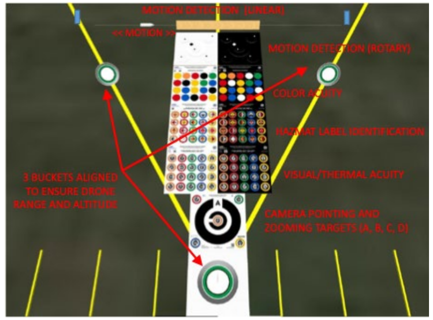
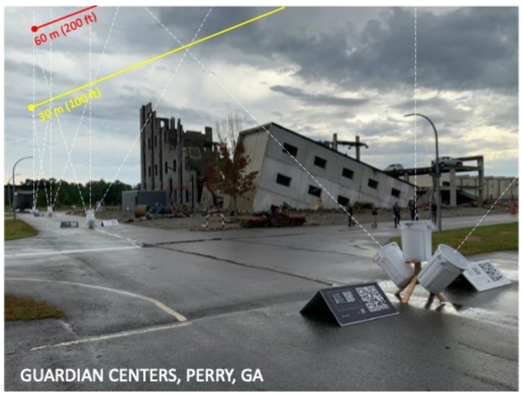
Visual and Thermal Sensor Tests

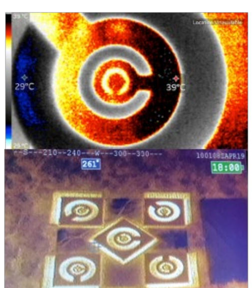
Comprehensive and Quick



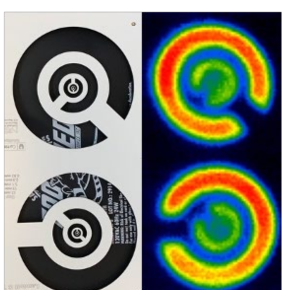
Comprehensive tests provide statistical significance.



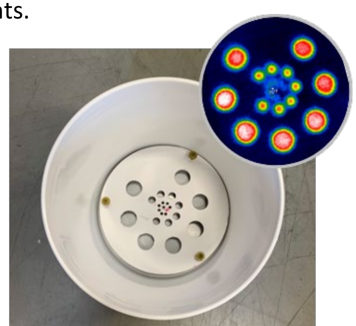
Small numbers of tests on panels allow for rapid testing of sensing capabilities in different directions and environments.



An array of Concentric C thermal targets placed throughout a scenario (needs power).



Concentric Cs laser cut into MDF with a reptile heater. A metal backing helps diffuse the heat.



Drill Holes (1in, 1/2in, 1/4in) through plastic disks with hand warmers heating a metal disk backing.

Thermal targets can be implemented using laser or waterjet cutting, or by drilling holes to minimize fabrication cost and complexity.

NIST National Institute of Standards and Technology U.S. Department of Commerce

Test Methods for Evaluating Aerial Drones
Safety | Capabilities | Proficiency
RobotTestMethods.nist.gov

Pocket Guide for Aerial Drones

SENSOR

Tests Lanes

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Version 2020A

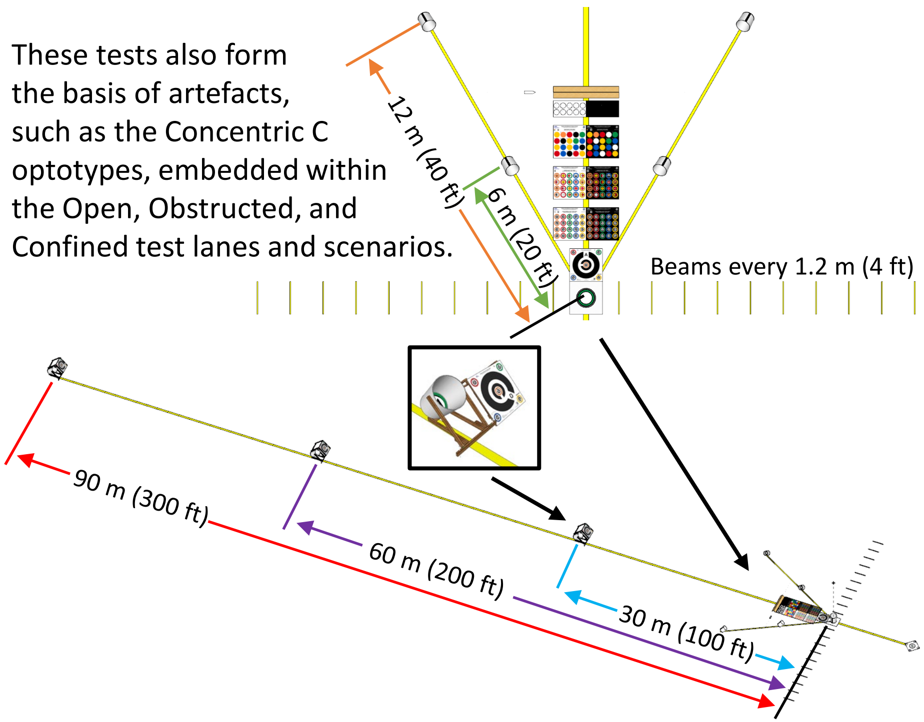
Sensor Test Lanes

Evaluate capabilities and proficiency

The Sensor Test Lanes measure the ability of remote pilots and aerial drones to inspect objects and observe the environment. They are quick, operationally informative field tests, based on more accurate but more time consuming tests.

