



# Objects as Universal Geolocation Cues: A Computer Vision Approach



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## MOTIVATION

**The WHY:** Narrow down the search space to assist law enforcement in combating crimes such as human trafficking and child exploitation.

**The WHAT:** Victims are often photographed in hotel rooms, and traffickers share these images within criminal networks and online advertisements. Identifying the hotel from such images can help determine where a victim was photographed and reveal potential trafficking hot spots [1].

**The HOW:** When a large and representative reference dataset is available, the task is formulated as a Content-based image retrieval (CBIR) problem. In the absence of such a dataset, geolocation relies on universal visual cues to infer location directly from the image.

## PLUG TO PLACE

Electrical plug sockets are consistent and recognisable indoor markers, as each country or region uses specific socket types defined by distinct pin configurations.

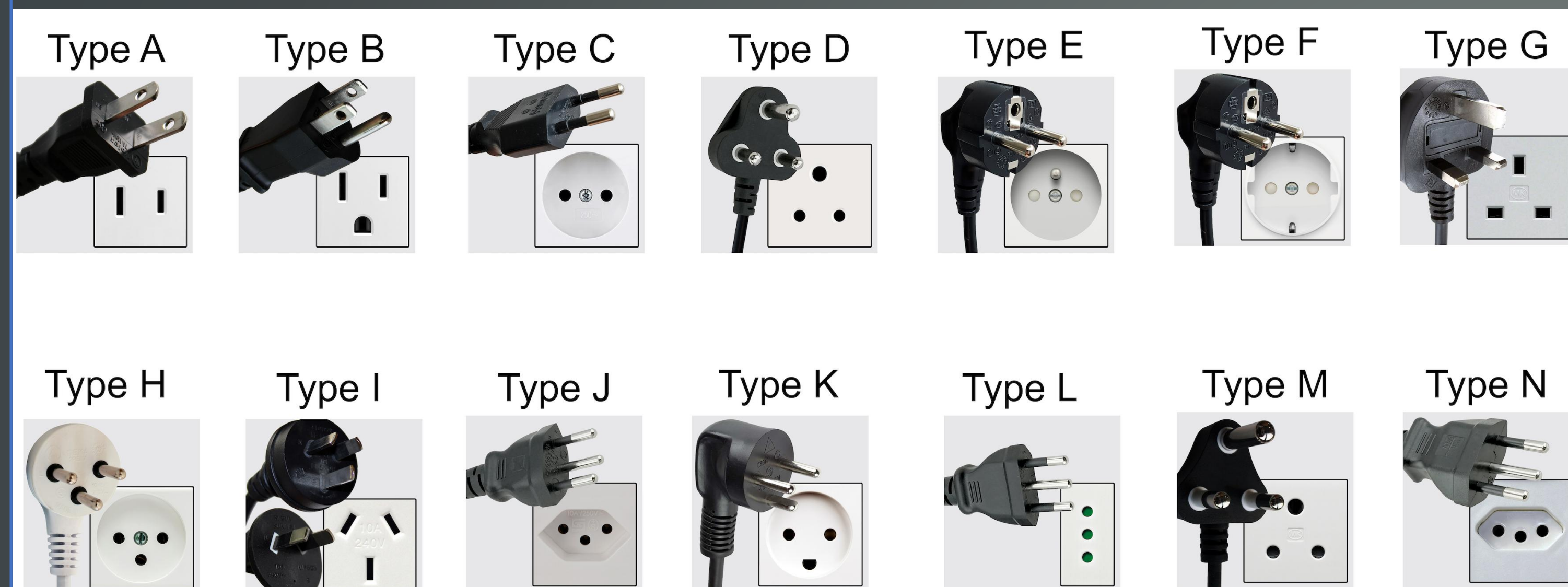


Figure 1: Plug and Socket Types from Type A to Type N [2].

