***­*Harris Search and Rescue Robot Test Plan**

**Team Members**

Tyler Culp [tculp2012@my.fit.edu](mailto:tculp2012@my.fit.edu)

Devin Martinez [dmartinez2012@my.fit.edu](mailto:dmartinez2012@my.fit.edu)

Milton Strafford [mstrafford2012@my.fit.edu](mailto:mstrafford2012@my.fit.edu)

1. **Purpose**

To prescribe the scope, approach, resources, and schedule of the testing activities. To identify the items being tested, the features to be tested, and the testing tasks to be performed.

1. **Introduction**
   1. **Objective**

This test plan covering the Harris Search and Rescue Robot supports the following objectives:

(1) To detail the activities required to prepare for and support each test.

(2) To communicate the schedule to be followed in performing the tasks.

(3) To define the sources of information used to prepare each test case.

(4) To define the test tools and environment needed to conduct each test.

* 1. **Scope**

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.

* 1. **References**

Application Specific Documentation:

Requirements Specification FIT Capstone Program Search and Rescue Robot (FIT/CSRR)

1. **Test Items**

The item to be tested will be the FIT Capstone Program Search and Rescue Robot. 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 a natural or man-made disaster event.

1. **Features to be Tested**
   1. **Control and Piloting**

* FIT/CSRR – 12
  + Pass: system responds to controls un-tethered.

Fail: system responds to controls, tethered, or not at all.

* FIT/CSRR – 13
  + Pass: system runs properly and consistently, un-tethered.

Fail: system runs while tethered, or not at all.

**3.2 Speed & Maneuverability**

* FIT/CSRR – 15
  + Pass: system can travel at up to 1 ft/s over a flat, unobstructed surface.

Fail: system cannot travel up to 1 ft/s over a flat, unobstructed surface, or does not travel at all.

* FIT/CSRR – 16
  + Pass: system is capable of executing a 360° turn within an 18” diameter circle.

Fail: system is not capable of executing a 360° turn within an 18” diameter circle, or cannot turn at all.

* FIT/CSRR – 17
  + Pass: system is shown to be laterally stable at an inclination up to +/- 30°.

Fail: system is not shown to be laterally stable at an inclination up to +/- 30°, or stable at all.

* FIT/CSRR – 18
  + Pass: system is shown to be capable of self-righting, inverted drive, or some other anti-tip-over strategy, to mitigate the risk of becoming immobile due to its orientation with respect to gravity.

Fail: system is not shown to be capable self-righting, inverted drive, or have some other anti-tip-over strategy.

**3.3 Optical Camera**

* FIT/CSRR – 20
  + Pass: system is shown to have a working optical camera feed with the specified features mentioned in FIT/CSRR – 20.

Fail: system optical camera feed does not function with the specified features mentioned in FIT/CSRR – 20, or does not function at all.

* FIT/CSRR – 21
  + Pass: system optical camera feed functions in the infrared frequency spectrum range, displayed to the FIT/CSRR operator, with the specified features mentioned in FIT/CSRR – 21.

Fail: system optical camera feed does not function in the infrared frequency spectrum range, or does not function at all.

* FIT/CSRR – 22
  + Pass: system optical cameras are shown to be capable of omni-directional vision (+90°/-90° elevation, 360° azimuth).

Fail: system optical cameras are not shown to be capable of omni-directional vision (+90°/-90° elevation, 360° azimuth), or optical cameras do not function.

**3.4 Audio/Acoustics**

* FIT/CSRR – 24
  + Pass: system is shown to provide two-way audio capability between the vehicle and operator.

Fail: system is not shown to provide fully functional two-way audio capability between the vehicle and operator, or any audio capability at all.

* FIT/CSRR – 25
  + Pass: system is shown to have a microphone, with an acoustic response of 5db minimum, over a frequency range of 20 to 20Hz.

Fail: system microphone does not meet specifications mentioned in FIT/CSRR – 25, or does not function at all.

* FIT/CSRR – 26
  + Pass: system is shown to have a fully functional speaker with the specifications mentioned in FIT/CSRR – 26.

Fail: system does not have a fully functional speaker with the specifications mentioned in FIT/CSRR – 26, or a speaker at all.

* FIT/CSRR – 27
  + Pass: system is shown to provide operator with audio received from the vehicle microphone. Operator is shown to be capable of adjusting the volume from 0 to 80 db, as measured a distance of 1 meter (39.4 ft) away.

Fail: system is unable to provide operator with audio received from the vehicle microphone. Operator is incapable of adjusting the volume.

**3.5 Illumination**

* FIT/CSRR – 29
  + Pass: system is shown to have external omni-directional lighting capability of 5000 lumens minimum, to support piloting, navigation, and search operations.

Fail: system is not shown to have external omni-directional lighting capability of 5000 lumens minimum, or any lighting capability at all.

* FIT/CSRR – 30
  + Pass: operator OCU is shown to have a display that is easily readable in bright daylight.

Fail: operator OCU display is not easily readable in bright daylight, or operator OCU has no fully functional display at all.

