Computer Vision and Its Applications in Infant Health Monitoring

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Abstract

The research involved collecting and processing data from videos of infants naturally interacting with their environments.
Machine learning models were utilized to understand motor functions, categorizing infants' actions into holding, reaching, and grabbing.
The concept of Pose was used to estimate infant joint coordinates, providing low-dimensional representations. These skeleton-based representations aid in understanding typical infant motor functions.
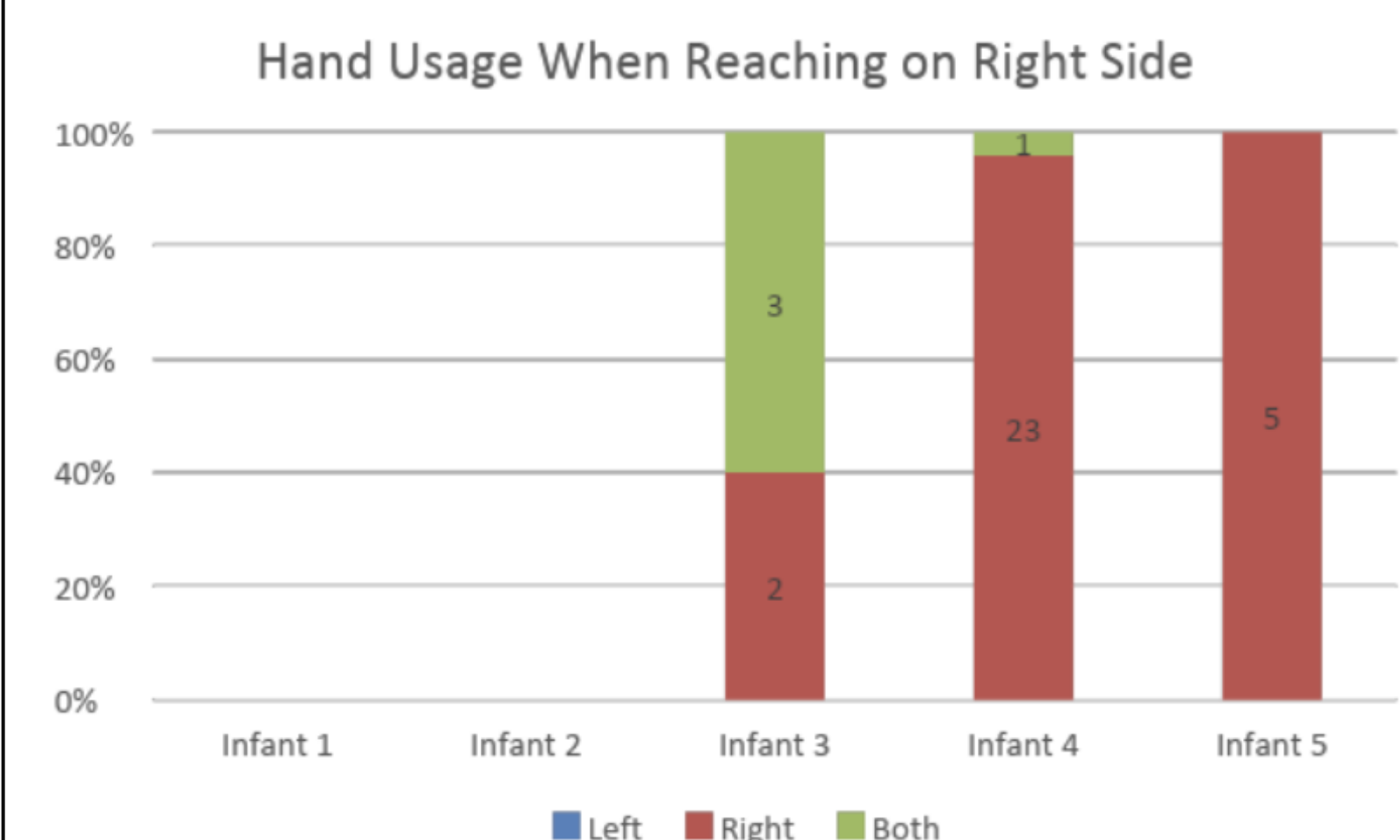
Background

Neurodevelopmental conditions affect nearly 7% of children in the US, yet only ⅓ of children under 5 years old receive recommended developmental screenings.

