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Development of a framework for the localization of radioactive sources and evaluation methods

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Introduction

- Historical incidents like Chernobyl (1986) and Fukushima (2011) have shown the severe impact of uncontrolled radioactive releases [4].
- Fukushima, caused by an earthquake and tsunami leading to the evacuation of over 154,000 people [9] while Chernobyl released 400 times more radiation than the Hiroshima bomb [7].
- Detection and securing of radioactive materials are crucial to prevent misuse and contamination.
- **Project Focus:** Develop methods to efficiently and accurately localize radioactive sources with minimal computational cost, avoiding full search space exploration.

Relevance of the topic

- The results of this project will be beneficial to the security agencies and law enforcement agencies to detect the radioactive sources in a timely manner.
- This localization of the radioactive sources can be useful to the nuclear power plants to detect the leakages in the reactor.
- Localizing the radioactive sources prevents the contamination of the environment and the food chain.

Figure 1: The number of the incidents recorded in ITDB during the period 1993-2022 per incident type group. [4]

Deficiencies of the current approaches

- Many methods are significantly **computationally expensive**, and easily **not scalable** to large environments. [12] [3] [6]
- UAV-based methods are constrained by **hardware limitations**, for example, battery life, weather conditions, and hardware capabilities. [1] [10]
- Achieving **real-time performance** while maintaining accuracy and reliability is a common challenge across many methods. [12] [6] [10]
- Many methods explore the **full search space**, leading to high exploration time and cost. [10] [1]

Related Work

- Rollout Algorithm [2]
- Entropy Algorithm [13]
- Gradient Descent [11]
- Spatial Statistical Method [8]
- Principle Component Analysis [5]

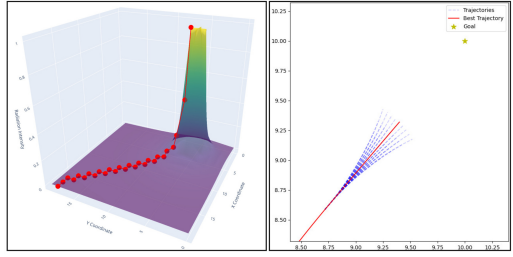

Figure 2: Gradient Descent Algorithm(left) and Rollout Algorithm (right)

Proposed approach

- Enhance localization and path planning for UAVs to detect radioactive sources.
- Develop simulation and evaluation framework for radioactive sources.
- Evaluate and compare different methods for radioactive source localization.
- Address challenges such as particle attenuation and scattering in detection methods.

Work Plan

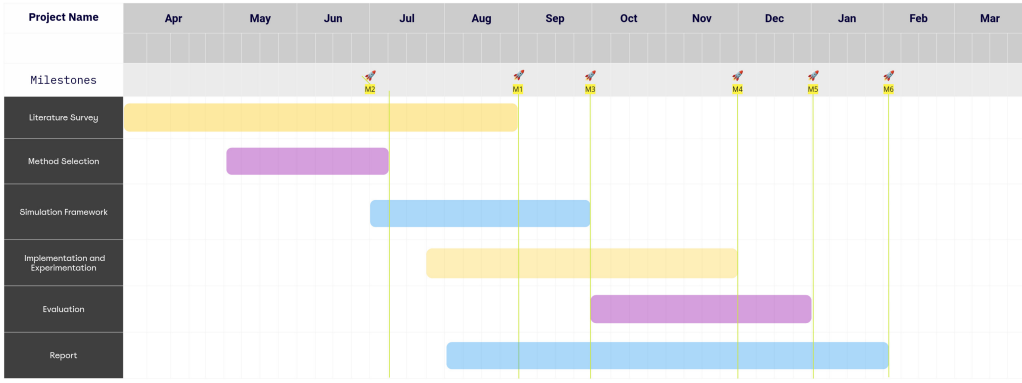

Figure 3: Work Plan

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