These tests can be performed outdoors or indoors to control lighting, weather, and access to GPS. Various hover altitudes measure performance at different distances from objects of interest. Performance at the limit of line-of-sight and non-line-of-sight radio range is also measured.

These tests also form the basis of artefacts, such as the Concentric C optotypes, embedded within the Open, Obstructed, and Confined test lanes and scenarios.



This work was developed by the NIST team, which includes Adam Jacoff, Raymond Sheh, Kamel Saidi, Alex Fraley, Kenny Kimble, and Ann Virts. Dozens more people have contributed to the development and validation of these test methods. They include FEMA urban search and rescue task force teams, firefighters, law enforcement, collaborating test facilities, other civilian and military organizations, and commercial manufacturers.

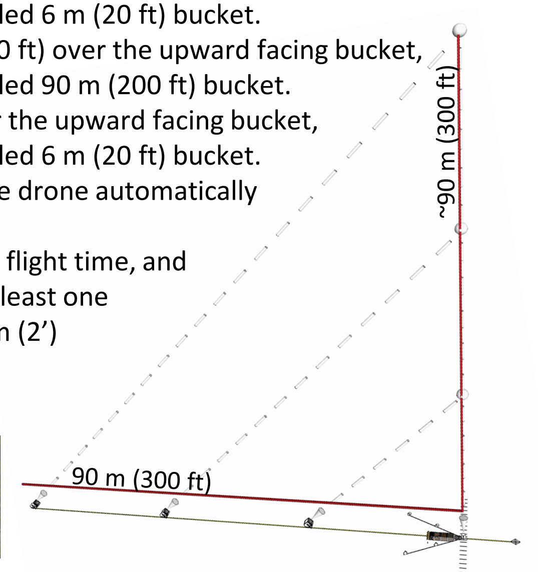
Stability and Endurance

Hover Stability: Measure the stability of the drone at *Hover* or *High Hover* altitudes (p6).

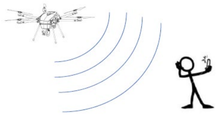
1. Take off and hover at the chosen altitude.
2. Align with and observe the upward pointing bucket for 30 seconds. 1 point is awarded if full alignment is maintained for the entire duration.
3. Align with and observe a/the 45 degree angled bucket for 30 seconds. 1 point is awarded if full alignment is maintained for the entire duration.
4. Repeat (2) and (3) 10 times each and record the total number of points awarded, out of a possible maximum of 20.

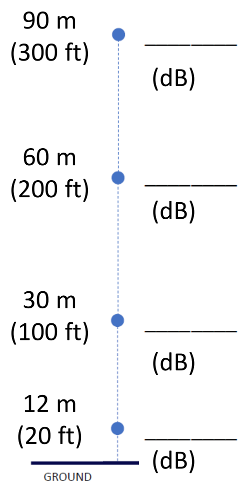
Endurance and Return Home: Measure the battery life of the drone, and its behavior and accuracy when returning to home.

1. Record the start time or take a picture of the clock. Set the drone home point to the launch pad.
2. Take off and hover 6 m (20 ft) over the upward facing bucket, aligning with it and the angled 6 m (20 ft) bucket.
3. Fly at speed straight over the 90 m (300 ft) angled bucket stand.
4. Turn and fly at speed straight back to the upward facing bucket, aligning with it and the angled 6 m (20 ft) bucket.
5. Climb at speed to 90 m (300 ft) over the upward facing bucket, aligning with it and the angled 90 m (200 ft) bucket.
6. Descend to 6 m (20 ft) over the upward facing bucket, aligning with it and the angled 6 m (20 ft) bucket.
7. Repeat from step 2 until the drone automatically returns home.
8. Record the number of laps, flight time, and if the drone landed with at least one ground contact in the 60 cm (2’) diameter landing circle.



Audio Tests

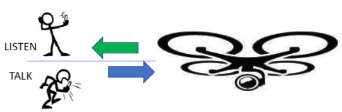




Noise Emission: Using a sound pressure level meter, measure the sound level caused by operating the drone at different altitudes.

1. Measure baseline sound level with drone switched off.
2. Hover at each designated altitude for at least 15 seconds.
3. Write the average sound level at each height.

Baseline Sound Level (dB): _________



Two-Way Audio: For drones equipped with speakers and/or microphones. Measure the ability of the drone to maintain two-way voice communication between the operator station and people in the environment.

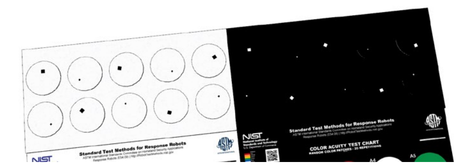
1. Place a speaker on the ground, 6 m (20 ft) from the landing pad. Volume should be set such that the sound level at the drone, due to the speaker, is 75-80 dB.
2. Take off from the landing pad and hover at 3 m (10 ft).
3. Listen at the operator station as alpha-numeric codes are played through the speaker. Write the codes on the form and total up the number of correctly heard codes.
4. Place the speaker at the operator station, close to the microphone. Set the volume such that the microphone is not overloaded.
5. Listen from 6 m (20 ft) in front of the hovering drone as alpha-numeric codes are played through the speaker. Write the codes on the form and total up the number of correctly heard codes.

