Guardian Wave

A Year in Review of Touchless Push Buttons

Hawaii ITE Technical Solutions Event-May 2021

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What’s an APS?

Accessible pedestrian signals are devices that communicate information about the WALK and DON'T WALK intervals at signalized intersections in non-visual formats to pedestrians who are blind or who have low vision.

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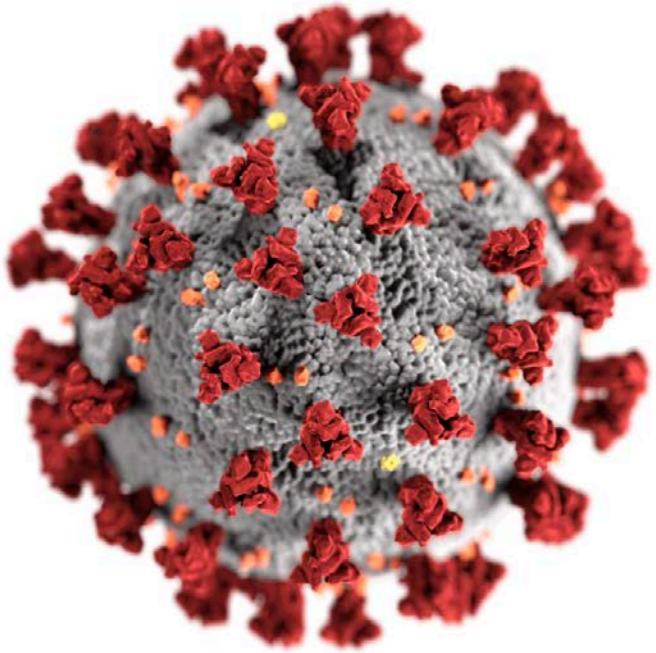

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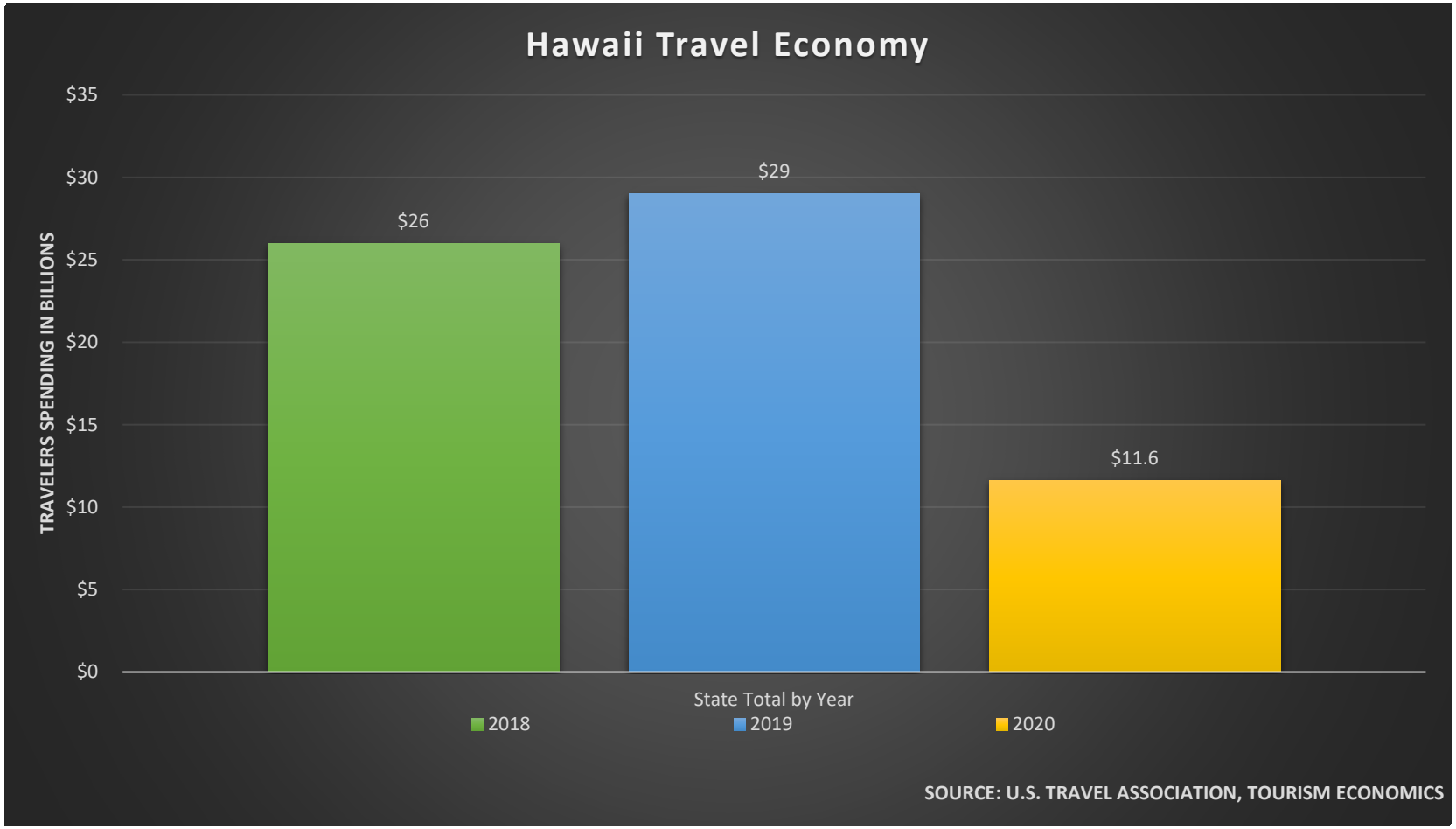
Hawaii- Travel Economy Impact



