Deep Learning Based Security for Automated Contraband Detection with Human in the Loop

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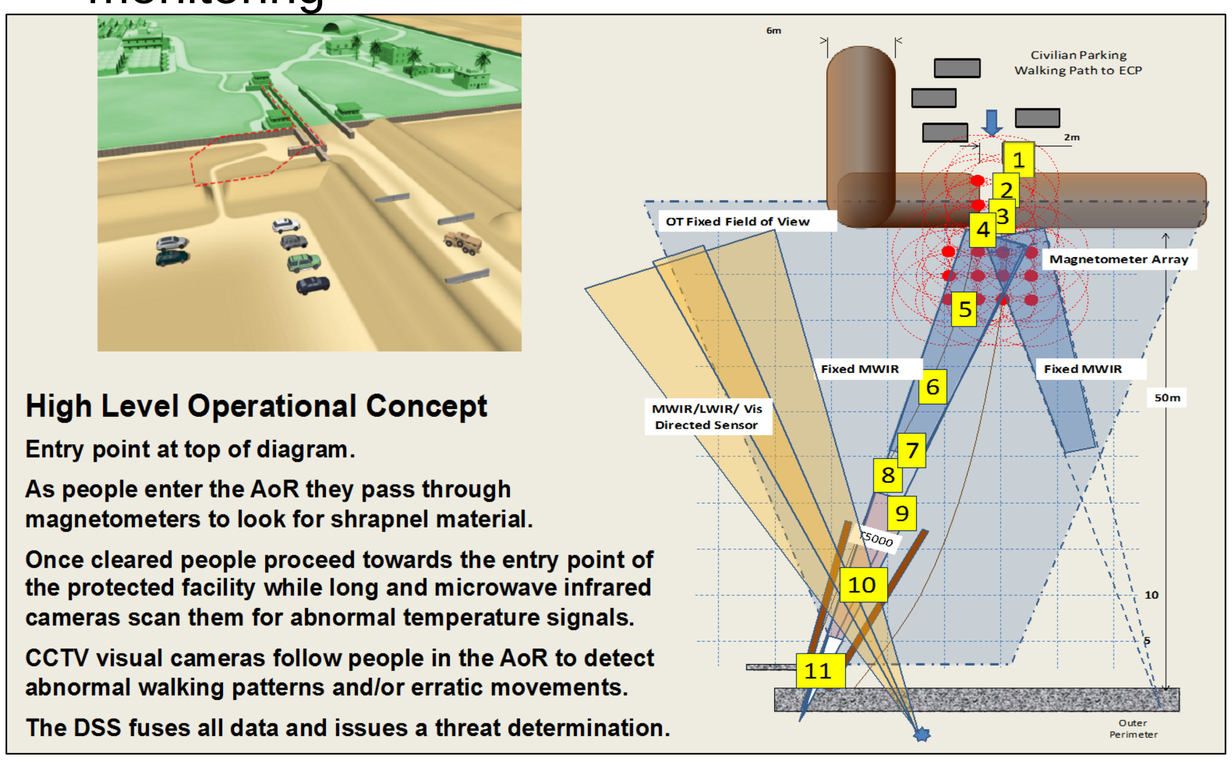
Research Task / Overview

- Investigate ways to detect, recognize and identify specific contraband with a man/unmanned team.
- Enable machine learning to help recognize related but previously unknown classes of contraband.
- Investigate ways to maintain security personnel focus and improve their responses to emergencies.

Goals & Objectives

- Improve contraband interdiction/mitigation
- Reduce manpower requirements
- Enable linking of individual systems for wide-area monitoring



High Level Operational Concept

Entry point at top of diagram.

