MANCHESTER 1824
The University of Manchester

Nuclear Inspection Case Study

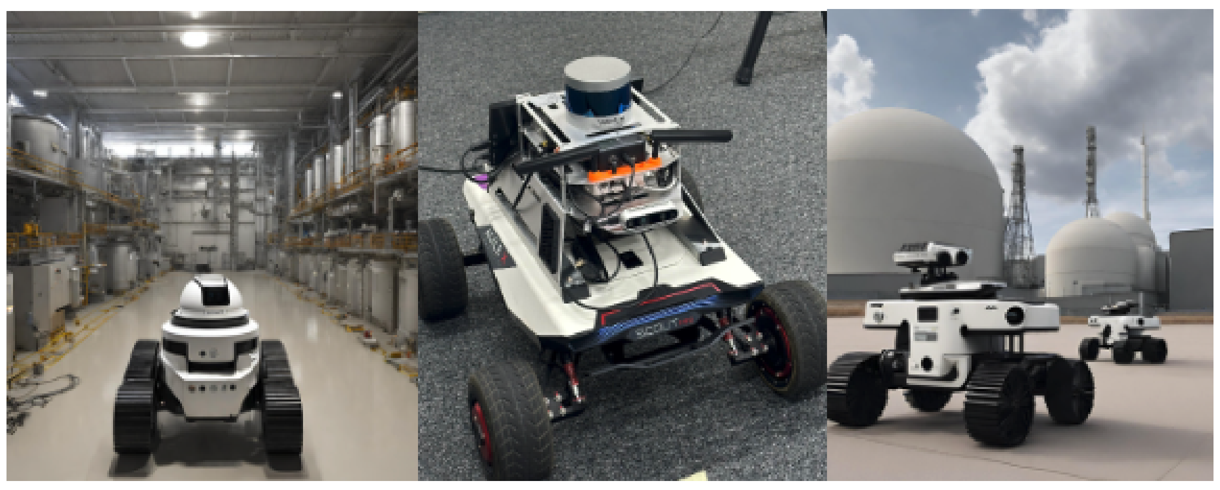
Dr. Hazel Taylor   Diana C. Benjumea

Autonomy and Verification Research Group

It is required to perform regular inspections in a nuclear room containing radioactive material, with the primary objective being the capture of high-quality images of specific locations for subsequent analysis and assessment. It is imperative to emphasize the safety importance in this scenario, with a dual focus on both achieving the mission's objectives and minimizing human exposure to radiation. After doing an evaluation of various options to address this critical task. The chosen solution involves the autonomous operation of the AgileX Scout mini robot.

Background

- The use of **Artificial Intelligence** in the **nuclear** industry is currently limited due to the inability to demonstrate that it is **safe** for particular operations.
- In the **UK**, the **nuclear regulatory regime** requires a safety claim to be argued and substantiated for any operation.
- Existing techniques for assuring the behaviour of **Robotic Autonomous Systems (RAS)**, are not robust enough for use in nuclear environments.

