Computer Vision and Its Application in Infant Health Monitoring

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Abstract

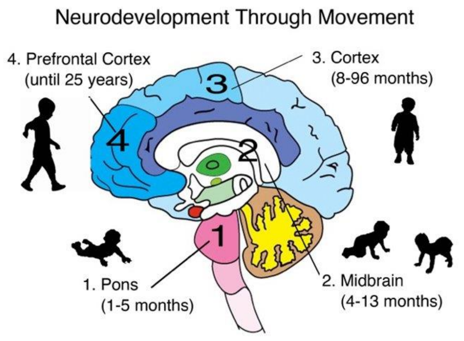
Motivation: In America, around 7% of children are affected by neurodevelopmental delays, and only a third receive recommended screenings. Screening delays can severely impact children who are at risk for neurodevelopmental delays, and cause them to not receive the proper care and support they need.

Objective: Collect data for a computer vision based method for the assessment of postural symmetry in infants in addition to providing infants with treatment of issues associated with motor and neural development. A monitoring device able to provide developmental screenings in infants using computer vision will be created using this data.

Results: Data was extracted from raw footage of infants and was analyzed. The data were formatted so that the artificial intelligence and computer vision algorithms would be able to process it.

Background

Neurodevelopment refers to the development and organization of the central nervous system and its functions, which also determines the functional abilities of a child later in life. Major developmental milestones are reached during the first few years of a child's life, such as developing gross motor skills, language abilities, and problem solving skills. Approximately 7% of children in the US are affected by neurodevelopmental delays (NDDs), like Cerebral Palsy and Autism, which can occur at any time during the early developmental stage to around five years old and persist their entire life. Delayed NDD screenings can impact infants and children who are at risk for neurodevelopmental delays and cause them to not receive proper support in time and have more difficulties in social interactions, academics, and other long-term developments.



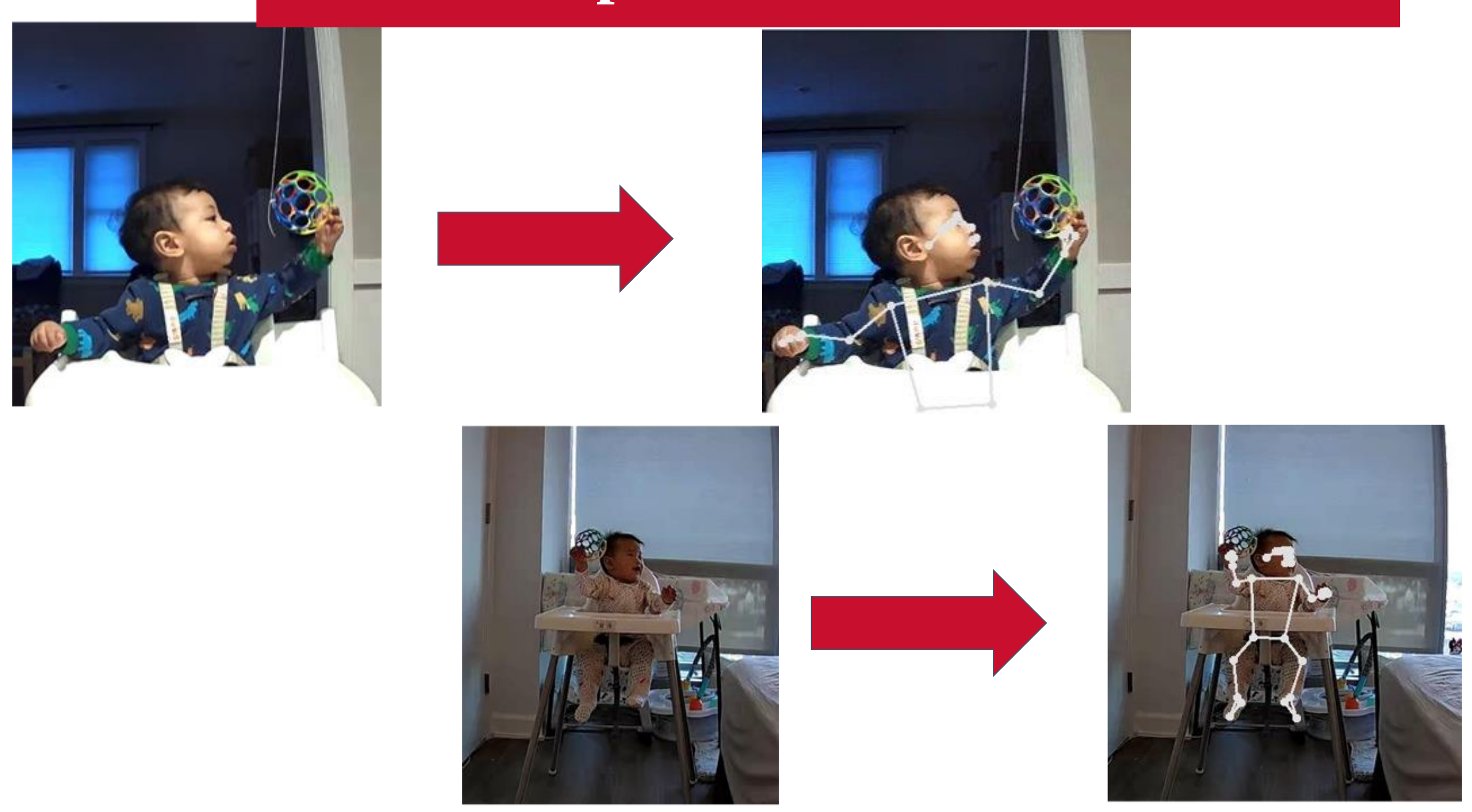
Pose estimation is a part of computer vision that focuses on detecting the position and orientation of a person or an object. This can be done by locating key points on a human, such as hands, elbows, and fingers. Much information can be interpreted through pose estimation and can be used as a semi-managed generative model to render and enlarge the labeled examples in the acted space for the purpose of data augmentation for deep learning processes.

