2024-25 HIVE Summer Internship Project

The impact of Virtual Reality headsets on children's necks
44SAE_EECMS_ImpactOfVRHeadsets

Primary Academic Supervisor
Andrew Rohl

Project Background
In childhood health research, there is much interest in measuring the head and neck region given that head injuries are the leading cause of death and disability in children under 18. Accurate information on child head anthropometry is critical in this research, e.g. in studies assessing the safety of children's car seat designs. Measures of head load are also often of interest as too much head load has been linked with future pain conditions. Virtual reality (VR) headsets, which can weight up to 600 g, are becoming increasingly available to children and have been shown to increase neck loads by as much as 25% in an adults. However, the size of load that virtual reality headsets create at the relatively smaller head and neck of young children and the injury risk this may pose is unknown. Therefore, a recent study aimed to measure head and neck loads of children with and without a VR headset. However, this study was hampered by the paucity of available head anthropometry data from children. The head anthropometry data is most often referred to as inertial parameters, and these may include measures of the segment mass, centre of mass, and moment of inertia, which are all critical inputs for 'load' calculations. Historically, researchers utilised cadavers to 'manually' derive the parameters. However, this method is time consuming and is limited to relatively small samples (i.e. < 10). This makes the data unlikely to be generalisable to large populations. Approaches on living subjects include photogrammetry, frontal gamma-ray spectroscopy as well as Computed Topography (CT). These methods have become increasingly popular and CT scans are considered the most accurate. Currently available inertial parameter data for children are limited to a single cohort of only twelve subjects, all boys (Jensen, 1986), that was derived using indirect measurements. A larger data set with broader ages and both genders, derived from direct methods is required.

Project Description, Expected Outputs, Possible Stretch Goals

The aim of this study is to measure the segment inertial parameters (mass, centre of mass and moment of inertia) of the head/neck on a large, gender diverse, cohort of children using computed tomography (CT) scans. The secondary aim will be to develop a regression equation that could be applied by researchers to scale their segment inertial parameter data to the individual children they are studying. Finally, we will compare the head and neck load calculations for children wearing virtual reality headsets between the developed and previously available (Jensen, 1986) inertial parameter approaches. The CT scans we have access to are of entire bodies of the children, so firstly they need to be restricted to slices from the head/neck only. Then each slice segmented into brain, bone and extracranial soft tissue. Then slices need to be “stacked” to produce a 3-D isosurface of each part. As densities of the three different types are known, densities can be assigned to each mesh. Finally, the head needs to be aligned along anatomical directions allowing the moment of inertia, centre of mass location and mass values to be calculated for each scan. Once we have extracted the segment inertial parameters for each participant, we will use collated data to calculate regression equations based on the participants age, height, weight, head circumference etc i.e. when studying the impact of VR/AR headsets on children, we don’t want to put each of them in a CT scanner. Rather we want to find relationships between easily measured quantities and the segment inertial parameters so they can be quickly approximated from those easily measured quantities.

Expected outputs:

1. Calculated inertial parameters of the head/neck for a cohort of children
2. Head and neck loads of young children with and without a virtual reality headset
3. Initial regression model to estimate inertial parameters from easily measured quantities such as age, height etc
4. Draft paper describing this work

Links to background reading and any relevant recent work in the field

Jensen 1986. Body segment mass, radius and radius of gyration proportions of children. https://doi.org/10.1016/0021-9290(86)90012-6
Loyd et al 2010. Pediatric head contours and inertial properties for ATD design. https://doi.org/10.4271/2010-22-0009 Astrologo et al 2024. Determining the effects of AR/VR HMD design parameters (mass and

inertia) on cervical spine joint torques.
https://doi.org/10.1016/j.apergo.2023.104183

What type of visualisation will the student develop or produce?
The primary goal of this project is to generate inertial parameters from CT scans. However, there is a requirement to generate a number of visualisations during that process. Firstly, the three different types of biological structures in the head will be visualised as 3D objects. Once the inertial parameters have been determined, how to visualise these superimposed on the 3D visualisations discussed above will need to be explored.

How will the visualisation contribute to your research outcomes?
Currently our research is limited to inertial parameter data that isn't representative of our cohort and a better set will improve the accuracy our research. The data generated through this project will have much broader impact through its use in musculoskeletal modelling in paediatric populations, from rehabilitation and disability applications, to more high-performance settings.

If the project is successful, where would you consider publishing the results?
We will prepare a manuscript and publish this in a suitable open access journal to ensure the derived data can be widely used (for example the journal of biomechanics).

<u>Draft Project Timeline:</u>

Week 1
As above

Week 2
Familiarisation with 3D Slicer and Drishti applied to a dataset from a single child

Week 3
Calculation of inertial parameters for the child

Week 4
Exploring visualisation of inertial parameters overlaid on CT scans

Week 5
Calculate parameters of additional 5-10 children

Week 6
Calculate parameters of additional 5-10 children

Week 7
Calculate parameters of additional 5-10 children

Week 8
Derive initial regression model

Week 9
As above with report writing focussed on draft paper

Week 10
As above with report writing focussed on draft paper

Student Experience and Supervision:

How often will you meet with the student over the 10-week period?

once a week with full team, twice a week with primary

Your work desk location and the location of student desk

314.446

<u>Student Attributes:</u>

Please indicate any preference for student's academic discipline or field of study

This project would be of interest for a student with a physics, mechanical/mechatronics engineering, or medical imaging background, who wants to develop new skills in visualisation and analysis. Please note that for an engineering student the hours spent on this project would count towards log book hours at full rate.

What competencies are required to start this project

Intermediate - Data structures, analytics, statistical modelling

Do you have any other student attributes you think are important to the project?

Not applicable