# CC DESIGN CENTER COLORADO

#### Motivation

- Current security systems are location specific, expensive, require human monitoring, and time-consuming to set up
- Design a rapidly deployable remote sensor package that can survive impact, self-orient, and autonomously detect and differentiate between humans and vehicles for at least 30 days

#### **Key Requirements**

Identify vehicles and people at 10 m	
90% detection rate and data transmission	
IP54 (weather proofing) rating	TBD
Operational range of -20 to 60 °C	TBD
Single user deployable weighing <16 kg	
Withstand a 1.2 m drop and self-orient	
Operate for at least 30 days	

### **Testing and Results**

- 100% success rate for positive detections within 15 m
- Detected vehicles and people at various speeds and directions of travel
- Passive system alerted up to 80 m away
- Test results met range specifications
- The device survived a max force of 160 G's when it was dropped on its side from 1.4 m



This image is of a vehicle moving 18.6 km/h at 10 meters from the device

This image is of a person walking at 20 meters from the device



# BASTION Broad Area Seismic Transducer and Infrared Optical Network

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Design

#### Main Assembly

Battery Provides 220 Wh (18 Li-ion battery cells)



**Geophone Case** Rigid mounting for vibration transfer

Solenoid Subassembly Locks stalk for pre and post deployment

> **Bumpers** Polyurethane foam provides impact mitigation and bevel provides selforientation

**Outer Case** High-Density Polyethylene (HDPE) and O-ring provide waterproofing

#### **System Flowchart**



#### Stalk Subassembly

Nvidia<sup>®</sup> Jetson Nano<sup>™</sup> Performs image analysis and alert transmission

> Servo Subassembly High torque servo raises the stalk by rotating the hollow shaft



IR Flash (4x) Allows for night imaging

#### Aluminum Shaft Hollow to guide wiring between main body and stalk subassembly

Solenoid Ring Accepts solenoid pin to lock the stalk in position

## **Passive Classification**

**Passive Infrared Sensor (PIR)** Detects motion by measuring changes in infrared radiation

#### Geophone

Detects motion by measuring vibrations through the ground; uses select frequencies to discern between humans and vehicles

#### **Electronics**

- power passive operation



Middle Body Holds aluminum shaft with bearings and lip seals for waterproofing





Stalk Mount Attaches stalk to aluminum shaft

Camera (4x) Combination of cameras on each face captures 360° image

#### **Active Classification**

Camera System Four cameras to acquire 360° picture of the surroundings

Image Recognition Camera images analyzed to differentiate between vehicles and people using the YOLOv8 model

Custom designed electronics for <20mW ultra-low

Integrated in-house battery module for energy density

Analog geophone detection circuit designed from ground up for high sensitivity and ultra-low power with high voltage front-end protection

A total of 18 PCBs spread across 8 custom designs

**Analog Geophone Circuit**