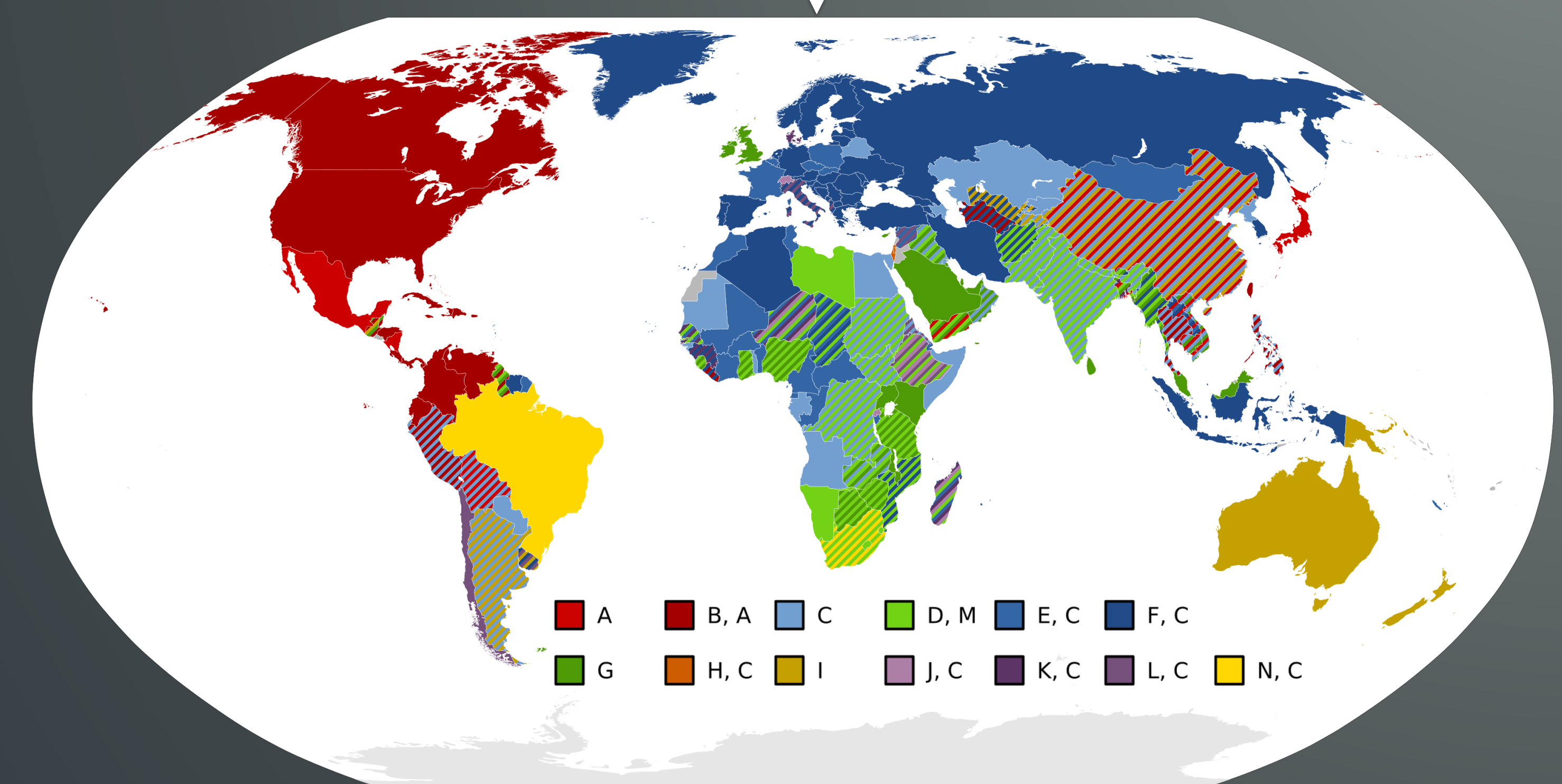


Figure 2: Worldwide plug type distribution map: Color indicate socket type; striped areas mean multiple socket types used in a region[3].

## EVALUATION AND RESULTS

Stage	Task/Model	Dataset	Metrics	Results
Stage 1	Socket Detection (YOLOv11-Small, K-Fold Cross-Validation)	Socket Detection	Precision	0.8675
		Dataset – 2,328 annotated images + 4,074 augmented	Recall	0.7990
			mAP@0.5	0.843
			mAP@0.5:0.95	0.5771
Stage 2	Socket Type Classification (Best Model: Xception)	Socket Type Classification	Accuracy	0.877
		Dataset – 12 socket type, 3,187 images	Precision	0.894
			Recall	0.884
			F1-Score	0.881
Stage 3	Geolocation	Evaluation Dataset: Hotels-50K (TraffickCam) 44,630	Accuracy @ Confidence	
			Thresholds (%)	91.61
			≥ 70%	93.73
			≥ 80%	96.29
Three-stage pipeline: (1) Socket detection, (2) Socket type classification, and (3) Geolocation				

For further details refer to our research paper [4]

## INSPIRATION

1) “Trace an Object” is a crowdsourcing campaign by Europol that enlists the public to identify everyday items such as furniture, logos, or locations appearing in the background of child sexual abuse material, helping law enforcement generate new investigative leads [5].