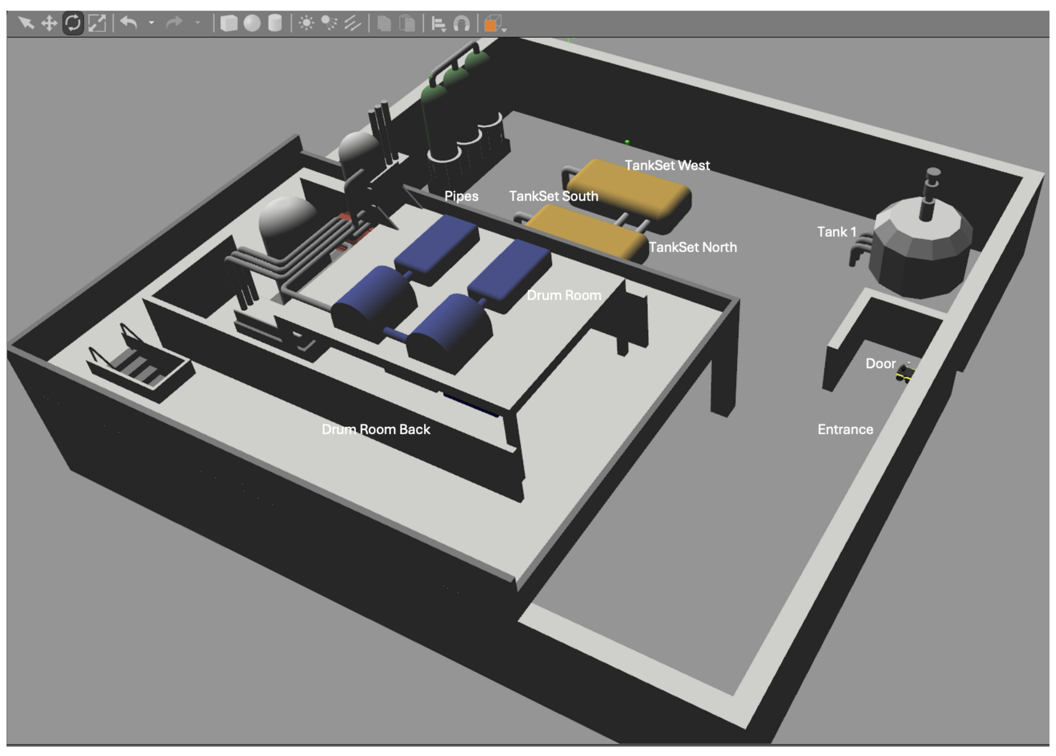


Safety System: These involve multiple components working together to ensure safe operations in hazardous conditions. They are crucial for safeguarding both the robot, operators, and the general public. [1]

Safety Instrumented Function (SIF): Designed to achieve and maintain a safe state for a process or system in the presence of hazardous conditions.

Deployment Environment

- The system will be deployed in an unpredictable environment where human interaction is limited to remote operations, potentially incorporating shared autonomy.
- It is improbable that a complete map of the environment will be available in advance.

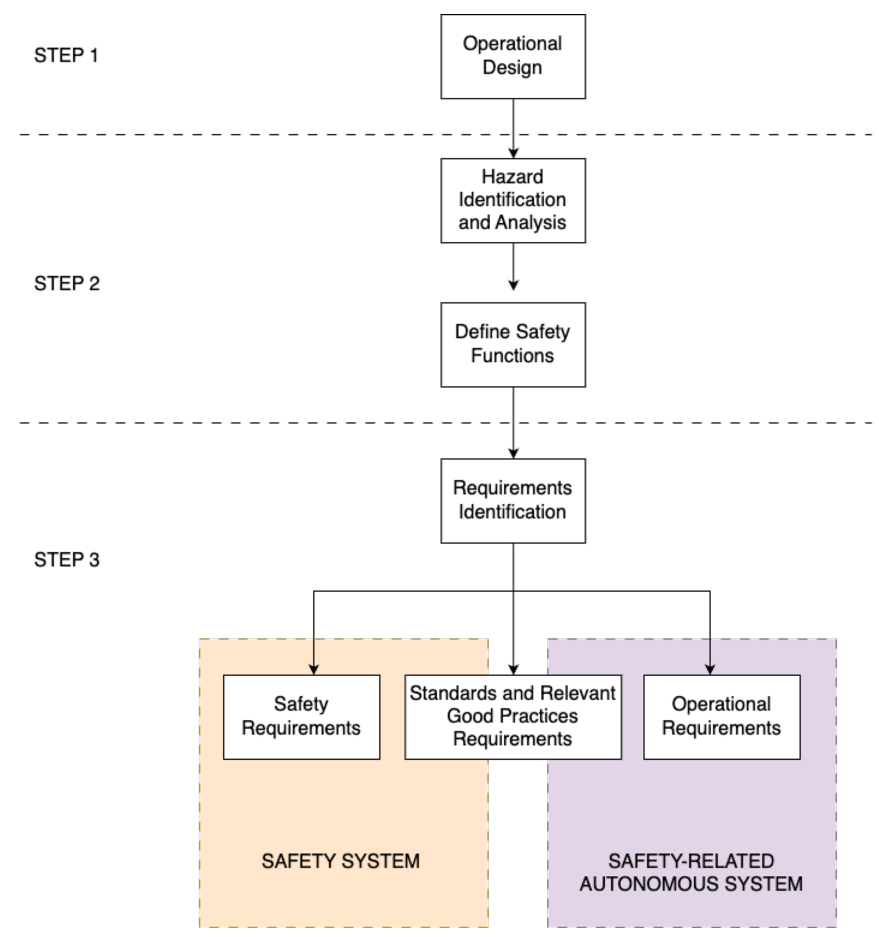


Simulation: Use of Gazebo environment to encode and test system behavior to ensure its readiness for real-world deployment.