Results

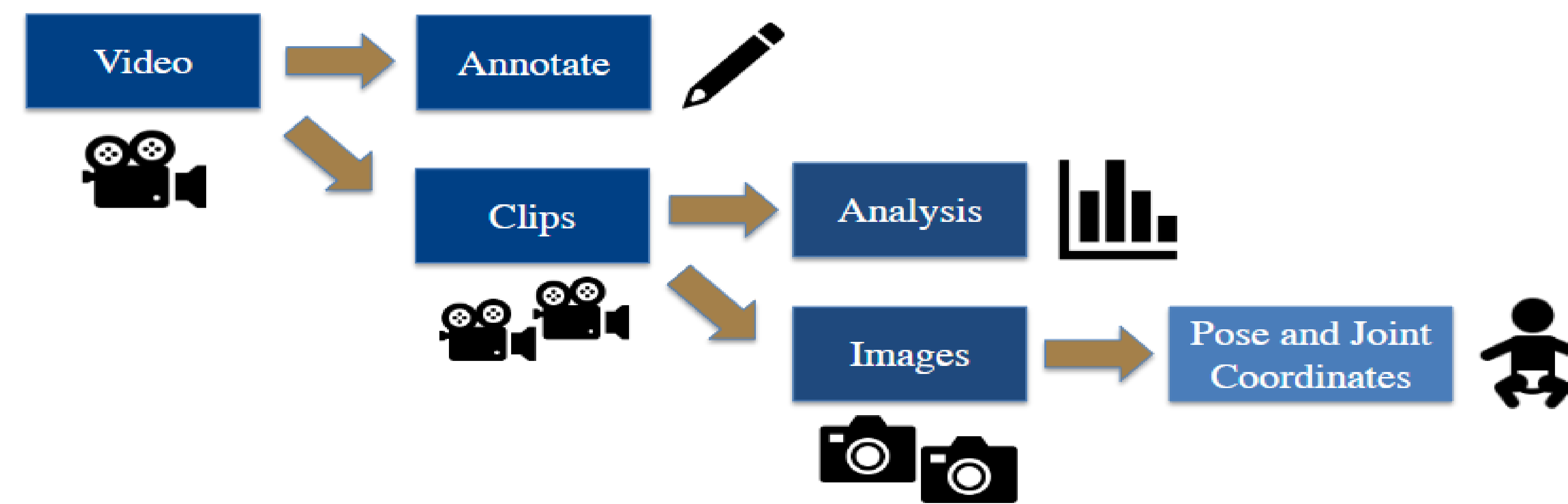
Hand Usage When Reaching on Left Side

Hand Usage When Reaching on Right Side
