Lift It Up Right: A Recommender System for Safer Lifting Postures

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Goal & Motivation

Manual lifting is a major source of workplace injuries. The NIOSH Lifting Equation is the standard tool to assess risk, but it requires time-consuming manual measurements by ergonomists.

We propose an automated, computer vision–based system that:

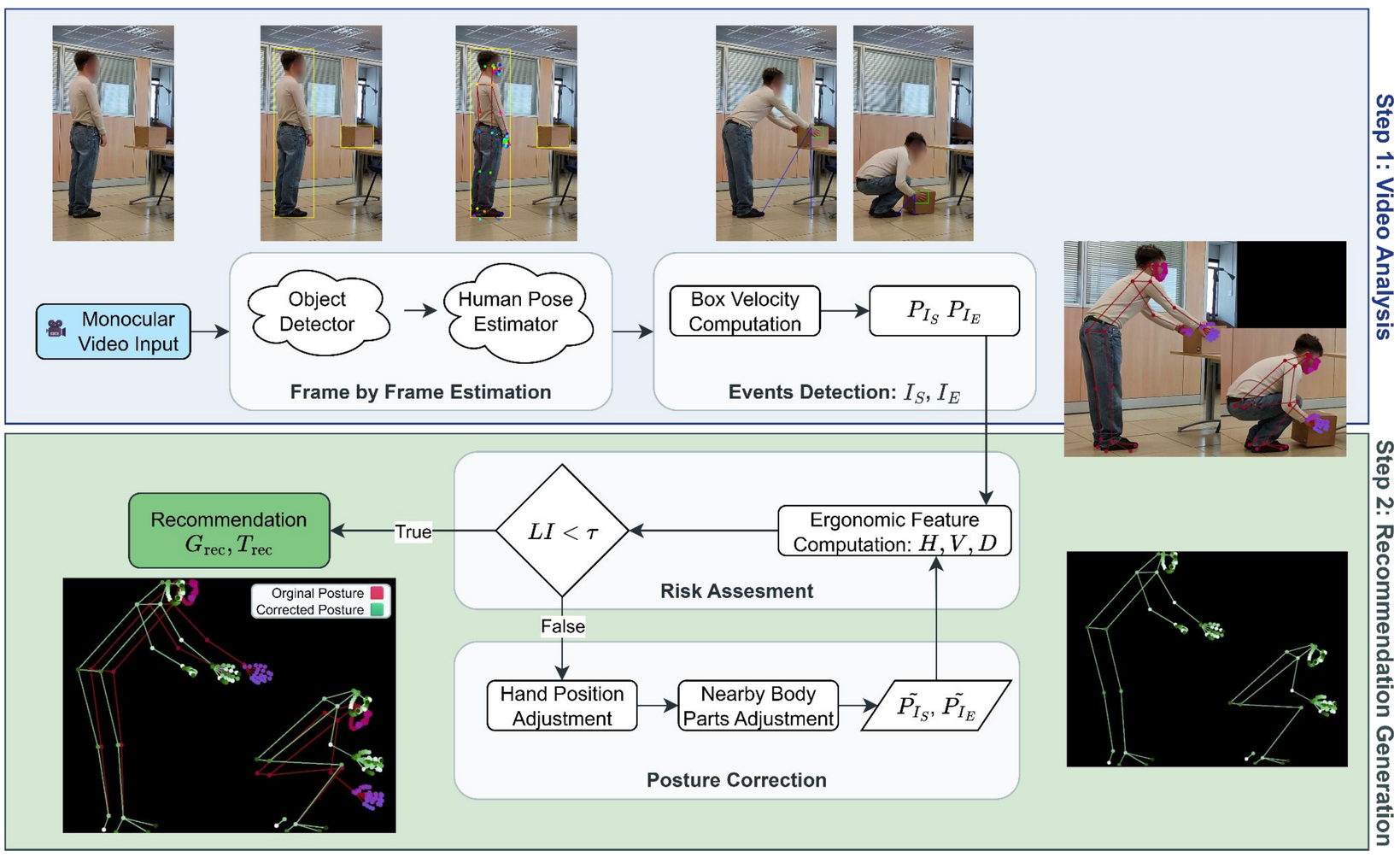
- Extracts lifting parameters directly from video.
- Estimates the Lifting Index (LI) without a time consuming labour.
- Provides real-time, safety-aware recommendations (graphical + text).

Our aim is to support workers and companies in preventing injuries through posture correction and safer lifting practices.

