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| Artifact ID:  TP-003 | Artifact Title:  Test Procedure, Thermal Camera Validation on Drone with Raspberry Pi 5 Running ROS 2 | |  |
| Revision:  01 | Revision Date:  2025-04-06 | |
| Prepared by:  Joshua Crookston | | Checked by:  Jacob Wilkins | |
| Purpose:  The purpose of this test is to validate the functionality of a thermal camera connected to a Raspberry Pi 5 running ROS 2, ensuring compatibility, power adequacy, and proper video feed visualization. This test does not evaluate any image processing algorithms but focuses solely on the operational aspects of the camera. | | | |

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| Revision History | | | |
| Revision | Revised by | Checked by | Date |
| 01 | Joshua Crookston | Jacob Wilkins | 2025-04-06 |

**Test Procedure Thermal Camera Validation on Drone with Raspberry Pi 5 Running ROS 2**

## **1. Test Objective**

The purpose of this test is to validate the functionality of a thermal camera connected to a Raspberry Pi 5 running ROS 2, ensuring compatibility, power adequacy, and proper video feed visualization. This test does not evaluate any image processing algorithms but focuses solely on the operational aspects of the camera.

## **2. Test Equipment & Setup**

### **2.1 Required Equipment**

* Thermal camera
* Raspberry Pi 5 with ROS 2 installed
* Power source (ensure sufficient wattage for Raspberry Pi 5 and camera)
* Drone (if applicable) or stable mounting platform
* Computer with ROS 2 and GUI for monitoring
* Fire source (controlled, 2 ft (0.6 m) in diameter)
* Safety equipment for fire handling

### **2.2 Setup Steps**

1. **Verify Camera Compatibility:**
   1. Confirm that the thermal camera is supported by ROS 2 and Raspberry Pi 5.
   2. Install necessary ROS 2 packages and drivers.
   3. Verify camera recognition in ROS 2 using the following commands:

ros2 topic list

ros2 topic echo /<camera\_topic>

* 1. Ensure the camera streams data properly in ROS 2.

1. **Power Verification:**
   1. Connect the camera to Raspberry Pi 5 and ensure sufficient power supply.
   2. Monitor voltage and current consumption to confirm stable operation.
2. **Mounting and Connectivity:**
   1. Securely attach the camera to the Raspberry Pi and ensure a stable data connection.
   2. Mount the Raspberry Pi onto the drone or a stationary platform.

## **3. Test Execution**

### **3.1 Fire Setup & Observation Distance**

1. Safely ignite a controlled fire measuring **2 ft (0.6 m) in diameter**.
2. Move **200 ft** (**61 m) away** from the fire while maintaining line-of-sight.
3. Ensure environmental safety and confirm wind conditions do not interfere with the test.

### **3.2 Live Video Feed Verification**

1. Open the ROS 2 GUI to display the live thermal feed.
2. Verify that the camera is streaming properly by observing:
   1. **Unfiltered video** (raw thermal data).
   2. **Filtered video** (preliminary filtering applied).
   3. **Auto-scaled video** (adjusted contrast for better visibility).
3. Observe the fire in the live feed and confirm visibility.

### **3.3 Filter Adjustment & Parameter Tuning**

Using real-time feed adjustments, modify the following parameters to isolate fire visibility:

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| **Parameter** | **Description** | **Adjustment Steps** |
| Grayscale Threshold | Cuts out pixels below a certain grayscale value | Increase until only fire remains visible |
| Value Addition | Adds a constant value to unfiltered pixels | Adjust to enhance contrast |
| Gaussian Blur | Applies a blur based on a sigma value | Tune to reduce noise while maintaining fire visibility |
| Final Threshold | Cuts out pixels below a new grayscale threshold | Fine-tune for optimal fire isolation |

1. Adjust parameters incrementally while monitoring live feed until only the fire remains visible.

## **4. Test Validation Criteria**

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| Test Step | Expected Outcome |
| Camera initialization | Camera is detected by ROS 2 and streams data |
| Power verification | Camera operates without power failures |
| Live feed display | Unfiltered, filtered, and auto-scaled video feeds are viewable |
| Fire detection | Fire is visible at 200 ft (61 m) distance |
| Parameter tuning | Fire is isolated using filter adjustments |

## **5. Test Completion & Documentation**

1. **Record Observations:** Document test results, including screenshots of video feeds at different filter settings.
2. **Log Errors & Issues:** Note any hardware/software failures, latency, or video quality problems.
3. **Save Configuration Settings:** Store optimal parameter values for future reference.
4. **Shutdown Procedures:** Safely power down the Raspberry Pi and camera.

## **6. Safety Considerations**

* Ensure fire safety measures are in place (fire extinguisher, controlled burn area).
* Maintain a safe distance from the fire.
* Verify drone stability (if applicable) before flight.

## **7. Test Status & Reporting**

Upon test completion, document results and submit a test report detailing:

* Camera functionality status
* Observed video feed quality
* Optimal filter parameters
* Identified issues and recommendations