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An optimization method of radar deployment based on detection probability combining PSO algorithm with variable weight

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Introduction

More and more attention has been paid to the detection of netted radar, which has many advantages over single radar in obtaining information. In general, it is impossible for a single radar to make a complete tracking and monitoring map. Netted radar can make up for the lack of single radar detection ability and realize the tactical cooperation between radars.

At present, the deployment of radar network is mainly based on different requirements and constraints, establish corresponding models, and then calculate the deployment optimization scheme.

Based on the relationship between detection probability and range of single radar[1], this paper establishes the model of range and detection probability of netted radar[2], and takes this model as the objective function. The PSO algorithm is adopted to give the solution process and steps, and the optimal deployment position of the entire radar network is optimized to maximize the area that meets the requirements.

Objectives

In a given area, N radars are networked for joint detection task, so the joint detection probability Pnet of the target at any position in the area can be calculated. In order to ensure that the target can be found, the joint detection probability Pnet is required to be no less than a certain value P0. The problem studied in this paper is how to deploy the radar in such a position that Pnet is not lower than the maximum area determined by a certain value P0.

Methods

In this paper, a calculation model based on radar detection probability is established for optimal deployment of netted radar. The model takes into account the number of pulse accumulation of pulse radar. Then, the PSO algorithm with variable weight is used to quickly calculate the optimal solution. The best deployment scheme maximizes the detection probability of the netted radar.

Procedure PSO and Charts

```
Procedure PSO
  For each particle i
    Initialize Vi and Xi for particle i
    Find particle I and pBesti=Xi
  End for
  gBest=min{pBesti}
  while not stop
    For i=1 to N
      Update the V and position of particle i
    Evaluate particle i
    If fit(Xi)<fit(pBesti)
      pBesti=Xi
    If fit(pBesti)<fit(gBest)
      gBesti=pBesti
    End for
  End while
  Print gBest
End procedure
```

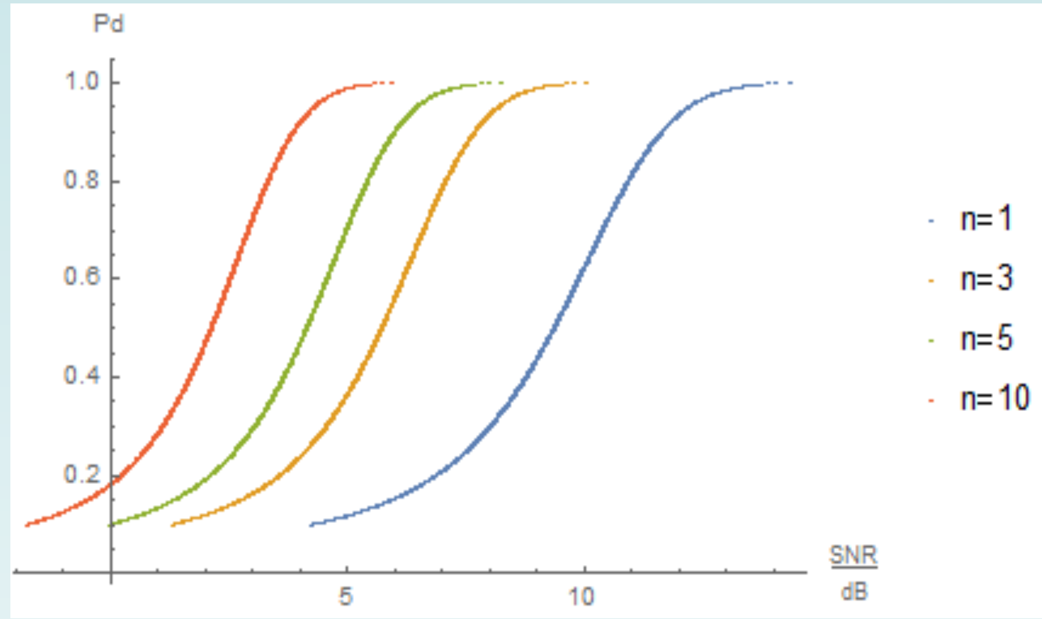

FIG. 1 Influence of pulse accumulation times of single radar on detection probability

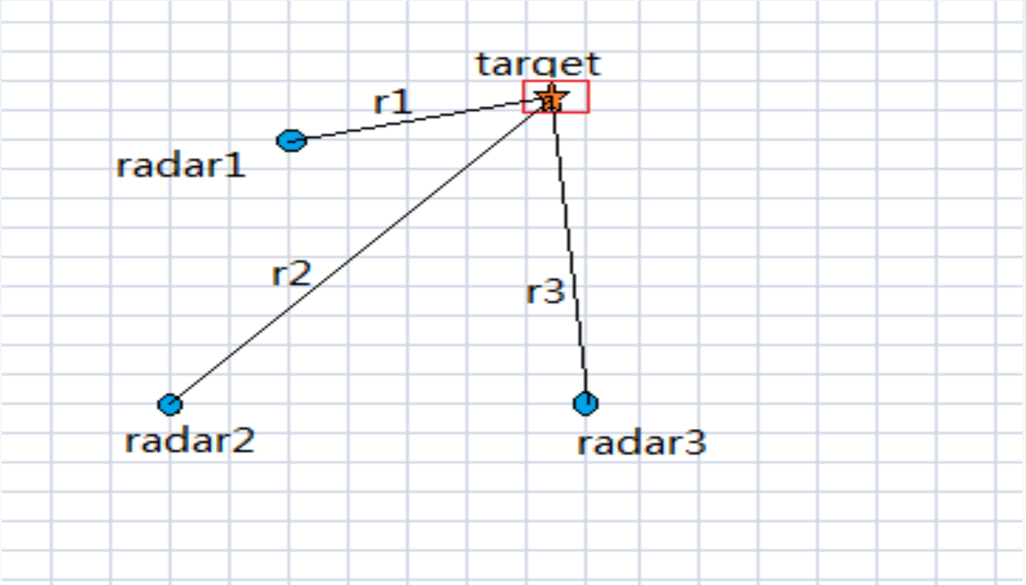

FIG. 2 Schematic diagram of radar joint detection network

Conclusion

This paper studies the calculation method of radar detection probability and establishes detection probability model based on experience. The empirical single radar detection probability model method is more accurate. The model is proved to be correct by comparing with the standard curve in radar manual. In a given area, some radars are networked for joint detection, and the joint detection probability of targets at any position in the area is calculated. In order to ensure that targets can be found, the joint detection probability is not lower than the threshold. By establishing the optimization function of the detection probability of the network radar, the PSO algorithm is used to find the optimal position of the deployment radar, so that the region determined by the system is not lower than the threshold value. Compared with Monte Carlo algorithm, the PSO algorithm improves the computational efficiency. The model can describe the detection probability of the netted radar against targets at different distances, which has important reference value for the optimization deployment of the actual radar network.

References

[1] Richards, M. A. Fundamentals of Radar Signal Processing. New York: McGraw-Hill, 2005.

[2] Skolnik, M. Introduction to Radar Systems, 3rd Ed. New York: McGraw-Hill, 2001.