FIT CAPSTONE PROGRAM, SEARCH & RESCUE ROBOT (FIT/CSRR)
CONOPS Outline

1. Scope

1.1 Identification

The FIT/CSRR is a remotely piloted vehicle, capable of search and rescue missions within the interior of an urban debris field, created as a result of natural or man-made disaster event. This project is sponsored by Harris Corporation as an initiative to provide undergraduate students with multidisciplinary project experience by using the Systems Engineering approach.

1.2 Document Overview

This document follows a similar format as the IEEE Std. 1362-1998 for Concept of Operations. The document is subdivided in the following sections:

- Scope
- System Overview
- Referenced Documents
- Current Systems
- Operational Concept
- Specific Project Goals
- Benefits of this Project

2. System Overview

The FIT/CSRR is a mobile search and rescue vehicle, capable of being wirelessly controlled by human operators, located on the perimeter of a debris field that has been created as the result of some natural or manmade disaster. The FIT/CSRR will have the capability of traversing the interior of the debris field, having a highly varied terrain, littered with obstacles of all sizes, shapes, textures, etc. The FIT/CSRR will have the capability of providing an optical camera feed, back to the operators, in both the human visual, and IR frequency spectrums, to be used for both vehicle navigation and search operations. The FIT/CSRR will have the capability of two way audio communication between the FIT/CSRR operators and any human survivors that have been located. The FIT/CSRR will have the capability of providing positional information back to the operators to aid in excavation and recovery activities.

3. Referenced Documents

- Requirements Specification FIT CAPSTONE Program Search and Rescue Robot (FIT/CSRR)
- IEEE Std 1362-1998 IEEE Guide for Information Technology - System Definition - Concept of Operations (ConOps) Document - Description
- Center for Robot-Assisted Search and Rescue (CRASAR) - Texas A&M University - Director: Dr. Robin R. Murphy
- University of California at Berkeley, Biomimetic Millisystems Lab, EECS Department: RoACH - A Robotic Autonomous Crawling Hexapod

4. Current Systems

4.1 Texas A&M University's Center for Robot-Assisted Search and Rescue

The Center for Robot-Assisted Search and Rescue (CRASAR) at Texas A&M University has implemented search and rescue robots on many occasions, most notably the 9/11 disaster.

The robots implemented by CRASAR were tethered to their operating station. This severely limits the range and mobility of the robot. The FIT/CSSRR will be untethered by having a wireless connection between the robot and operator.

4.2 University of California at Berkeley Roach Robot

The University of California at Berkeley has created an insectoid robot roach that leverages its small size, specialized limbs, and an ellipsoidal shell to navigate through obstacles. The shell alone allowed the robot to move freely without an obstacle-sensing system.

Although the robot implements insect-like features to overcome its surroundings, possibly debris, it does not meet some of the necessary requirements. The roach cannot climb over large gaps or up a ledge, nor is it capable of relaying data to an operator for locating.

4.3 Assumptions and Constraints

The FIT/CSRR will be limited by the environment that it will be operating in. Navigating through rubble creates many limitations on the size and mobility of the robot. Rubble itself is very unpredictable and large amounts of irritation may topple the already unstable structure, crushing the survivors. This means that the robot will need to skillfully move through the rubble, trying not to disrupt its stability. One way to do this is to have the robot small enough to maneuver through small openings. This problem is addressed by limiting the FIT/CSRR size so it can easily fit through a 12in X 12in opening. This would symbolize a small clearance in the rubble.

