PORT SECURITY AND SAFETY ISSUES IN THE GULF REGION

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Abstract
The Gulf region of the U.S. has a number of critical petroleum and general cargo ports such as Corpus Christi, Galveston, Houston, New Orleans and Mobile. Any type of closure in these ports will have devastating impact of the region's economy. In this presentation, we will discuss port security and safety issues and present methodologies such as risk analysis, resource allocation and simulation modeling to deal with some of the key issues in the Gulf region.

1. Introduction

Gulf region presents a unique situation regarding port security and safety. The immense amount of petroleum exploration and production activities bring massive infrastructure for the oil and gas industry in the form of oil rigs and platforms, pipelines and tanker traffic along with other regular cargo port activities. The system has numerous vulnerabilities to incidents such as the explosion experienced in the Deepwater Spill, collisions, ramming into pipelines, equipment failures as well as terrorism incidents, all resulting in potentially significant consequences. In addition, the Gulf region experiences dynamic risks with surges and severe highs and lows due to hurricanes. Maritime environments can be highly complex, especially in ports with long channels, such as the Delaware River and the Houston Ship Channel. It is critically important to be able to quantify risks in these waterways so that sound risk-mitigation policies can be developed to minimize high consequence events damaging the infrastructure [1].

The concept of risk and risk assessment has been around since when it was first used primarily in the safety analysis of nuclear reactors after the Second World War (NRC, 1975). Traditionally, risk assessments are made solely based on expert opinion. That, is experts are asked to rate a number of incident scenarios with its instigators and consequences using scales of some numbers. Then numbers are crunched and risks are calculated. Expert opinion must be an integral part of risk assessment but should not comprise all of it. Simply put, there are too many instigators, situational factors and consequence levels, especially in geographies like the Gulf. There is a variety of deleterious events, their instigators (human error, equipment failures, navigational failures and others), their consequences (human casualty, environmental damage, property damage and others), and situational factors (hurricanes, current, tide, visibility, day/night and others). Once terrorism-related incidents are placed on top of this list, it easily gets out of hand and one ends up with a very large number of potential scenarios of incidents. The solution is to develop a model of the operations, typically a simulation model that will create all potential incident scenarios. We define risk as the expected consequence involving possibilities of incidents along with their consequences [2]. A mathematical risk model is then used to calculate risks for each scenario as they develop in the simulation model [3]. The parameters of the risk model are obtained using expert opinion and historical data. That is, the risk and simulation models work hand in hand.

In the case of safety risks assessment, after defining all the potential accidents, instigators, situational factors and consequences, the next step in the model-based risk assessment is to develop a simulation model of the maritime traffic that will capture the vessel entry and navigation procedures through the waterway, and generate water and weather conditions (e.g., congestion, current and visibility) that will result in hazardous situations that can potentially cause maritime accidents as shown in Figure 1 of the Delaware River around the Philadelphia area. A vector of situational variables is used to maintain information on the components of the situations, such as vessel and cargo types, vessel locations, interactions among vessels (opposite direction, same direction, overtaking, etc.), current, visibility, local facilities and infrastructure, and other relevant data.

2. Objective

The ultimate objective in port risk analysis is the effective management of risks inherent in decision making under uncertainty aiming at risk reduction/mitigation, which certainly comes at some cost.

3. Analyses

Once a model-based risk analysis approach is developed, it can be used in mainly two areas: Port Safety and Port Security. In the area of port safety, the focus is on the maritime accidents such as collisions, groundings ramming and spill, and the mitigation policies typically involve introduction of navigational rules, use of pilots/tugboats and possibly vessel scheduling. A risk profile of the port is created and the impact of these mitigation policies on the risk profile is sought after. In the area of port security, the risk-based approach typically focuses on the port infrastructure such as cargo points of entry, ship channel facilities, vessels themselves, bridges (if any), off-shore and underwater installations, among others. Here we will discuss underwater detection that is an important element of port security. Underwater surveillance and detection is critical for the ports in the Gulf region due to underwater pipelines as well as off-shore oil and gas exploration/production activities.

4. Discussions

Underwater detection is achieved using sonars. It is basically a resource allocation and an optimization problem. Sonar uses sound propagation to detect targets underwater [4,5]. Targets may be a diver, an unidentified floating object, crack on a pipeline or a potential explosive device under the hull of a vessel. For the sonar allocation problem, a grid is formed in the area of interest and cells in the grid are used to locate sonars. Cell size and the number of cells in the grid are functions of sonar coverage properties. Cells have a characteristic value representing their importance in the grid. The characteristic value of a cell is a number calculated based on the maritime traffic and infrastructure in the cell, geographic location and possibly some other properties of the cell. Smaller characteristic value indicates smaller risk. An optimization problem is formulated based on parameters such as detection probability, cell characteristic value, detection range and a budget limitation to decide on where to allocate sonars. Using the algorithm, one can allocate sonars in a simple grid as shown in Figure 1.

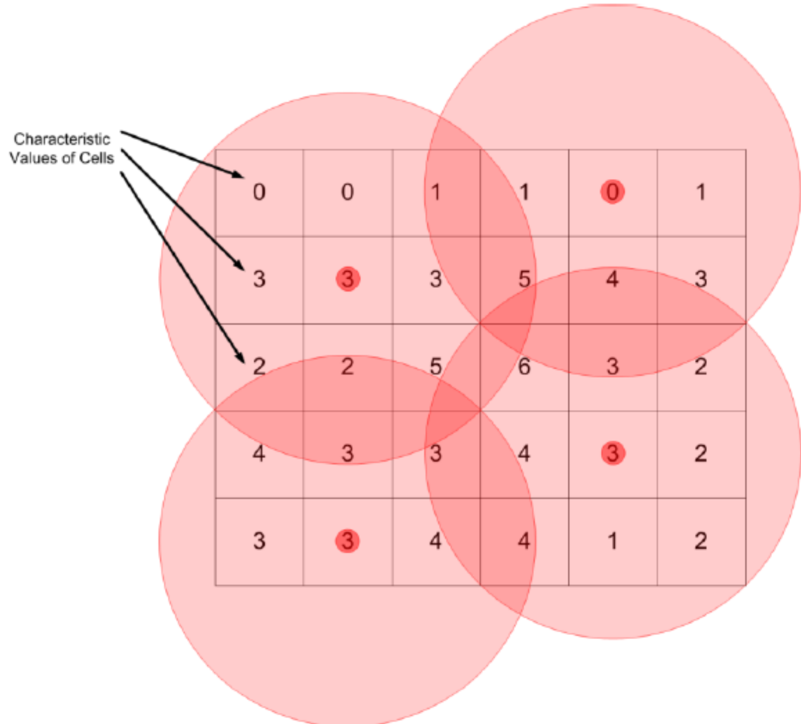

Figure 1. Sonar allocation in a simple grid of 30 cells with designated cell characteristic values (Source: Amir Ghafoori at CAIT-DIMACS LPS – Rutgers University)

5. Conclusions

We discussed issues around port security and safety and presented a simple methodology to place sonars for underwater detection. Placement of sonars is a critical technology issue since it is a highly expensive activity. This is an ongoing research at the CAIT-DIMACS Laboratory for Port Security at Rutgers University.

6. References

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