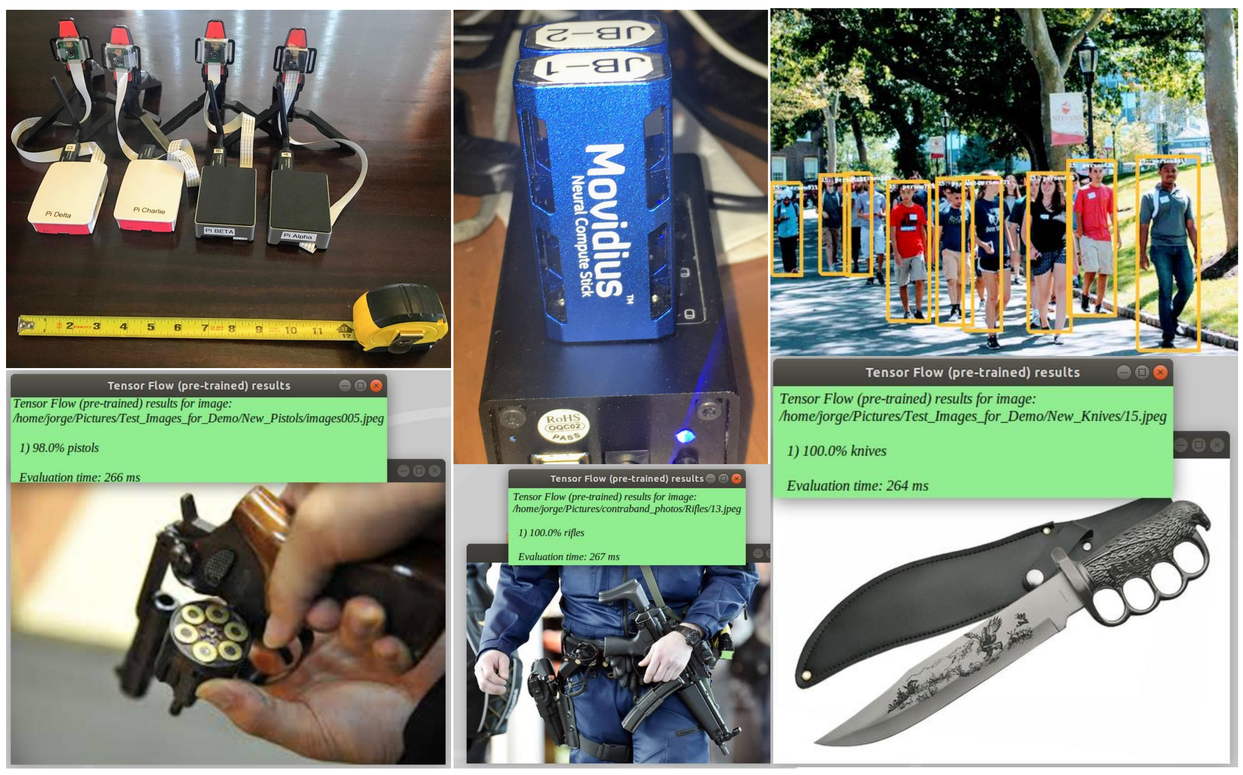
As people enter the AoR they pass through magnetometers to look for shrapnel material.

Once cleared people proceed towards the entry point of the protected facility while long and microwave infrared cameras scan them for abnormal temperature signals.

CCTV visual cameras follow people in the AoR to detect abnormal walking patterns and/or erratic movements.

The DSS fuses all data and issues a threat determination.

Data & Analysis



- A basic system prototype (shown above) was tested to validate feasibility of key technologies of the proposed solution. SafetyNet 2 is my implementation using MobileNet, and SafetyNet 3 is my implementation using Inception v3, which I retrained for the categories shown in the table below.
- The prototype demonstrated: a) detection of specific categories of contraband; b) ability to generalize well when shown new contraband for which it was not trained (such as parts of contraband); c) ability to take automatic action when specified conditions are detected.
- Results were compared against GoogLeNet. Results were better than anticipated.

		People	Knives	Pistols	Rifles	Bullets	Generic	Average
GoogLeNet p2	Top-1 Precision	100%	100%	100%	100%	100%	18%	86%
	Top-1 Recall	6%	22%	74%	86%	8%	18%	36%
	Top-1 F1	11%	36%	85%	92%	15%	18%	43%
	Top-1 Accuracy	53%	61%	87%	93%	55%	18%	61%
	Top-5 Precision	100%	100%	100%	100%	100%	41%	90%
	Top-5 Recall	24%	64%	98%	98%	38%	41%	61%
	Top-5 F1	39%	78%	99%	99%	55%	41%	69%
	Top-5 Accuracy	62%	83%	99%	99%	69%	41%	75%
SafetyNet 2	Top-1 Precision	98%	100%	100%	100%	91%	100%	98%
	Top-1 Recall	100%	98%	88%	90%	98%	94%	95%
	Top-1 F1	99%	99%	93%	95%	94%	97%	96%
	Top-1 Accuracy	99%	99%	94%	95%	94%	91%	95%
SafetyNet 3	Top-1 Precision	100%	100%	100%	100%	92%	100%	99%
	Top-1 Recall	100%	100%	94%	98%	100%	100%	99%
	Top-1 F1	100%	100%	97%	99%	98%	100%	99%
	Top-1 Accuracy	100%	100%	97%	99%	99%	100%	99%

Methodology

- Apply Transfer Learning methodology to Convolutional Neural Networks to recognize desired categories of contraband.
- Implement a Systems Dynamics model to provide temporal context to hypothesis evaluations.
- Produce an assessment of the presence of contraband indicating confidence level.
- Issue alerts and/or alarms for high confidence levels of contraband detection as appropriate.
- Take emergency mitigations if warranted.

Future Research

- Full solution implementation with improvements to the human-machine-interface and integration with military grade sensors.
- Inference engine application to school security to detect firearms and long knives.
- Inference engine and computer night vision application to commercial and industrial physical security.
- Inference engine and semantic web technologies to cyber security.

Contacts/References

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