Data Collection

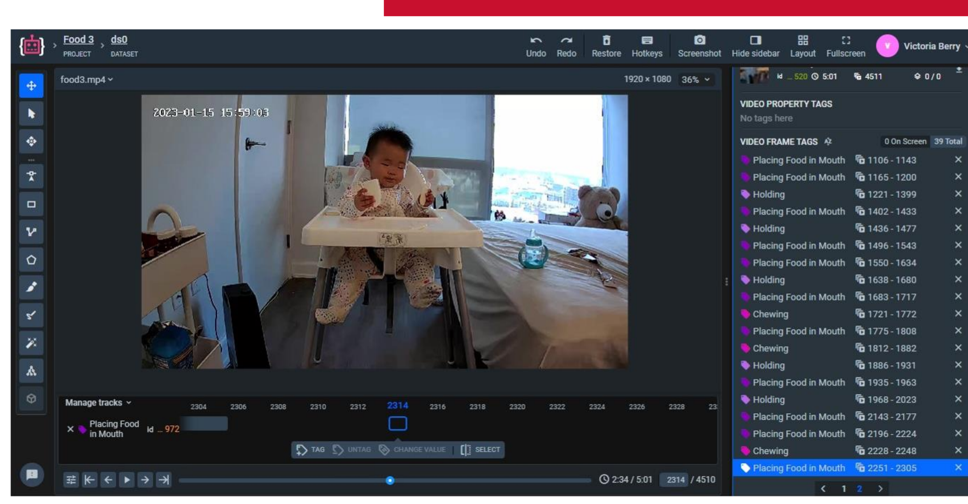
Videos: Raw home videos were collected that displayed various infants naturally interacting with their environment. Infants were video recorded playing with a ball, eating, and drinking. 3–5 second clips displaying motor function were extracted from the videos. Videos of five different infants were analyzed and 211 clips were created and organized into their respective categories. The modified video clips will then used to create a CNN-LSTM (long short-term memory network). The LTSM network processes sequence prediction problems with spatial inputs and time dimensions. The network will provide information about the infants' motor development based on physical and emotional behaviors.

Photos: From the clips, images were taken that displayed the infants during peak action. They were run through MediaPipe Pose, a Python-based program, which estimated the joint coordinates and infant pose onto the images as low-dimensional pose and body landmark representations for the machine learning models. These skeleton-based representations will provide researchers, as well as the machine learning and computer vision models, with a better understanding of typical infant motor function while interacting with their environments. The new images generated by MediaPipe Pose will be fed to deep neural networks to help automatically detect infant abnormalities.

Experimental Results



Annotations



Supervisely, a computer vision and machine learning platform, was also used to further annotate the raw home videos. These annotations served the purpose of tagging the specific time frames for the different motor functions displayed—such as holding, grabbing, chewing, and placing food in their mouth—to help the machine learning models understand the data.

The annotations for the different actions and their time frames were exported from the program, and a frame code was created for further use in the research.

