



Colorado Science and Engineering Fair

2025 Individual Project Abstract Form

Please print 2 copies of the completed form. Sign both copies, keep 1 for your notebook and submit 1 copy to your Regional Fair Director with your other paperwork.

Title of Project: A Cohesive Method of Subterranean Object Detection Using Infrared Sensors

Finalist's Name: Ethan Bonnell

School and City: Centaurus High School, Lafayette

Sponsor's Name: Eric Mattys

Category: Mathematics & Computer Sciences

Division: Senior (grades 9 - 12)

Abstract (250 words or less):

Objects buried underground are not easily detected using traditional ground survey methods. While this issue can usually be circumvented with technology such as Ground-Penetrating Radar, dangerous objects such as landmines require other methods to be used. Researchers have attempted to solve this problem by using infrared sensors attached to Unmanned Aerial Vehicles (UAVs), but these systems often use highly expensive thermal cameras. Therefore, using photos of subterranean objects taken with an inexpensive and easily procured infrared thermography camera, this study develops a method of classifying infrared thermal data using Machine Learning (ML). Specifically, this ML system is a Convolutional Neural Network (CNN) which was trained with positive (having a subterranean object present in the image) and negative (no subterranean object) and was subjected to tests of its accuracy when classifying infrared images into categories of positive and negative. Two types of data were tested: raw infrared images and combined-signal images which were created via a synthesis of infrared data from two different times of day to highlight thermal anomalies created by subterranean objects. The most accurate model had a micro-average accuracy of 0.9286, and it was particularly accurate in its classification of the combined-signal data, which was at levels suitable for a sensitive application such as landmine detection. Despite the low-quality thermal camera, the CNN performed well against accuracy rates seen in the literature. I have concluded that this classification method should be further developed and used in a full-fledged UAV-based subterranean object detection system.

I hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I also attest that the above properly reflects my own work.

Finalist's Signature:

Date:

In addition, all students must complete the ISEF Student Checklist (1A), Research Plan, Approval Form (1B), and Checklist for Adult Sponsor (1), and any other ISEF forms required for this type of project. See the International Rules and Guidelines for form requirements. Return COPIES of all of these forms to your Regional Fair Director with you Finalist Verification/Permission Form. **A signed copy of this form must be included in your notebook.**