

Aug 6 2014