NANYANG TECHNOLOGICAL UNIVERSITY

Simulation and Automatic Navigation of an Intravascular Interventional System

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Outline

- Introduction
- Literature Review
- Ongoing & Future work

Introduction

Catheterization

-Passage of a catheter into a body channel or cavity.

Cardiac catheterization

Image source: Wikipedia

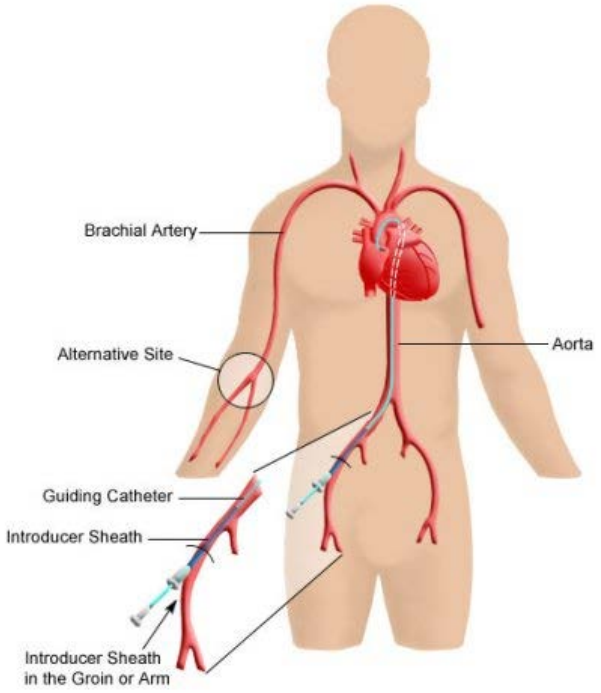


Image source: Stanford Hospital & Clinics

Current Techniques

Robotic-assisted Systems

- Magellan Robotic System
- CorPath 200 System

Hansen Medical: Magellan Robotic System

Magnetic Navigation Systems

- Niobe II System

Stereotaxis: Niobe II System

Motivation

Risk of vascular access procedures

•Damage to blood vessels due to the complexity of the blood vessel structure or improper operation.

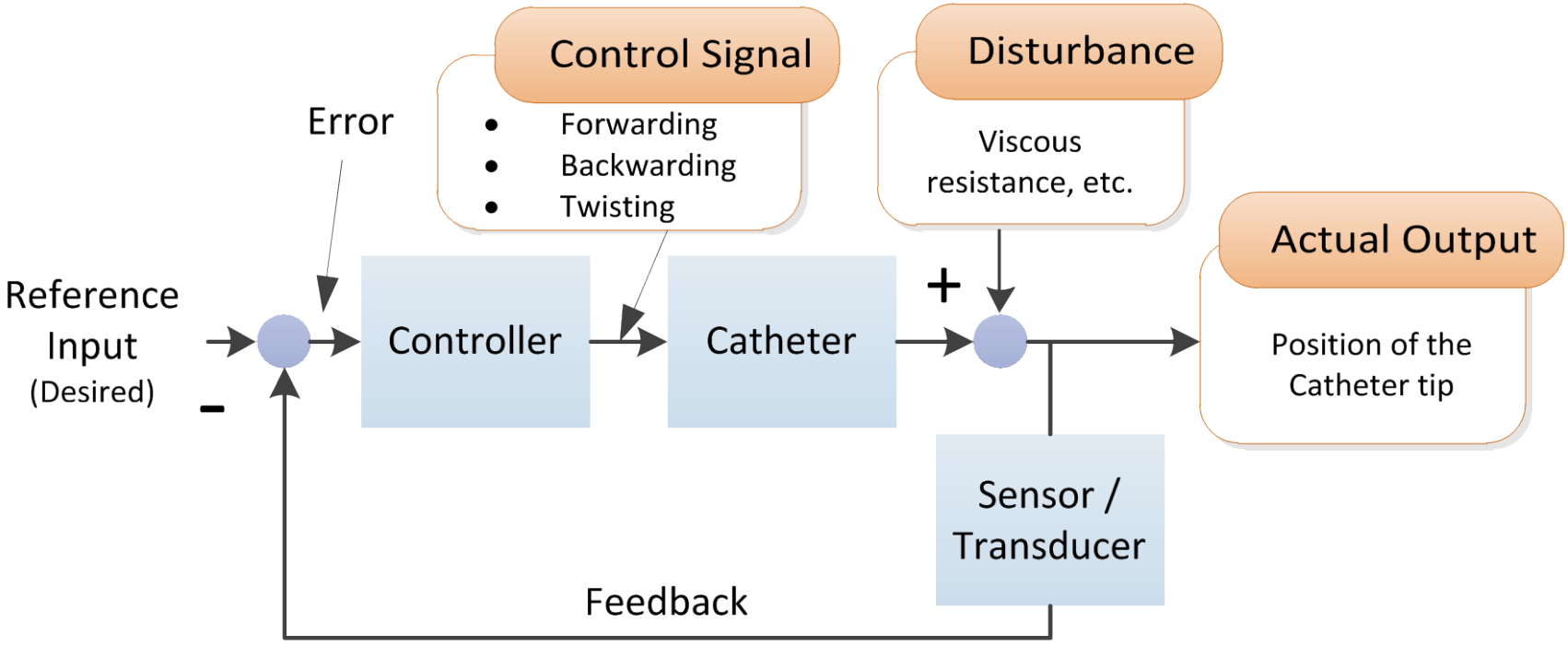
•Slipping into the wrong blood vessel.

