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Feasible course trajectories for Undersea sonar target tracking systems

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Abstract

Background/Objectives: In underwater sonar environment, the target motion parameters can be obtained only when observer maneuvers in some particular manner is satisfying certain requirements.
Methods/Statistical analysis: The algorithm is evaluated using Line of sight measurements which are obtained from intercept radar. Though the recommended maneuver may not be optimum, observability is ensured.
Findings: Recursive Maximum Likelihood Estimator with initial estimation from Recursive Pseudo Linear Estimator is used to evaluate the process.
Application/Improvements: For the purpose of analysis, the proposed observer maneuver is used for a typical scenario at low, medium and high target angles. Convergence time and the accuracy of the solution in Monte-Carlo simulation are presented in detail.

Keywords: estimation,sonar,simulation,target motion analysis,maneuver, Line of sight measurements

1. Introduction

In [1] detailed the prominence and significance of observer movement with respect to the target in order to estimate the future target position [1-4]. This work is further extended using basic mathematical equations. The algorithm is evaluated using Line of sight measurements which are obtained from intercept radar. Here, the active sonar transmission system is considered where the range in addition to the bearing measurements are available . Recursive Maximum Likelihood Estimator with initial estimation from Recursive Pseudo Linear Estimator is used to evaluate the process [2-6]. For the purpose of analysis, the proposed observer maneuver is used for a typical scenario at low, medium and high target angles [5-7].

2. Simulation and Results

Multistage estimation algorithm (Pseudo Linear and maximum likelihood estimators) is chosen in this paper in order to determine the optimal trajectory of the observer. The course geometry of ownship and target is given in Figures 1 ,2 and 3 respectively. The LOS measurements are initially corrupted with noise having the characterstics of white Gaussian of standard deviation 1 degree. These measurements are processed before using them to compute the target kinematics. The interval of the preprocessing is typically 20 seconds. The scenarios in the table 1 are considered for performance evaluation. The observer manuever to be followed is given in form of flowchart as shown in Figure 4. The Monte Carlo simulation is also performed and the errors in the estimated target motion parameters for 100 Monte Carlo runs have been presented in Figure 5 and 6 corrosponding to scenario 1 and 2 respectively.

Figure 1. Detailed schematic diagram of Tracking

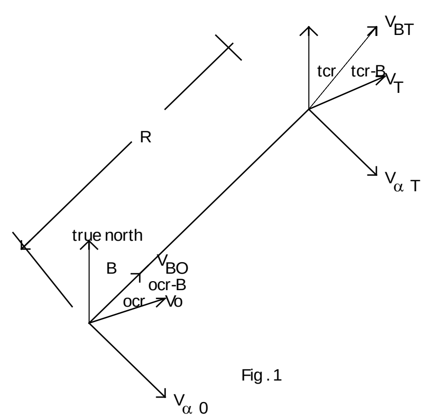

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Figure 2.Target –Observer geometry

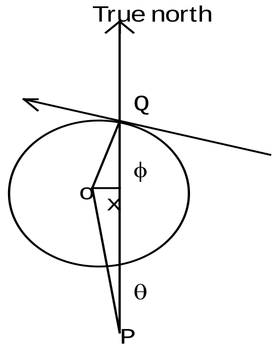
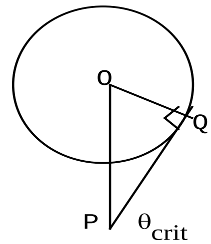


Figure 3.Critical Angle



3. Observer Maneuver Recommendation

Figure 4. Flow chart of observer maneuver recommendation.