**3.6 Operational Endurance**

* FIT/CSRR – 32
  + Pass: system is shown to have a minimum operational endurance time of 1 hour, at maximum (100%) duty cycle.

Fail: system is not shown to have a minimum operational endurance time of 1 hour, at maximum (100%) duty cycle.

**3.7 Operational Availability**

* FIT/CSRR – 34
  + Pass: system is shown to be capable of full mission deployment in less than 5 minutes from its fully stowed transit case configuration.

Fail: system is unable to fulfill the full mission deployment time of under 5 minutes from its fully stowed transit case configuration.

* FIT/CSRR – 35
  + Pass: system is shown to be capable of being fully charged, from a completely depleted condition, in less than one hour (1 hr).

Fail: system is unable to be fully charged, from a completely depleted condition, in less than one hour (1 hr).

**3.8 External Interfaces**

**3.8.1 Debris Field Characterization**

**3.8.1.1 Distance**

* FIT/CSRR – 39
  + Pass: system is shown to be capable of traversing a debris field for a distance of up to 50m.

Fail: system is incapable of traversing a debris field for a distance of up to 50m, or a debris field for any distance.

**3.8.1.2 Inclination**

* FIT/CSRR – 43
  + Pass: system is shown to be capable of traversing a debris field with an average inclination of 30 degree, measured of a distance of one meter (30°/m).

Fail: system is incapable of traversing a debris field with an average inclination of 30 degree, measured of a distance of one meter (30°/m), or a debris field with any inclination.

**3.8.1.3 Pass-through Opening**

* FIT/CSRR – 48
  + Pass: system is shown to be capable of traversing a minimum opening in the debris field of 12” high x 12” wide.

Fail: system is incapable of traversing a minimum opening in the debris field of 12” high x 12” wide.

**3.8.1.4 Standing Water**

* FIT/CSRR – 53
  + Pass: system is shown to be capable of fording standing water with a depth up to 1 inch (1”) maximum.

Fail: system shown to not be capable of fording standing water with a depth up to 1 inch (1”) maximum.

**3.8.1.5 Climbing/”Curb” Height**

* FIT/CSRR – 58
  + Pass: system is shown to be capable of traversing curb heights up to 10 cm (4 in).

Fail: system is not capable of traversing curb heights up to 10 cm (4 in), or any curbs at all.

**3.8.1.6 Trench Width**

* FIT/CSRR – 60
  + Pass: system is shown to be capable of traversing trench widths up to 15.4 cm (6 in).

Fail: system is incapable of traversing trench widths up to 15.4 cm (6 in), or any trenches.

**3.8.2 RF Link**

* FIT/CSRR – 62
  + Pass: system is shown to provide a wireless communication link with an operator/pilot located on the perimeter of the debris field.

Fail: system does not provide a wireless communication link with an operator/pilot.

**3.8.2.1 Transmit EMI**

* FIT/CSRR – 64
  + Pass: system is shown to have the ability to transmit and receive data, at (TBD) frequency, through a debris field having (TBD) dbm of RF attenuation.

Fail: system is unable to transmit and receive data properly, or at all.

* FIT/CSRR – 65
  + Pass: system is shown to be capable of transmitting no less than (TBD) dBm EIRP peak across the EM spectrum of (TBD) to (TBD) Hz.

Fail: system is incapable of transmitting no less than (TBD) dBm EIRP peak across the EM spectrum of (TBD) to (TBD) Hz.

* + - 1. **Receive EMI**
* FIT/CSRR – 67
  + Pass: system is shown to accept continuous fields with combined potentials of (TBD) V/m across the band of (TBD) to (TBD) Hz.

Fail: system is unable to accept continuous fields with combined potentials of (TBD) V/m across the band of (TBD) to (TBD) Hz.

* + 1. **External Power Interface**
* FIT/CSRR – 69
  + Pass: system is shown to be capable of connecting to an external power source for charging, and to operate without depleting the onboard battery during staging, prior to mission ingress.

Fail: system is incapable of connecting to an external power source for charging, and to operate without depleting the onboard battery during staging, prior to mission ingress.

* + 1. **Control, Status, Data Interface**
* FIT/CSRR – 71
  + Pass: system is able to provide physical space on the SEP for a control, status and data interface connections, as required to diagnose and troubleshoot failures in the field.

Fail: system is unable to provide physical space on the SEP for a control, status and data interface connections.

**3.8.5 Transport**

* FIT/CSRR – 73
  + Pass: system is shown to be capable of withstanding a 45 deg drop, on any corner, from a height of 12 inches (0.3 m) in its shipping container.

Fail: system is in capable of withstanding a 45 deg drop, on any corner, from a height of 12 inches (0.3 m) in its shipping container.

* FIT/CSRR – 74
  + Pass: system is shown to be capable of withstanding a drop, on any flat side, from a height of 12 inches (0.3 m) in its shipping container.

Fail: system is incapable of withstanding a drop, on any flat side, from a height of 12 inches (0.3 m) in its shipping container.