Resources

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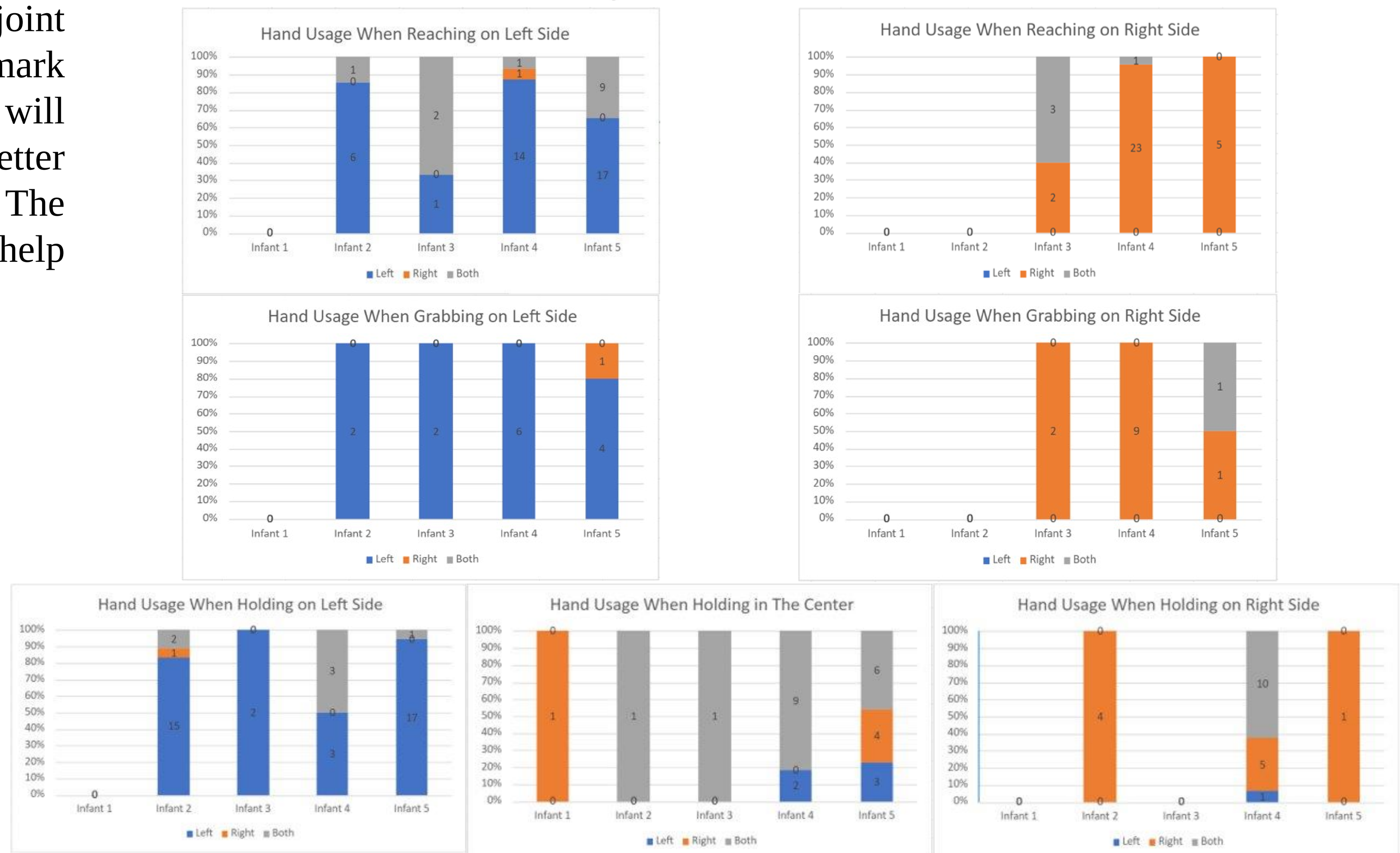
Tables and Graphs

Further data collection was performed on the video clips, by examining each infant's movements when performing different actions—such as which hand they used when interacting with the ball and the ball's relative position. The newly collected data was organized in Excel to perform data analysis and create graphs based on the collected data. These graphs displayed the percentage of time each infant performed certain movements during different actions. These newly collected data assist researchers and the artificial intelligence to become familiar with infant motor patterns and detect irregular behaviors—such as never using their left hand.



Conclusion and Future Steps

Conclusion: The graphs displayed tendencies of the infants and the percentage of times the infants used each appendage while interacting with the plastic ball. More data, along with further processing and analysis, are required to draw more conclusive results about the infants' health status.

Future Steps: The video clips and other data collected will undergo further processing and be used by researchers to fed to train the machine learning and computer vision algorithms. Researchers will reach out to more parents to collect raw home footage and data. In the future, the infants will be checked if they're diagnosed with neurodevelopmental delay and data will be adjusted. The developed programs will be implemented into a smart monitoring device.

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