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Shut It Down

- Intersections with pedestrian detectors are put into Recall
- Signs to discourage the pressing of buttons
- Greater awareness of Germs and Viruses on public use item

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Call to Action

- April 13th 2020- Santa Clara County CA contacts multiple APS manufactures looking for a hands-free solution
  - NFC- Requested without special app.
  - Touchless Sensor using hand wave

and then on May 9th 2020...

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The Solution

- Guardian Wave
  - Engineering delivered a working prototype in under 4 weeks
  - Integrated Tried and True IR technology
  - Non-exclusive pedestrian usage

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Theory of Operation

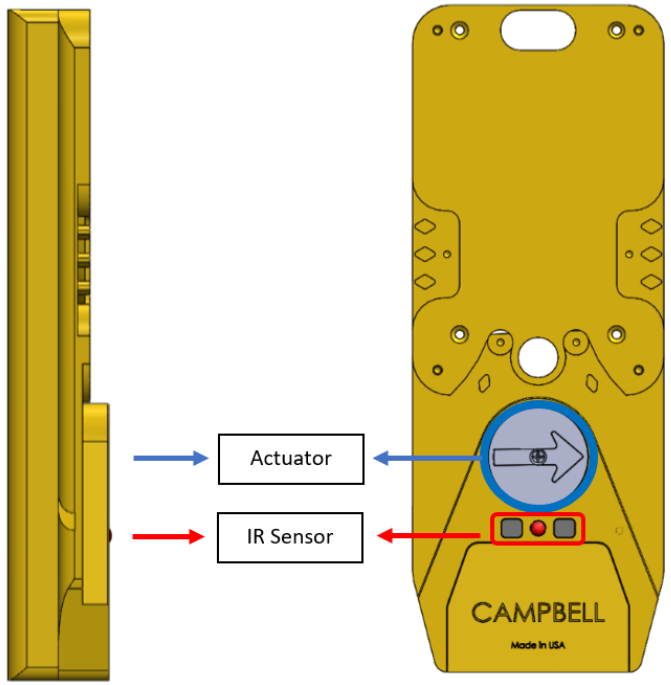
- Active Infra-Red (AIR) detection employs an optical sensor and a transmitter. The signal generated by the transmitter reflects off the surface of a pedestrian's hand and is registered by the receiver.

- The IR Transmitter modulates a specific digital signal into the carrier signal. When the transmitted light is reflected back, the IR Receiver demodulates the signal which filters out the carrier and extracts only the digital signal from the transmitter. The demodulated signal is then sent back to the processor.