**3.8.6 Maintainer/Installer Interface**

* FIT/CSRR – 76
  + Pass: system is shown to have included at least one environmentally sealed access panel to facilitate connecting to an external power source, service, diagnostics/troubleshooting, and repair in the field.

Fail: system did not include at least one environmentally sealed access panel to facilitate connecting to an external power source, service, diagnostics/troubleshooting, and repair in the field.

* FIT/CSRR – 77
  + Pass: system is shown to have used captive fasteners on all field service panels to facilitate access in the field.

Fail: system did not use captive fasteners on all field service panels.

**3.8.7 Electromagnetic Interference (EMI) Environment**

* FIT/CSRR – 79
  + Pass: system is shown to comply with all FCC and VDE regulations for radiated RF emissions.

Fail: system does not comply with all FCC and VDE regulations for radiated RF emissions.

**3.9 Physical Characteristics**

**3.9.1 Size**

* FIT/CSRR – 82
  + Pass: system does not exceed a total size envelope of 12” high x 12” wide x 12” long, in its stowed configuration.

Fail: system exceeds a total size envelope of 12” high x 12” wide x 12” long.

**3.9.2 Weight**

* FIT/CSRR – 84
  + Pass: system vehicle weight does not exceed 12 pounds (TBR).

Fail: system vehicle weight exceeds 12 pounds.

* FIT/CSRR – 85
  + Verification: The FIT/CSRR
  + Pass: system total weight, which includes the vehicle, transit case, and all other support equipment required for the staging and execution of urban search and rescue operations, does not exceed 42 pounds (TBR).

Fail: system total weight exceeds 42 pounds.

**3.10 Environmental**

**3.10.1 Temperature**

* FIT/CSRR – 88
  + Pass: system is shown to be capable of operating in temperatures ranging from -20 C (-4 F) to +60 C (140 F).

Fail: system is not able to operating properly in temperatures ranging from -20 C (-4 F) to +60 C (140 F), or at all.

**3.10.2 Sealing**

**3.10.2.1 Operational**

* FIT/CSRR – 91
  + Pass: system is shown to be IP-65 (dust tight, resistant to water spray) compliant while operating.

Fail: system is unable to be completely dust tight or resistant to water spray.

**3.10.2.2 Non Operational Cleaning**

* FIT/CSRR – 93
  + Pass: system is able to fully withstand cleaning with common household surfactants and a fresh water spray.

Fail: system cannot withstand cleaning with common household surfactants and a fresh water spray.

**3.11 Nameplates and Product Marking(s)**

* FIT/CSRR – 95
  + Pass: system nameplate is shown to be marked with the manufacturer's name, symbol, lot or date code, part number and serial number.

Fail: system nameplate does not have one of the items mentioned above, or any at all; system does not have a nameplate.

1. **Features Not to be Tested**

* FIT/CSRR – 6
  + Verification: The FIT/CSRR **Shall** be comprised of a vehicle, transit case, and other support equipment required for the staging and execution of urban search and rescue missions.

Robot functionality will not be analyzed down to the software debug level. The functionality and interoperability of application software in either of the features under test will not be evaluated.

1. **Item Pass/Fail Criteria**

The Pass/Fail criterion for each of the test items is that they should exhibit the behavior expressed in the referenced Application Specific Documentation. For each test in each category, the operational events should take place in the proper sequence and each of the test item entities should be left in the appropriate state following the operation.

1. **Testing tasks**

Tasks include:

(1) Preparation of the test plan

(2) Preparation of the test design specification

(3) Preparation of eight test-case specifications

(4) Prepare the hardware test environment

(5) Perform the test procedures

(6) Resolve test incident reports

(7) Repeat tasks (5) - (8) until all test procedures are successful

(8) Prepare the test summary report

1. **Environment**
   1. **Environmental needs**

The following represent the essential hardware and software needs:

* The FIT/CSRR vehicle, transit case, and other support equipment required for the staging and execution of urban search and rescue missions.

**Description of Actual Testing Environment**

An environment equivalent to an urban debris field, created as a result of a natural or man-made disaster event is necessary and most preferred for system testing. The initial testing environment will need to include a flat, unobstructed surface and an incline with the desired angle mentioned in section 3 of this document. Further testing must include an area filled with at most an inch of water as well as trenches 6 inches in width and curbs with heights up to 4 inches tall.

1. **Schedule**

Milestone 1 ​(Sep 28)

● Investigate and select tools for transferring commands and media

● Investigate the possibility of simulating the robot in order to test hardware-­independent software;

● Create “hello, world” test for simulation and communication

● Write a software section for B­-Specification document

● Create Test Plan

Milestone 2 ​(Oct 26)

● Implement, test, demo audiovisual feedback mechanism in open air

● Implement, test, demo controller input handling and movement in a simulated, open-­air environment with a few obstacles

Milestone 3 ​(Nov 23)

● Implement, test, demo audiovisual feedback mechanism through obstacles and underground

● Implement, test, demo controller input handling and movement in a simulated, rubble­-filled environment with many obstacles

1. **Approvals**

Name: Dr. Phillip K. Chan, Sponsor.

Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_