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Infant Automated Motion Recognition Technology using RGB-Depth sensors for marker-less, rater-independent detection of abnormal movements in early infancy - In A Motion Project

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Background: Increasing evidence supports the value of early therapeutic interventions in children with developmental disorders. Early intervention requires early diagnosis. Established clinical tools to rate spontaneous movements in early infancy (e.g. General Movement Assessment, GMA) require highly trained clinical experts. Different movement analysis systems in infancy have been developed using markers, accelerometers, or magnetic sensors for capturing movements. These systems are complex and therefore restricted to use in research settings. A cheap, marker-less and rater-independent objective screening instrument would be beneficial to allow for screening and follow up in paediatric clinical practice.

Aim: To evaluate the previously published approach for automated movement recognition in infancy using RGB-Depth sensors (KineMAT system) without the need of external markers. We hypothesise that the KineMAT is able to detect differences in kinetic parameters of spontaneous movements in infancy across various diagnoses.

Method: The KineMAT system consists of a commercially available infrared RGB-Depth sensor (Kinect 1.0) integrated into a mobile recording setup that is easy to use in routine clinical examination. The KineMAT builds on an approach that accurately estimates 3D positions of 21 infant body joints in depth images using a variant of random decision trees. The clinical motion spectrum measured with the KineMAT system assesses motion parameters of head, trunk, upper and lower limbs of both body sides. These parameters are related to range, variability, and symmetry of motions. For the assessment, infants were placed in supine position and spontaneous movements were recorded for three minutes without interacting with the infant. The local ethical committee gave approval prior to initialising the study.

Results: Since 7/2016 more than 150 KineMAT recordings have been performed at Hauner Children's University Hospital in Munich. We present seven recordings of six patients with different clinical diagnoses: 1. DH (Definitely Healthy infant at 14 weeks of age); 2. HR (High Risk former preterm infant with 25+2 WGA recorded twice at 12, respectively 16 weeks of corrected age); 3. SLO (Smith-Lemli-Opitz syndrome); 4. BPI (Brachial Plexus Injury); 5. CP (Cerebral Palsy), 6. SMA (Spinal Muscle Atrophy). The kinetic parameters of the first patient shows symmetric spontaneous activity with a dominance of the lower limb activity and unremarkable head and trunk activity. Remarkable deviations in the kinetic parameters occur in each of the individuals that seem to discriminate between the individual diagnosis.

Conclusion: the KineMAT system allows accurate, marker less, whole-body motion quantification in early infancy. It seems to discriminate between disease-specific movement characteristics. The KineMAT system therefore offers potential diagnostic information during the assessment of motor behaviour in infancy. Within the "In A Motion Project", we plan to add multiple recordings of infants with "normal" and "abnormal" spontaneous movement activity to further train the system with healthy age- and also disease specific data and to further enhance automation of movement analysis in infancy.