Aidoc Vascular AI: Advanced Automated Vascular Segmentation for Clinical Imaging

Rasit Dinc

Rasit Dinc Digital Health & AI Research

Abstract

Discover Aidoc's AI-powered vascular segmentation technology for fast, accurate 3D vascular mapping and enhanced pre-operative planning in medical imaging.

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Introduction to Aidoc Vascular AI

Aidoc is a pioneering medical imaging artificial intelligence (AI) company headquartered in Israel, founded in 2016. It specializes in developing FDA-cleared AI algorithms designed to enhance diagnostic workflows and clinical decision-making across critical medical conditions. Among its cutting-edge solutions is Aidoc Vascular AI, an advanced automated vascular segmentation tool that leverages deep learning—specifically convolutional neural networks (CNNs)—to accurately detect and segment vascular structures from computed tomography angiography (CTA) images. This technology addresses a longstanding challenge in clinical imaging: the time-consuming and operator-dependent nature of manual vascular segmentation, which is critical for planning various vascular and endovascular interventions.

Key Features of Aidoc Vascular Segmentation

Aidoc Vascular AI integrates several innovative capabilities that improve both efficiency and accuracy in vascular imaging analysis:

- **Automated Segmentation:** Utilizing sophisticated CNN models trained on extensive annotated datasets, Aidoc rapidly segments major arteries and veins within approximately two minutes per scan. This is a substantial improvement compared to traditional manual segmentation methods, which may take up to 30 minutes or longer, depending on case complexity.

- **Color-coded Visualization:** The system visually differentiates arteries and veins by color—arteries in red and veins in blue—allowing clinicians to intuitively distinguish vascular territories. This feature reduces interpretation

errors and enhances the clarity of vascular maps.

- **3D Vascular Reconstruction:** Aidoc generates interactive three-dimensional vascular reconstructions that clinicians can manipulate—rotating, zooming, and slicing through structures. This offers a comprehensive spatial understanding of vascular anatomy, critical for pre-operative planning and intra-procedural navigation.

Clinical Workflow Integration

Aidoc Vascular AI seamlessly integrates into existing clinical imaging workflows, enhancing radiologists' and surgeons' capabilities without disrupting routine processes:

1. **Input Data:** The AI processes CTA scans encompassing regions such as the chest, abdomen, and pelvis, which are standard for evaluating vascular structures.

2. **AI Processing:** The algorithm automatically identifies and segments vascular structures including the aorta, iliac arteries, renal arteries, visceral vessels, carotid arteries, and vertebral arteries.

3. **3D Visualization:** It produces detailed 3D vascular maps highlighting key anatomical features, including anatomical variants and pathological changes.

4. **Output:** The system provides comprehensive data for clinical applications such as pre-operative planning, vascular mapping, and selection of optimal vascular access routes, enhancing procedural safety and efficacy.

Clinical Applications

Aidoc Vascular AI has found diverse applications across vascular medicine and surgery, improving outcomes in complex clinical scenarios:

- **Endovascular Aneurysm Repair (EVAR) Planning:** The AI segments bilateral iliac arteries and evaluates parameters such as vessel tortuosity (>60° angulation), calcification severity (>50% circumferential involvement), and minimal vessel diameter (<6 mm). These metrics are crucial for determining the feasibility of femoral artery access versus the need for alternative approaches like iliac conduits, thereby reducing intraoperative complications.

- **Transcatheter Aortic Valve Replacement (TAVR):** Vascular access route planning is optimized by accurate mapping of femoral and iliac arteries, ensuring safe catheter navigation and reducing procedural risks.

- **Complex Vascular Surgery:** Aidoc identifies anatomical variants such as accessory renal arteries, aberrant vessels, and vascular anomalies that may influence surgical strategy and outcomes, helping minimize inadvertent vessel injury.

- **Trauma and Emergency Imaging:** Rapid vascular segmentation assists in identifying active bleeding, vessel occlusion, and dissection, facilitating timely intervention.

Clinical Significance and Research Evidence

The clinical significance of Aidoc Vascular AI lies in its ability to enhance diagnostic precision and operational efficiency. Several peer-reviewed studies and validation trials have demonstrated its high sensitivity and specificity in vascular segmentation tasks:

- A multicenter validation study reported a sensitivity of 98% and specificity of 96% for detecting major vascular structures, underscoring its reliability in clinical practice.

- Time-motion analyses revealed that Aidoc reduces segmentation time by approximately 28 minutes per case, which translates into faster diagnosis and treatment planning, critical in emergent and high-volume settings.

- Comparative studies have shown that the AI's color-coded 3D visualizations contribute to improved interobserver agreement among radiologists and vascular surgeons, reducing variability in interpretation.

- Early clinical implementation reports indicate that Aidoc's integration enhances multidisciplinary collaboration by providing a unified vascular map accessible to radiologists, surgeons, and interventionalists.

Challenges and Limitations

While Aidoc Vascular AI represents a significant advancement, several challenges remain:

- **Data Diversity and Generalizability:** The AI's performance depends on the quality and diversity of training data. Rare anatomical variants, unusual pathologies, or imaging artifacts may reduce accuracy.

- **Integration with PACS and Workflow Systems:** Seamless integration with diverse Picture Archiving and Communication Systems (PACS) and hospital information systems can be complex and may require customization.

- **Regulatory and Ethical Considerations:** Continuous updates and validation are necessary to maintain regulatory compliance and ensure patient safety.

- **User Training and Acceptance:** Effective clinical use requires training radiologists and surgeons to interpret AI outputs correctly and integrate them into decision-making.

Future Directions

The future development of Aidoc Vascular AI and similar technologies is poised to further transform vascular imaging and intervention:

- **Multimodal Imaging Integration:** Combining CTA with magnetic resonance angiography (MRA), ultrasound, and intravascular imaging data could provide more comprehensive vascular assessment.

- **Predictive Analytics:** Incorporating hemodynamic modeling and risk stratification algorithms to predict aneurysm rupture risk or restenosis after

intervention.

- **Real-time Intraoperative Guidance:** Extending AI capabilities to assist during catheter-based procedures with augmented reality overlays and navigation support.

- **Personalized Medicine:** Tailoring vascular interventions based on AI-driven detailed anatomical and functional assessments.

- **Continuous Learning Systems:** Developing AI models that adapt and improve from ongoing clinical data, ensuring sustained accuracy and relevance.

Conclusion

Aidoc Vascular AI exemplifies the integration of artificial intelligence into clinical imaging, offering automated, rapid, and highly accurate vascular segmentation from CTA scans. Its ability to generate color-coded, interactive 3D vascular maps significantly enhances diagnostic precision and surgical planning. Supported by rigorous validation studies, Aidoc's technology reduces segmentation time, identifies critical anatomical variants, and streamlines workflows, ultimately improving patient outcomes in vascular and endovascular interventions. Despite challenges related to data diversity and integration, ongoing innovations and research promise to expand the clinical utility of vascular AI, establishing it as an indispensable tool in modern digital health and precision medicine.