Tests for Different Aspects of Sensing

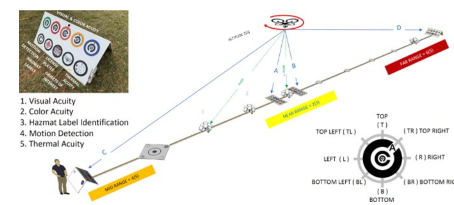
Acuity and Field of View (Visual, Thermal)

Color and Hazmat

Motion Perception and Tracking



Pointing and Zooming



Video and Control Latency

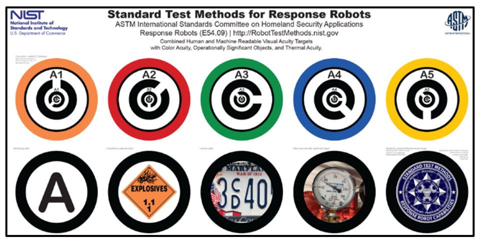
Audio, Stability, Endurance and Return Home, Specialized Tests

Measurements and the Mission

Accurately communicate mission requirements and system capabilities

Measurements Relate to Requirements:
Measurement Science, through the Standard Test Methods, enables the needs of different applications and users to be expressed in a common measurement language that unambiguously relates their requirements to system capabilities.

Embedding Measurements: Placing visual acuity targets with operationally significant objects of interest allow users to relate their requirements to measurable quantities. From an operational distance, what level of acuity is needed to tell between hazmat labels, read a license plate or gauge, or tell a gun from a cellphone?



Statistically Significant and Repeatable: The standard tests are fixed and common for different users. They yield results that are the same, to a known level of precision. Unlike operational tests, they represent fair comparisons between systems, users, locations, and through time.

Measurements do not replace Practice Scenarios: Coaches don't just play games to select and train their players. They also use a variety of fitness tests and exercises, often standardized and replicable for anyone from a school student through to a professional. Similarly, Standard Test Methods focus the measurement of performance, help to determine capabilities and deficiencies and, along with Practice Scenarios, indicate when a system or pilot is ready for gametime and what position they are suited to play.

SENSORS | VIDEO AND CONTROL LATENCY

Circle one per line.

Lit	Dark
Wide	Zoom
Visible	Thermal
Interface	Streamed

Camera name: _____________

High Speed Recording Camera Framerate: ____________

Video Latency:

Frames between flash directly observed and observed through drone:

1: ______ frames	6: ______ frames
2: ______ frames	7: ______ frames
3: ______ frames	8: ______ frames
4: ______ frames	9: ______ frames
5: ______ frames	10: ______ frames

Average number of frames: ______ frames

Divided by framerate = ______ seconds average video latency.

Control Latency:

Frames between command directly observed and the drone moving:

1: ______ frames	6: ______ frames
2: ______ frames	7: ______ frames
3: ______ frames	8: ______ frames
4: ______ frames	9: ______ frames
5: ______ frames	10: ______ frames

Average number of frames: ______ frames

Divided by framerate = ______ seconds average control latency.

Latency

Video Latency:

- Measures the time between an event being observed by the drone, and that event being shown on the operator screen.
- A high speed recording camera (e.g. a cellphone in 120 frames per second high speed/slow motion video mode) is used to record a flashing light, seen both directly and through the drone via its operator screen, for 10 flashes.
- The high speed video is inspected and the number of frames between the light turning on when observed directly, and when observed through the drone via its operator screen, divided by the high speed recording camera’s framerate, is the video latency, and averaged over the 10 flashes.

Control Latency:

- Measures the time between a control input being commanded and the drone moving based on that command.
- A high speed recording camera is used to record both the operator control unit and the drone at the same time.
- The operator quickly pushes the yaw control (generally the left stick) fully to one side to command a yaw and releases it once the robot begins to move. The operator repeats this 10 times.
- The high speed video is inspected and the number of frames between the control being fully applied and the drone starting to move, divided by the high speed recording camera’s framerate, is the control latency, and averaged over 10 yaw commands.

Evaluating Multiple Aspects of Sensing

Trade-offs reflect mission requirements

Acuity and Field of View: Consider the need to see objects in detail and maintain situation awareness of the “big picture”.

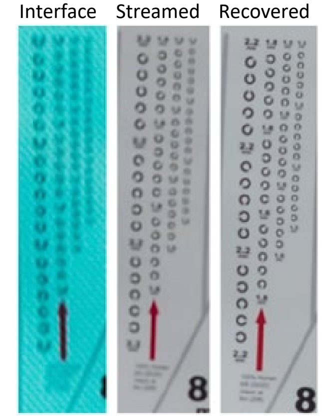
Motion, Latency, Radio Communications: Consider the effect of different resolutions on framerate, latency, and radio range.

Light and Dark: Consider the need to observe detail in bright environments along with maintaining the ability to see in dim and dark conditions.

Pointing and Zooming: Consider the need to pan and zoom to maintain situational awareness, observe what is needed in one visual frame, and maintain image stability.

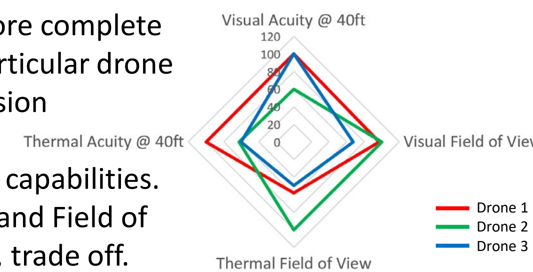
Same view, from the same drone and camera, at the same time.

Interface Streamed Recovered



Live Interfaces vs Streamed vs Recovered: Consider the difference in acuity when observed through the small **interface** screen outdoors, compared to **streamed** to a large monitor in a command vehicle, and compared to images from a memory card **recovered** from the drone.