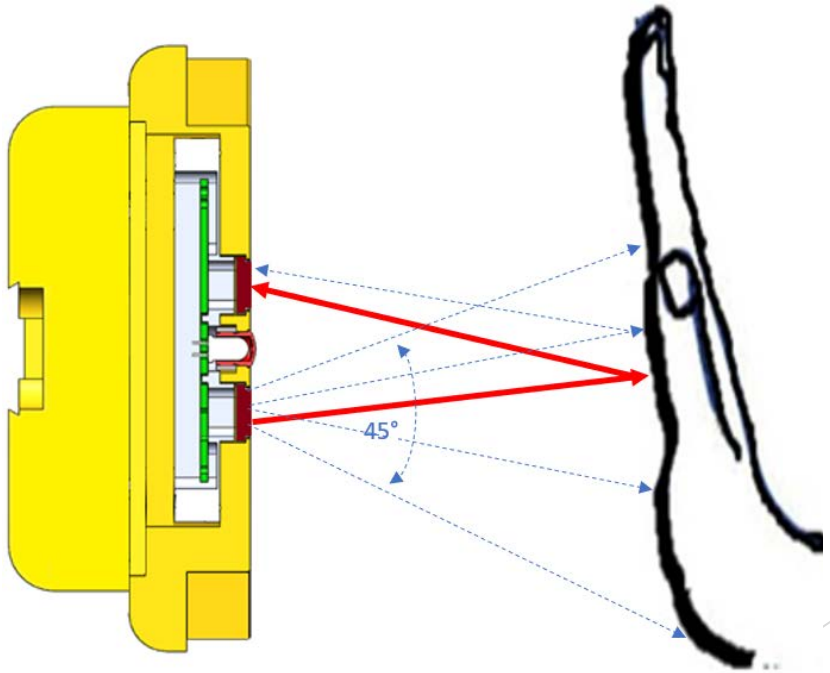
- The processor analyzes the demodulated signal to verify that it matches the signal sent by the IR Transmitter

Detection

Identification



Detection Angle – Top View



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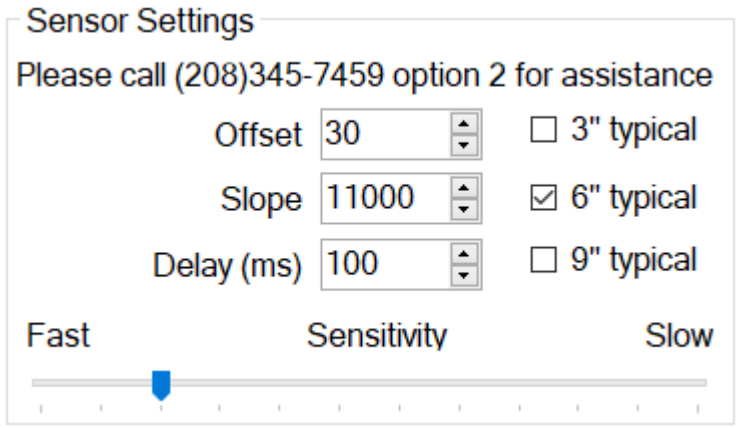
Detection

- The Wave sensor detects the presence of a pedestrian's hand between 1 to 6 inches away from the sensor (standard setting).
- PedConnex™ utility has the ability to modify the detection distance from 1 to 3 up to 1 to 9 inches from the sensor.
- PedConnex utility has the ability to adjust the sensitivity of the sensor to determine the amount of time a hand needs to be left in front of the device.



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Detection Safeguards

- The system has three layers of protection to ensure that it is receiving an accurate call.
  - 1)The IR Receiver has a narrow-band response, ignoring any light that does not have the correct infrared wavelength.
  - 2)The IR Receiver ignores all light that is not pulsing at the correct carrier frequency. This includes infrared light of the correct wavelength.
  - 3)The firmware only interprets a valid call if the demodulated signal from the IR Receiver matches the signal modulated by the IR transmitter.

Testing

Do two sensors interfere with each other when placed at 90 degree angles towards each other?

Test Step:	Data Collection at Step:	Hardware Required:
• **Place stations adjacent at right angles as close together as possible, then power them up.**	• Check that the stations do not set each other off. PASS • Check that the stations can be actuated individually via the Freedom Wave sensor. PASS	• Two Guardian Wave stations with power supplies.

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When exposed to continuous sources of infrared radiation, will the sensor generate false actuations?

Test Step:	Data Collection at Step:	Hardware Required:
• **Place station in front of Infrared Heater.** • **Repeat test holding station at many different angles and orientations.**	• Check that the IR radiation does not trigger a false actuation. PASS • Check that the station can still respond to a hand wave while exposed to the IR radiation. PASS	• Guardian Wave station with power supply. • Infrared space heater.

