

3D Reconstruction of Infants' Cranial Shape using Mobile Devices

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Mentors: Can Kocabalkanli, Dr. Reza Seifabadi
& Dr. Özgür Güler



The Team

Members:

David and Tara: jointly responsible for all project work

Mentors:

Can Kocabalkanli: Primary Mentor

Dr. Reza Seifabadi: Administrative Mentor and Project Owner

Dr. Özgür Güler: Technical Expert



Our Goal

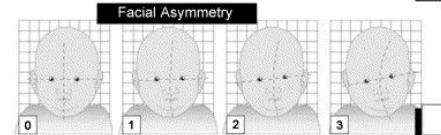
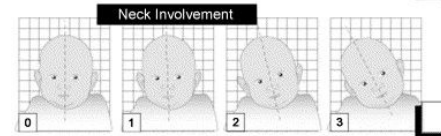
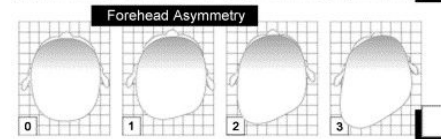
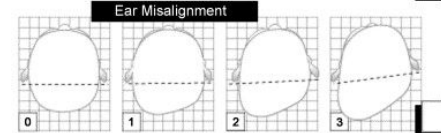
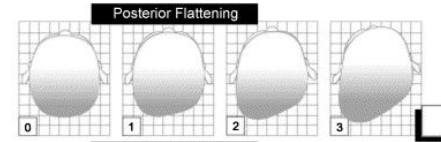
Create a software pipeline to **reconstruct** an accurate 3D model of a baby's head from **depth** information to aid in the diagnosis of **cranial deformities**

Background

- Before 6 months of age, skulls are easily **deformed**
- Deformational plagiocephaly (DPB) is becoming a pediatric epidemic, affecting 20-30% of newborns in the US [2][7]
- Early detection of DPB and other skull-related deformities like craniosynostosis can prevent trauma and potential surgery
- We want to **improve** the way skull shape changes are measured by pediatricians

Severity Assessment for **PLAGIOCEPHALY**

Patient Name _____
Date _____
Date of Birth _____



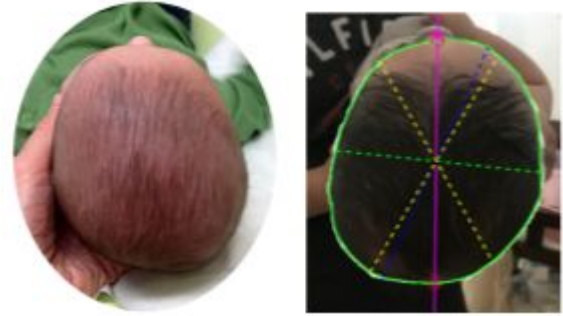
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Courtesy of [Losee et Al.](#)



Current Status

- Simple measuring tape for circumference
- Computer vision with 2D photos from above a baby's head has been developed
- **However...**
 - 2D has inherent limitations: can't measure 3D parameters like volume and height
- 3D models hold more information, allowing for better detection