5. Operational Concept

5.1 System Description

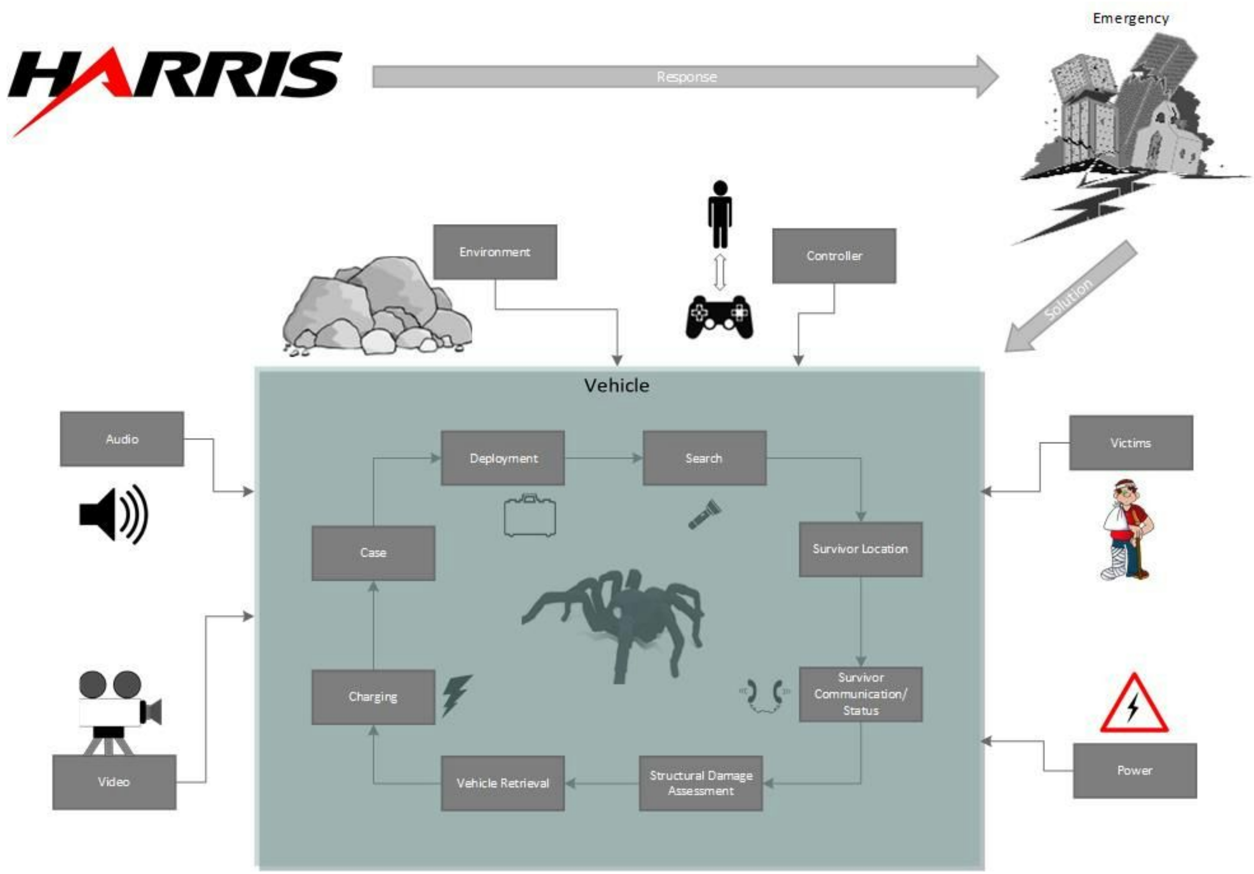

Figure 5.1.1: FIT/CSRR overview diagram.

The FIT/CSRR is a system with the primary function of locating survivors trapped in rubble. Upon deployment from the transit case, the operator will maneuver the vehicle to the area where the search will be conducted. To assist with searching, the FIT/CSRR will have many features that allow it to communicate with its operator and the surroundings. This includes human visual video feed, infrared video feed, two-way audio, and location tracking. These features allow the FIT/CSRR to not only locate survivors, but pass on their location to rescue crews. Once the survivor is located the operator can maneuver the vehicle back to its original deployment location. Once returned the FIT/CSRR can be recharged to begin another mission, or stowed its transit case.