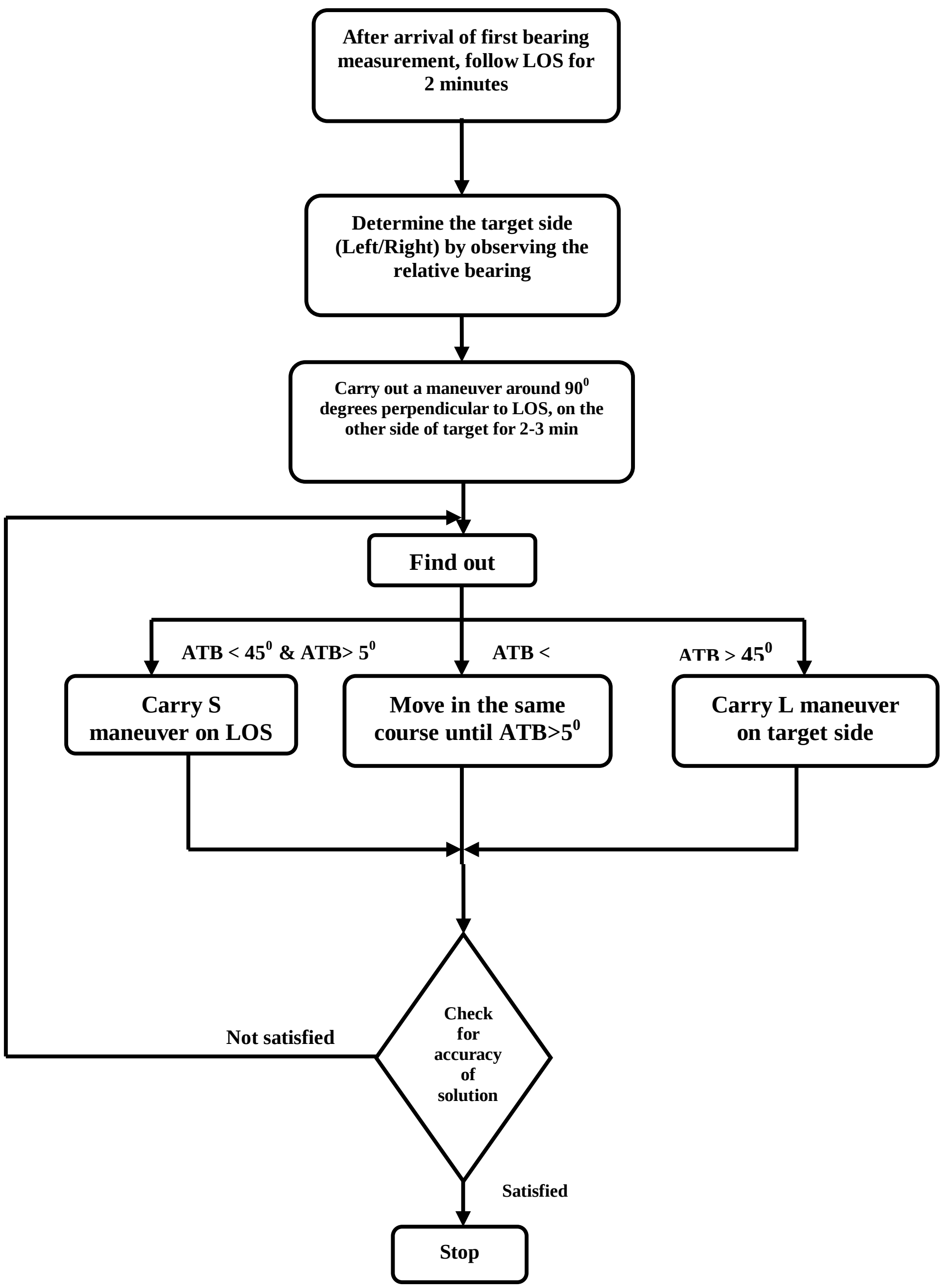
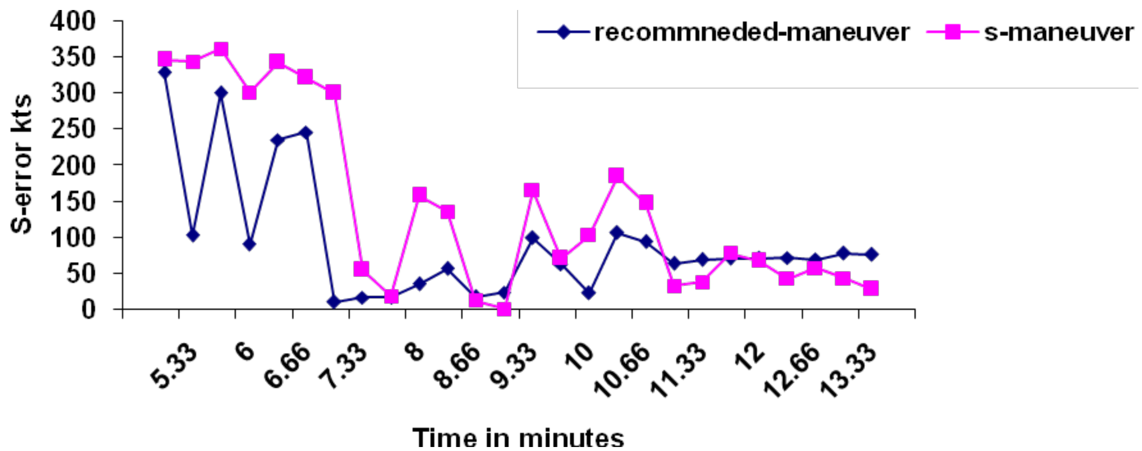