Courtesy of PediaMetric

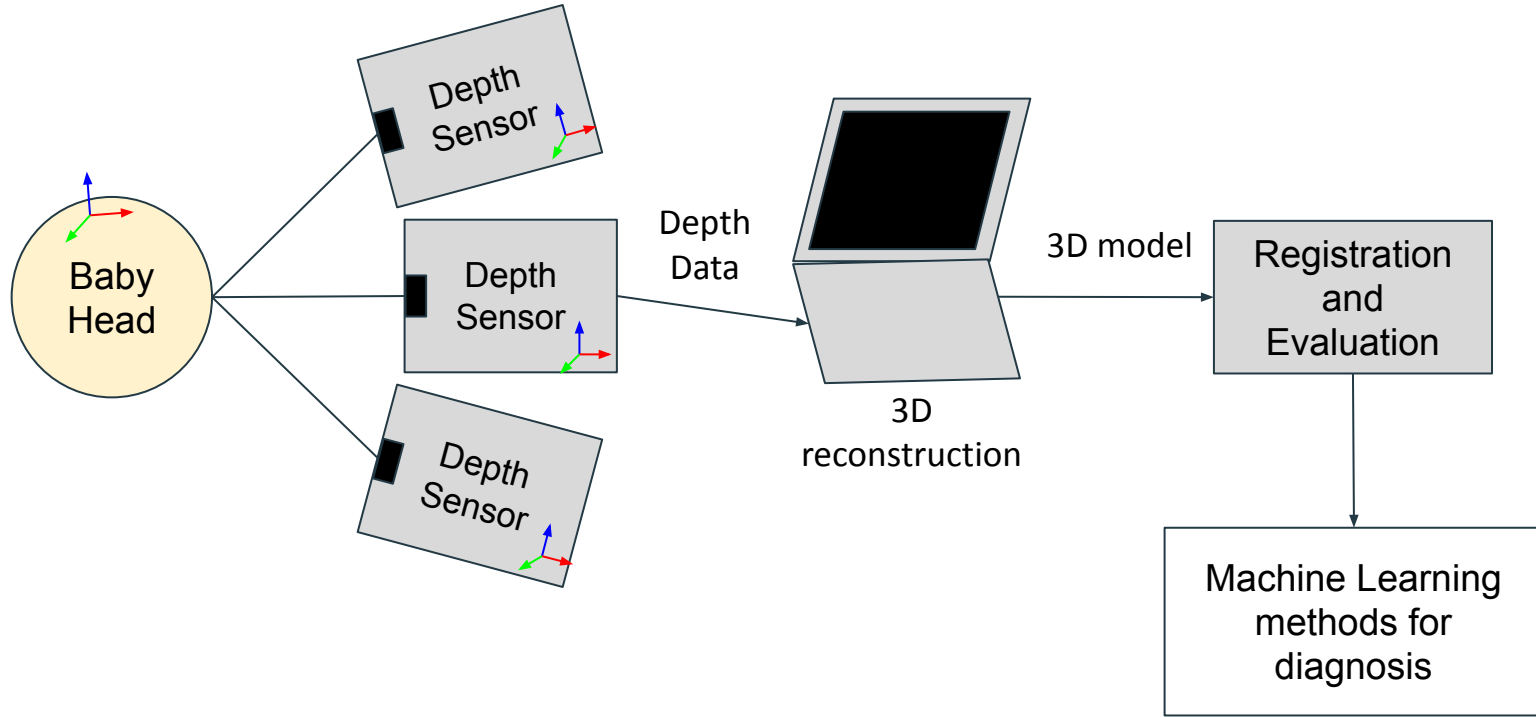


Technical Approach

- Custom depth sensor app from Dr. Güler
- Use depth information to generate a 3D reconstructed model (SLAM algorithm) [3]
- Register 3D model (ICP) to world frame [9]
- Evaluate against ground-truth and/or Occipital reconstruction:
 - Average contour/surface distance, cranial index (CI), cranial vault asymmetry (CVA), head circumference, voxel-by-voxel comparison
- Position phantom on moving shaker to add motion



Pipeline Schematic



Deliverables

Minimum

- Collected and processed depth data
- Working software pipeline and documentation
- Accuracy evaluation results (average surface distance threshold #1)
- Robust pipeline for moving head, slow head motion

Expected

- Accuracy evaluation results (average surface distance threshold #2)
- Robust pipeline for moving head, linear motion with no acceleration

Maximum

- Robust pipeline for moving head with acceleration



Dependencies

Name	Status	Contingency	Deadline
Depth data	RGB-D SLAM Dataset benchmark available	N/A	3/1
Ground-truth models	Available through PediaMetrix and Occipital	Reference some known object like a deformed ball	3/15
Software for calculating evaluation metrics	Available through PediaMetrix	Write our own code for calculating	3/15
Custom depth data collection app	Dr. Güler is working on it, should be finished in a week	Evaluate pipeline based on other depth and point cloud datasets	3/15
Compatible iPad for depth data collection	Tara has one	PediaMetrix can provide us with one of their own	3/15
Hardware for shaker testing	Dr. Seifabadi is looking into availability	Manual, slow movement only, calculate speed from video footage	3/20



Management Plan

- Weekly Zoom meetings with Can, Dr. Seifabadi, and Dr. Güler
- Impromptu meetings throughout the week if necessary
- Slack channel to communicate with entire team
- Private GitHub repository
- David and Tara will be working over Zoom multiple times a week



Reading List and References

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[6] Losee, J. E., & Mason, A. C. (2005). Deformational plagiocephaly: diagnosis, prevention, and treatment. *Clinics in plastic surgery*, 32(1), 53–viii.
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