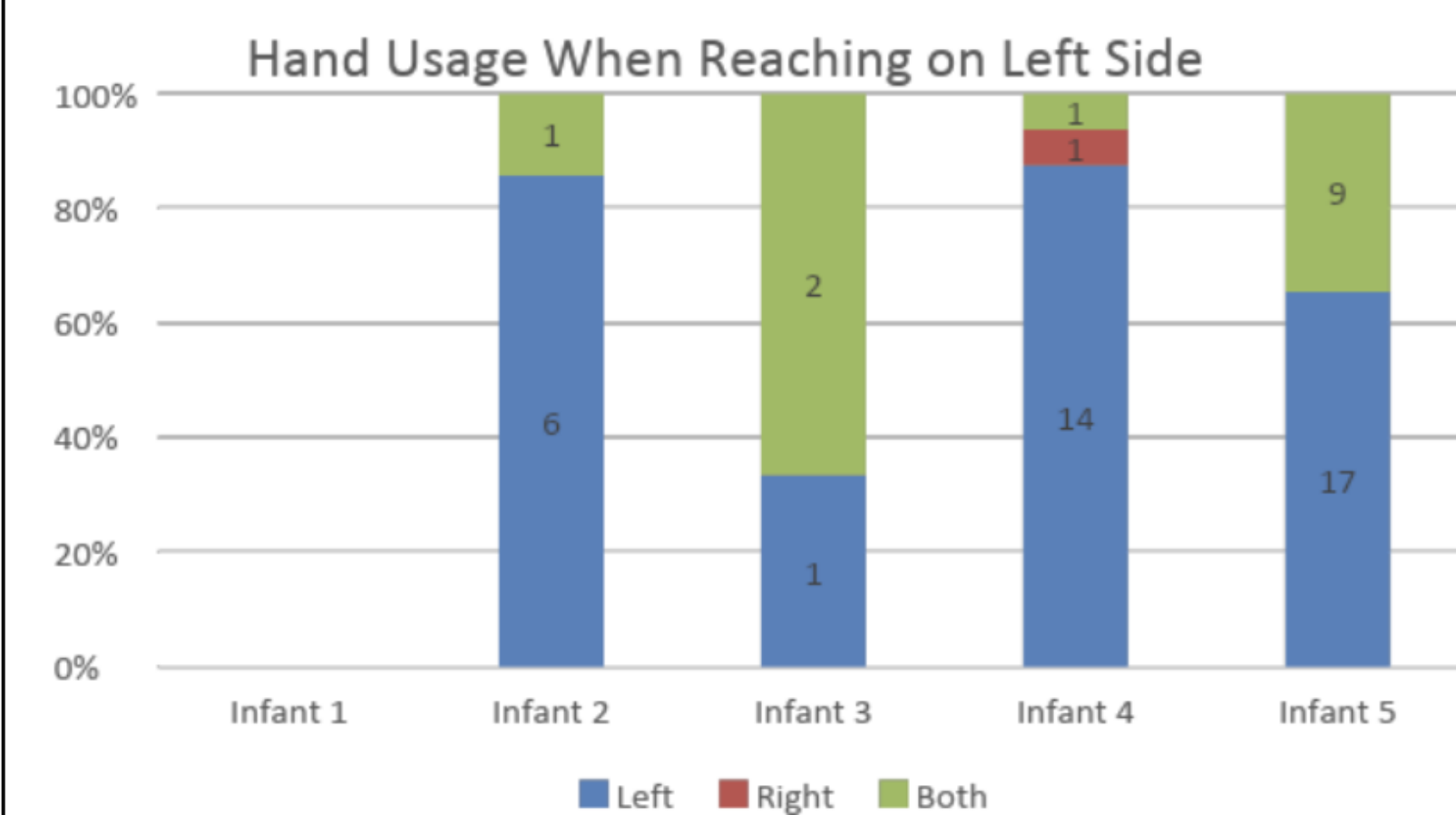
- 40+ home videos 211 clips were annotated for infants reaching grasping and holding a ball.

