Project 14

Motion Compensation and Evaluation of 3D Head Reconstruction

PediaMetrix Inc.

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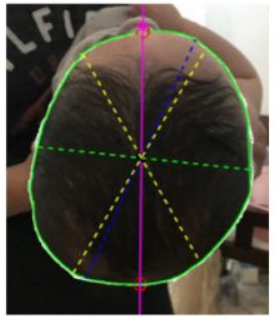
Outline:

- Background
  - Head deformation
  - Scanning techniques
  - Surface reconstruction
  - Existing solutions
- Technical Approach
  - Different Algorithmic approach
  - Testing
  - Optimization of mesh
- Deliverables
- Key dates
- Dependencies and their resolution
- Management Plan
- Reading List and References

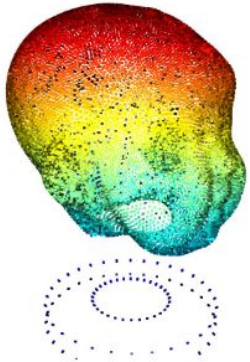
Background

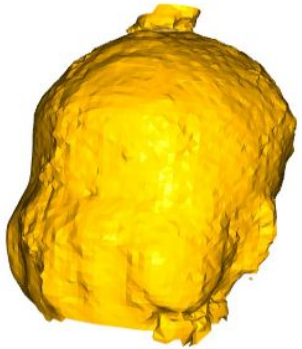
- Head deformation in babies
- No robust tool to measure baby heads to detect deformity
- Current tool includes manually measuring the dimensions using a measure tape
- Currently employed solution by Pediametrix is to use computer vision on 2D images to extract the shape and thus dimensions necessary to calculate indexes like Cranial Index(CI-head breadth/head length) and Cranial Vault Index(CVAI- difference between two diagonals(yellow) / a diagonal).

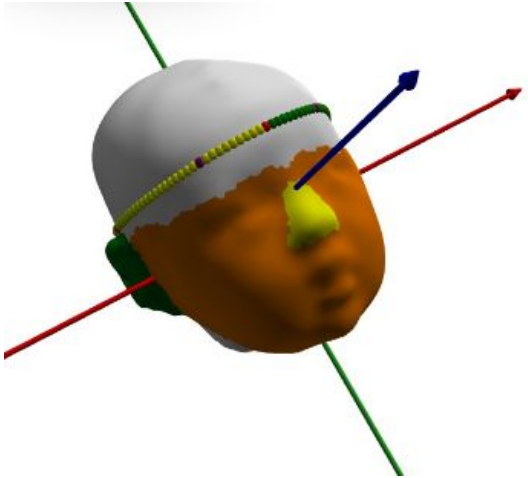


Problem

- Cannot get more information from 2D images e.g., depth information
- Need 3D spatial data to determine deformity in a complete sense
- Able to construct smooth yet detailed mesh for better inspection
- Current solution only for static scans and doesn't account for motion





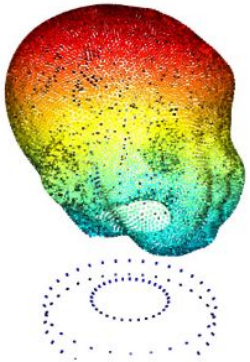


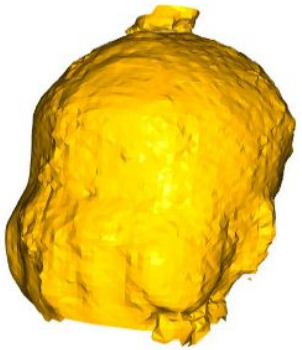
Technical Approach

- Motion Compensation:
  - Explore different algorithms available and implement on the existing pipeline
  - Loop Closure; Robust 3D registration algorithms, Increasing fps
  - Rigorous testing on phantom to determine performance metric
  - Preparing detailed report of performance of all the algorithms explored
- Evaluation:
  - Use controlled motion on phantom head to simulate head motion
  - Controlling the acceleration and velocity, checking the limit of each till which the algorithm gives acceptable results
- Surface Reconstruction:
  - Explore different approaches for surface reconstruction and matching performance of each method
  - Current methods employed are at least 20 years old. Test out latest methods and again test to see which algorithms perform better in handling noisy motion models.

