Assistive Robotics

Behavioral Intervention with Autonomous Robots

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Background

- Complex disorders of brain development, like autism, create difficulties for children in developing social skills.
- Artificially intelligent embodied robots are increasingly proving their potential to help in behavioral intervention of children with developmental delays.
- This work presents our preliminary work to design a set of techniques to assist in robot-mediated behavioral intervention.

Objectives

Assist in the automation of delivering behavior intervention plans to individuals with autism, delivered by a NAO robot.

- Utilize biometric measurements including galvanic skin response.
- Track head focus and body position to mirror participants posturing.
- Model the participant's level of interest.

Testing / Results

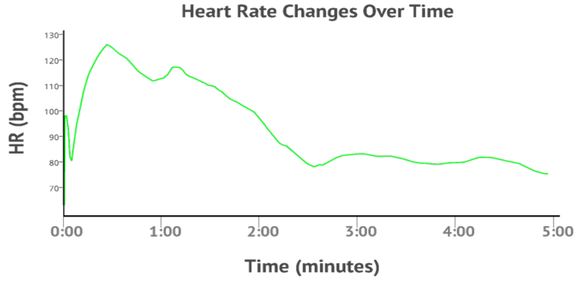

Figure 1: Measures a patient's heart rate over a period of time. A Normal resting heart rate for adults ranges from 60-100 bpm. Generally, a lower heart rate at rest implies more efficient heart function.

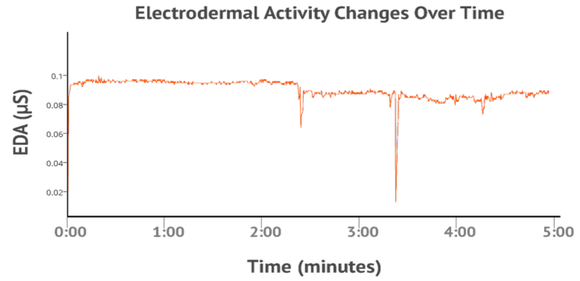

Figure 2: Measures a patient's electrodermal activity over a period of time. The surface of the skin receives EDA signals from the brain. Electrical conductance increases through cognitive stimulation or physical exertion.

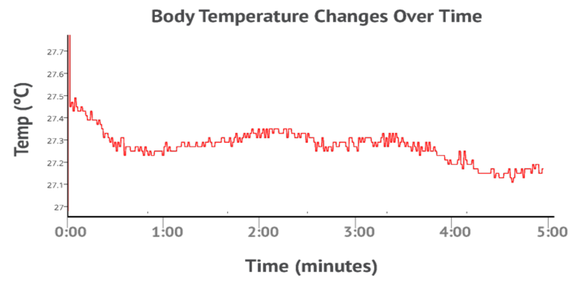

Figure 3: Measures a patient's body temperature over a period of time. Changes in the patient's body temperature can be an indication that the patient is experiencing emotional or physical stress.

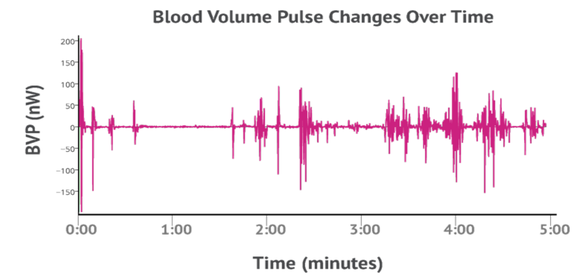

Figure 4: Measures a patient's blood volume changes over a period of time. BVP measurement is obtained by the use of a photoplethysmography sensor. Several measures can be derived from BVP, such as changes in heart rate and peripheral blood flow.

Figure 5: Points plotted along the contour of a face using open source libraries such as OpenCV and Dlib C++. The orientation and position of the head is marked by the colored lines from the center of the face.

The head pose estimation is done using dlib c++ libraries for face detection and OpenCV's solvePnP function, which uses adult male anthropometric data to match a real 3D head to the projected image.

The position and orientation data of the head is used by the NAO robot to update its head position to mimic the participant's gaze.

Derived from the Github open source project Attention Tracker.

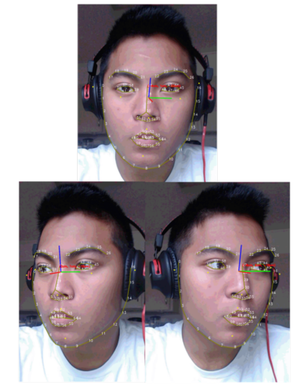

Figure 6: Shows the interaction between the participant and the NAO robot. Using the head pose tracking algorithm, the NAO robot is able to follow the participant's gaze.

Future Works

- Integrate full body skeletal tracking using a Kinect sensor.
- Integrate all measurements into a combined patient model interpreted via reinforcement learning.

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