Visualizations Compare Tradeoffs: A coach doesn’t just look at the 40 ft dash when deciding on a player’s potential, so users should not just look at single tests. A whole suite of tests provides a more complete understanding of how a particular drone or pilot proficiency fits mission requirements and what the trade-offs are between capabilities. For instance, Visual Acuity and Field of View often, but not always, trade off.



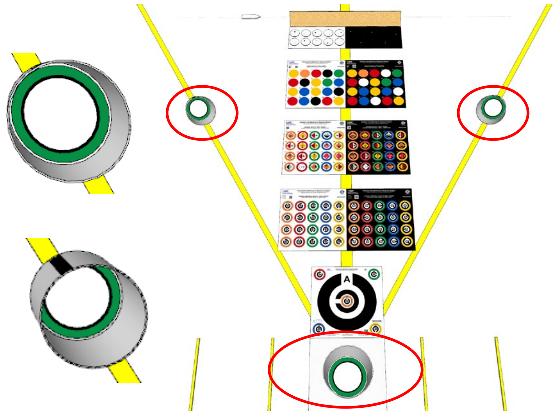
Positioning for Testing

Conducted at Chosen Hover Altitudes and at the Limits of Radio Communications

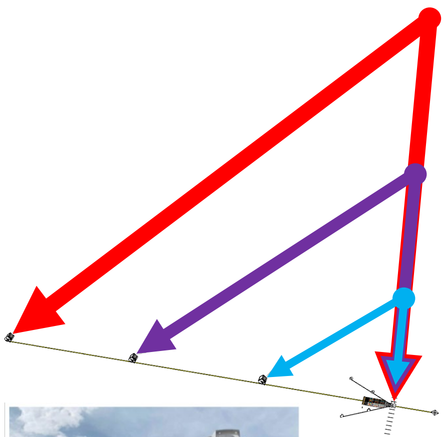
ALIGN WITH BUCKETS AND OBSERVE TARGETS

Aligned. Perform test while ensuring drone maintains alignment.

Not aligned. Move until aligned before performing test.



ALIGN BUCKETS AT THE CHOSEN HOVER ALTITUDE TO ENSURE CORRECT POSITIONING.

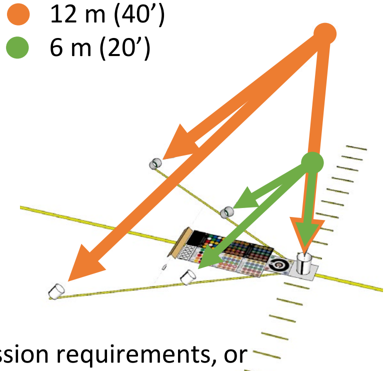


Dual bucket alignments define ***High Hover*** altitudes of:

- 90 m (300').
- 60 m (200')
- 30 m (100')

Triple bucket alignments define ***Hover*** altitudes of:

- 12 m (40')
- 6 m (20')



Altitude is chosen either based on the mission requirements, or such that the system scores 2 to 4 rings into each Concentric C. If the system only scores 1 ring, move closer!

SENSORS | POINTING and ZOOMING

Circle one per line.

Lit		Dark
Quick		Complete
Visible		Thermal
Interface	Streamed	Recovered

Camera name: ______________

Hover Height: _______________ m/ft

Start time (clock image): ___:___:___

TARGET ID	COLOR ACUITY	CIRCLE THE RING GAP DIRECTION WHEN CORRECT. DON'T GUESS! IF INCORRECT, STRIKE THE ENTIRE LINE!				
A1		T	BL	R	BR	L
A2		TR	B	TR	L	BR
A3		R	TL	T	BL	B
A4		BR	R	TL	L	BR
A5		B	TL	R	BL	T
B1		BL	T	BR	R	TL
B2		L	BR	T	TL	R
B3		TL	R	TL	L	BR
B4		T	BL	R	TL	B
B5		TR	B	TL	B	BL
C1		R	TL	B	BL	R
C2		BR	T	TL	R	BL
C3		B	TR	R	BL	T
C4		BL	R	BL	T	BR
C5		L	TL	R	BR	T
D1		TL	B	TR	R	BR
D2		T	BL	B	TR	L
D3		TR	L	BL	R	TL
D4		R	BL	T	TR	B
D5		BR	B	TL	B	TR
TARGET ID	CORRECT COLORS	CORRECT RINGS FOR THE GIVEN LANE SPACING. RESULTS ARE NOT COMPARABLE WITH OTHER LANE SPACINGS.				
	/20	TOAL CORRECT RINGS:				/100

End time (clock image): ___:___:___

Total correct / Elapsed time
= Efficiency (rate) _________ rings/min

Circle one per line.

Lit		Dark
Quick		Complete
Visible		Thermal
Interface	Streamed	Recovered

Camera name: ______________

Hover Height: _______________ m/ft

Start time (clock image): ___:___:___

TARGET ID	COLOR ACUITY	CIRCLE THE RING GAP DIRECTION WHEN CORRECT. DON'T GUESS! IF INCORRECT, STRIKE THE ENTIRE LINE!				
A1		T	BL	R	BR	L
A2		TR	B	TR	L	BR
A3		R	TL	T	BL	B
A4		BR	R	TL	L	BR
A5		B	TL	R	BL	T
B1		BL	T	BR	R	TL
B2		L	BR	T	TL	R
B3		TL	R	TL	L	BR
B4		T	BL	R	TL	B
B5		TR	B	TL	B	BL
C1		R	TL	B	BL	R
C2		BR	T	TL	R	BL
C3		B	TR	R	BL	T
C4		BL	R	BL	T	BR
C5		L	TL	R	BR	T
D1		TL	B	TR	R	BR
D2		T	BL	B	TR	L
D3		TR	L	BL	R	TL
D4		R	BL	T	TR	B
D5		BR	B	TL	B	TR
TARGET ID	CORRECT COLORS	CORRECT RINGS FOR THE GIVEN LANE SPACING. RESULTS ARE NOT COMPARABLE WITH OTHER LANE SPACINGS.				
	/20	TOAL CORRECT RINGS:				/100