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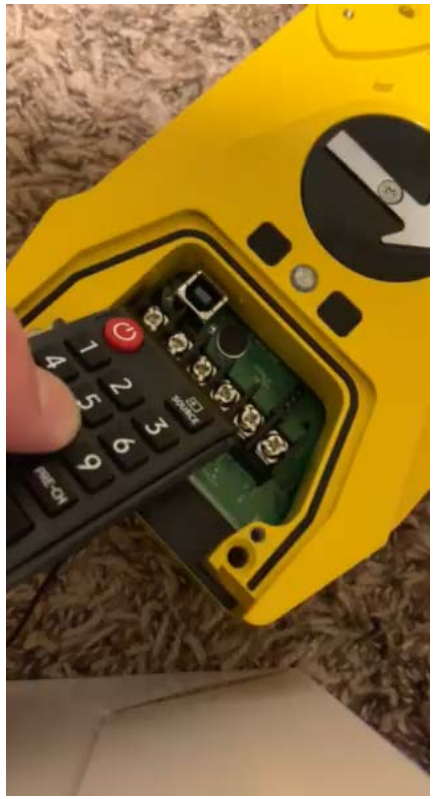
When exposed to pulsed sources of infrared radiation, will stations generate false actuations or fail to actuate?



Test Step:	Data Collection at Step:	Hardware Required:
• **Press buttons with TV remote aimed at powered Guardian Wave station.**	• Check that TV remote does not generate an actuation. PASS • Check that station can still recognize a hand while exposed to TV remote signals. PASS	• Guardian Wave station with power supply. • TV Remote

Test Notes: Using our diagnostic tools we could see that the sensor responds to the TV remote, but our software algorithm filters this signal out as noise. The noise is not enough to block a true actuation.

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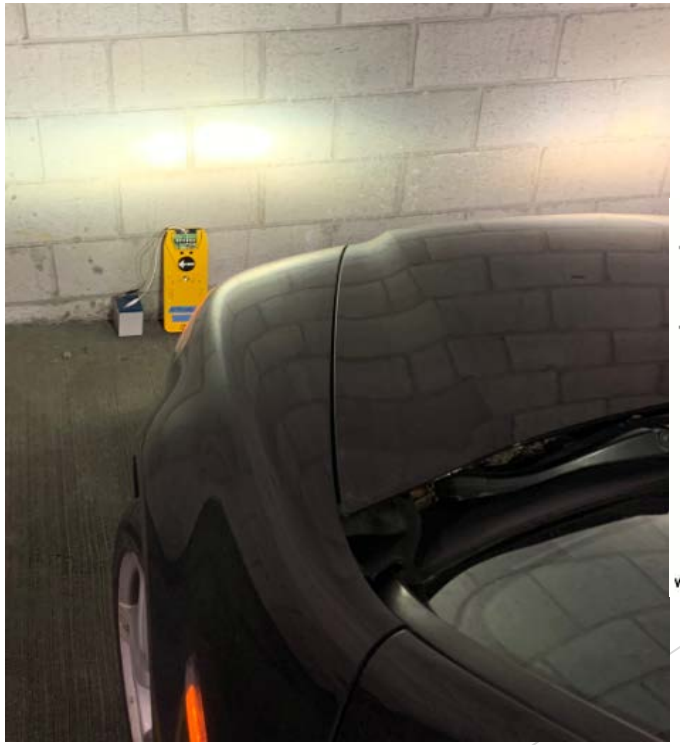
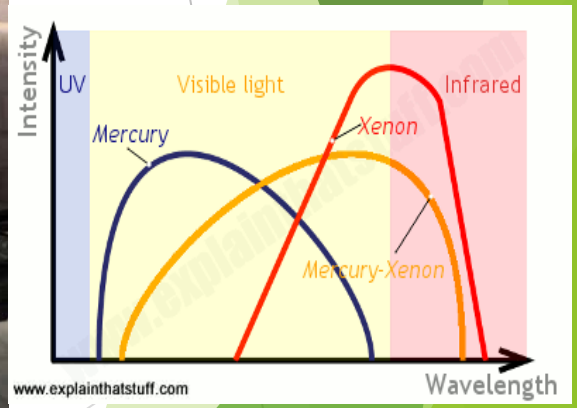
When exposed to car headlights, will the sensor generate false actuations or fail to actuate?

