Towards More Accurate Image-Based Assessment of Hoarding Clutter

Boyang Zhang (Advisor: Prof. Janusz Konrad) Master's Project

1. Problem

Hoarding disorder (HD):

- Trouble discarding items, no matter their value
- Results in excessive clutter in living space
- Mental-health and public-health problem
- Affects ~5% of US adult population

Dangers:

- Fires, falls, poor sanitation, social challenges

HD assessment methods (manual):

- Psychological assessment by a professional
- *Clutter Image Rating (CIR)* [Frost et al., 2008]

Challenges:

- Subjective, time-consuming, not always repeatable
- Professionals admit assigning CIR value within ±1

2. State of the Art

Sun et al., 2025:

- ***Vision Transformer + MLP Head (ViT-Base)***
- Transformer encoder unchanged
- 4-fold cross-validation, each with 10 runs

Performance measure:

- Correct Classification Rate (CCR)
- CCR_1 to capture ±1 uncertainty

$$CCR_1 = \frac{1}{N}\sum_{k=1}^{N} \mathbf{1}(|\xi_k - \hat{\xi}_k| \le 1)$$

Estimated CIR (pointing to $\hat{\xi}_k$)

True CIR (pointing to ξ_k)

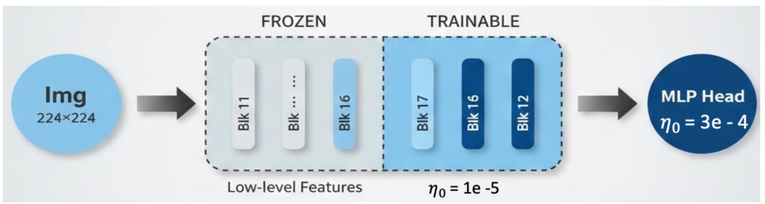
Baseline reproduction:

	CCR [%]	CCR-1 [%]
Sun et al., 2025	53.46%	93.24%
Our reproduction	53.58%	93.15%

3. Approach

ViT backbone fine-tuning:

Last 6 ViT blocks trained in addition to the MLP head using either ***SGD*** or ***AdamW*** optimizer



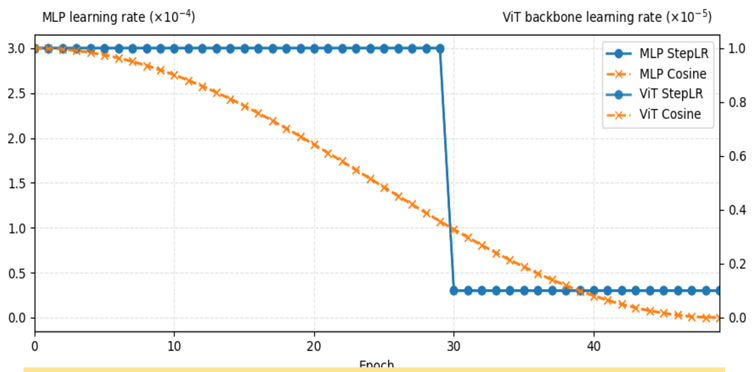
Data augmentation:

	Original	Revised
Translation	±k·5, k=0-6	±15
Rotation range	±k·3°, k=0-3	±5°
Color jitter	brightness, contrast, saturation, hue (0.1, 0.1, 0.1, 0.1)	brightness, contrast, saturation, hue (0.08, 0.08, 0.08, 0)

Learning-rate scheduler:

StepLR: $\eta_t = \eta_0\,\gamma^{\lfloor t/5 \rfloor}, \quad \gamma = 0.5$

Cosine: $\eta_t = 0.5\,\eta_0\left(1 + \cos\frac{\pi t}{T-1}\right), \; T = 50\text{epochs}$



Improved performance over SOTA:
CCR by 4.8%, CCR-1 by 0.7%
Reduced CCR/CCR-1 variations over SOTA

4. Experimental Results

1. Ablation study with 1 feature changed at the time:

Steps	Data augment.	ViT backbone	Optimizer	Scheduler	CCR [%]	CCR-1 [%]
Sun et al. [2025]	Original	Original	SGD	StepLR	**53.46**	**93.24**
Step 1	**None**	Original	SGD	StepLR	49.92	90.12
Step 2	None	**Re-trained**	SGD	StepLR	50.50	88.94
Step 3	None	Re-trained	**AdamW**	StepLR	53.33	89.67
Step 4	None	Re-trained	AdamW	**Cosine**	53.93	90.07
Step 5	**Original**	Re-trained	AdamW	Cosine	54.78	93.06
Step 6	**Revised**	Re-trained	AdamW	Cosine	**58.23**	**93.94**

2. Performance stability in the last 10 epochs (40 runs):

Mean spread (highest - lowest)	ΔCCR	ΔCCR-1
Sun et al. [2025] → Step 6	3.5% → 1%	2.4% → 0.6%