NRI: Integrated Soft Wearable Robotics Technology to Assist Arm Movement of Infants with Physical Impairments

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Award #: CMMI-2133084; Award Date: 12/01/2021; PI: K. Karydis; Co-PIs: E. Kokkoni, W. Grover, S. Asif, P. Brisk, UC River de

Motivation and Goal of this Project

- Need to provide infants with or at risk of physical impairments with devices that detect, measure, inform, and <u>adjust</u> to changes in learning and growth
- ✓ Iterative design, development and evaluation an actuated, adaptive and user-centered pediatric upper extremity (UE) soft pneumatically-actuated wearable robotic device

Proposed Approach Multi-modal Sensing (Aim 1) Actuation, Control & Computation (Aim 2) Motion generation for the wearable robotic device via synergisti Inferring intention of UE movement through multi-modal sensory feedback soft pneumatic actuators. > Object recognition and tracking of infant arm motion via ego-centric lensless visual sensing Offering assistive feedback via data-driven shared human-robot admittance control Onboard sensing and control via real-time embedded computation Participatory & Iterative Design Process (Aim 3 Collection o kinematic physiological and behavioral data fro infants Evaluation of the device's potential effectively assist infant arm movement Infant reaching for an object

Preliminary Results

- Design of a soft-actuated wearable prototype and testing with an engineered mannequin in open loop ^[1]
- Infant reaching action-recognition from stationary offbody cameras in unconstrained environments ^[2]
- Pneumatic soft logic circuit design and testing to operate multiple soft actuators with fewer valves ^[3]

[1] E. Kokkoni, Z. Liu, and K. Karydis, "<u>Development of a Soft Robotic Wearable Device to Assist Infant Reaching</u>," ASME Journal of Engineering and Science in Medical Diagnostics and Therapy 2020.

[2] A. Dechemi, V. Bhakri, I. Sahin, A. Modi, J. Mestas, P. Peiris, D. Enriquez Barrundia, E. Kokkoni, and K. Karydis, "<u>BabyNet: A Lightweight Network for Infant Reaching Action Recognition in Unconstrained Environments to Support Future Pediatric Rehabilitation Applications</u>," IEEE RO-MAN 2021.

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<sup>[3]</sup> S. Hoang, K. Karydis, P. Brisk, and W. Grover, "<u>A Pneumatic Random-access Memory for Controlling Soft Robots</u>," PloS one 2021.
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2022 NRI & FRR Principal Investigators' Meeting April 19-21, 2022