Test Step:	Data Collection at Step:	Hardware Required:
• **Aim standard vehicle headlights at station Test with lights steady-on and flickering.** • **Aim Xenon HID headlights at station. (Xenon HID lamps contain significant IR content.) Test with lights steady-on and flickering.** • **Aim "bights" at station. Test with lights steady-on and flickering.**	• Check that no type of headlight triggers false actuation. PASS • Check that station can still recognize a hand while exposed to all types of headlights. PASS	• Guardian Wave station with power supply. • Vehicle with incandescent headlights as well as Xenon HID lamps.





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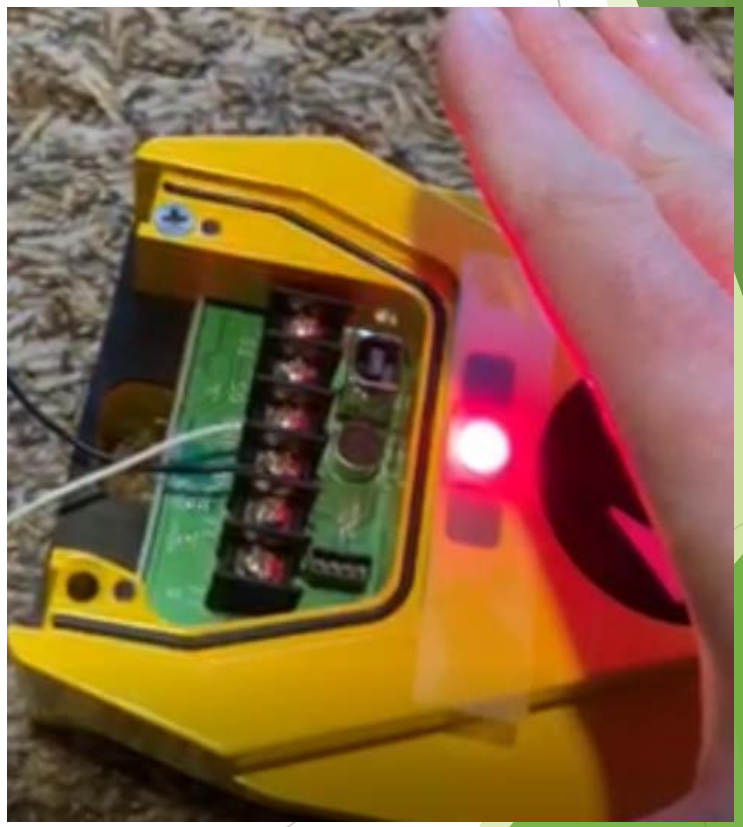
When covered by a moderate to heavy-duty tape, can the sensor go into constant call? Can calls be placed through a layer of various tapes and coverings?

Test Step:	Data Collection at Step:	Hardware Required:
• **Test with clear scotch tape over sensor.** • **Test with beige masking tape over sensor.** • **Test with blue painter's tape over sensor.** • **Test with heavy electrical tape over sensor.** • **Test with heavy vinyl sticker over sensor.**	• Check that station still actuates through scotch tape, masking tape, and painter's tape. PASS • Check that heavy electrical tape or a thick sticker does not place the station into constant call. PASS	• Guardian Wave station with power supply. • Scotch tape, masking tape, painter's tape, electrical tape, vinyl sticker.



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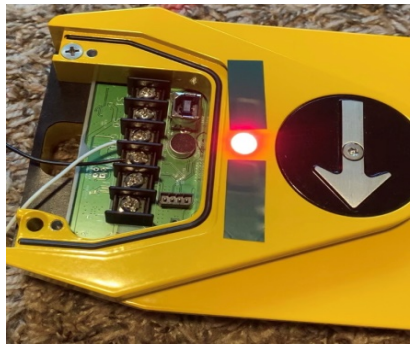

Test Notes: Detection range was slightly reduced with Masking Tape and Painter's Tape. Sensor can still function if only one window is covered by electrical tape or sticker.

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When exposed to extreme temperatures and thermal cycling, can the sensor perform repeatably?