2) In Computer vision many researchers have explored methods like skyline detection, landmark recognition, and sun azimuth estimation to determine location in outdoor environment [6][7].

## FUTURE DIRECTIONS

Country-specific brands/logos, language cues, and window-visible landmarks; group same-room images to propagate contextual signals; and CBIR based fabric patterns can be explored to improve geographic prediction

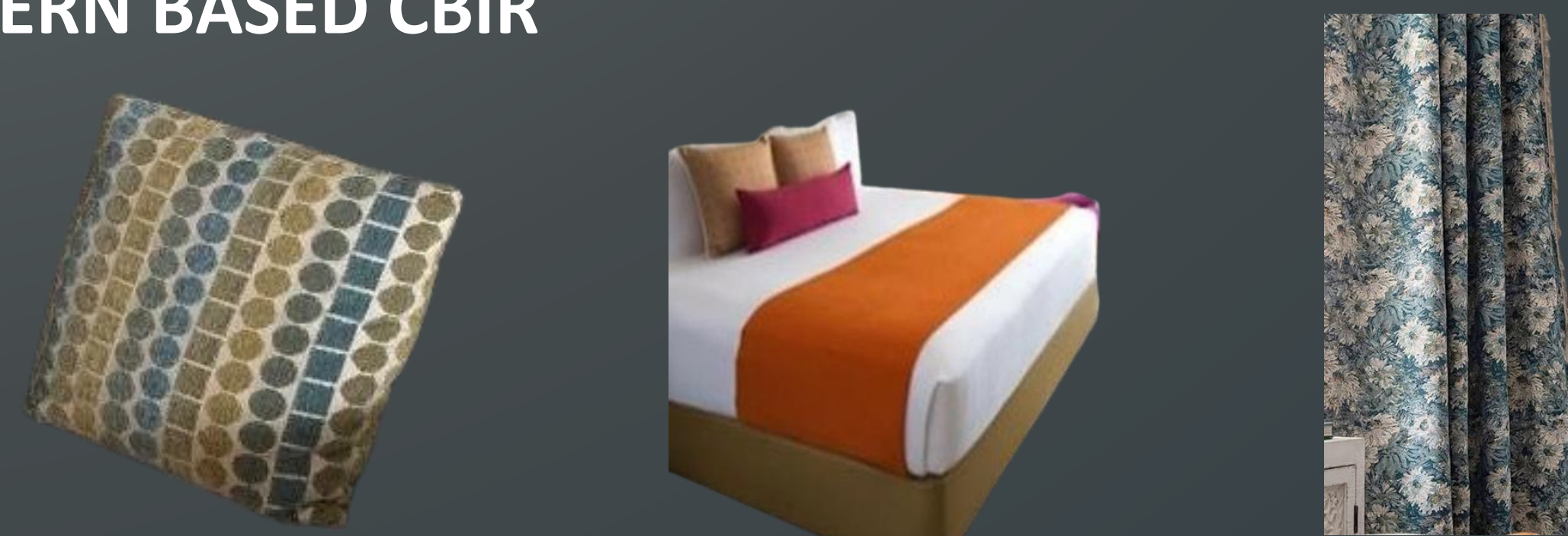
## 1. INDOOR GEOLOCATION CUES



## 2. SAME ROOM DETECTION



## 3. PATTERN BASED CBIR



## REFERENCES

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- [4] K. Aftab, G. Adams, and M. Scanlon, “Plug to Place: Indoor multimedia geolocation from electrical sockets for digital investigation,” *arXiv preprint arXiv:2512.16620*, 2025.
- [5] Europol, “Stop Child Abuse.” [Online]. Available: <https://www.europol.europa.eu/stopchildabuse>
- [6] P. Kakar and N. Sudha, “Authenticating image metadata elements using geolocation information and sun direction estimation,” in *Proc. IEEE Int. Conf. on Multimedia and Expo*, 2012.
- [7] S. Ramalingam et al., “Skyline2gps: Localization in urban canyons using omni-skylines,” in *Proc. IEEE/RSJ Int. Conf. on Intelligent Robots and Systems*, 2010.