Base-station Based Underwater Acoustic Network

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Introduction

Scopes of the Research

- A base-station based underwater acoustic communication network for efficient use of frequency resources in underwater channel environments and for reliable communication with a large number of fixed and mobile underwater sensor nodes.

- Development of Distributed Underwater Monitoring and Control Networks

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Introduction

Scopes of the Research

Operating frequency and Bandwidth
Objective of the Research

- **Reliable communication**
  - Selects optimal communication methods (CSS/OFDM/CDMA/…)
  - Selects optimal communication parameters (Modulation, Coding rate, Pilot spacing…)
  - Link adaptation using AI (Machine learning, Deep learning …)

- **Increase battery life**
  - Transmit power control
  - Duty cycle control (active/sleep mode)
  - Event mode (automatic detection and reporting triggered by a threshold)

- **Network management**
  - Underwater node status monitoring
  - Battery level monitoring

- **Cost-effective**
  - 1:N communication
  - Single base-station can control multiple underwater nodes in wide areas
Implementation

- Modem board for UWC
- Analog amps and filters
- Power board
- Battery housing
- Transducer + integrated UWC system
- LTE Cat.M1 Modem interface
Contents of Research & Development

Underwater Base-station

- Underwater Base-station

< Installation >
Contents of Research & Development

Buoy

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation LED</td>
<td>0.3kg</td>
</tr>
<tr>
<td>Solar Panel</td>
<td>1.2kg</td>
</tr>
<tr>
<td>Water Sensor</td>
<td>0.6kg</td>
</tr>
<tr>
<td>Buoy Weight</td>
<td>5.9kg</td>
</tr>
<tr>
<td>Control Frame</td>
<td>1.2kg</td>
</tr>
<tr>
<td>Seismic Frame</td>
<td>0.3kg</td>
</tr>
<tr>
<td>2.0m Buoy Rod</td>
<td>200kg</td>
</tr>
<tr>
<td>Battery, Control Switch</td>
<td>7.8kg</td>
</tr>
<tr>
<td>ARP, Wiring</td>
<td>7.8kg</td>
</tr>
<tr>
<td>Total</td>
<td>96.2kg</td>
</tr>
</tbody>
</table>
Contents of Research & Development

Application software

- Application program
  - For mobile phone
  - UW base-station -> Buoy -> terrestrial network
  - Web server at Hoseo Univ. -> mobile phone

< application for UWC parameters setting >

< application software for mobile phone >
Experimental Video

Experiments 1
Experimental Video

Experiments 2
## Considerations for Deployment

### Deployment (example)

<table>
<thead>
<tr>
<th>Wireless</th>
<th>Wired</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial or Satellite comm.</td>
<td>Wired connection</td>
</tr>
<tr>
<td>Monitoring center</td>
<td>Monitoring center</td>
</tr>
<tr>
<td>Underwater comm.</td>
<td>Underwater comm.</td>
</tr>
</tbody>
</table>

- Wireless: Terrestrial or Satellite communication with Underwater communication.
- Wired: Wired connection with Monitoring center.
Considerations for Deployment

Channel Modeling

Modeled transmission loss of a signal sent from the bottom of the Mentawai Basin, which demonstrates how sound, refracts at the surface and returns to the bottom 15 to 45 km away (not all angles are shown).


Depth: 4400 m
Conclusion

- Base-station based Underwater Network
  - More reliable communication
  - Network management
  - Increase battery life of underwater node
  - Controls multiple underwater nodes in wide areas
  - can be used to develop more cost-effective and reliable Tsunami warning system

- Future Work
  - develop more realistic and particular system for Tsunami Early Warning
  - need help from experts related to Tsunami
Thank You

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