

# Active Shooter Tracking and Evacuation Routing for Survival (ASTERS)

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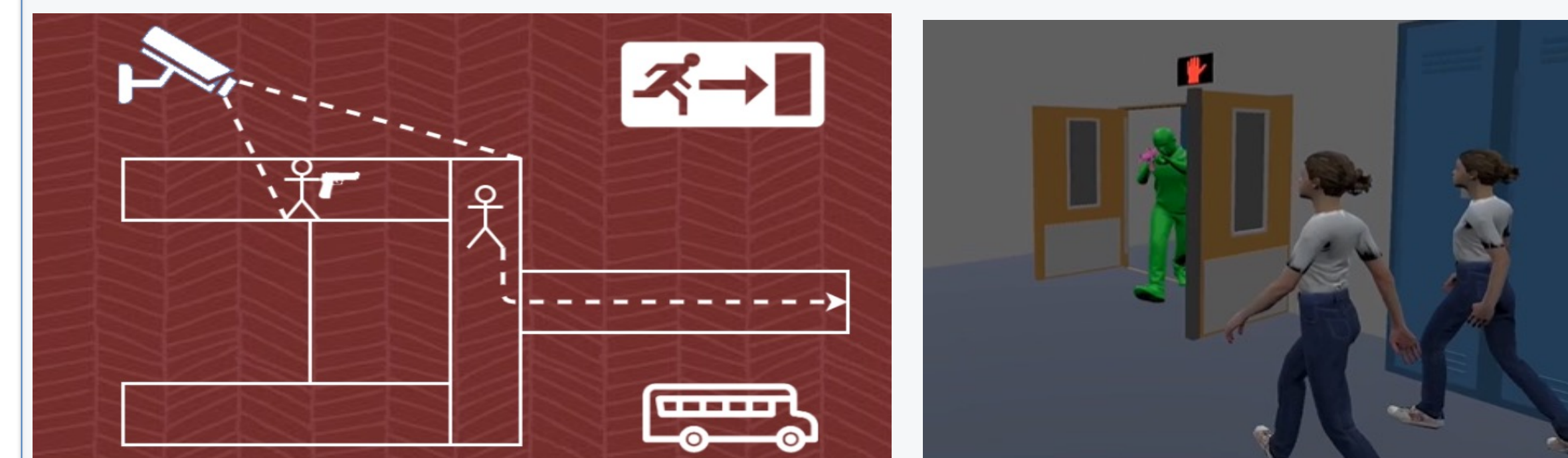
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<https://sites.google.com/view/asters/home>

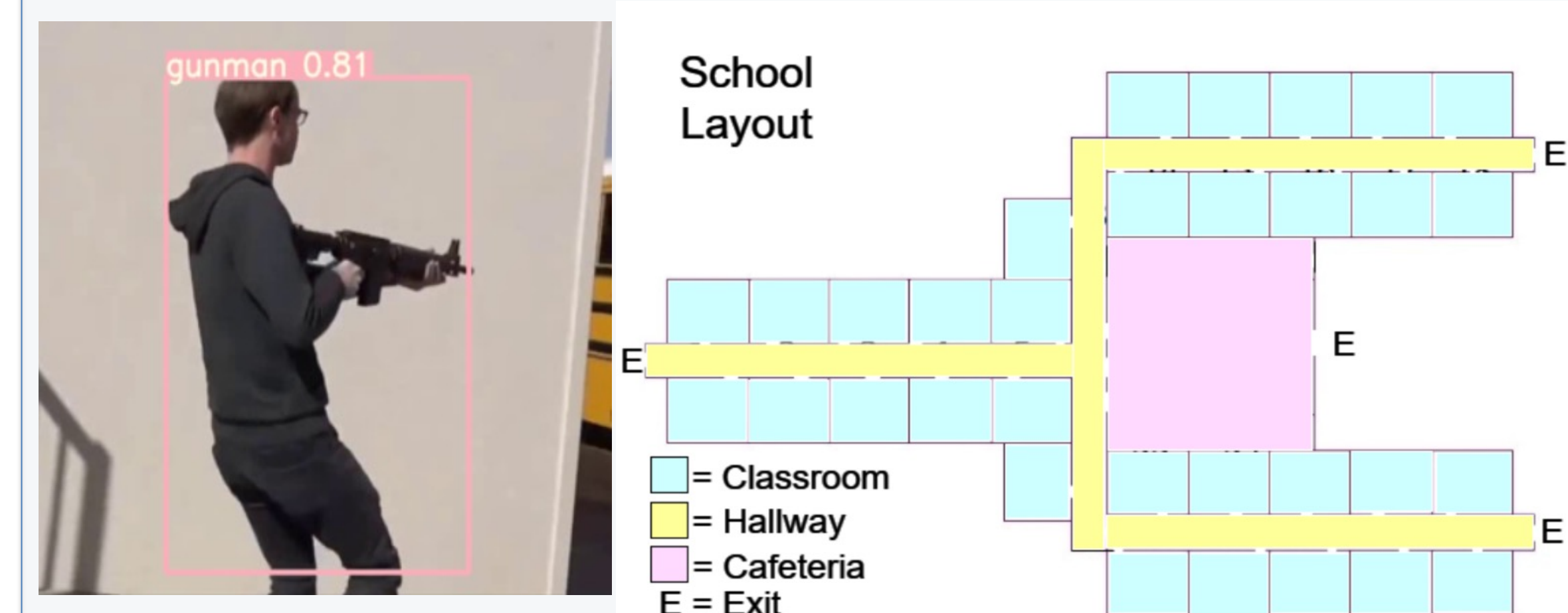
## Introduction and Objectives

- 110+ active-shooter incidents in the US since 1992, 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.