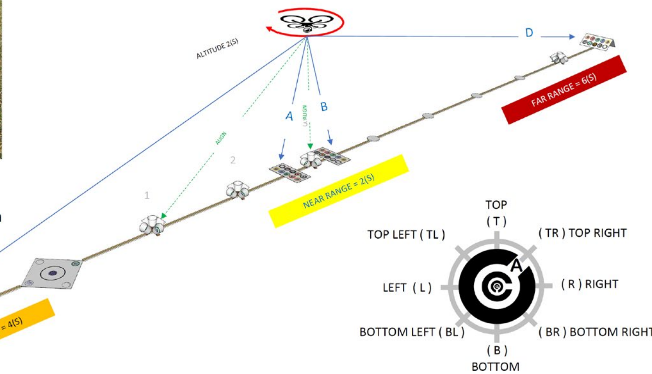
End time (clock image): ___:___:___

Total correct / Elapsed time
= Efficiency (rate) _________ rings/min

Pointing and Zooming

Visible, Thermal

1. Visual Acuity
2. Color Acuity
3. Hazmat Label Identification
4. Motion Detection
5. Thermal Acuity



- Test may be performed at Hover and High Hover altitudes (see p6), or in an Open Lane as shown above.
- Two panels are placed under the hover location, one at a horizontal distance twice the hover height, one at a horizontal distance three times the hover height.
- Each target has five Concentric C targets, as well as a rotating letter, hazmat label, license plate, operationally significant object, and thermal target. These relate measurements to operational capabilities.
- Robot shall yaw 180 degrees between panels A and B (both under the robot).
- Repeat in daylight and in the dark, lit by the drone's on-board lighting (if so equipped).

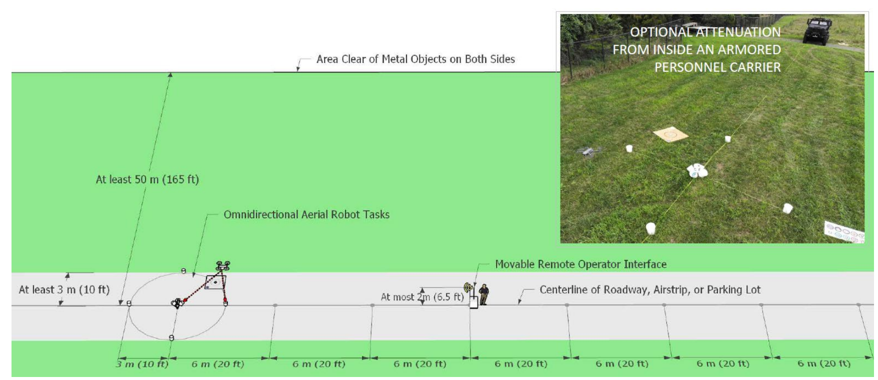
Quick protocol:

- Read as far in as possible into every Concentric Cs target on each panel before moving on to the next.

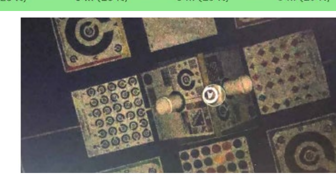
Complete protocol:

- Read the first Concentric C target on panel A, then panel B, C, and D, before returning to panel A to read the second Concentric C target, and so-on.

- An upward pointing center bucket, and one (for **High Hover**) or two (for **Hover**) angled bucket(s) point to the correct location above the charts to perform the test.
- Robot shall maintain its position between observing the buckets and performing the test. Robot should look back at buckets periodically to check that it is still aligned during the test.
- Tests at the limits of radio communications are performed with dual bucket alignments at four different orientations to test antenna directionality, with the operator station at increasing distances (and optionally within a vehicle), and with obstacles (buildings, ISO containers) between the operator station and drone.



- Buckets may be lit to assist in positioning during dim and dark testing conditions. Charts and targets should be lit from/by the drone.



Teams Rotate Through Each Role

Each Pilot flies a 5-minute trial with help from others.
Test in 3-4 person teams.

TEAM ROTATIONS

GET DRONE READY TO FLY

VO | PILOT | PROCTOR

FACING AWAY FROM THE TEST LANE

Four person teams always have one person getting their aircraft ready to launch right after the previous lands.

Three person teams work too, but require some time between each rotation to prepare the next aircraft.

PILOT

- Maintain control of the aircraft.
- Call out each intention of movement before doing so.
- Call out each acuity target gap or measurement.

PROCTOR

- Fill in the form header.
- Read the test procedures to the Pilot.
- Confirm, record, and attest to scoring after the trial.

VISUAL OBSERVER (VO)

- Maintain sight with the aircraft and surroundings.
- Repeat the Pilot's intention of movement to confirm.
- Call out corrections and warnings as necessary.

SENSORS | MOTION PERCEPTION AND TRACKING

Circle one per line.