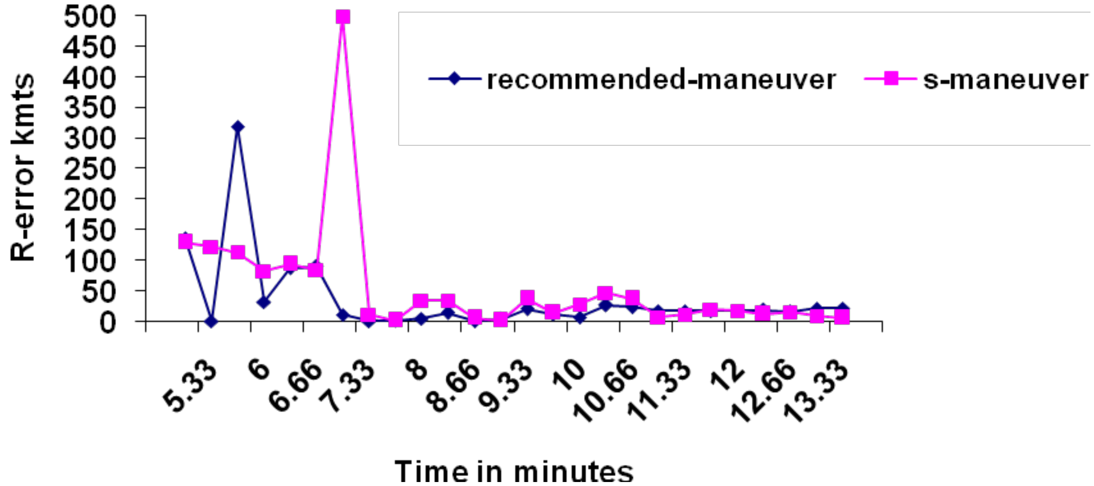