Goals

- Design an automatic navigation system of catheterization, especially for branched arteries, to make the vascular surgery easier and more efficient.

Navigation System	Control
	Navigation
	Simulation

Control System



Navigation

- Medial axis and local radius information
- Catheter Positioning
  - Fluoroscopy (conventional method)
  - ultrasonic transducers

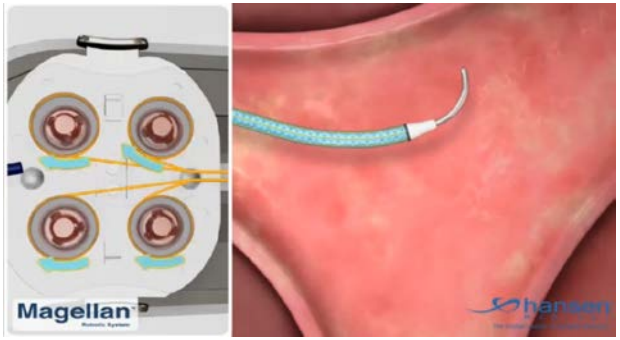


Image source: Hansen Medical

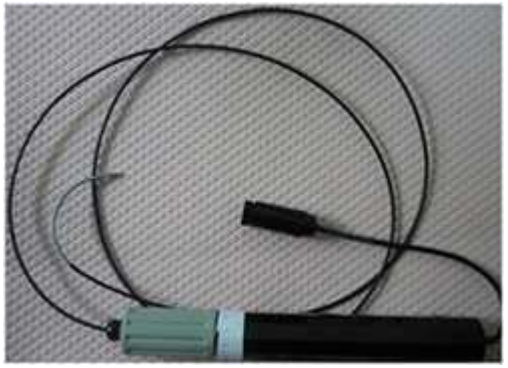
Simulation

