A Multi-Objective Optimization Approach to Reliable Robot-Assisted Sensor Relocation

Benjamin Desjardins, Rafael Falcon, Rami Abielmona and Emil Petriu

***Abstract*—**

***Index Terms*—evolutionary multi-objective optimization; genetic algorithms; wireless sensor and robot networks; robotics; wireless sensor networks; sensor relocation**

I. Introduction

Wireless sensor networks: Definition

Wireless sensor and robot networks: Definition

Robot-assisted sensor relocation: Problem definition and limitations

Proposed approach: high-level overview

Contributions of this paper

The rest of the manuscript is structured as follows. Section II briefly reviews relevant works. Section III formalizes the RRASR problem while Section IV elaborates on the algorithmic building blocks for the EMOO schemes under consideration. Section V is concerned with the empirical evaluation of the methodology being put forth. Finally, Section VI concludes the paper.

II. Related Work

This Section briefly reviews relevant studies concerning robot-assisted sensor relocation and its underlying optimization backbone.

A. Robot-Assisted Sensor Relocation

B. Related Optimization Problems

III. RRASR: A Multi-Objective RASR Formulation

Fig. 1 displays the proposed adaptation to the RMF in [1] [2]

MOO Mathematical Problem Formulation

IV. EMOO Algorithms for RRASR

In this Section we unveil several common building blocks of the EMOO algorithms that will be applied to solve the RRASR problem.

B. Desjardins and E. Petriu are with the School of Electrical Engineering & Computer Science, University of Ottawa, Ottawa ON, K1N 6N5 Canada {bdesj038, petriu}@uottawa.ca
R. Falcon and R. Abielmona are with the Research & Engineering Division, Larus Technologies Corporation, Ottawa ON, K1P 5V5 Canada {rafael.falcon,rami.abielmona}@larus.com

A. Solution Encoding

B. Objective Functions

C. Evolutionary Operators

1) Selection Operator:

2) Crossover Operator:

3) Mutation Operator:

D. Infeasibility Handling

E. Stop Criteria

V. Experimental Results

This Section elaborates on the empirical evaluation of the proposed MOO methodology for the RRASR problem.

A. Experimental Setup

1) Synthetic Scenario Generation:

2) Algorithm and Parameter Configurations:

3) Performance Metrics:

B. Experiment 1: Scalability Analysis

C. Experiment 2: Network Density Analysis

Fig. 2. Another feasible candidate response comprising 4 maritime and 2 aerial assets. This response has high latency and low cost.

VI. Conclusions

References

[1] R. Falcon, R. Abielmona, and A. Nayak, "An evolving risk management framework for wireless sensor networks," in *Proceedings of the 2011 IEEE Int'l Conference on Computational Intelligence for Measurement Systems and Applications (CIMSA)*, pp. 1–6, September 2011.

[2] R. Falcon and R. Abielmona, "A response-aware risk management framework for search-and-rescue operations," in *2012 IEEE Congress on Evolutionary Computation (CEC)*, pp. 1540–1547, June 2012.

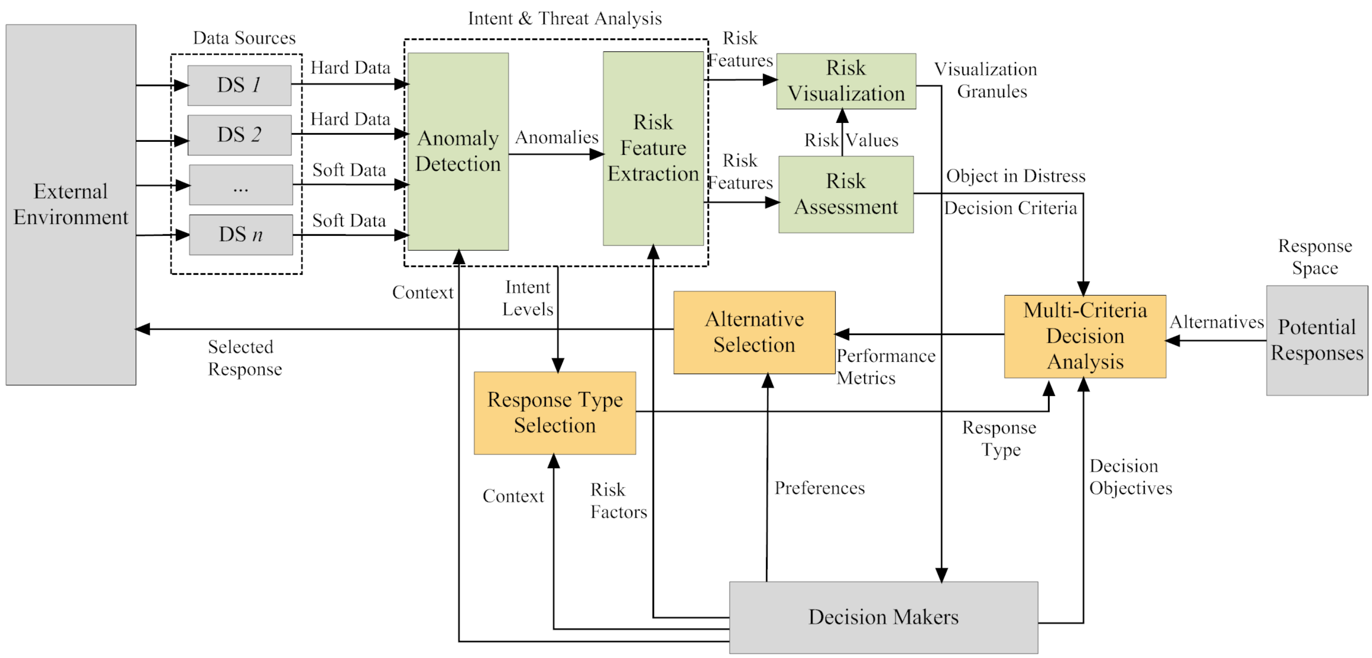

Fig. 1. The RMF's architectural blueprint showcasing risk feature extraction from anomalies detected in the object space. Gray boxes indicate external RMF elements. Green and yellow boxes indicate RMF's situational assessment and impact assessment capabilities, respectively.