Process of Data Collection
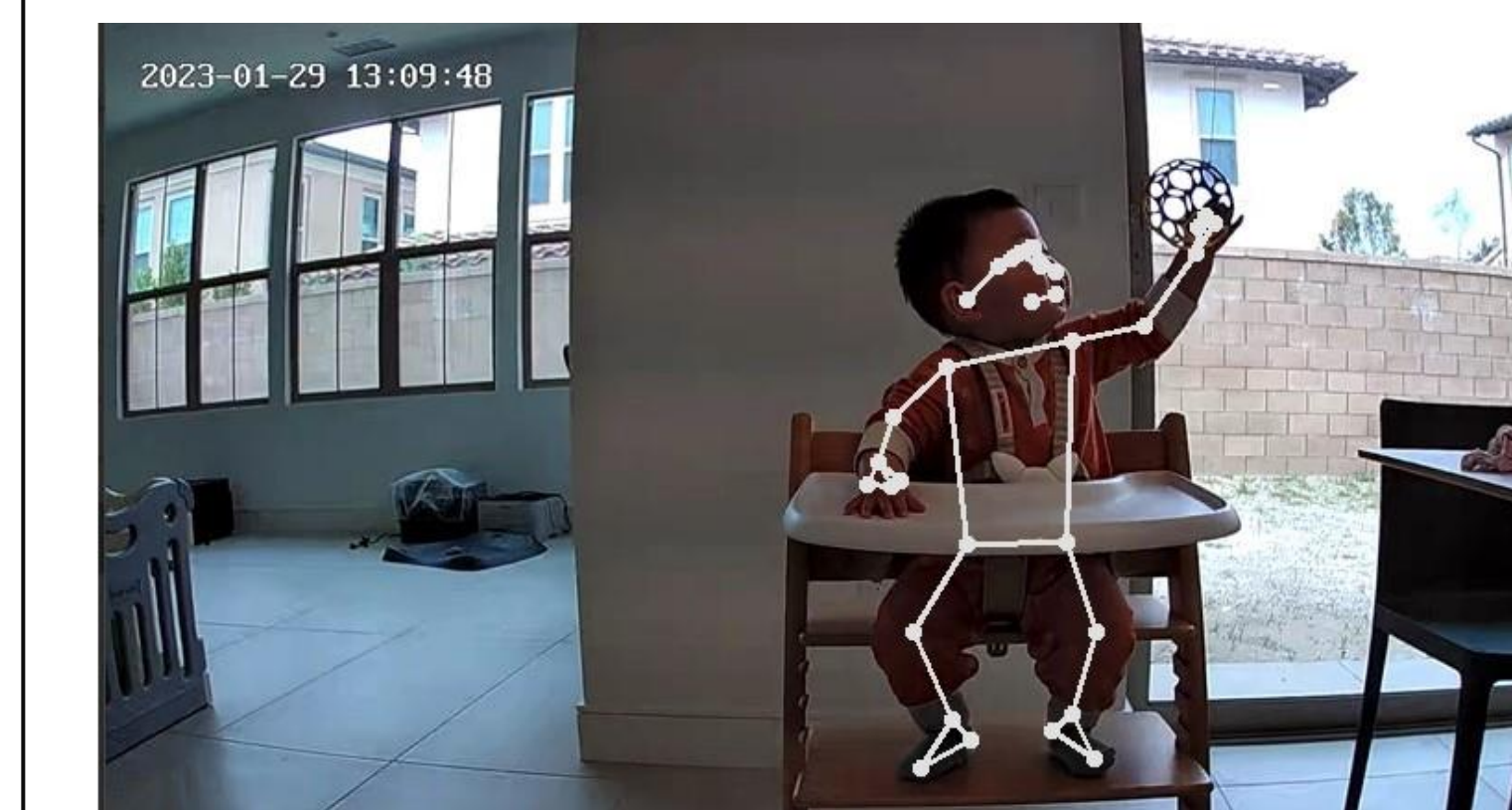
Operating System for Computer Vision

SUPERVISELY
API Documentation

- Analyze, verify and annotate the frame-by-frame action for the different motor functions displayed.

