Accessible Ergonomics Assessment of Burkina Faso Weavers Using DeepLabCut™ and Deep Learning

Sydney Garrah[1], Amidou Sawadogo[2], Samuel Brost[1], **Qingguo Li[1]**
[1] Department of Mechanical and Materials Engineering, Queen's University, Kingston, Canada
[2]Institute of Sports and Human Development Sciences, Joseph Ki-Zerbo University, Ouagadougou, Burkina Faso
Email: ql3@queensu.ca

Summary

This study evaluates DeepLabCut™ (DLC) for cost-effective ergonomic analysis in resource-limited settings. Traditional motion capture is often inaccessible, but DLC, an open-source deep learning tool, enables markerless motion tracking using 2D video data with minimal resources. We applied DLC to analyze joint kinematics in women weaving in Burkina Faso, comparing their range of motion (ROM) and joint angles with exercise postures from exercise machines designed to reduce musculoskeletal risks. Using low-resolution videos, 10 manually labeled frames per video, and 10,000 training iterations, DLC successfully tracked nine anatomical landmarks and extracted joint angle trajectories. Results showed that the neck and elbow joints during rowing had the most similar ROM to weaving, while the upper arm angle during elliptical exercises resembled weaving. Our findings demonstrate the potential of DLC and deep learning for accessible motion capture and ergonomic assessments.

Introduction

In Burkina Faso's textile sector, 98% of weavers reported experiencing musculoskeletal disorders (MSDs), linked to repetitive motions and poor posture during weaving, a physically demanding task mostly performed by women [1]. Exercise machines designed to simulate weaving movements aim to improve strength, endurance, and flexibility. Ergonomic assessments of weaving and exercise through video analysis are essential to understanding the effectiveness of exercises in reducing MSDs. We propose using DeepLabCut (DLC) [2] for ergonomic assessment of weaving and exercise movements through 2D video recordings.

Methods

Videos from 5 weavers using handlooms and 8 weavers using rowing and elliptical machines were analyzed with DLC (Ethics Approved: GMECH-067-22). A 2D skeleton with 9 anatomical markers (head, neck, shoulder, elbow, hand, hip, knee, ankle, toe) was created, and 10 frames were labeled before training the algorithm with 10,000 iterations. DLC tracked joint angles (trunk, elbow, upper arm, neck) during rowing, elliptical, and weaving activities. The average joint angle trajectory and range of motion (ROM) were compared to assess movement similarities, as the exercises aimed to improve musculoskeletal health for weaving.

Results and Discussion

The comparison of weaving motion with exercises (Table 1) revealed that the neck and elbow joints during rowing had the most similar ROM to weaving, while the upper arm angle during elliptical exercises resembled weaving. Weaving required a more intense forward trunk lean with less ROM than the exercises. The extremes of joint angles varied: the trunk angle extremes during elliptical exercises closely matched weaving, while the elbow and neck angles showed mixed similarities, with elliptical and rowing exercises showing both minimum and maximum angles similar to weaving. However, both rowing and elliptical exercises had greater upper arm angles than weaving.

Conclusions

The preliminary results demonstrate that DLC enables ergonomics assessment, providing valuable insights into the comparison of weaving and exercise postures. With 2D video recording, DLC offers an accessible motion capture and ergonomics assessment solution for biomechanics and occupational health research in resource-limited regions.

References

[1] Sawadogo A et al. (2019). *Int. J. Med. Pharm. Sci.* ,**9(6):**83–94
[2] Mathis, A., et al. (2018) *Nature Neuroscience*, **21(9),** 1281–1289

Table 1: Mean ROMs for joint angle trajectories across test subjects for all exercises/activities (Maximum and minimum angles reached, and angle range with standard deviation). Shaded ROM highlights a comparison of exercise ROM to the weaving ROM.

Activity	Trunk Angle [deg]			Elbow Angle [deg]		
	Min	Max	Range	Min	Max	Range
Rowing	0.4 ± 0.3	13 ± 3	13 ± 3	−46 ± 12	103 ± 12	147 ± 3
Elliptical	3 ± 2	14 ± 4	12 ± 2	−80 ± 12	46 ± 6	120 ± 12
Weaving	8 ± 3	15 ± 4	6.4 ± 0.5	−103 ± 6	86 ± 6	183 ± 12
	Upper-arm Angle [deg]			Neck Angle [deg]		
Rowing	−109 ± 29	139 ± 5	246 ± 34	3 ± 5	34 ± 17	29 ± 17
Elliptical	−23 ± 40	115 ± 12	138 ± 52	5 ± 4	14 ± 5	9 ± 3
Weaving	−155 ± 6	10 ± 3	166 ± 6	24 ± 3	40 ± 12	17 ± 12