Underwater Sonar Placement for Maritime Surveillance

Taofeek Biobaku 2, Gino Lim 2, Selim Bora1, Jaeyoung Cho 2, and Hamid Parsaei 1
1 Texas A & M University at Qatar; 2 Department of Industrial Engineering, University of Houston.

Background

• It is widely accepted that over 90% of world international trade travels by sea
• Global economic inter-dependency among cities and nations is largely dependent on the success of the maritime industry
• With the incidence of terrorism, piracy and arson attacks, it becomes necessary to protect ports, waterways and other maritime infrastructures from these attacks

Methods

• Develop risk-based, multi-objective mathematical model—include physics and principles behind sonar technology and underwater acoustics
• Include sonar mobility in deployment
• Implement and verify model using numerical experiments
• Use proposed hexagonal grid system introduced and validated in our earlier work
• Multi-periodic surveillance: Changing criticality per period

Numerical Experiments

Solution Approach: Lexicographic Multi-Objective Method with goal #1 having the priority.

• Static and mobile sonars considered (with different costs, ranges, and coverage orientations: Omni-directional, 180° Coverage & 90° Coverage)

- 2-Coverage
- 3-Coverage

Results-Discussions

• Multi-periodic deployment scheme not only generally improves the objective functions but also permits other regions initially un-covered to be eligible for coverage at other time periods
• Sonar mobility (patrol-scheme) helps to increase total detection probabilities.
• Sonar mobility over multi-period helps to reduce coverage “holes”.
• Sensitivity Analysis suggests the desirability of restricting maximum cover per grid to a small integer.
• Current work-extensions: Development of Heuristics (for large-scale problems).

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