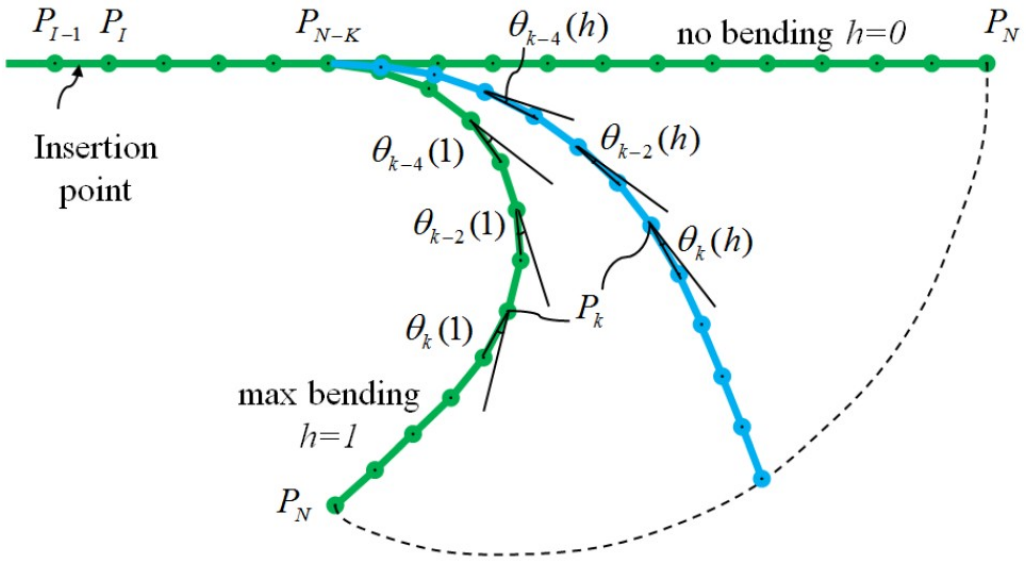
- Catheter Modeling
  - Simulate the non-linear deformation of wire-like structures
  - Definite a large number of constraints to confine the catheter inside the vascular network

- Vessel Modeling & Simulation
  - Catheter in vessels
  - Effect of arterial flow

Related Work

- Geometric Based Catheter Modeling

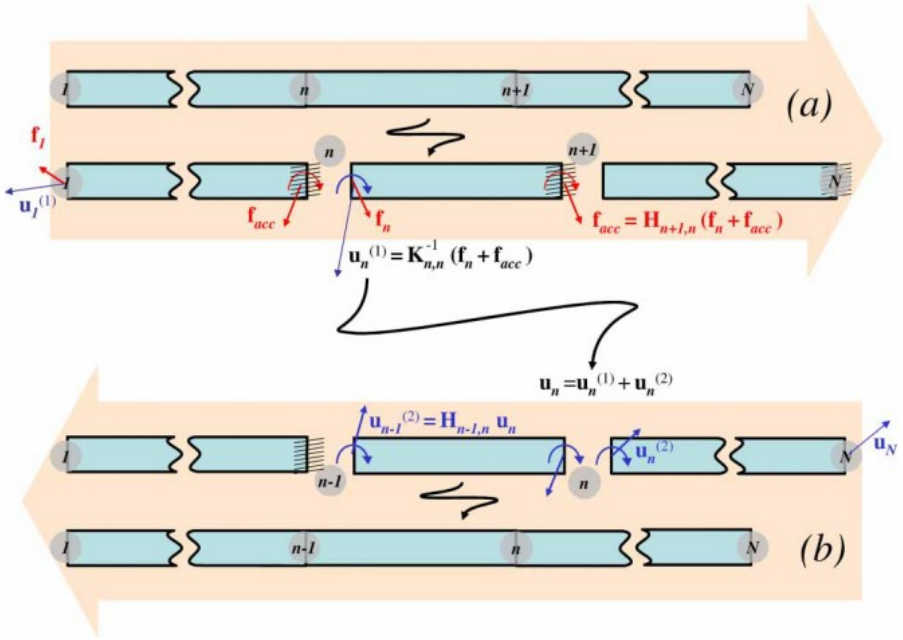




-- *Simulated Modeling and Image Processing for Intra-Cardiac Interventional Diagnosis and Therapy*, Patricia Chiang Wei Yin

