Summary and Future Work

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July 29, 2019

USNCCM15
Austin, Texas, USA
**Statistical description of data**

- **76 Scoliosis Cases** (Patient ID = 1, 2, …, 76)
- **54 Normal Cases** (Patient ID = 77, 78, …, 130)

### Graphs

#### Male vs. Female
- **(amongst Scoliosis Patients)**
- **(amongst Normal Patients)**

#### Operated vs. Non-Operated
- **(amongst Scoliosis Patients)**

#### Normal vs. Scoliosis

### Pie Charts

- **Scoliosis vs. Combined Deformities**
- **Female**
- **Male**
- **Operated**
- **Non-Operated**

### Data Summary
- **76 Scoliosis Cases**
- **54 Normal Cases**

**Patient ID**
- 1, 2, …, 76
- 77, 78, …, 130

**Deformities**
- Scoliosis
- Combined Deformities

**Gender Distribution**
- Female
- Male

**Operative Status**
- Operated
- Non-Operated
Possible approach

First visit of a patient (x-ray image)

Extract model features

Image segmentation

Age
Co-ordinates
Spinal Angle
Stress
BMD

Predict spine shape over years

Age: $t_1$ months $t_2$ months $t_3$ months

Spinal fusion

Surgery (Spinal Fusion)
Design Patient Specific Brace
Physical Therapy
Observation

Treatment plan

*Bone Mineral Density

Prediction (A. pre-processing data)

A.1. Document the data in Lurie
Document the patient’s spinal deformity type, gender, pre- and post-operated data

A.2. Xray data (2D images)
Get the anteroposterior (AP) and lateral (Lat) views of each individual patient

A.3. Image segmentation
Segment the 2D images to distinguish the vertebrae

A.4. Assigning landmarks
Assign six landmarks to each vertebra on each view to characterize the position of individual vertebrae

A.5. Unifying data
Perform rigid body transformation and rotations to make the bottom center point of L5 the reference
Prediction plan (B. detailed model and ROM)

B.1. Register landmarks on the detailed vertebra STL file

A detailed geometric model is generated based on the assigned landmarks

B.2. Elements are clustered based on the normal direction to incorporate the growth

B.3. Generate ROM based on the detailed geometric model

B.4. Dynamic ROM formulation to calculate
- Newly formed bone at each time step
- Growth bone
- Cortical and cancellous bone
- Clusters corresponding to the detailed model

Clusters based on the normal direction of the surface
Prediction plan (C. calculating growth)

C.1. Apply BC and load
C.2. Capture stress on clusters in ROM
C.3. Input the stress to the NN
C.4. Calculate the growth with NN
C.5. Update the cluster nodes based on the normal direction of the elements

- Gravity Load at the center of each vertebra
- Bottom part is fixed at all translational degrees of freedom
- Top vertebra is fixed in x and y

- Geometrically detailed model is updated based on the growth value proposed by the NN
- Cluster numbers are updated corresponding the new position of the elements
Predict the curvature (from PGNN)

Cluster the deformity type (3D)
Combination of lordosis, kyphosis and other deformities

Potential treatment plan

Spinal fusion (combination of selecting two vertebra)  
Correcting rod

Existing Methods are based on 2D Classifications

Lumbar  Thoracic  Double  thoracolumbar

Brace design by applying correction force
Objective: a specific method and system to aggregate dissimilar material geometry, properties, and interactions to predict combined properties and performance