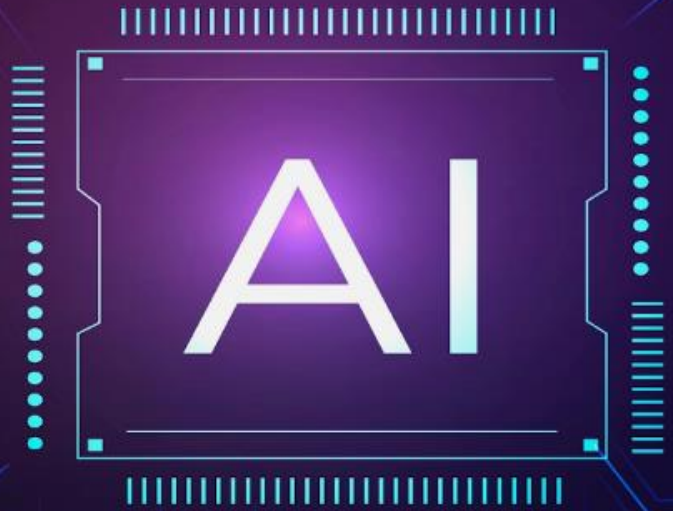
SHYENA TECH YARNS

A Data Science Company



Case Study

Advancing Surgical Simulation Accuracy Using 3D U-Net and Sequence-Aware AI – Phase 2

www.shyenatechyarns.com

About the Client

The Client is a Health Care Tech Start-up involved in research work in the field of Orthopaedics & Bone Implants

Business Problem

The need to enhance the accuracy of 3D volume construction from 2D Di-com Images was paramount. While the MRI Scan data comprised a sequence of 2D Di-com images, the existing 2D image segmentation models did not consider the sequence's crucial information. This discrepancy prompted a quest for an improved model capable of harnessing the sequence context.

Solution

To tackle this challenge, the team embarked on a multifaceted approach, combining sequence-aware AI and advanced 3D image segmentation techniques. The initial attempt involved using a Bi-Directional Long Short-Term Memory (LSTM) network. The objective was to enable the AI model to remember the sequence in which image slices appeared in the Di-com data. However, this approach did not yield the significant accuracy enhancement desired. Recognizing the limitations of the LSTM approach, the project evolved towards the next phase, which centered around bone segmentation within 3D Di-com volume data. The team embarked on experimenting with the 3D U-Net architecture, a powerful tool known for its efficacy in 3D image segmentation tasks.

Implementation

- **Data Preprocessing:** The MRI Scan, represented as a sequence of 2D Di-com images, required careful preprocessing to leverage the sequence context effectively.
- **Bi-Directional LSTM Analysis:** While the LSTM approach was explored, its efficacy did not match expectations in significantly enhancing accuracy.
- **3D U-Net Experimentation:** The team ventured into the realm of 3D U-Net, aiming to achieve enhanced bone segmentation within the 3D Di-com volume data.
- **Model Optimization:** Rigorous optimization and tuning were conducted to ensure the 3D U-Net yielded optimal results, eventually reaching a dice coefficient of over 88% - a remarkable achievement given the complexity of the task.
- **Integration with AR Platform:** The output of the segmentation process was transformed into a 3D mesh format, readily consumed by the Augmented Reality (AR) platform, thus advancing the surgical simulation experience.

Outcome

The implementation of the 3D U-Net model marked a pivotal milestone in the client's pursuit of precision and innovation. With a dice coefficient exceeding 88%, the model effectively identified Humerus and Scapula bones directly from MRI Scan data. This accomplishment not only enhanced the accuracy of surgical simulations but also deepened the understanding of bone anatomy within the medical community.

The success of this phase opens doors to further advancements. One potential avenue could involve exploring hybrid models that combine the strengths of sequence-aware AI and 3D segmentation. Additionally, the application of such advanced models could expand beyond shoulder bone anatomy to other regions of the body, fostering comprehensive surgical simulations.

By synergizing sequence-aware AI and 3D image segmentation, our collaboration with the client pushed the boundaries of accuracy in surgical simulations, further solidifying the start-up's reputation as a trailblazer in the field of Orthopaedics and Bone Implants.

Technology Used

Python, OpenCV, Tensor-flow, Deep Learning, Bi-Directional LSTM, 3D U-Net

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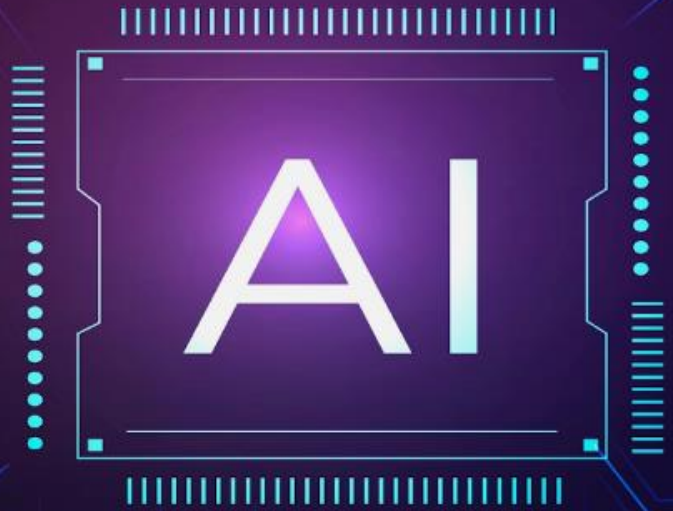

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