VascuVision

Real-Time AI Collision Avoidance for Neurointervention

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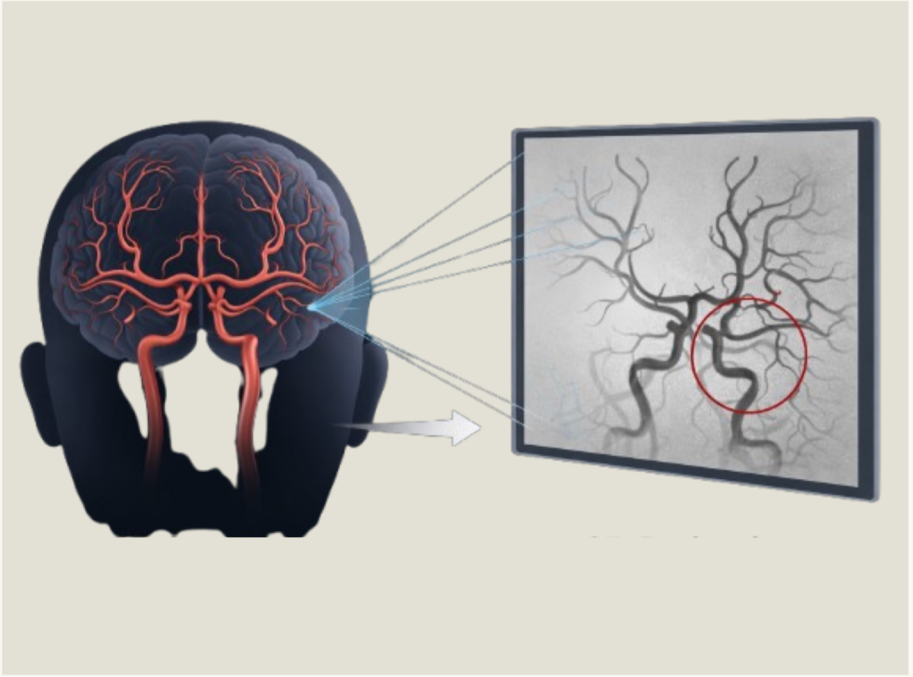
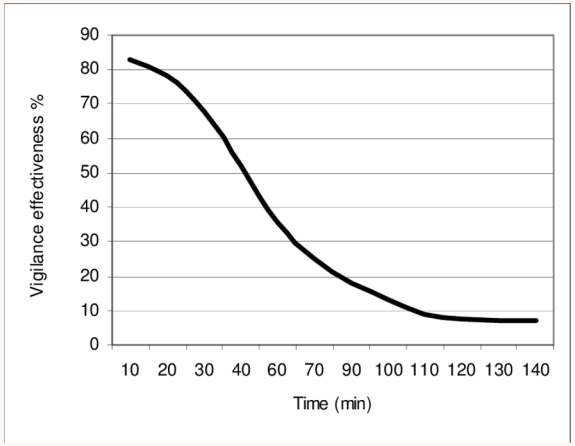
Imaging Constraints

- Fluoroscopy compresses 3D anatomy into a 2D projection
- Neurovasculature is tortuous, small caliber, and fragile
- Vessel overlap and depth ambiguity obscure spatial relationships
- Safe navigation requires real-time mental 3D reconstruction



Sustained Vigilance in Neurointervention



Vigilance Decrement Curve[3]

Some Procedures Remain Complicated

- Recent trial of Thrombectomy for Large Ischemic Strokes had complication rate of 18.5%
- Vascular dissections, arterioral perforations, and intraprocedural vasospasm[1]

Long Procedure Times

- Mechanical Thrombectomy is ~60 minutes[1]
- Stent Retrieval aims for 70 minutes[2]

1. Sarraj, Amrou, et al. "Trial of endovascular thrombectomy for large ischemic strokes." New England Journal of Medicine 388.14 (2023): 1259-1271.
2. Saver, Jeffrey L., et al. "Stent-retriever thrombectomy after intravenous t-PA vs. t-PA alone in stroke." New England Journal of Medicine 372.24 (2015): 2285-2295.
3. Hobbs, Alan. "An overview of human factors in aviation maintenance." ATSB Safty Report, Aviation Research and Analysis Report AR 55.2008 (2008): 1-37.

