HRI: Live Detection Tests

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Purpose

This test will verify if a robot/system can reliably detect humans and common obstacles before proceeding to **Safety: Stopping and Collision Avoidance Tests**. This test focuses solely on detection rates. The test applies to mobile platforms operating in semi-structured agricultural environments (fields, greenhouses). The test is scored by an external (human) observer marking correct and incorrect responses by the robot system to changing conditions during each trial.

Precondition: The robot system must have passed the separate **HRI: Off-line Detection and Tracking Test** before involving real people in the test procedure described here (refer to Figure 2 for detailed information).

Test Facility

The test shall be conducted in a setting controlled outdoor environment simulating typical deployment (e.g. strawberry polytunnel), with the following properties (specifics to be recorded in test report):

- **Size and Layout:** Straight path 10–20 m long, 2–4 m wide with randomized obstacle placements.
- **Boundary Marking Method:** Cones or flags at edges; painted centreline and lateral offset markers (or none).
- **Ground Conditions:** Paved, gravel, or grass (firm, dry), coefficient of friction between 0.6–1.0 (ISO 18646-2:2019).
- **Lighting:** 100–1,000 lux for vision-based systems (ISO 18646-2:2019).
- **Temperature/Humidity:** 10–30 °C, 0–80% RH.
- **Obstacles:**
  - **Human Obstacles:**
    - Standing dummy height: 1.6–1.8 m; width: 0.4–0.6 m (based on ISO 13482:2014 dummy anthropometry).
    - Moving dummy on caster platform/trolley (simulates pedestrian crossing). Dynamic obstacles enter robot path 5s prior to robot arrival.
    - Human: Adult person, varying clothing (light/dark/high-vis), with and without carrying items (e.g., tray, box), possibly partially occluded.
  - **Non-Human Obstacles:**
    - Static trolley (height around 1.2 m).
    - Cubical block – cardboard boxes (side: 0.4–0.8 m).
    - Other similar equipment used on site; record size, material, and reflectivity.

The robot may remain stationary during the whole test procedure. The robot is expected to operate with full autonomous mode enabled. An optional logging facility can be included in the robot system to record onboard time-synced logs and/or external motion capture/video.

Test Procedure

Trials should follow the steps outlined below. During the test, keep the robot stationary. Power on the system; confirm sensor and detector operation. Start recording logs and/or video. Then, follow the steps below for each trial:

1. Position a human or obstacle within the robot's sensing coverage (e.g., camera field of view, LiDAR scan area) at a defined location and distance.
2. For moving scenarios, actor/obstacle passes across or into the robot's sensing coverage.
3. Record whether the system reports a detection, along with detection time and distance.
4. Repeat trials with variations in distance, angle, lighting, occlusion, and object type.

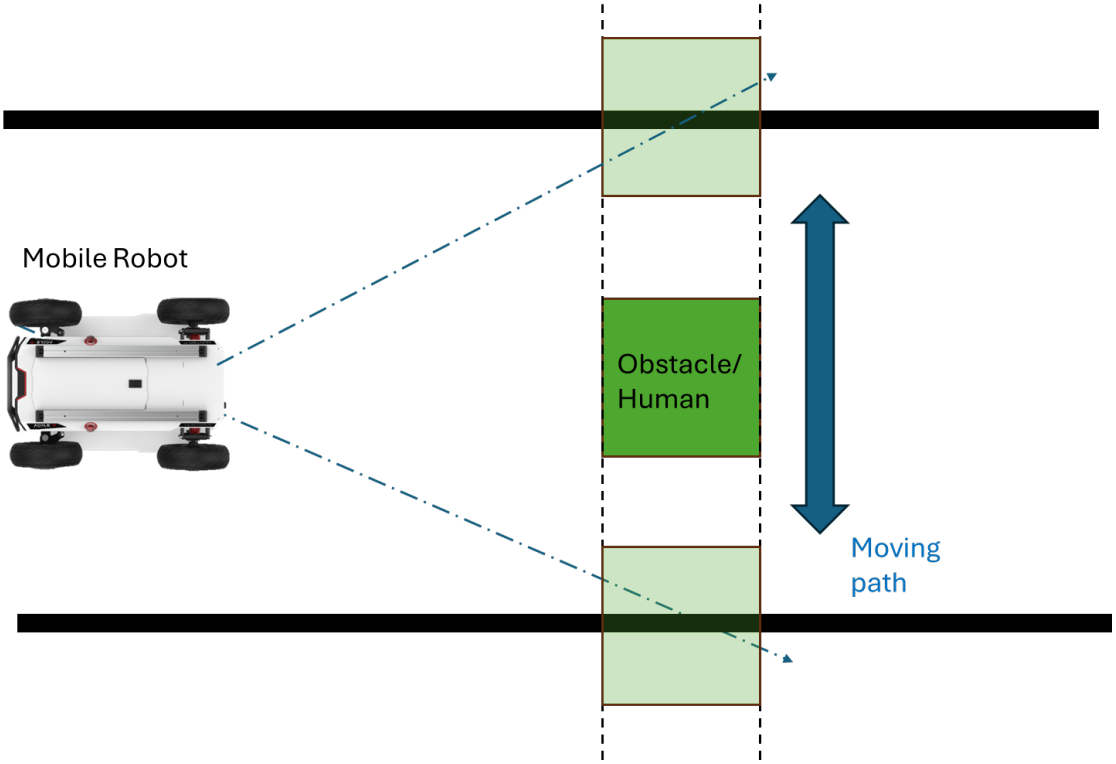

Figure 1: Test Scenario Example

Evaluation Criteria and Error Conditions

Success is measured as:

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Detection rate = (Number of successful detections) ÷ (Total trials)
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Conditions

- Use consistent trial conditions for comparison.
- No ground truth bounding boxes are required; pass/fail is based on system reporting detection and scored by an external (human) observer.

Test Result

The following shall be recorded and included in the test report:

- Test facility conditions, as above, including:
  - Size, layout and boundary marking method
  - Ground conditions, lighting, temperature and humidity
  - Obstacles: type, size, number and position of each (within the layout)
- For each trial:
  - Detection result (yes/no).
  - Detection time and distance (if available).
  - Detection rates, per-scenario and in aggregate.
  - Target type (human/obstacle).
  - Trial conditions (distance, angle, lighting, occlusion).
  - Notes on false detections or missed detections (e.g. poor performance in low light or heavy occlusion).

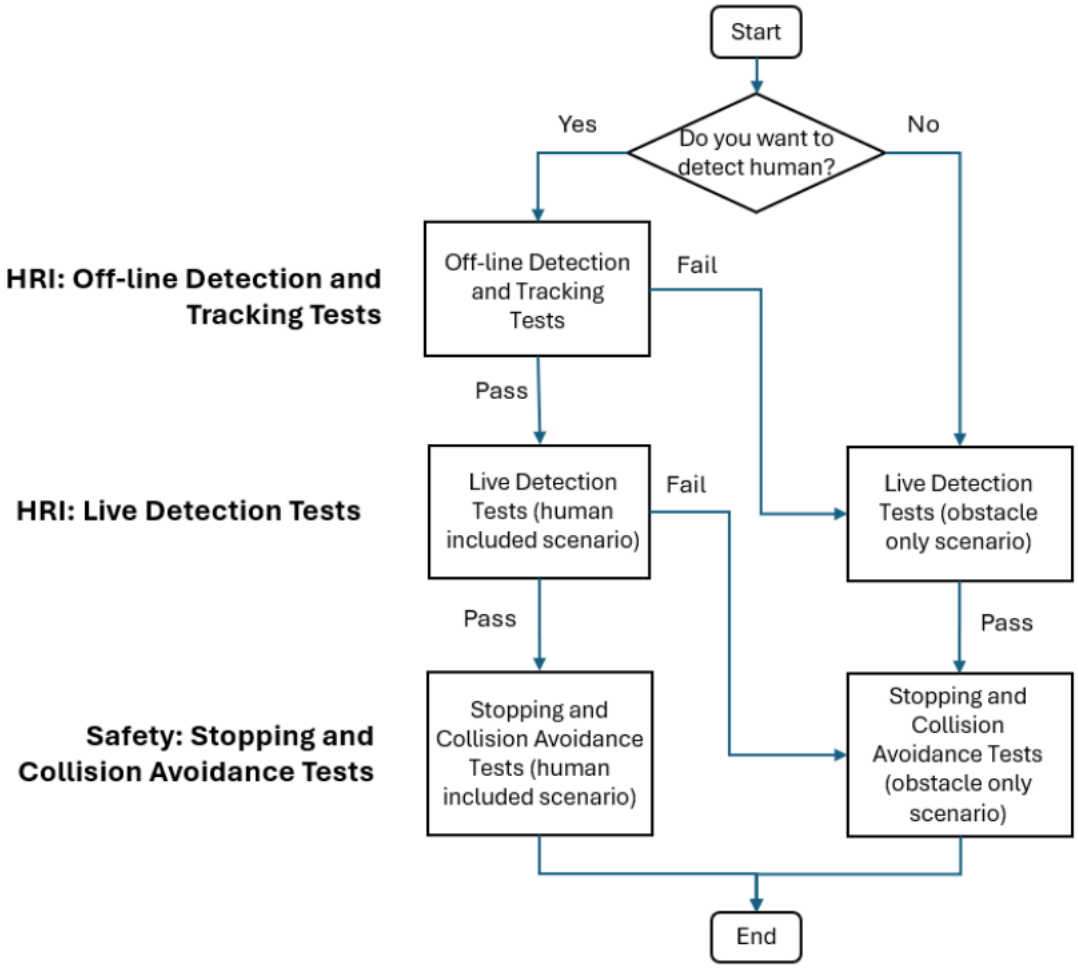

Figure 2. Test Sequence Flow

References

1. ISO 18497:2024 – Safety of highly automated agricultural machines. Sets expectations for safe detection and response.
2. ISO 18646-2:2019 – Performance requirements for service robots in outdoor environments.