Figure 5. (a) Speed error (b) Range error (c) Course error for Scenario 1





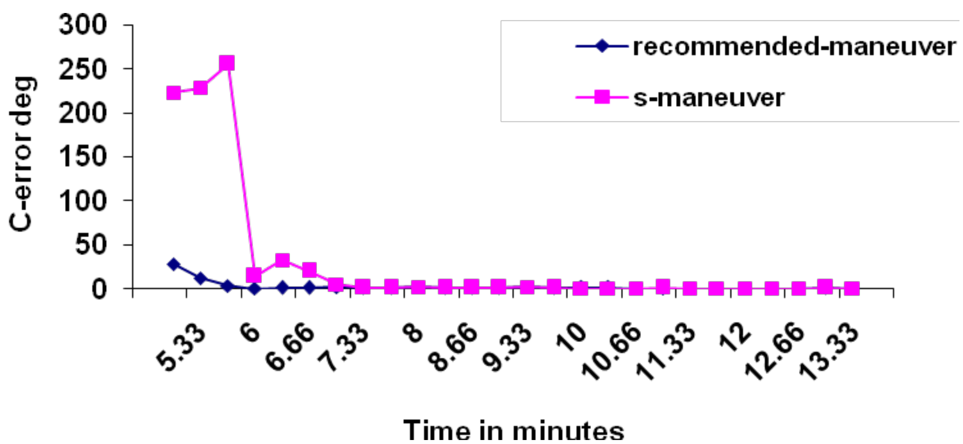


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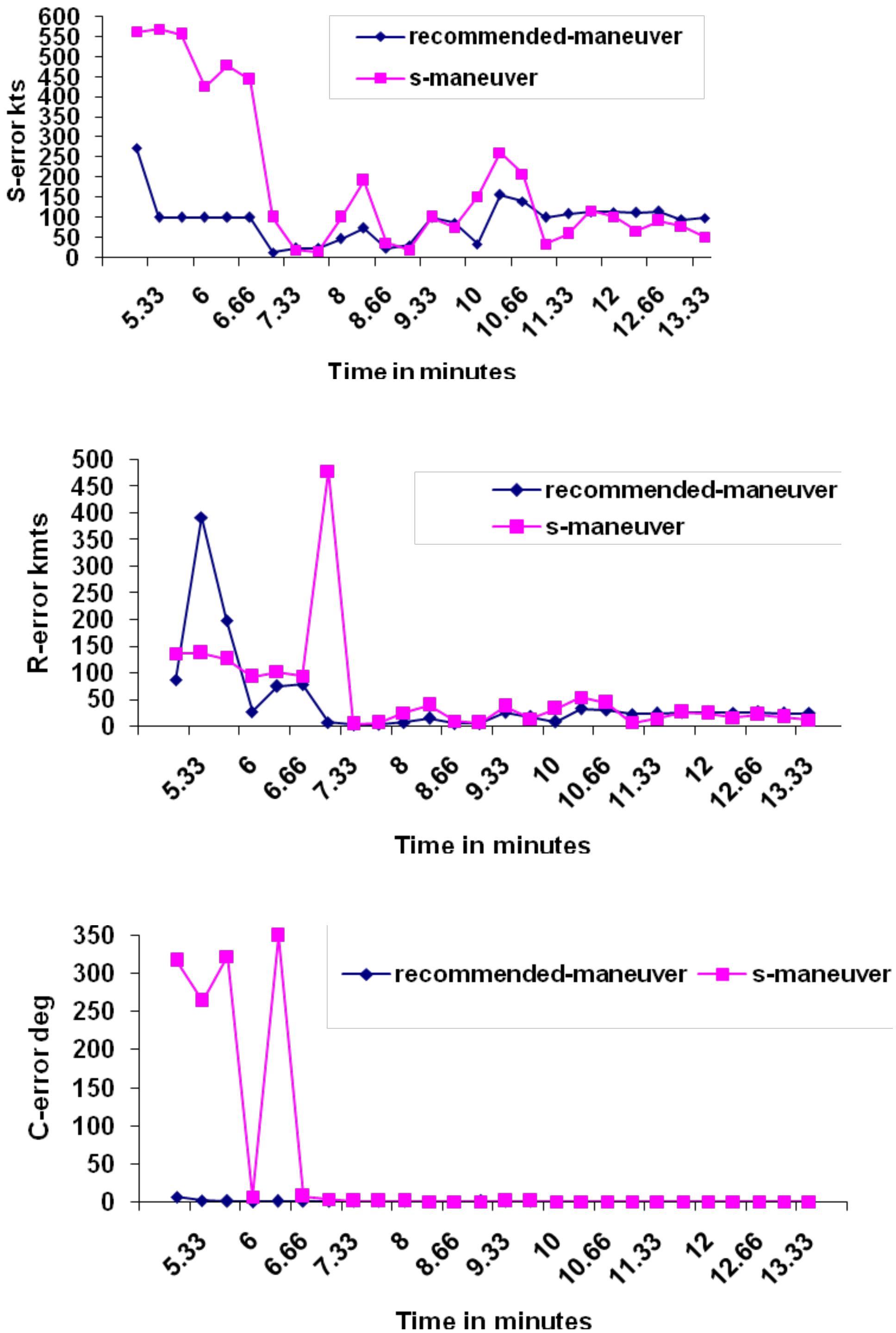
Figure 6. (a) Speed error (b) Range error (c) Course error for Scenario 2



4. Conclusion

In general, the strategy for the observer movement is aimed at achieveing high bearing rate in order to estimate the observer motion. In this paper, a methodology is suggested to utilize the bearings information to understand the geometry and suggest a maneuver accordingly to the observer. This suggested observer courses may not be optimum, but it is guaranteed that the entire solution is observable and convergence is within acceptable time. The accuracy of the solution can be improved by increasing the number of maneuvers for high noisy scenarios.

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