Related Work

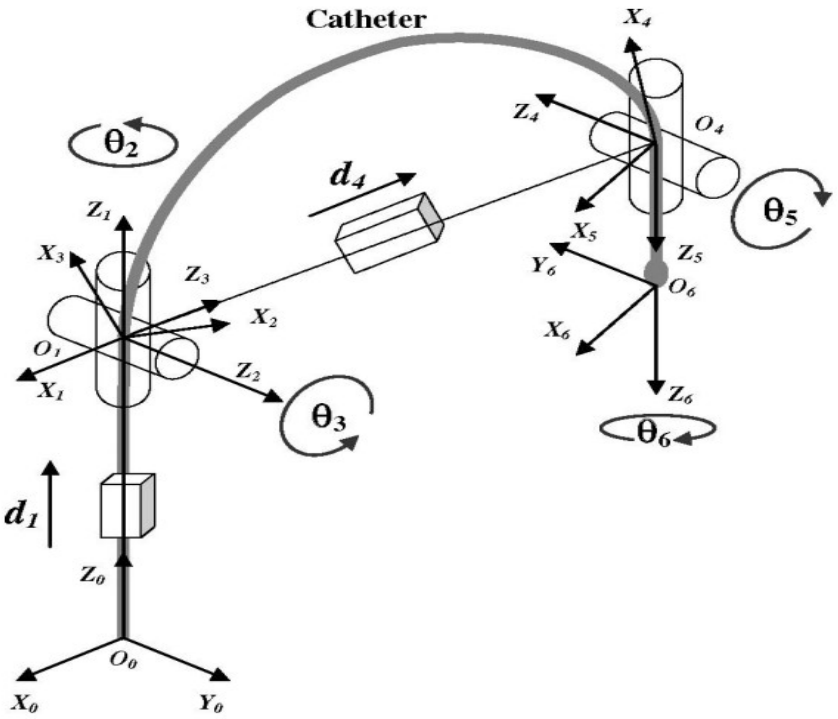
- FEM Model: Incremental FEM method (multi-body system)



-- *New approach to catheter navigation for interventional radiology simulation*, Harvard Medical School etc.

Related Work

•Kinematic Modeling



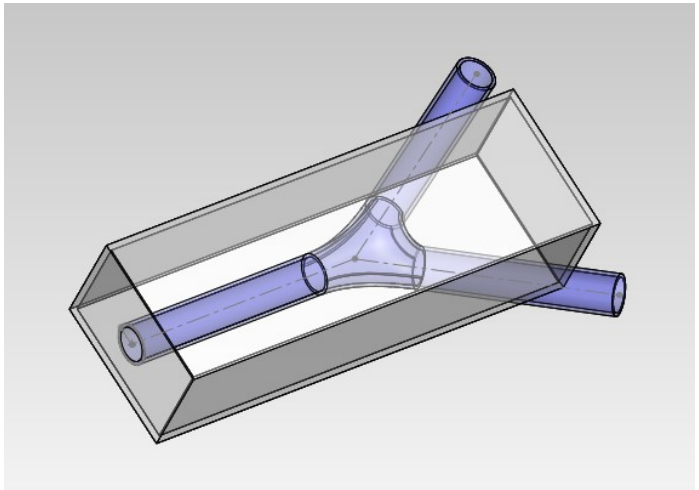
-- *Catheter Kinematics for Intracardiac Navigation,* Earrokh Janabi-Sharifi, et al.

Ongoing Work

- Test and simulate the physical properties of the catheter based on geometrical method
  - Slipping behavior
  - Relationship between the bending curvatures and twisted angles
  - The properties of formed contact points between the catheter and the vascular wall

Ongoing Work

- Navigation strategy of the catheter at arterial bifurcations
  - Test using the bifurcation phantom
  - Integrate with the automatic operation system



Future Work

- Experiment on catheters with different tip shapes
- Compare results with real tissues
- Take the motion of vessels and blood flows into consideration