ASL Webcam Recognition

Daniel Kaufman, Ryan Martin, Mona Jawad, Cheyenne Vondrak

Bioengineering Department, The Grainger College of Engineering, University of Illinois Urbana-Champaign

Problem/Identified Need

- Only 0.8% of STEM majors are deaf or hard of hearing (DHH), disproportionate of their percentage in general population.[1]
- Problem tied to a lack of STEM vocabulary practice in the classroom.[2]
- Educators of the deaf have limited time to incorporate ASL STEM into their curriculums.
- Students need a way to learn and practice these crucial words on their own.
- Potential solution: webcam machine learning validation tool for learning sign language .

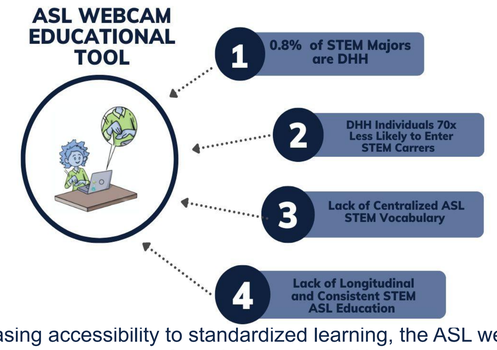

Figure 1. By increasing accessibility to standardized learning, the ASL webcam educational tool will help address a plethora of needs from the DHH community, improving DHH representation in STEM related fields and industries.

Prototype Details

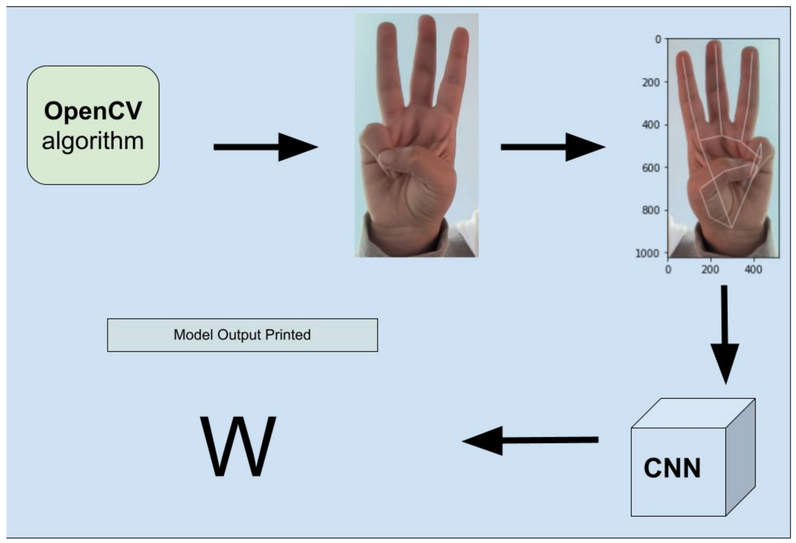

Figure 2. Pipeline of first version webcam machine learning app. Image of hand is fed into Mediapipe for landmark extract, then landmarks are processed in a 4 layer CNN. Model predictions are made and outputted to console as a single letter.

Testing Results

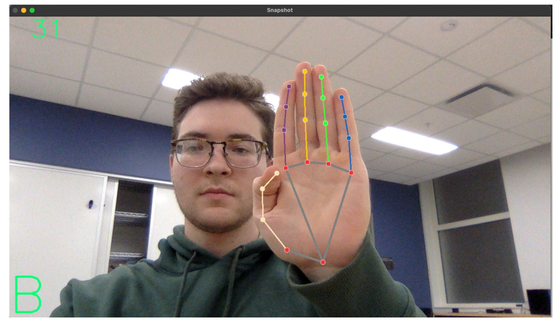

Figure 3. Demonstration of prototype with Mediapipe overlay of webcam input and live sign detection and characterization. Number of frames taken portrayed on the top left corner. Letter predicted portrayed on the bottom right corner.

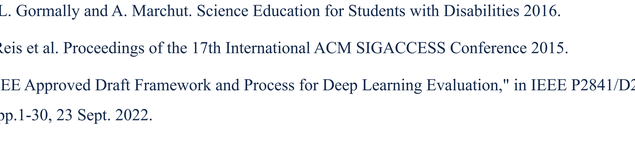

Figure 4. Tensorboard recording of model loss over ten epochs (a) and histogram of biases (b)

Design Criteria

Need	Design Requirement
Model Accuracy	Machine learning model classification accuracy of at least 95%.
Instantaneous User Feedback	Webcam recognition and the proceeding classification of the ASL sign occurs within 1 second of the user performing the sign.
Device Compatibility	Web application performance on lower-end devices with a constant framerate of at least 30fps.
Ease of Use	Web application offers a clean and functional interface for the user, meeting their needs.

Standards

	Deep Learning Standards (IEEE)
Standard	**Specification**
Model Robustness	Machine learning model must achieve target accuracy across a variety of hardware and operating systems (ex: Linux, Macintosh, Windows, etc.)
Dataset Quality	Training dataset must be sufficiently large enough for greater example diversity and robust model classification.
Key Evaluation Metrics	Model's performance should be evaluated based on standard metrics: recall, precision, accuracy, and response time; these metrics should be optimized when adjusting model's implementation.

Future Directions

- Number signs for math games
- Upload to website
- Full sign recognition via action-recognition and pose detection
- Creation of game utilizing this base mechanism

Acknowledgements

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References

[1] C. L. Gormally and A. Marchut. Science Education for Students with Disabilities 2016.

[2] J. Reis et al. Proceedings of the 17th International ACM SIGACCESS Conference 2015.

[3] "IEEE Approved Draft Framework and Process for Deep Learning Evaluation," in IEEE P2841/D2.1, June 2022 , vol., no., pp.1-30, 23 Sept. 2022.