VascuVision Model Set-Up

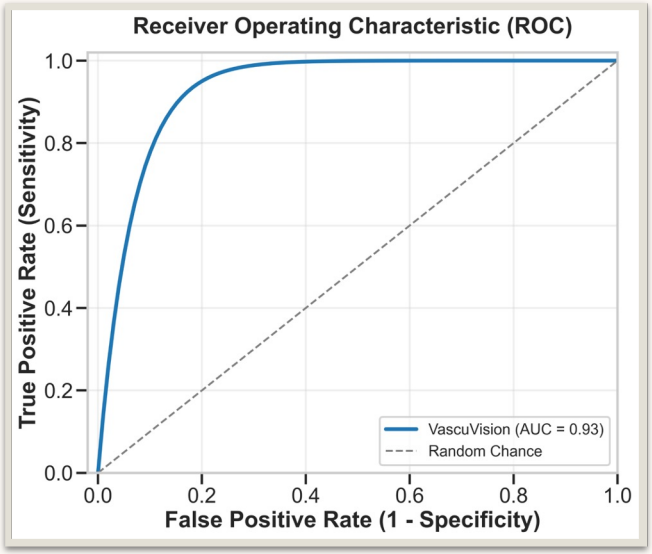
- **Dataset & Training**
  - Trained on the CathAction dataset: large-scale fluoroscopic video sequences annotated for catheter-wall proximity and collision events[4]

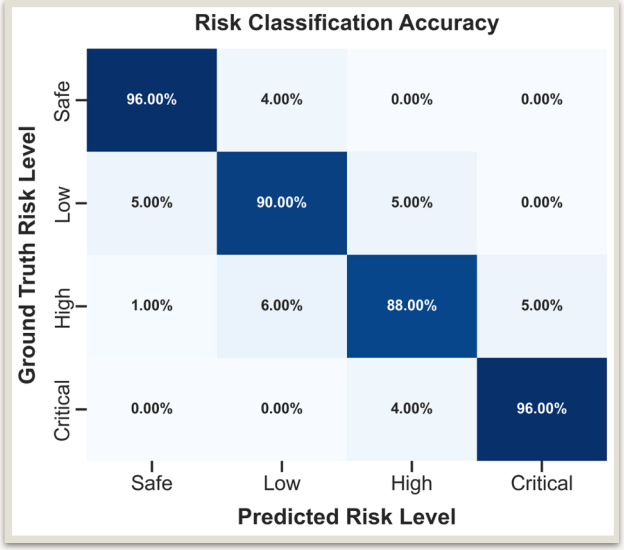
- **Model Architecture**
  - ResNet-34 spatial encoder + temporal modeling to capture trajectory and velocity
  - Bidirectional LSTM models motion dynamics over a 16-frame temporal window

- **Clinical Simulation & Evaluation**
  - Assessed by AUC-ROC, inference latency, and predictive lead time
  - Early Warning System uses exponential moving average smoothing + velocity trend analysis

4. Huang, Baoru, et al. "Cathaction: A benchmark for endovascular intervention understanding." *arXiv preprint arXiv:2408.13126* (2024).