## Methodology

- Shooter Detection:** YOLOv5 algorithm was used for detection of gunmen. Training was done with real images, & synthetic images, both Actual Texture (AT) & Domain-Randomized (DR).
- 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, probability of being in the shooter's line of sight, etc.
- 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:** The algorithm was tested with 200 real images, 100 with annotated shooters, and 100 without.

	Trained with		
	Real	Synthetic (AT)	Synthetic (DR)
Mean average precision	0.995	0.647	0.869

## Broader Impacts

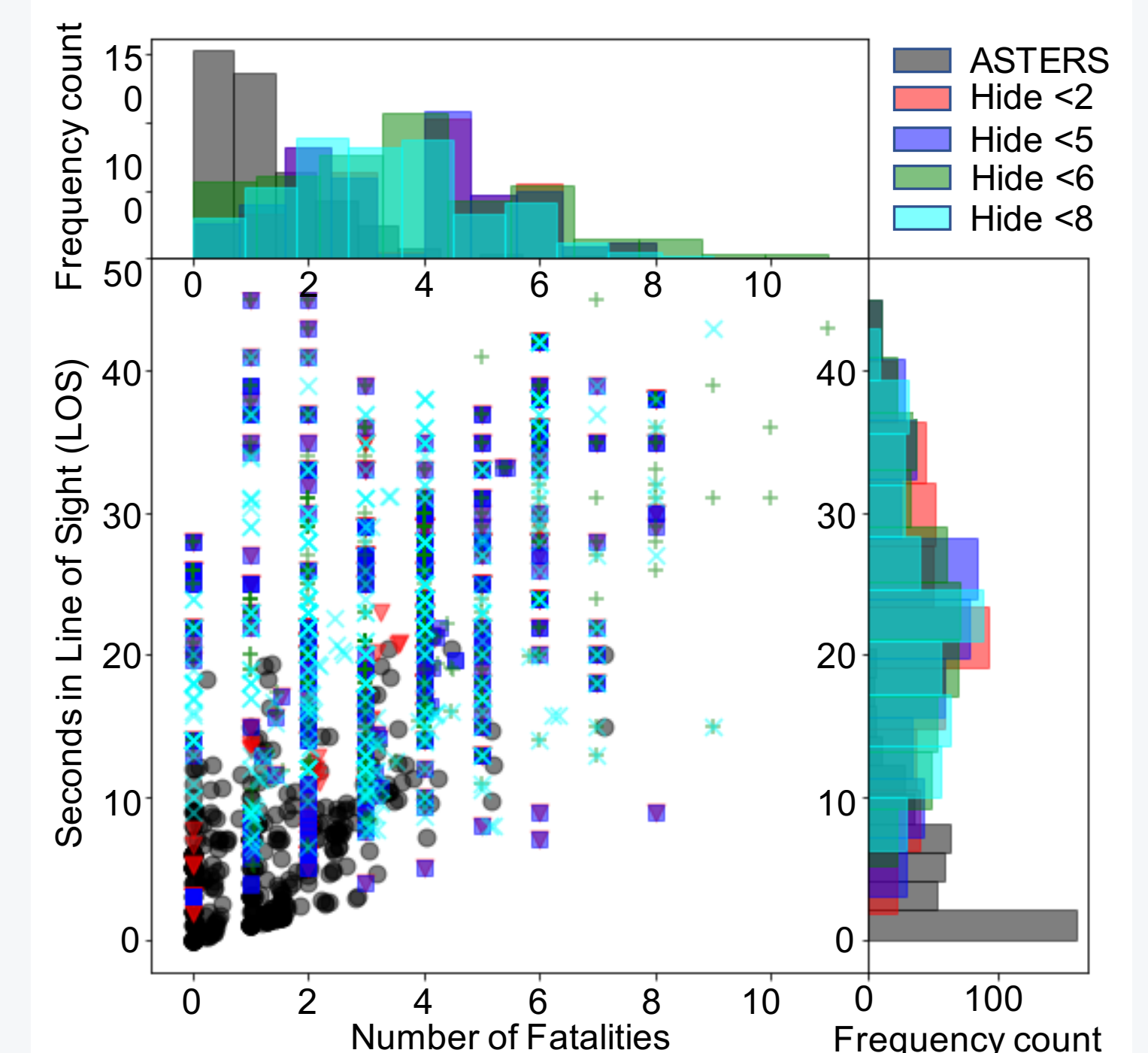
- ASTERS has showed promising results in 1. High detection rate of gunmen, 2. significant improvement in safeguarding evacuees from entering shooter's LOS and 3. efficacy, clarity and trustworthiness of dynamic signs through online experiments. A deployment ready version of such "smart safety systems" will provide potentially life-saving information to vulnerable people.
- Impacts students (9 grad students and 4 UG researchers are currently members of the ASTERS team) and stakeholders through education and computing outreach, a part of experimentation and evaluation of ASTERS.

## Results continued

- Egress algorithm:** Compared to naturalistic responses, the ASTERS algorithm performed significantly better over 432 scenarios, with respect to time spent in the line of sight of the shooter and number of casualties.

- Dynamic Signs:** Participants encountered the shooter significantly more often in the static sign scene ( $p = .037$ ) and the reverse crowd scene ( $p = .020$ ).

Participants ( $n=123$ ) escaped significantly more quickly with dynamic signs compared to static ( $p = .007$ ) and reverse crowd ( $p = .004$ ).



Hide <  $k$  implies that the evacuees within  $k$  nodes of the shooter stays hidden in their rooms, while those outside that zone and in the hallways move towards the nearest exit without delay.