5.2 “Test” Mission

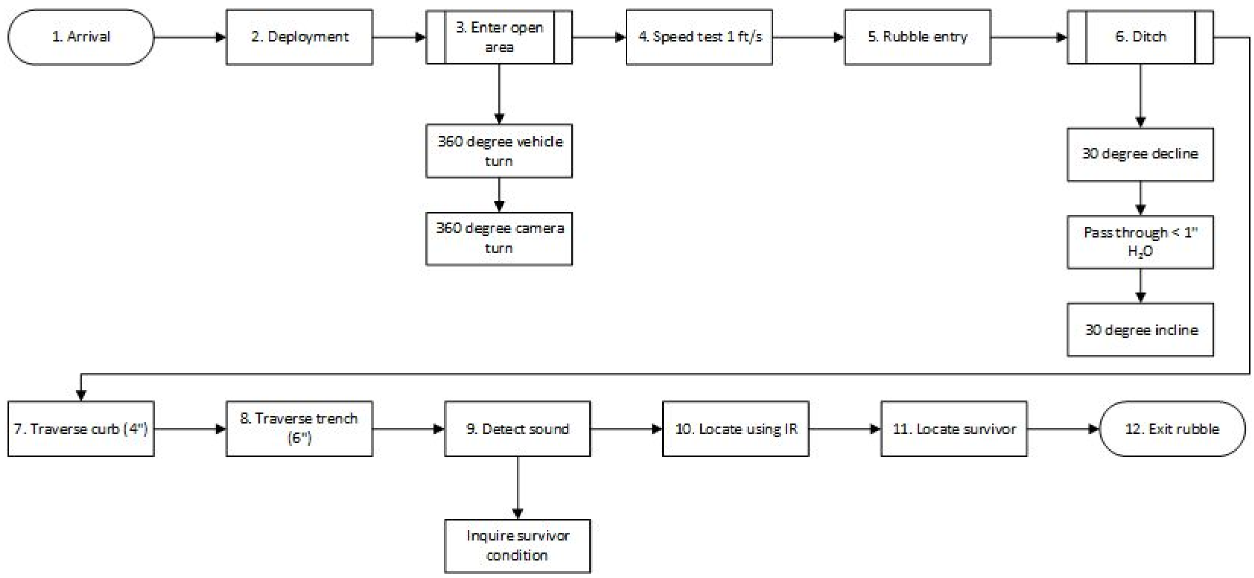

Figure 5.2.1: FIT/CSRR test mission flowchart.

1. An earthquake has toppled a building in San Francisco and the urban search and rescue team has arrived on location.
2. The FIT/CSRR is removed from the transit case and is deployed a safe distance from the toppled structure.
3. Six feet into the structure, the robot approaches multiple paths and the operator chooses one. After proceeding down the path, the robot encounters a large open area. The robot uses its video camera to observe its immediate surroundings. Failing to find a valid path forward, the operator turns the robot around.
4. Utilizing the speed of the robot, the operator quickly backtracks to the junction.
5. Upon returning to the split in paths, the operator notices a small entry point in the rubble, and decides to enter.
6. From the optical feed, the operator notices a steep decline. Proceeding down the decline, the robot encounters a pool of standing water. After fording the pool, the robot encounters a steep incline, and the operator chooses to continue.
7. Shortly after, robot is required to climb a curb along its path.
8. The robot is then met with a large trench in the rubble, and proceeds to traverse it.
9. The operator hears across the two-way audio feed a distress call. The operator initiates communication with the survivor and begins searching.
10. Upon encountering a junction, the operator utilizes the infrared camera to choose which path to proceed.
11. The robot locates the survivor and relays its location to the operator who then relays the survivor’s location to the search and rescue team.
12. The robot is then piloted out of the rubble to be recharged and begin its next mission.

This procedure is modeled in Figure 5.2.1, with a rough drawing of the proposed path appearing in Figure 5.2.2.

