



RA.2: Low Complexity, AI Based Fusion of Crowd-Sourced Heterogeneous Data Streams for Real-Time Threat Detection and Mitigation

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SENTRY Challenge

Problem: Identify, localize, and track over space and time evolving security threats from crowd-sourced data streams of opportunity

Importance and Challenges:

- This project seeks to provide DHS with principled, adaptive approach to the acquisition and processing of heterogeneous streams of data for threat mitigation
- Especially appropriate for venues where video may be limited/absent or where automated video processing methods are not available
- Crowd-sourced data streams could provide highly informative threat information.
- Extraction of such information not trivial
- Find precursor signals or patterns that might provide some warning of an impending event
- Focus on sensor data from mobile devices (**accelerometer now**, eventually audio, video)

Accomplishments

Milestone 1: Simulation Environment Created

Objective: Create simulated accelerometer data for crowd of people moving in a realistic environment

Approach:

- Used Unity software engine to simulate crowd motion in a transit platform scenario.
 - People entering platform moving to train doors.
 - People proceeding from train to platform exit.
 - People milling about on platform
- Post-process Unity data to create accelerometer traces
- Can tune number of agents, arrival rates, speed etc.
- Easily generate data for hundreds or thousands of instances for Monte-Carlo analysis, construction of probabilistic or machine learning models, etc.
- Capable of simulating anomalous behaviors to test detection methods

Milestone 2: Problem Formulation & Lit. Review

Objective: Develop model and processing methods to detect anomalous events from crowd-sourced accelerometer data

Approach:

- On-going exploration of recent literature in areas including models of crowd motion, accelerometer time series processing, deep learning methods for anomaly detection, human activity models
- Initial approach using autoencoder techniques to learn low dimensional model for nominal behavior from which anomalous activity will be detected.

Addressing the Challenges

Challenge:

- Large quantities of potentially informative exist but:
- Little or none is *labeled* → supervised machine learning methods cannot be used.
 - The vast majority of the data would be from benign behaviors with very few threat cases → significant *class imbalance* problem

Approach:

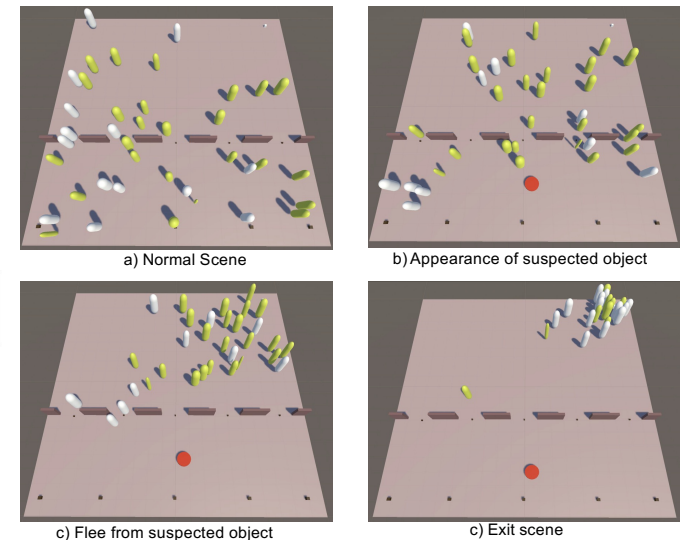
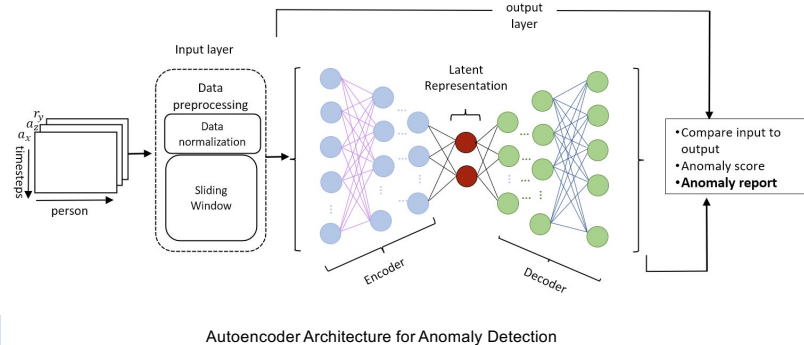
- Build models defining nominal behaviors of crowds in a given scenario
- Develop methods for detecting (and eventually tracking) significant deviations, or anomalies, in crowd motion

Challenge:

- The methods require behavior data (in this case accelerometer) from “real” crowds in “real” scenarios.
- Such data do not exist and would be costly to obtain

Approach:

- Sophisticated crowd simulation tools have been developed in the video gaming industry
- Can be configured to accommodate the needs of this project



Next Steps

Supporting the Virtual Sentry Framework:

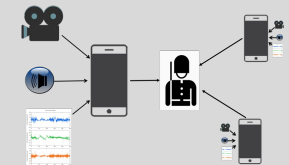
- RA.1, RA.3, RB.1, RB.2, RC.2, RD.3: projects focusing on processing schemes, data sources, platforms, resource allocation, and crowd control.
- Will explore collaboration with Incorporate methods and codes in Virtual Sentry: Versatile Solutions for STCs and Real Time Decision Support using Big Data.

Partnerships and Stakeholders:

- Prof. Miller will brief the PAB in June 2023 and meet with Cambridge Consultants in April 2023 to discuss collaboration building on the ideas in this project
- Primary end-users of this project are venues such as schools houses of worship or lacking robust security installations
- FEMA's Response and Recovery Division and Center for Disaster Preparedness could leverage this tool to get real-time situational awareness as emergencies unfold.
- The app developed would serve as a force-multiplier for the Secret Service in securing public events while the data aggregated from this project would bolster real-time and location-based intelligence gathering.

Plans for Next Year

- Transition simulation tool to broader community
- Develop, test and refine methods to detect anomalous behaviors in crowds from accelerometer data
- Formulate approach to tracking evolving threat scenarios



Crowd Sourced data
from mobile devices