Active Shooter Tracking and Evacuation Routing for Survival (ASTERS)

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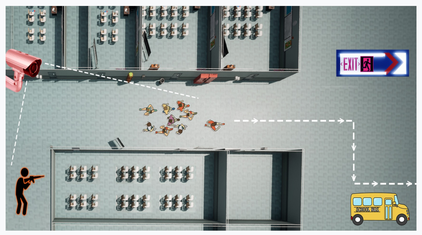
https://sites.google.com/view/asters/home

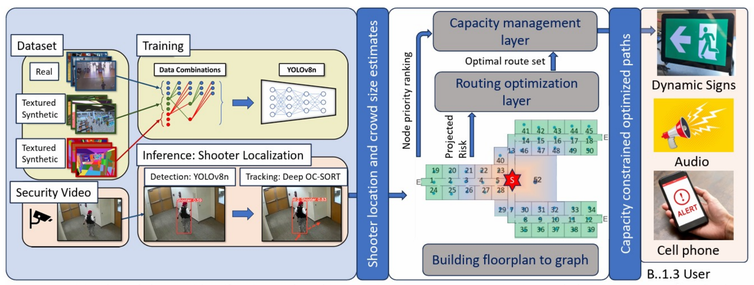
Introduction and Objectives

- 150+ active-shooter incidents in the US since 1982, more than half of which were in school or workplace.
- Other than generalized protocols like "Run-Hide-Fight," evacuees escaping these scenarios do not have any guidance for safe escape.
- ASTERS aims to provide real-time information to evacuees about the safest dynamic escape plan.

Components of ASTERS



- **Computer Vision:** Involves development of algorithms for shooter detection & multimodal information fusion for shooter tracking.
- **Egress Routing:** Real-time dynamic safest escape paths with capacity-constraints, human-factors is computed using this location data.
- **Communications:** Involves efficiently conveying the computed escape paths to the evacuees.



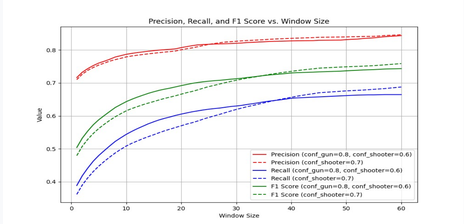
B..1.1 Vision based shooter identification and tracking | B..1.2 Route Optimization and Planning | B..1.3 User Interface Design

Methodology

- **Shooter Detection:** Gunmen detection and tracking using YOLOv8n + Deep OC-SORT algorithms along with Domain Randomization and Transfer Learning. Re-ID based tracking System running on edge hardware.
- **Egress algorithm:** Propagating an unbiased shooter's trajectory probability over time, a finite horizon Markov Reward Process was used to determine optimum escape routes for evacuees using metrics such as safety of rooms, time to exit, time spent in the shooter's line of sight & capacity constraints.
- **Dynamic Signs:** A virtual school simulation containing a series of hallways and classrooms was created in Unity, hosted online and distributed alongside a Qualtrics survey to collect data on both the participants' behavior within the simulation and the effect of the dynamic signs.

Results

- **Shooter Detection:** 12,698 synthetic + 500 real images used for training. Tested with 100 real images.

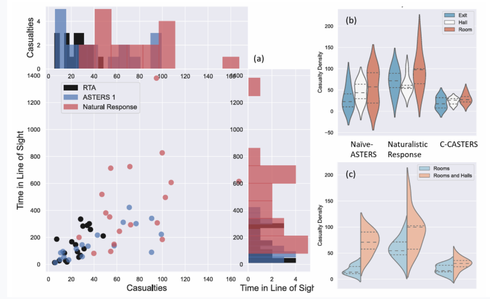


- **Shooter Tracking:** Below is the inference speed results for running detection & tracking on selected edge devices.

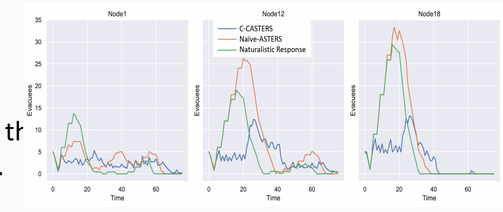
Device	Computation Time per Image (ms)			Total (FPS)
	Detection	Tracking	Total	
Raspberry Pi 4	650	250	900	1.11
Jetson Nano	125	55	180	5.56

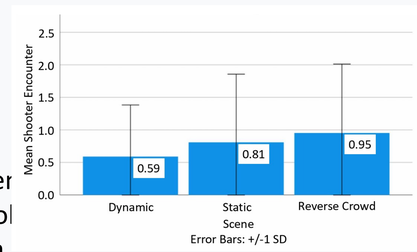
Results continued

- **Egress algorithm:** Compared to naturalistic response & Naïve-ASTERS, C-CASATERS algorithm performed significantly in multi-parameter study. It also reduced crowding, leading to 50% reduction in key bottlenecking nodes.



- **Dynamic Signs:** Participants encountered the shooter significantly more often in the static sign scene (p = .037) and th reverse crowd scene (p = .020). Participants (n =123) escaped significantly more quickly with dynamic signs compared to static (p = .007) and reverse crowd (p = .004).





- **Education:** The education team has been working with the superintender and principal from the ASTERS school district partner, Center Point Urbana (CPU).
A meeting between these educational stakeholders and the ASTERS technical team was facilitated to give feedback on technical progress thus far. Also, key school safety issues were identified by interviewing stakeholders in law enforcement (2), school leadership (2) and the state department of education (1).

Broader Impacts

- ASTERS has showed promising results in 1. High detection rate and tracking of gunmen 2. significant improvement in safeguarding evacuees from entering shooter's LOS and 3. efficacy, clarity and trustworthiness of dynamic signs through online experiments. A deployment ready version of such "smart safety systems" will provide potentially life-saving information to vulnerable people.
- Impacts students and stakeholders through education and computing outreach, part of experimentation and evaluation of ASTERS.

2024 NSF Cyber-Physical Systems Principal Investigators' Meeting
Mar 20-21, 2024 | Nashville, TN

Award ID#: 1932505
1932033