**Thermal camera data collection protocol**

**1. Apparatus set up**

1. Assemble and fully extend both tripods in desired location. Tripods should be ~2m apart with all legs facing out of the plot.
2. Attach wood plank across the top of the tripods. Use zipties through small holes to attach wood plank to tops of tripods
3. Attach guy wires to tripods and stake them. Tie ropes/guylines to central post of tripod, and extend wires in 3 directions away from centre of plot. Tie to stake and firmly stake into ground. Ensure guy wires are tight. 3 guy wires for each tripod.
4. Mount thermal camera to heat sink. Screw in all 4 screws snugly (not too tight).
5. Attach tripod mount to bottom of thermal camera
6. Mount thermal camera to wood plank using tripod mount. Face thermal camera directly downwards.
7. Mount control box to one tripod using zipties.
8. Attach cable from light sensor to input line going to control box. Pull light sensor away from wood.
9. Attach power cable (with exposed wires) to FLIR camera port “PWR/DIG I/O”. Run cable along wood plank and down tripods toward batteries. Ensure cable does not hang into the frame.
10. Attach ethernet adaptor to FLIR camera port “ETH/PoE”. Plug in ethernet cable from RPi controller.
11. Run power cable (USB-C + transformer with bare wires) from control box to battery.
12. Plug in reference plate to blue thermocouple cable. Run cable to ground level along tripod. Place reference plate, metal/tape side up, into the frame of the thermal camera.
13. Connect 8 motorcycle batteries in a series-parallel configuration.
    1. Separate batteries into pairs, and connect each pair in series. For each pair, connect the + from one battery to the – from another. Each pair now acts as one “compound battery” with 24V each.
    2. Connect the four pairs of batteries together in parallel. Each pair should have one + and one – terminal that is not connected to anything. Connect all the free + terminals together and all the free – terminals together.
14. Attach power cables for controller and FLIR camera to batteries using alligator clips. Red goes to +, black goes to -. The clips should be attached to the battery terminals which are NOT connected to each other. Both the red wires from the FLIR and controller should go to +, and both the black wires from the FLIR and the controller should go to -.
15. **Level the FLIR camera.** Use the square level.
16. Install 4-5 flags/indicators in the ground within the frame of the FLIR camera. These are used in later image processing stages to help stabilize the thermal video.

**2. Logging data**

1. Plug Ethernet cable into ethernet port on Raspberry Pi; plug other end into laptop using USB adaptor if necessary.
2. RPi should already be powered on from the time the battery was connected. Allow several minutes for RPi to boot up.
3. Open VNC viewer on laptop. Type “ubuntu.local” into address bar and hit enter. When login screen opens, enter password “todobien”. If the login screen does not appear, wait a few minutes and try again – RPi may not be fully booted up yet.
4. Set time and date on RPi (system settings)
5. Open file explorer “Thunar” and navigate to “Thermal Camera Acquisition Code” directory.
6. Right click in the file explorer and open terminal in folder “Thermal Camera Acquisition Code”
7. In the terminal, run command “sudo python3 thermal.control.py”
8. Watch the code execute. The code should find the thermal and visual camera, the weather station, the data acquisition board, etc. Finally, the code should say “Entering main loop”, and begin taking thermal images every 5 seconds.
9. After the code has entered the main loop, use the file manager to navigate to the folder where the data are being logged to. Open up a few of the visual and thermal images to check for quality
   1. Ensure images are correct – thermal image should be a blue and white image, visual image should show the same land area.
   2. Check that images are in focus and calibrated – excessively noisy images may require non-uniformity calibration to be performed
   3. Check that the reference plate is visible and identifiable in both the thermal and visual images
   4. Check that the flags/indicators are visible within the frame
   5. Ensure no extra objects are in the frame
   6. Check the “stats” files. Ensure that all of the columns are being filled in correctly and that the values shown are realistic
10. If there are problems with the data being logged, resolve them (see troubleshooting below), then restart logging.
11. Once logging is started and incoming data look good, disconnect VNC connection, unplug ethernet, and close up the control box.
12. Data collection will continue for up to 24 hours, or until manually stopped. Data collection will also stop if power is lost
    1. For this reason, it may be worthwhile to periodically log back in to the controller and ensure that data collection is continuing. To do this, log back into the RPi following the directions above. When your VNC connection starts, you will see the code running in the terminal; new logs should be occurring every 5 s. If this is not the case, you will need to restart data collection from step 4.

**3. Finishing data collection**

1. Log back into RPi. Plug Ethernet cable into ethernet port on Raspberry Pi; plug other end into laptop using USB adaptor if necessary. Open VNC viewer on laptop. Type “ubuntu.local” into address bar and hit enter. When login screen opens, enter password “todobien”.
2. Kill logging code. Select console where logging code is running. Press CTRL+C. Allow a few moments for the code to terminate.
3. Shut down RPi. Go to menu bar on top right? And select shut down. Your VNC screen will likely go black at this point. Allow a few minutes for the RPi to finish shutting down.
4. Unplug RPi and FLIR from power source.
5. Disassemble apparatus. Follow assembly steps in reverse.