**AUTOMATED MEASUREMENT OF PEDIATRIC CRANIAL BONE THICKNESS AND DENSITY FROM CLINICAL COMPUTED TOMOGRAPHY**

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**ABSTRACT:** Skull thickness and density measures of normal pediatric crania would inform multiple disciplines including neurosurgery, optical and magnetoencephalophysiological imaging, and biomechanical modeling of head trauma. We report on a new method for automated extraction of skull thickness and density measures of pediatric crania based on x-ray computed tomography scans (CT). Data were obtained from a clinical image repository for pediatric populations in whom no pathology was noted. Skull thickness and density measures were systematically obtained across the calvarium. We find a set of measures that correlate with physiological age that are likely to prove useful in multiple disciplines.

**Problem Statement:** EEG source localization depends on accurate conductivity values for skull tissues.

Chips of skull thickness and skull plate composition make simple scaling of adult head models inappropriate in infants and children [1-4].

**Sampling Skull Thickness and Density**

**Align to Local Coordinate System**

- NAS, PAR, PAL
- Align & extract head surface
- 0.5 mm³ voxels

**Calculate Surface Normal**

- (left) Patch selected (blue) by intersecting a sphere with the skin surface at a given landmark location.
- (middle) Spherical patch (yellow) with same radius is fitted (least squares). Estimated parameters are radius and the x,y,z origin of the sphere.
- (right) Landmark x,y,z and center of fitted sphere define surface normal.

**Calculate Measurement Locations**

- Points specified by azimuth and elevation
- Line projected from origin through specified point
- Minimum distance between each boundary voxel and the line is found to locate the skin surface.

**Extract Profile**

- Surface normals projected into planes (left) and extracted boundary (right).

**Thickness and Density**

- Zero crossings denote max and min of intensity plot. Average HU between peak is calculated, tissue edge found, and distance calculated. HUs are averaged along the profile between inner and outer skull tables.

**RESULTS**

Typical scatter plots for thickness and physiological age:

- **Top Right:** BT 5: constant with age
- **Bottom Left:** BT 7: accelerated change with age
- **Bottom Right:** BT 16: changed monotonically with age

**Conclusions**

- Automated analyses of skull thickness and density from clinical CT data is feasible.
- Data quality generally poor, leading to a small subset for analysis.
- Bone thickness and density had a positive correlation with age.
- Three patterns emerged in the correlation of physiological age to bone density and thickness.
  1. Increased monotonically with physiological age
  2. Accelerated change during early years of development
  3. Remained relatively constant with physiological age

**REFERENCES**


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