Current Tech Flow:

- Capture images from different angles in sequence using iPad and sensor
- Send the images to current pipeline hosted on AWS
- Registers using point-to-normal algorithm and generates a surface mesh using poisson reconstruction





Deliverables

- Minimum:
  - Data collection at various stages
  - Working pipeline for a few algorithmic approaches
  - Accuracy Evaluation for both static and moving models:
    - < 2 mm average surface distance, ± 2.5% CI/CVAI
- Expected:
  - All of minimum deliverables
  - Testing and documentation of more than 3 algorithms
  - Accuracy Evaluation for both static and moving models:
    - < 2 mm average surface distance, ± 2.5% CI/CVAI
- Maximum:
  - All of expected deliverables
  - Building a simulation environment and pipeline for data extraction for testing using CoppelliaSim software

Dependencies(Impact)

Dependency	Type	Current Status
iPad	Hardware	Shipped
Occipital Sensor	Hardware	Shipped
Elliptical Motion Generator	Hardware	Required
Aurora Sensor	Hardware	Required
Phantom Heads	Hardware	Shipped
AWS	Software	Required
Custom App	Software	Required

Timeline

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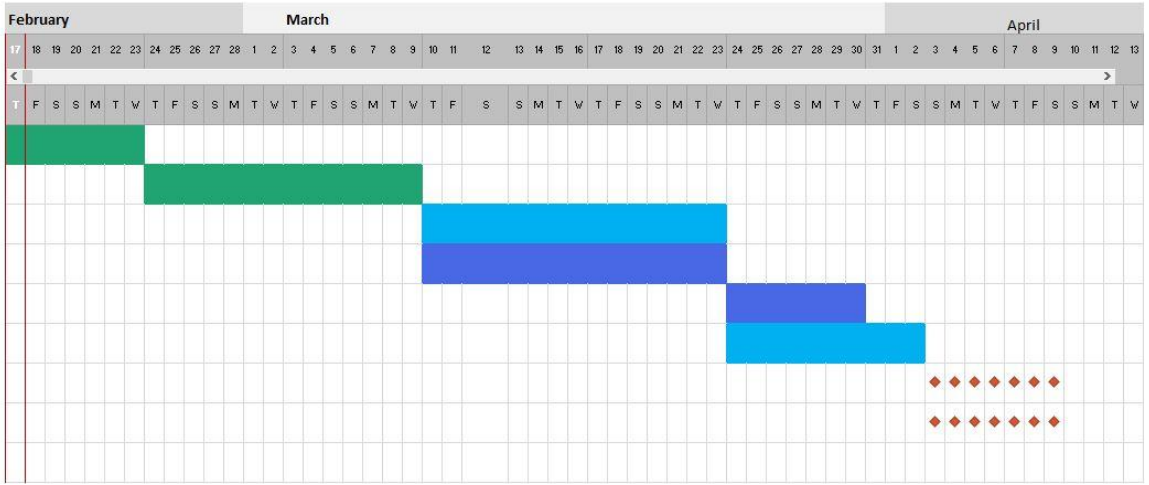
Legend: In Progress | Minimum | Experiment | Expected | Maximum

Project Start Date:

Scrolling Increment:

Milestone description	Progress	Start	Days
Literature review and writing code samples for algorithms	20%	17-02-2022	7
Experimental set-up	5%	24-02-2022	14
Benchmark the current solution	0%	10-03-2022	14
Testing of algorithms and data collection	0%	10-03-2022	14
Refining and testing	0%	24-03-2022	7
Report writing and submission	0%	24-03-2022	10
Setting up simulation environment	0%	03-04-2022	7
Testing and comparing with real world data	0%	03-04-2022	7



Management Plan

- Weekly meeting with Mentors on Tuesday
- Slack channel for communication and sharing files
- Code and version management through GitHub
- All documents shared via Google Drive

Reading List and References

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Thank you !