Illuminating Engagement: Real-Time Thermal Imaging of Child Affect During Child-Robot Interactions

Ameer Helmi[1], Lara Rupnawar[1], Samuel W. Logan[2], Naomi T. Fitter[1]

1: Collaborative Robotics and Intelligent Systems (CoRIS) Institute, Oregon State University, Corvallis, OR

2: Disability and Mobility Do-It-Yourself Co-op, Oregon State University, Corvallis, OR

helmia@oregonstate.edu, rupnawal@oregonstate.edu, logansa@oregonstate.edu, fittern@oregonstate.edu

Objective

Incorporate real-time low-cost thermal sensing of the affect of a child with a motor disability during child-robot interactions in physical therapy sessions

Motivation

- For children with motor disabilities, staying engaged during physical therapy is important to success [1]
- Thermal imaging can estimate child affect by evaluating temperature changes in regions of the face [2]
- High quality thermal imaging cameras tend to be expensive
- Assistive robots as part of physical therapy interventions can leverage thermal affect data to adapt behaviors

Hardware

- FLIR Lepton 3.5 thermal camera
  - 160x120 pixel resolution, 8.7 Hz
- Logitech RGB webcam
  - 720x1280 pixel resolution, 30 Hz

Hardware configuration including thermal camera (left) and RGB camera (right)

Close up view of thermal camera

Raw thermal image

Key Insight

Real-time low-cost thermal imaging of a child with a motor disability could be used to estimate the child's affect during robot-mediated physical therapy interventions

Software

Thermal Images

1. PureThermal1 is used to store thermal images and raw temperature data
2. Thermal images are run through YOLOv5n-Face pre-trained model to determine nose tip location
3. Nose tip temperature is extracted from thermal image using raw temperature data

RGB Images

1. OpenCV is used to store RGB images
2. RGB images are run through OpenFace to extract nose tip location and facial action unit data

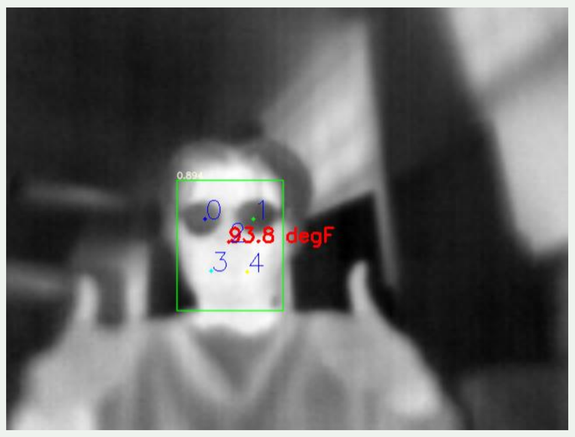
Early Methods

- Conduct initial validation with adult population
- Using CARMA software [3], users rate OASIS [4] images on valence and arousal
- Compare time-synced user ratings with nose tip temperatures

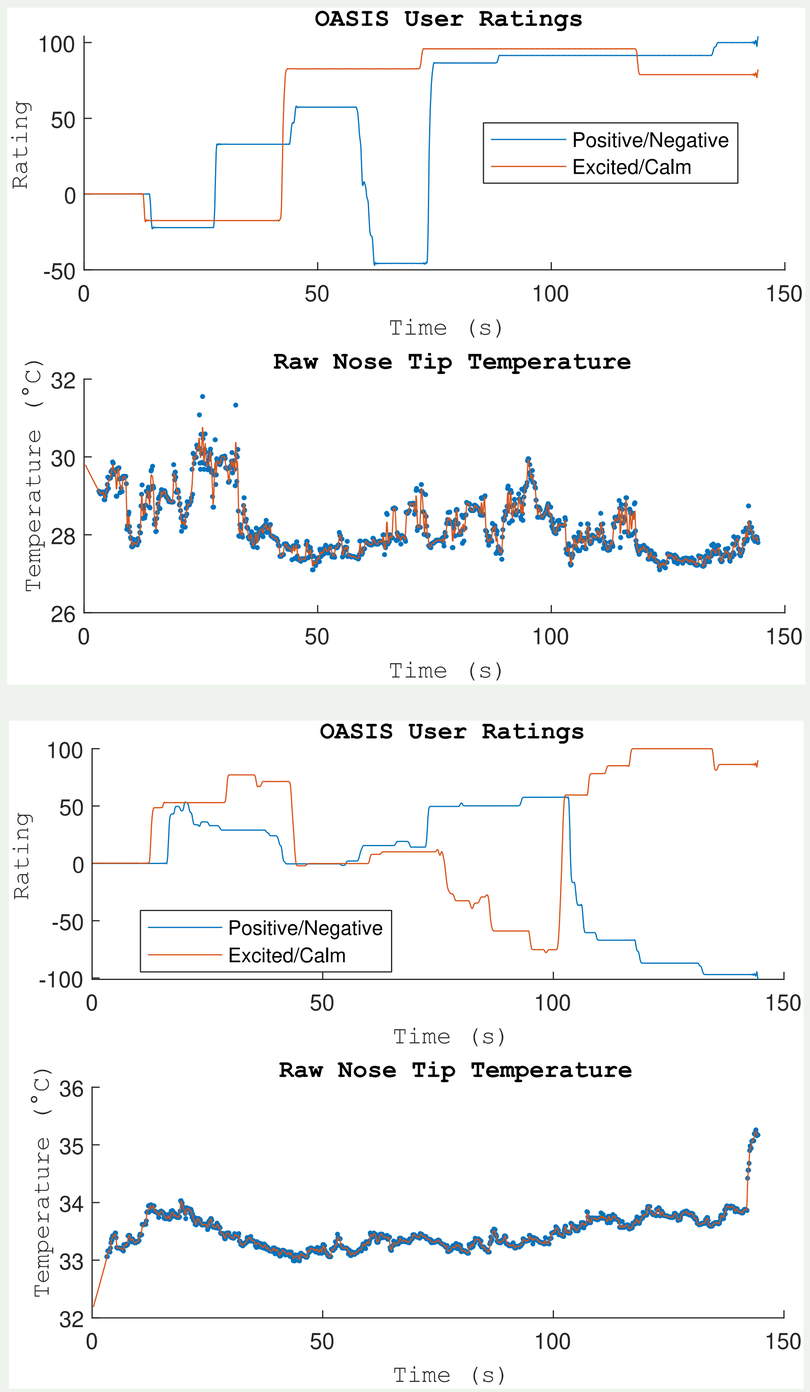
Future Work

- Collect data in stationary physical therapy interventions
- Incorporate machine learning methods for modeling affect recognition
- Collect data in mobile physical therapy interventions

Early Results



Raw nose tip temperature value from thermal image



Raw nose tip temperature readings for two participants while rating OASIS images

References

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