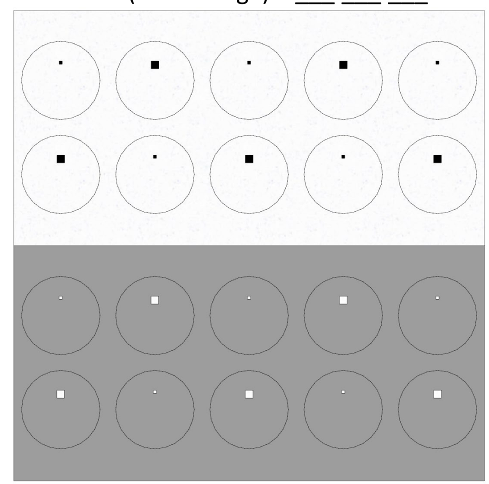
Lit Dark
Wide Zoom
Visible Thermal
Interface Streamed Recovered

Camera name: _______________
Hover Height: _______________ m/ft

Small motion perception and tracking:

Circle targets whose rotation is correctly identified. Write "T" in targets successfully tracked. Cross out incorrectly identified targets.

Start time (clock image): ___:___:___



End time (clock image): ___:___:___

SCORE

TOTAL CORRECT

OF 20

÷

ELAPSED TIME (DECIMAL)

MINUTES

=

EFFICIENCY (RATE)

TARGETS / MIN

Large motion tracking:

For 20 transits of the flag (10 in each direction), circle if the flag was initially tracked, motion predicted while obscured, and re-acquired.

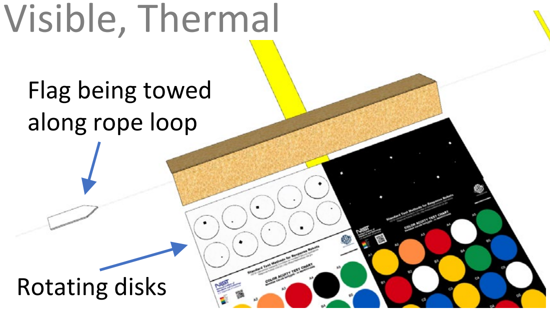
Start time (clock image): ___:___:___

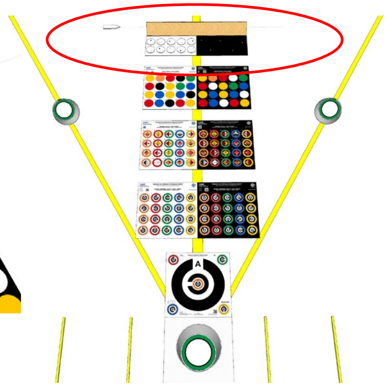
Initial tracking:	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Motion predicted:	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Re-acquired:	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

End time (clock image): ___:___:___

Motion Perception and Tracking

Visible, Thermal





Small movement perception:

- 10 randomly rotating disks, black and white, with two different sizes of contrasting squares that correspond in size to the two largest Concentric C gaps, are observed at different hover altitudes and provide statistically significant measures of motion perception.
- Correctly report if each target is rotating, and the direction of rotation. Repeat separately for each camera, zoomed in and out if so equipped.
- In daylight, difference in heating between black and white allow thermal cameras to be tested.

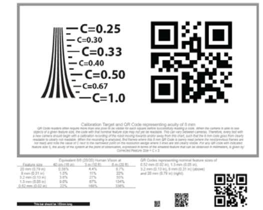
Small movement tracking *(for systems so equipped):*

- Demonstrate the tracking of the squares on the rotating disks while no (stationary) objects in the view are flagged as moving.

Large movement tracking *(for systems so equipped):*

- A 60 cm (2 ft) long, 15 cm (6 in) wide plastic flag, of a contrasting color to the background, is towed along a continuous rope loop (e.g. using a canine lure course winch), across the view of the drone, at a speed of 1.3 to 2.6 m/s (5 to 10 km/h, 3 to 6 mph). The center 2.4 m (8 ft) is obscured.
- Demonstrate tracking of the flag, and prediction of the movement of the flag through the obscured area.

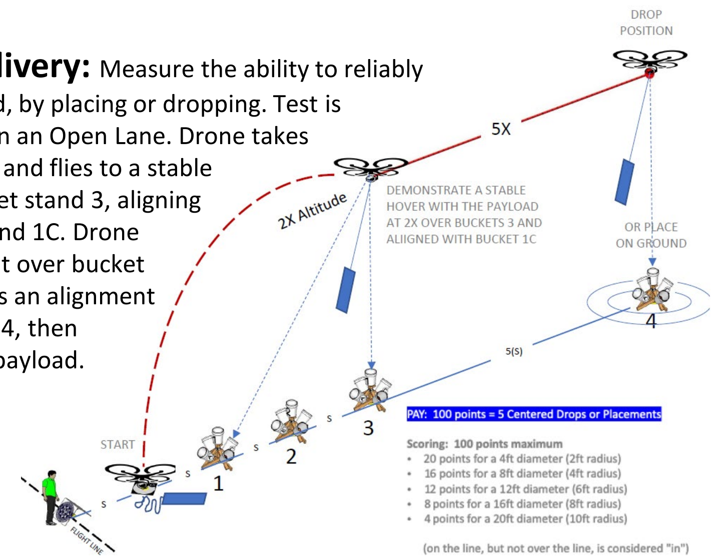
Specialized Tests



Survey Acuity: Automatically readable visual acuity targets, consisting of QR codes of different sizes, are placed at regular intervals along a line (for a test lane) or placed on objects of interest (when embedded in a scenario). The drone flies along the line or through the scenario at different heights, speeds, and conditions, under pilot control or in autonomous mapping mode. The resulting images and/or video are analyzed and the readable QR codes of each size are counted. This reflects the amount of the environment that was observed at different resolutions. A resolution wedge on the chart allows the QR code reading system (and its threshold for code detection) to be calibrated.

