血管モデルと画像認識を用いた血管内検査および治療手技評価システム

Evaluation System for Intravascular Examination and Treatment Procedures using Vessel Models and Image Recognition

血管内検査および治療手技において，手技の定量化と，手技によるガイドワイヤーやカテーテルなどの器具の移動や形状変化，周囲の血管壁の変位などの情報を得ることで，医師のトレーニングや器具の特性の評価などに役立つ．簡易かつ精度の高いシステムを目指し，器具の挿入，引き抜き，時計方向，反時計方向の回転操作などの手技操作をAI画像認識を用いて定量化を行い，併せて血管モデル内に挿入された器具と，器具によって押され変形した血管モデル壁を，画像処理を用いて節点化処理し，対象の形状のデータ化と位置情報の取得を行った(Fig.1)．手技計測では，ガイドワイヤーに取り付けられたトルクデバイスを検出し，座標と回転状態を識別することで，各操作を定量化した．回転計測のためトルクデバイスにはFig.1右上のように4面に異なる色を着色している．結果をFig.2に示す．モデル内の器具形状と血管壁は，二値化処理によって領域を分離して抽出し，逐次的に節点化を行う処理により情報を取得した(Fig.3)．両者のシステムを用い，時相を合わせ比較し関連付けることで様々な分析と評価が可能になる(Fig.4).

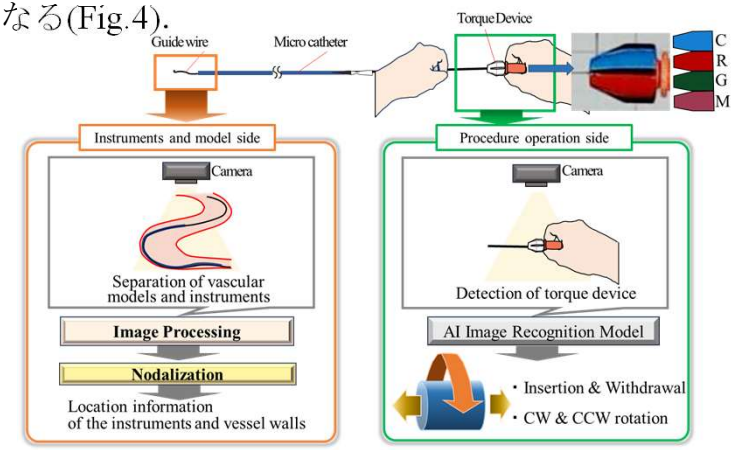

Fig. 1 システム構成
System Configurations

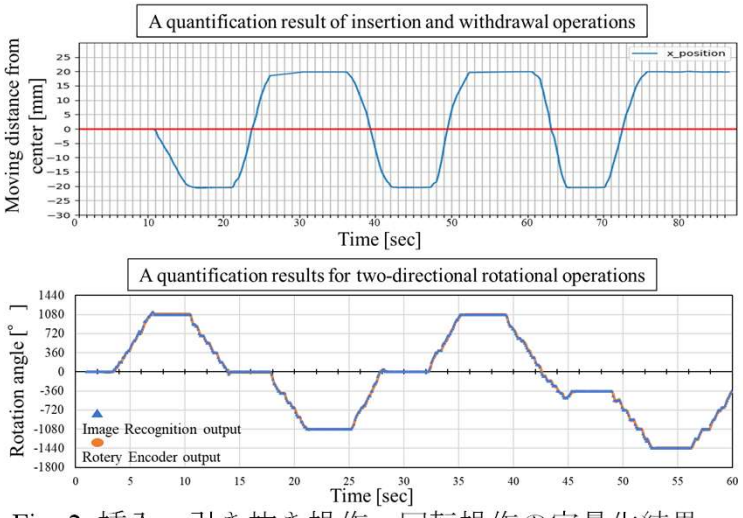

Fig. 2 挿入・引き抜き操作，回転操作の定量化結果
Quantification results of insertion and withdrawal operations and rotational operations

In endovascular examination and treatment procedures, it is useful for physician's training and evaluation of device characteristics to quantify the procedure and to obtain information on the movement and shape changes of devices such as guide wires and catheters and the displacement of the surrounding vessel wall. Aiming for a simple and highly accurate system, we used AI image recognition to quantify procedural operations such as insertion, withdrawal, and clockwise and counterclockwise rotation operations of the device and also used image processing to nodalize the instrument inserted into blood vessel model and the deformed the blood vessel model wall pushed by the instrument to obtain quantified shape data and the position information (Fig.1). In the procedure measurement, the torque device attached to the guide wire is detected, and each operation is quantified by discriminating the coordinates and rotational state. For measuring rotation, the torque device is colored in different colors on four sides, as shown in the upper right corner of Fig.1. Results are shown in Fig.2. The instrument shape and vessel wall in the model were extracted by separating the regions using a binarization process, and the information was obtained by sequential nodalization (Fig.3). Using both systems, various analyses and evaluations can be performed by comparing and correlating the data at same time phase (Fig.4).

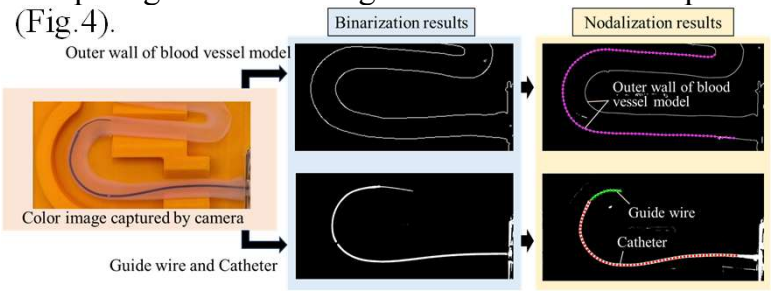

Fig. 3 対象の抽出と節点化
Target Extraction and Nodalization

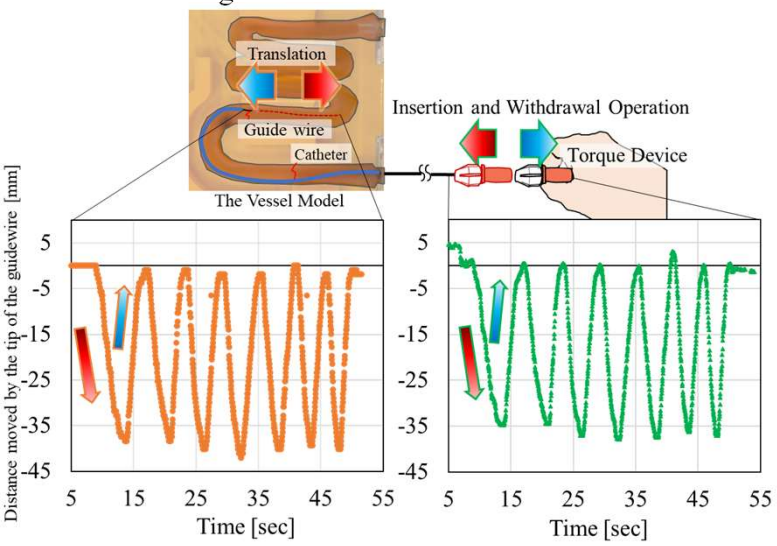

Fig. 4 挿入・引き抜き操作と血管モデル内でのガイドワイヤー先端位置の移動の比較
Comparison between insertion and withdrawal operation and motion of guide wire tip