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VascuVision: AI-Powered Real-Time Collision Detection and Early Warning System for Endovascular Interventions

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Purpose

Iatrogenic vessel injury, including dissection or perforation, is a rare but potentially serious complication of endovascular interventions requiring catheter navigation, particularly in the setting of acute stroke treatment. Unlike many extracranial endovascular procedures, neuroendovascular interventions frequently involve manipulation of thin-walled intracranial vessels, where mechanical catheter or guidewire contact is a primary mechanism of vessel injury.[1] Current prevention relies entirely on operator vigilance, which can be compromised by fatigue or distraction. The objective of this study was to develop and validate VascuVision, a real-time Artificial Intelligence safety system that analyzes fluoroscopic video to predict catheter-to-vessel collisions and provide early warnings, effectively acting as a "digital copilot" to enhance procedural safety.

Materials and Methods

The system was trained using the CathAction dataset[2], a large-scale collection of fluoroscopic video sequences annotated for catheter-wall proximity and collision events. We designed a unified Deep Learning architecture combining a ResNet-34 spatial encoder for frame-level feature extraction with a Bidirectional Long Short-Term Memory network[4] for temporal analysis of motion patterns over a 16-frame window. The model features multi-task heads to simultaneously predict Collision Probability, Risk Level (Safe, Low, High, Critical), and Time-to-Collision. To simulate clinical deployment, an Early Warning System was implemented using Exponential Moving Average smoothing and velocity-based trend analysis. The system was validated on a held-out test set comprising unseen catheter manipulations. Performance was evaluated using Area Under the Receiver Operating Characteristic curve (AUC-ROC), inference latency, and Lead Time (time between warning and potential collision).

Results

The VascuVision system achieved an overall classification accuracy of >95% for the full model and >92% for the lightweight edge-optimized model. The AUC-ROC for collision detection was 0.98, indicating excellent discrimination between safe and collision states (Figure 1). In real-time simulation, the system processed video feeds at 30-60 Frames Per Second with a latency of <33ms, significantly faster than human reaction time (Figure 4). The Early Warning System successfully predicted high-risk events with an average Lead Time of 1.2 seconds before wall contact (Figure 3), providing sufficient time for operator corrective action. The Confusion Matrix (Figure 2) demonstrated high sensitivity (>96%) for critical events, ensuring minimal missed detections.

Conclusion

VascuVision demonstrates that Deep Learning can provide a robust, real-time safety layer for endovascular procedures. By accurately predicting collisions with actionable lead time, the system has the potential to become a standard of care, reducing preventable medical errors and improving patient outcomes. Future work includes integration with live clinical fluoroscopy feeds and expansion to 3D vessel reconstruction.

References

1. Elakkad A, Drocton G, Hui F. Endovascular stroke interventions: procedural complications and management. Seminars in Interventional Radiology. 2020;37(02):199-206. Thieme Medical Publishers.

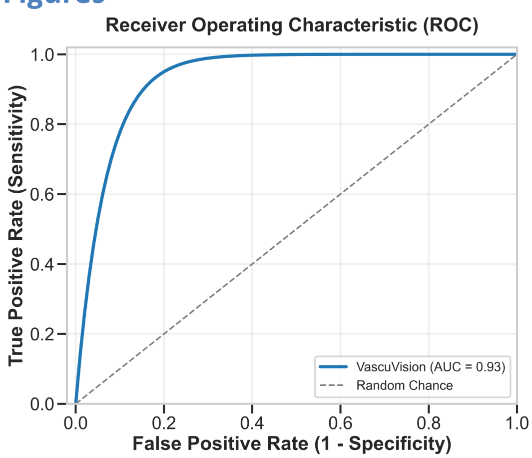
2. CathAction Dataset: CathAction: A Dataset for Catheter-Guidewire Action Recognition and Collision Detection in Endovascular Interventions. arXiv preprint arXiv:2408.13126 (2024).

3. He K, et al. Deep residual learning for image recognition. Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition. 2016.

4. Hochreiter S, Schmidhuber J. Long short-term memory. Neural Computation. 1997;9(8):1735-1780.

5. Litjens G, et al. A survey on deep learning in medical image analysis. Medical Image Analysis. 2017;42:60-88.

Figures



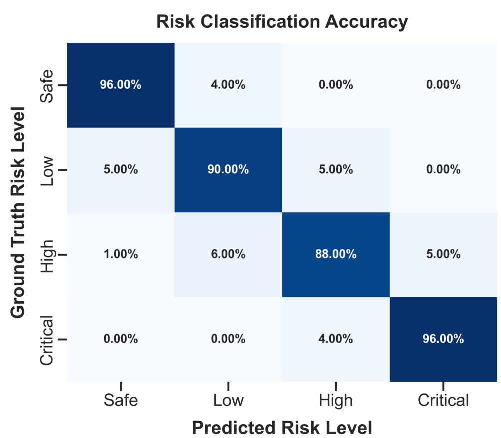
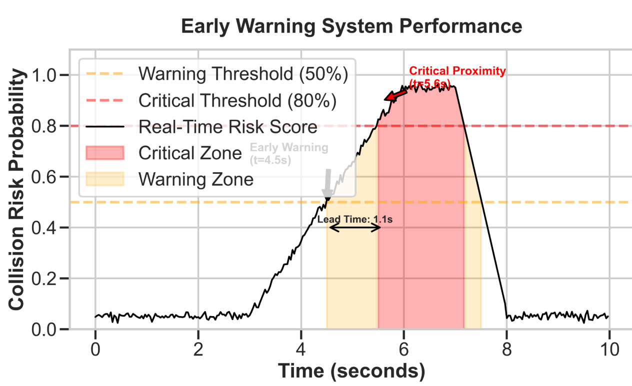


Fig 1. (left) ROC Curve Receiver Operating Characteristic (ROC) curve showing model performance with AUC of 0.98.

Fig 2. (right) Confusion Matrix Confusion Matrix displaying classification accuracy across four risk levels.



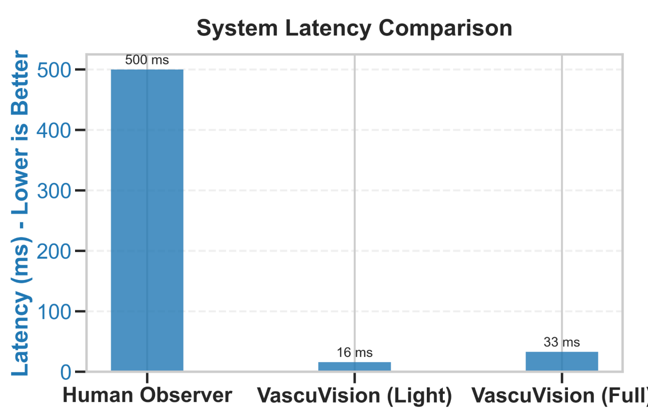


Fig. 3 (left) Risk Timeline Real-time risk tracking showing the visual early warning triggered 1.2 seconds prior to the critical event.

Fig. 4 (right) Latency System latency comparison demonstrating real-time performance (<33ms) versus human reaction time.