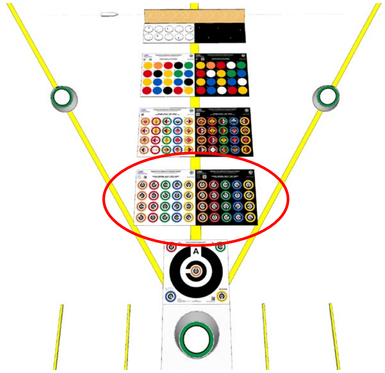
3D Vision: The Visual Acuity and Field of View tests are performed with targets consisting of concentric rings of 7 half spheres, one in each of the 8 directions with one missing (equivalent to the gap in the Concentric C pattern). This is scaled up and/or performed at close range as necessary.

Payload Delivery: Measure the ability to reliably deliver a payload, by placing or dropping. Test is conducted within an Open Lane. Drone takes off with payload and flies to a stable hover over bucket stand 3, aligning with buckets 3 and 1C. Drone then flies straight over bucket stand 4, captures an alignment image of bucket 4, then places or drops payload.



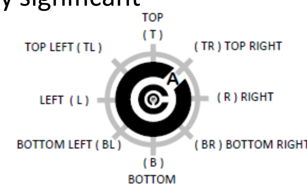
Acuity and Field of View

Visible, Thermal

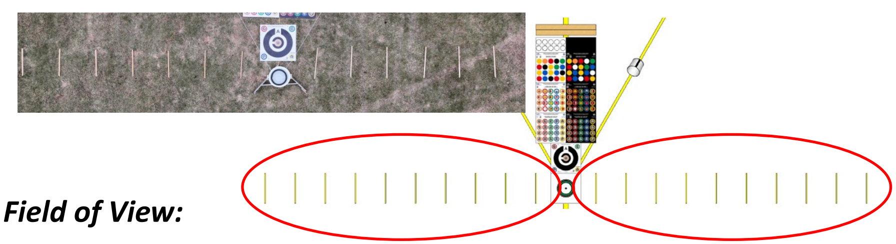


Acuity:

- 20 Concentric C targets, black-on-white and white-on-black, at different hover altitudes, provide statistically significant measures of acuity.
- Correctly report the orientation of each visible target. Repeat separately for each camera, zoomed in and out if so equipped.



- Performance will differ when test is conducted through the operator **interface** screen, **streamed** to a large monitor, or based on images **recovered** from a card on the drone.
- In daylight, difference in heating between black and white allow thermal cameras to be tested.



Field of View:

- At a chosen altitude, look straight down and use the markings, spaced at 1.2 m (4 ft), to determine the width of the field of view of the camera.
- Repeat for each camera, zoomed in and out if so equipped.

SENSORS | HAZMAT

Circle one per line.

Lit	Dark	
Wide	Zoom	
Visible	Thermal	
Interface	Streamed	Recovered

Camera name: _______________

Hover Height: ________________ m/ft

Circle labels that are correctly identified. Cross out incorrectly identified labels.

Start time (clock image): ___:___:___

End time (clock image): ___:___:___

SCORE

TOTAL CORRECT LABELS

OF 20

ELAPSED TIME (DECIMAL)

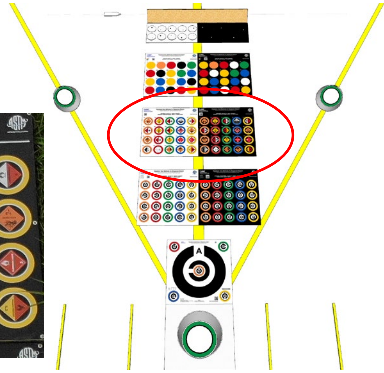
MINUTES

EFFICIENCY (RATE)

LABELS / MIN

Hazmat

Visible, Thermal



- 20 standard 10 cm (4 in) hazmat labels on white and black backgrounds, at different hover altitudes, provide statistically significant measures of the ability to use detail and color to identify patterns and text.
- Correctly report the identity of each label. Repeat separately for each camera and zoomed in and out.
- Repeat in daylight and in the dark, lit by the drone's on-board lighting (if so equipped).
- In daylight, difference in heating between black and white allow thermal cameras to be tested.

SENSORS | VISUAL/THERMAL ACUITY and FIELD OF VIEW

Circle one per line.

Lit Dark
Wide Zoom
Visible Thermal
Interface Streamed Recovered

Camera name: ____________
Hover Height: ______________ m/ft
Field of View: ______________ m/ft

Start time (clock image): ___:___:___

TARGET ID	COLOR ACUITY	CIRCLE THE RING GAP DIRECTION WHEN CORRECT. DON'T GUESS! IF INCORRECT, STRIKE THE ENTIRE LINE!				
A1		T	BL	R	BR	L
A2		TR	B	TR	L	BR
A3		R	TL	T	BL	B
A4		BR	R	TL	L	BR
A5		B	TL	R	BL	T
B1		BL	T	BR	R	TL
B2		L	BR	T	TL	R
B3		TL	R	TL	L	BR
B4		T	BL	R	TL	B
B5		TR	B	TL	B	BL
C1		R	TL	B	BL	R
C2		BR	T	TL	R	BL
C3		B	TR	R	BL	T
C4		BL	R	BL	T	BR
C5		L	TL	R	BR	T
D1		TL	B	TR	R	BR
D2		T	BL	B	TR	L
D3		TR	L	BL	R	TL
D4		R	BL	T	TR	B
D5		BR	B	TL	B	TR
TARGET ID	CORRECT COLORS	CORRECT RINGS FOR THE GIVEN LANE SPACING. RESULTS ARE NOT COMPARABLE WITH OTHER LANE SPACINGS.				
	/20	TOAL CORRECT RINGS:				/100

End time (clock image): ___:___:___

Total correct / Elapsed time
= Efficiency (rate) ________ rings/min

Circle one per line.