Test Step:	Data Collection at Step:	Hardware Required:
• **Soak stations at 80C for 12 hours unpowered.** • **Soak station exposed at -40C for 12 hours unpowered.** • **Thermal cycle the stations with power applied between -40C and +80C, with 90 minute ramp and 30 minute soak times, for 3 days continuously.**	• Check that stations boot up after -40C and +80C soaks, and verify sensor function. PASS • Verify all station functionality after thermal cycling. PASS	• Guardian Wave stations with power supply. • Thermotron environmental chamber.

Test Notes: Our thermal cycle test is extremely aggressive and consistently induces failures in weakened components and off-the-shelf parts that are not up to spec

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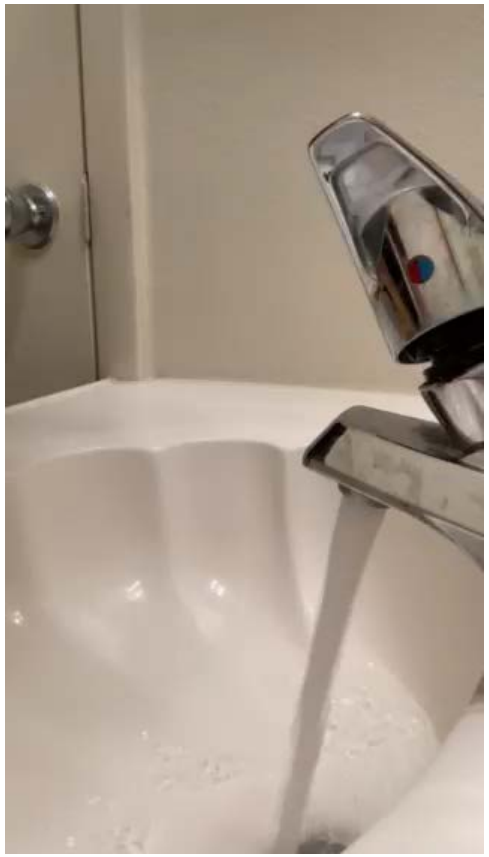
Does water running down the face of the sensor trigger unwanted actuations? Can the sensor detect a hand through running water?



Test Step:	Data Collection at Step:	Hardware Required:
• **Run water down the face of the station, focusing on the sensor area.**	• Verify that running water does not trigger an actuation. PASS • Verify that the sensor can still detect a hand through running water. PASS	• Guardian Wave station with power supply. • Sink faucet.

Test Notes: This test was performed with the field wiring cavity wide open, hence the plastic covering. When the field wiring cavity is covered by the access door, running water down the face of the station is not a problem.

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When exposed to various environments found in most metropolitan areas, will the device trigger false actuations or fail to actuate?

Test Step:	Data Collection at Step:	Hardware Required:
• **Hook station up to battery power and put it in a location in the car that receives a lot of sunlight through the window.** • **Drive through busy downtown intersections.** • **Drive through heavy industrial areas.** • **Drive through heavy commercial areas** • **Drive near large transformers.** • **Drive near cell phone towers.** • **Drive past tall buildings.** • **Drive through areas where sunlight flickers in and out through trees or buildings.** • **Drive past power substations.** • **Drive under overhead power near the airport.** • **Drive near national guard airfield.**	• Verify that no environment triggers false actuations. PASS • Verify that the sensor can still detect a hand in all environments. PASS	• Guardian Wave station with power supply. • 12V battery. • Car.

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Lessons Learned

- Allow agency to adjust sensor distance and sensitivity settings via software
  - SCC wanted faster hand registration.
- Open settings for noise filtering; not all intersections are created equal
  - Discovered electromagnetic noise radiating from the traffic pole could cause issues at one of our SCC test sites.
- Refined firmware
  - Additional Debounce time for noise immunity
  - Add sensor specific data logs
  - Option to disable the sensor
  - Faster response to ambient light
  - Optimize settings configuration for production orders.

Applying Touch-less APS

- This problem is not exclusive to SCC
- The price difference is minimal
  - 2020- 6% higher than standard Guardian
  - 2021- 4.6% higher than standard Guardian
- Eliminate the need for recall
  - Remove the “no touching” signs and take intersections out of recall
- Help prevent spread of germs and viruses at typical intersections of RRFB crossings
  - Airports, schools, downtown corridors, heavy tourist locations with traffic signals

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Just a Piece of the Puzzle

- Adding a touchless feature to our device is a small piece in a larger puzzle of pedestrian safety and will help prevent the spread of germs and viruses at the intersection now and in the future.

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