AutoZero: AI- Assisted Marksmanship for Speed & Precision

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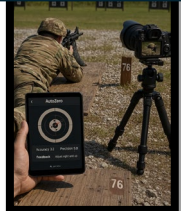**Advisors**: COL Christopher Lowrance & COL Malcolm Haynes

Project Goal

AutoZero streamlines zeroing, eliminates manual scoring, and delivers real-time feedback to improve marksmanship and readiness.

BEFORE

AFTER

Features

Our system is fully functional, scalable, and AI-powered to enhance marksmanship training with automated feedback and performance tracking. It detects bullet holes, scores accuracy and precision, and delivers actionable insights through a secure, role-based web platform. Features include the following:

- Image Upload Interface
- Leader Dashboard for Performance Oversight
- Automated Image Scoring Engine
- Individualized Marksmanship Feedback

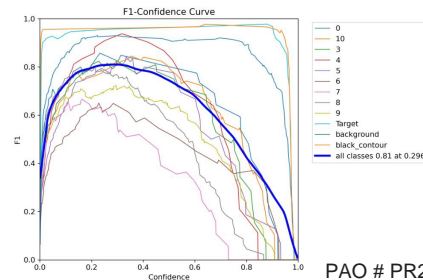## System Details

KEY

- Future Work
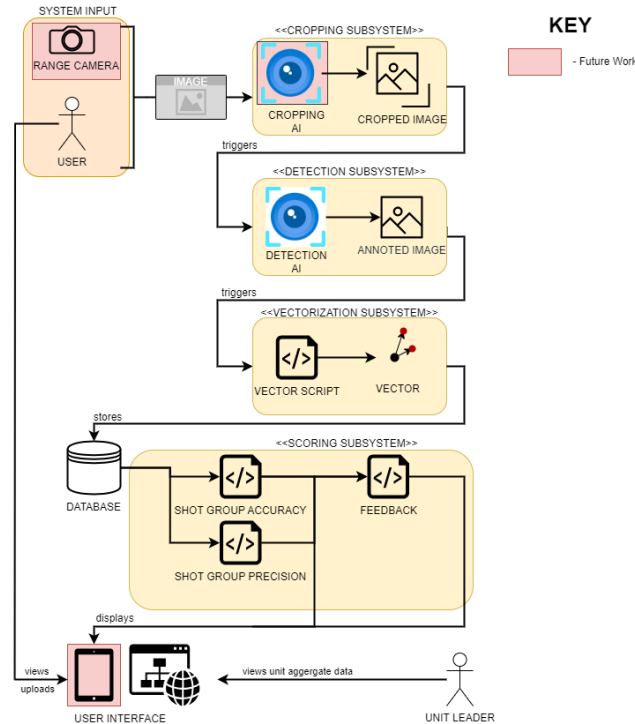
AI Metrics

The AI system uses computer vision to detect bullet holes and calculates shot grouping metrics in real time.
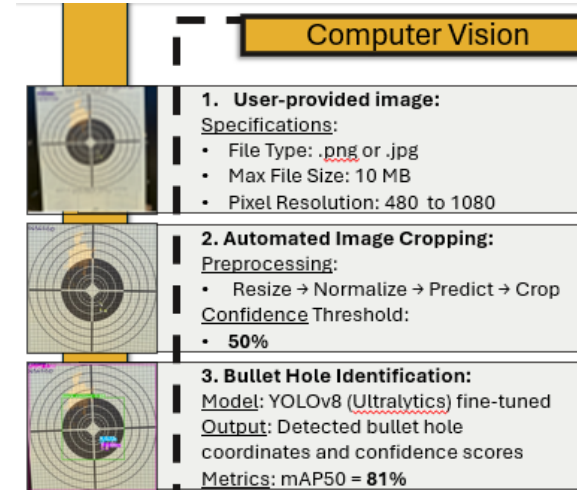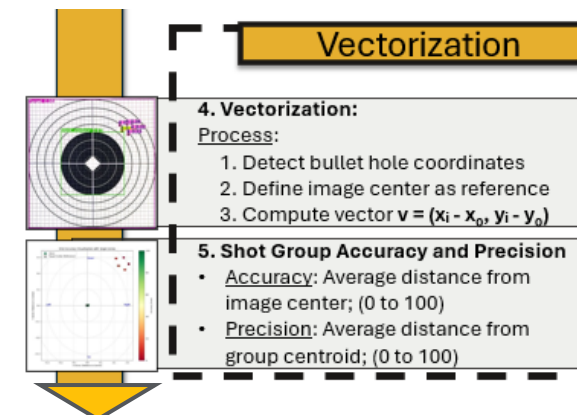Precision: 84%
Recall: 79%
mAP50: 81%

AI-Powered Image Processing Pipeline

The computer vision pipeline begins with a user-uploaded target image which is preprocessed and cropped using a YOLOv8 model.

Computer Vision

1. **User-provided image:**
Specifications:
- File Type: .png or .jpg
- Max File Size: 10 MB
- Pixel Resolution: 480 to 1080

2. **Automated Image Cropping:**
Preprocessing:
- Resize → Normalize → Predict → Crop
Confidence Threshold:
- **50%**

3. **Bullet Hole Identification:**
Model: YOLOv8 (Ultralytics) fine-tuned
Output: Detected bullet hole coordinates and confidence scores
Metrics: mAP50 = **81%**

In the vectorization phase, each shot is converted into a vector. These vectors are used to compute accuracy (distance to target center) and precision (distance to shot group centroid), generating performance metrics for shooter feedback.

Vectorization

4. **Vectorization:**
Process:
1. Detect bullet hole coordinates
2. Define image center as reference
3. Compute vector $v = (x_i - x_0, y_i - y_0)$

5. **Shot Group Accuracy and Precision**
- Accuracy: Average distance from image center; (0 to 100)
- Precision: Average distance from group centroid; (0 to 100)

End User Interface

The website features a secure, user-friendly interface where users can upload target images, view annotated results, and access performance metrics. A dashboard displays historical data, shot group feedback, and system-generated posts. Role-based access supports personalized views for soldiers, commanders, and admins.