Lit Dark
Wide Zoom
Visible Thermal
Interface Streamed Recovered

Camera name: ____________
Hover Height: ______________ m/ft
Field of View: ______________ m/ft

Start time (clock image): ___:___:___

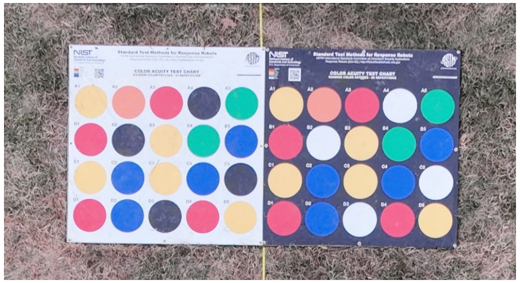
TARGET ID	COLOR ACUITY	CIRCLE THE RING GAP DIRECTION WHEN CORRECT. DON'T GUESS! IF INCORRECT, STRIKE THE ENTIRE LINE!				
A1		T	BL	R	BR	L
A2		TR	B	TR	L	BR
A3		R	TL	T	BL	B
A4		BR	R	TL	L	BR
A5		B	TL	R	BL	T
B1		BL	T	BR	R	TL
B2		L	BR	T	TL	R
B3		TL	R	TL	L	BR
B4		T	BL	R	TL	B
B5		TR	B	TL	B	BL
C1		R	TL	B	BL	R
C2		BR	T	TL	R	BL
C3		B	TR	R	BL	T
C4		BL	R	BL	T	BR
C5		L	TL	R	BR	T
D1		TL	B	TR	R	BR
D2		T	BL	B	TR	L
D3		TR	L	BL	R	TL
D4		R	BL	T	TR	B
D5		BR	B	TL	B	TR
TARGET ID	CORRECT COLORS	CORRECT RINGS FOR THE GIVEN LANE SPACING. RESULTS ARE NOT COMPARABLE WITH OTHER LANE SPACINGS.				
	/20	TOAL CORRECT RINGS:				/100

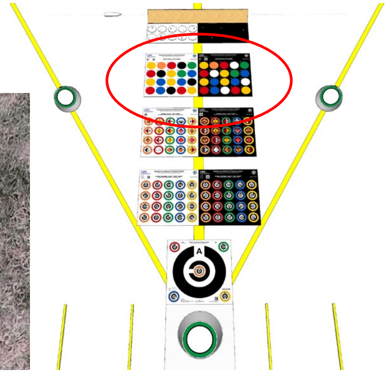
End time (clock image): ___:___:___

Total correct / Elapsed time
= Efficiency (rate) ________ rings/min

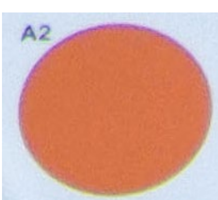
Color Acuity

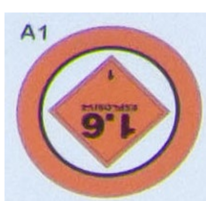
Visible





- 20 colored circles on white and black backgrounds, at different hover altitudes, provide statistically significant measures of color identification and potential for confusion between colors.
- Correctly report the identity of the color of each circle. Repeat separately for each camera and zoomed in and out.
- Repeat in daylight and in the dark, lit by the drone's on-board lighting (if so equipped).
- Black and white backgrounds allow users to see if particular colors get "lost" in a dark or light environment.
- Colored rings in other tests (e.g. Visual Acuity and Hazmat) evaluate the ability to perceive color when presented as a thin line, rather than as a solid block.





SENSORS | COLOR

Circle one per line.

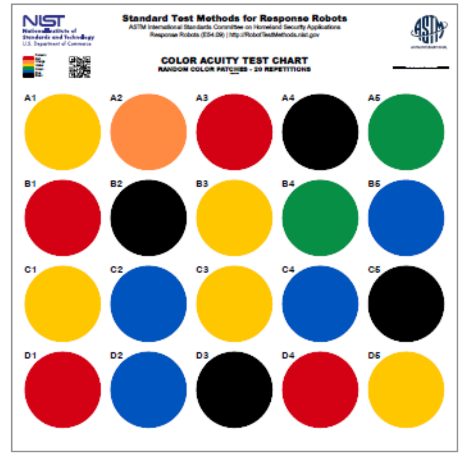
Lit	Dark	
Wide	Zoom	
Interface	Streamed	Recovered

Camera name: ______________

Hover Height: _______________ m/ft

Circle circles that are correctly identified. Cross out incorrectly identified circles.

Start time (clock image): ___:___:___



End time (clock image): ___:___:___

SCORE

TOTAL CORRECT COLORS

OF 20

ELAPSED TIME (DECIMAL)

MINUTES

EFFICIENCY (RATE)

COLORS / MIN