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        "createdAt": "2023-06-21T16:04:20.776Z",
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```

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        "id": 30678197,
        "hotkey": "",
        "applicable_type": "all",
        "classes": []
    }
```

- Semi-automated code by Supervisely
- Evaluates classes, keys and tags

Sources

1. "AI-Guided Cloud-Based Baby Monitoring System." *Northeastern.Portals.In*, 17 Mar. 2022, northeastern.portals.in-part.com/AMx7Bbw87paO?utm_source=technologies&utm_medium=portal&utm_term=latest.
2. .Brighton Center for Pediatric Neurodevelopment. (n.d.). What is Neurodevelopment?. Brighton Center for Pediatric Neurodevelopment. https://www.bcpn.org/what-is-neurodevelopment-html
3. Brown, Stephanie. "Why Your Newborn Has a Grasping Reflex." *Verywell Family*, 19 Sept. 2019, www.verywellfamily.com/get-to-know-your-newborns-grasping-reflex-290100.
4. "Importance of Brain Development in the First Five Years." *Theme Loader*, www.themeloader.com/importance-of-brain-development-in-the-first-five-years.
5. Kojovic, Nada, et al. "Using 2D Video-Based Pose Estimation for Automated Prediction of Autism Spectrum Disorders in Young Children." *Nature News*, 23 July 2021, www.nature.com/articles/s41598-021-94378-z#citeas.
6. LDV Capital, director. *AI-Powered Infant Monitoring to Enable Early Detection of Autism & Other Developmental Disorders*. YouTube, YouTube, 6 Apr. 2023, https://www.youtube.com/watch?v=Q&97GTj00fY. Accessed 29 July 2023.
7. Ostadabbas, Sarah. (2023). An overview of one of our research at the Augmented Cognition Lab at Northeastern University. YouTube. YouTube. Retrieved July 18, 2023, from https://www.youtube.com/watch?v=_1ZIxC4Q65I.
8. Ostadabbas, Sarah. "Infant Pose Learning with Small Data." *Augmented Cognition Lab*, 9 Oct. 2021,https://www. web.northeastern.edu/ostadabbas/2020/10/09/infant-pose-learning-with-small-data/.
9. "Screening for Professionals." *Centers for Disease Control and Prevention*, 22 Feb. 2021, www.cdc.gov/ncbddd/childdevelopment/screening-hcp.html.
10. . Stenum, Jan, et al. "Applications of Pose Estimation in Human Health and Performance across the Lifespan." *MDPI*, 3 Nov. 2021, www.mdpi.com/1424-8220/21/21/7315.
11. .Papers with Code - Pose Estimation. (n.d.). https://paperswithcode.com/task/pose-estimation
12. Turesky, Ted K, et al. "Imaging the Rapidly Developing Brain: Current Challenges for MRI Studies in the First Five Years of Life." *Developmental Cognitive Neuroscience*, 11 Dec. 2020, www.sciencedirect.com/science/article/pii/S1878929320301432.
13. United States Environmental Protection Agency. (2019, August). America's Children and the Environment | Third Edition. United States Environmental Protection Agency. https://www.epa.gov/system/files/documents/2022-04/ace3-neurodevelopmental-updates_0.pdf
14. Villagomez, A. N., Muñoz, F. M., Peterson, R. L., Colbert, A. M., Gladstone, M., MacDonald, B., Wilson, R., Fairlie, L., Gerner, G. J., Patterson, J., Boghossian, N. S., Burton, V. J., Cortés, M., Katikaneni, L. D., Larson, J. C. G., Angulo, A. S., Joshi, J., Nesin, M., Padula, M. A., … Brighton Collaboration Neurodevelopmental Delay Working Group. (2019, December 10). Neurodevelopmental Delay: Case definition & guidelines for data collection, analysis, and presentation of Immunization Safety Data. Vaccine. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6899448/
15. Xiaofei Huang, Lingfei Luan, Elaheh Hatamimajoumerd, Michael Wan, Pooria Daneshvar Kakhaki, Rita Obeid, Sarah Ostadabbas; Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops, 2023, pp. 4911-4920

Results

Before:

After:

MediaPipe Pose API
- Key body points
- Analyzes posture
- Categorizes action

Outcomes

- Analyzed raw video data
- Developed deep learning techniques
- Supported the developmental assessment of infants

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