Classification Performance

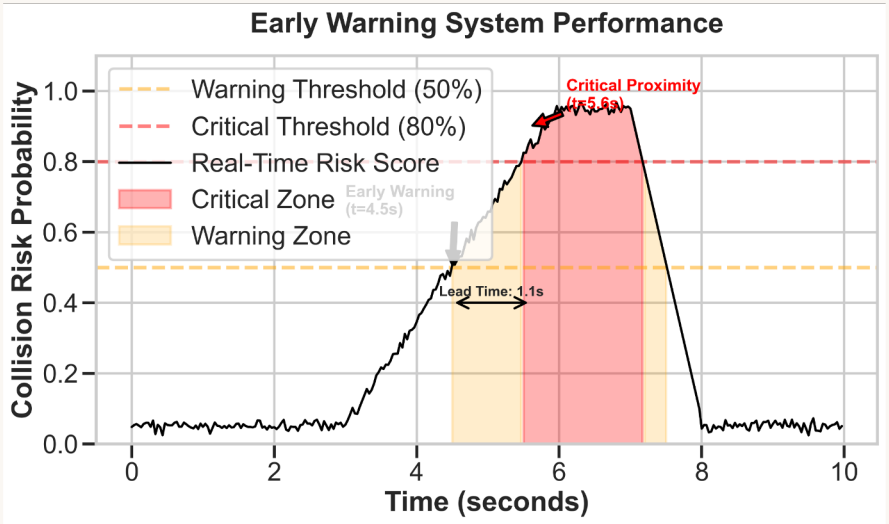


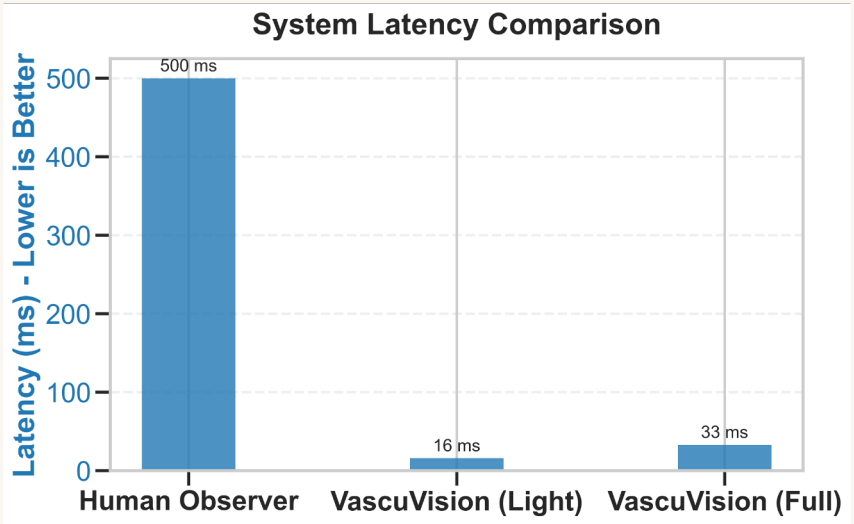


Key Findings

- Overall Accuracy: >95% (full model), >92% (light model)
- AUC-ROC: 0.98 demonstrates outstanding discrimination
- High sensitivity for critical events (>96%) minimizes missed detections

Real-Time Performance





30-60 FPS Processing

Continuous video analysis at clinical frame rates

<33 ms Latency

Full model processes frames in under 33 milliseconds

15-30x Faster

Significantly faster than 500ms human reaction time

Clinical Implications & Future Directions

VascuVision represents a robust AI safety layer with potential to become a standard of care for endovascular procedures, reducing preventable injuries and improving patient outcomes.

Enhancing Procedural Safety

- Complements operator skill without replacing clinical judgement
- May decrease iatrogenic vessel injury rates
- Particularly valuable during complex cases & extended procedures
- Reduces complication risk in the case of operator fatigue

Path to Clinical Deployment

- Integration with live clinical fluoroscopy systems
- Expansion to 3D vessel construction for spatial awareness
- Multicenter clinical trials to validate real-world safety benefits
- Regulatory pathways as FDA-cleared medical device

Live Demonstration

TEXAS A&M UNIVERSITY

School of Engineering Medicine

THANK YOU