Dataset

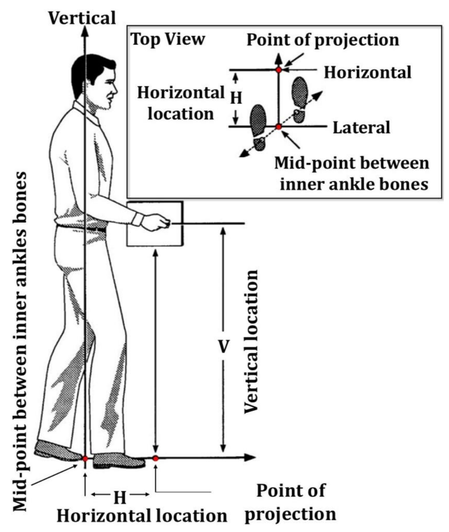
We recorded a dataset consisting of 133 lifting sequences across three environments, involving 13 distinct subjects.

Methodology



Video Analysis

- Object Detector: YOLOv8x-world
- Human Pose Estimator: ViTPose



Recommendation Generation

- Lifting Index (**LI**): Quantifies lifting risk according to RNLE, computed directly from the pose estimator.
- If **LI** > **τ**, the system detects unsafe posture.
- Posture is adjusted by modifying the body through the representation in terms of keypoint coordinates from the pose estimator.

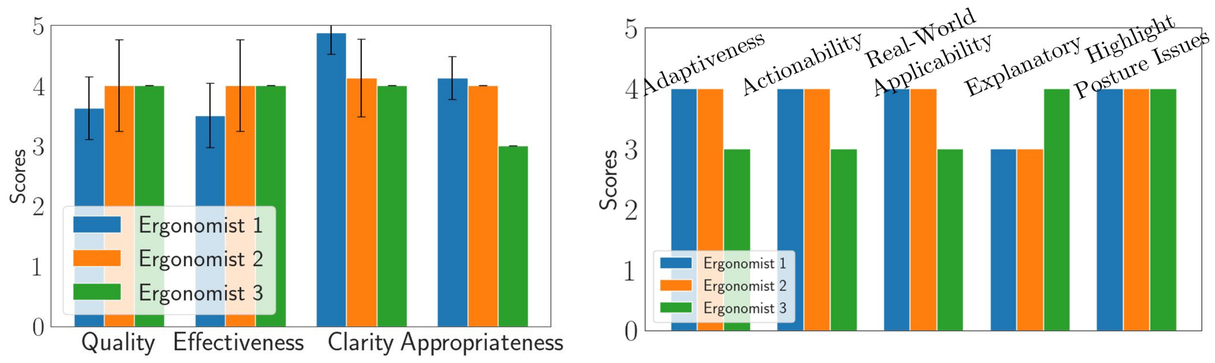
Experimental Evaluation

Distance Estimation Error

Env	Camera Angle	#Subjects	#Videos	Box Errors (cm)			Hand Errors (cm)			RWL Errors	
				V	H	D	V	H	D	MAE	RMSE
1	Side	3	23	1.69	29.47	1.17	39.08	-	-	7.27	7.60
	Rear side	3	18	2.72	23.05	2.66	38.55	-	-	5.76	6.63
	Combined	3	41	2.14	26.36	1.82	38.85	-	-	5.28	6.18
2	Side	2	8	1.00	15.62	6.12	17.50	-	18.50	0.00	0.00
	Rear side	2	8	4.12	1.12	0.75	23.12	-	26.12	8.13	8.22
	Combined	2	16	2.56	8.37	3.43	20.31	-	22.31	4.06	5.81
3	Side	8	37	1.40	9.29	1.59	48.43	-	58.76	1.22	1.43
	Rear side	8	39	2.74	1.92	1.61	42.07	-	51.15	3.84	4.35
	Combined	8	76	2.09	5.51	1.60	45.17	-	54.88	2.57	3.28
AVG	-	13	133	2.16	12.37	1.89	40.23	-	47.10	3.73	4.87

- Our system achieves centimeter-level accuracy in estimating *V* and *D* distances across three environments.
- *H* is the most error-prone parameter, strongly affecting the Recommended Weight Limit (RWL) due to its threshold effect in the RNLE.
- Overall RWL errors remained with MAE = 3.7 and RMSE = 4.9.

Expert Review of Recommendation



- Recommendations evaluated by three professional ergonomists.
- Clarity scored highest (avg. 4.3/5), confirming that recommendations were easy to understand.
- Other aspects, quality (3.9), effectiveness (3.8), and appropriateness (3.7), were rated positively but indicating room for refinement.

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