Use Cases

- Self-Diagnosis and Condition Monitoring
- Manipulation Based Tasks
- Inspection and Exploration
- Path Planning
- Sort and Segregation
- Waste Consignment

Requirements



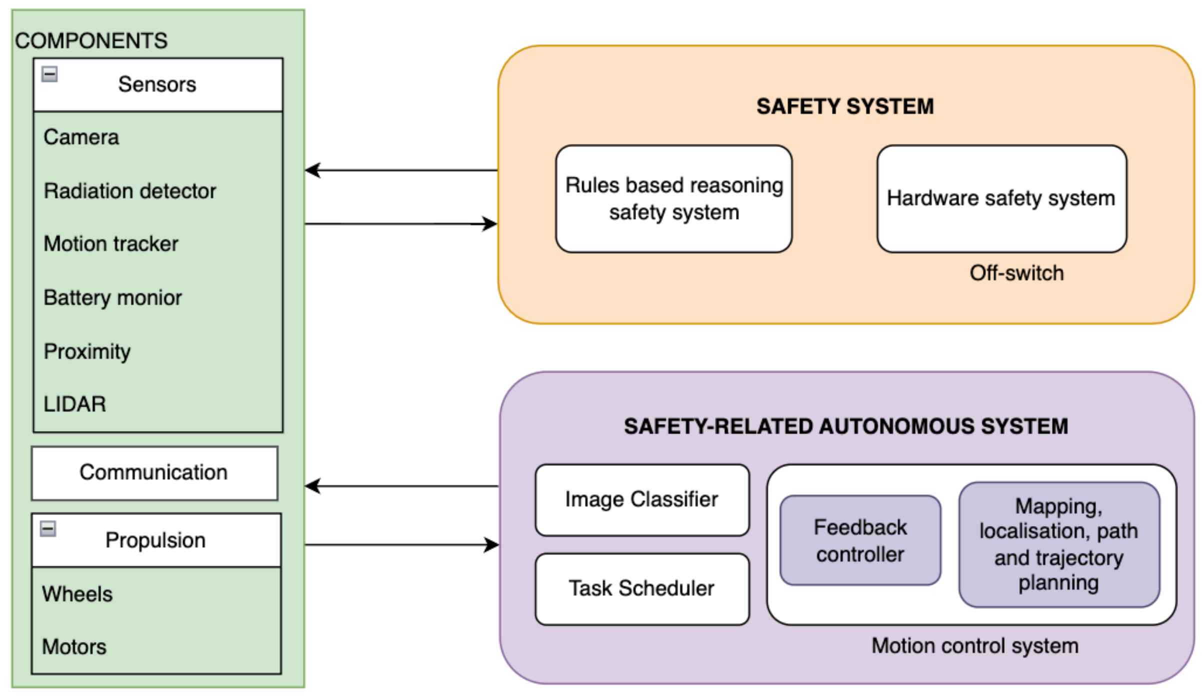
Our 3-step process for defining safety requirements

Scan me to see safety, operational and good practice requirements

System Architecture

The proposed architecture incorporates:

- A traditional control system: **safety-related autonomous system.**
- A **safety system** which implements the SIF, offering independent oversight with strong guarantees for safety requirements.



This work extends a previously proposed method [3]. When safety properties are at risk of violation, a rule-based SIF intervenes, bringing the robot to a safe state and maintaining it.

Regulation/Assurance Considerations

- Safety systems must be physically separate and independent, with sufficient redundancy and segregation to maintain reliability. [2]
- Robust verification methods and testing are crucial to ensure predictable and safe robot behaviour. [4]

References

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