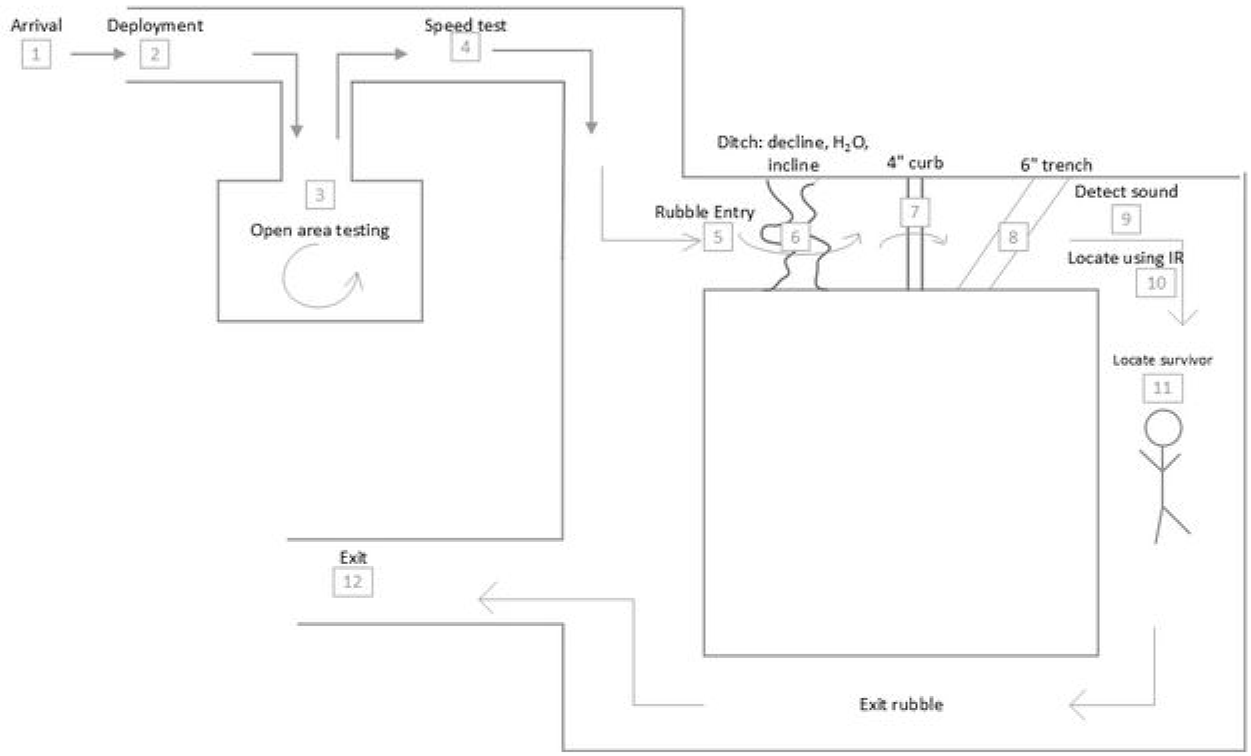

Figure 5.2.2: FIT/CSRR vehicle testing diagram.

6. Specific Project Goals

- Introduce the systems engineering process to undergraduates at Florida Tech. This is to help them prepare for the engineering processes in their post-academic careers.
- Create a system to quickly and easily deploy a robotic device to areas suffering from natural disasters. (FIT/CSRR-34) The robot will remain wirelessly controlled while deployed. (FIT/CSRR-12)
- Design a transit case for the FIT/CSRR system that functions as protection for the robot (FIT/CSRR-73&74).
- Develop a robot capable of traversing through rubble without damaging itself (FIT/CSRR-17&18). The robot will be able to overcome a variety of obstacles that will likely present themselves in a disaster scenario. This includes inclines, (FIT/CSRR-43) vertical climbs, (FIT/CSRR-58) traversing trenches, (FIT/CSRR-60) and standing water (FIT/CSRR-55).
- Integrate an optical system with the robot, with cameras in the visual (FIT/CSRR-20) and infrared spectrum (FIT/CSRR-21). The camera feed will help the operator make decisions based on the robot's surroundings.

- Provide two-way audio (FIT/CSRR-24), so the operator and survivors trapped within the rubble will be able to communicate through the robot.
- Relay data from the robot back to the operating station (FIT/CSRR-64). This will allow for the recovery of the survivors.
- Create an interface on the robot that allows it to be connected to an external power source (FIT/CSRR-69) and quickly charged (FIT/CSRR-35).

7. Benefits of this Project

- Unique, state-of-the-art, marketable system - profit
- System will be wireless while competing systems are wired, increasing search and rescue operation mobility, success and system demand.
- Increased effectiveness of search and rescue teams resulting in increased disaster survival rates
- Undergraduate students exposed to the Systems Engineering Approach
- Increased effectiveness of recently graduated students in industry
- Accelerated progress of interdepartmental projects and experience for students at Florida Tech