GenAug: Retargeting behaviors to unseen situations via Generative Augmentation

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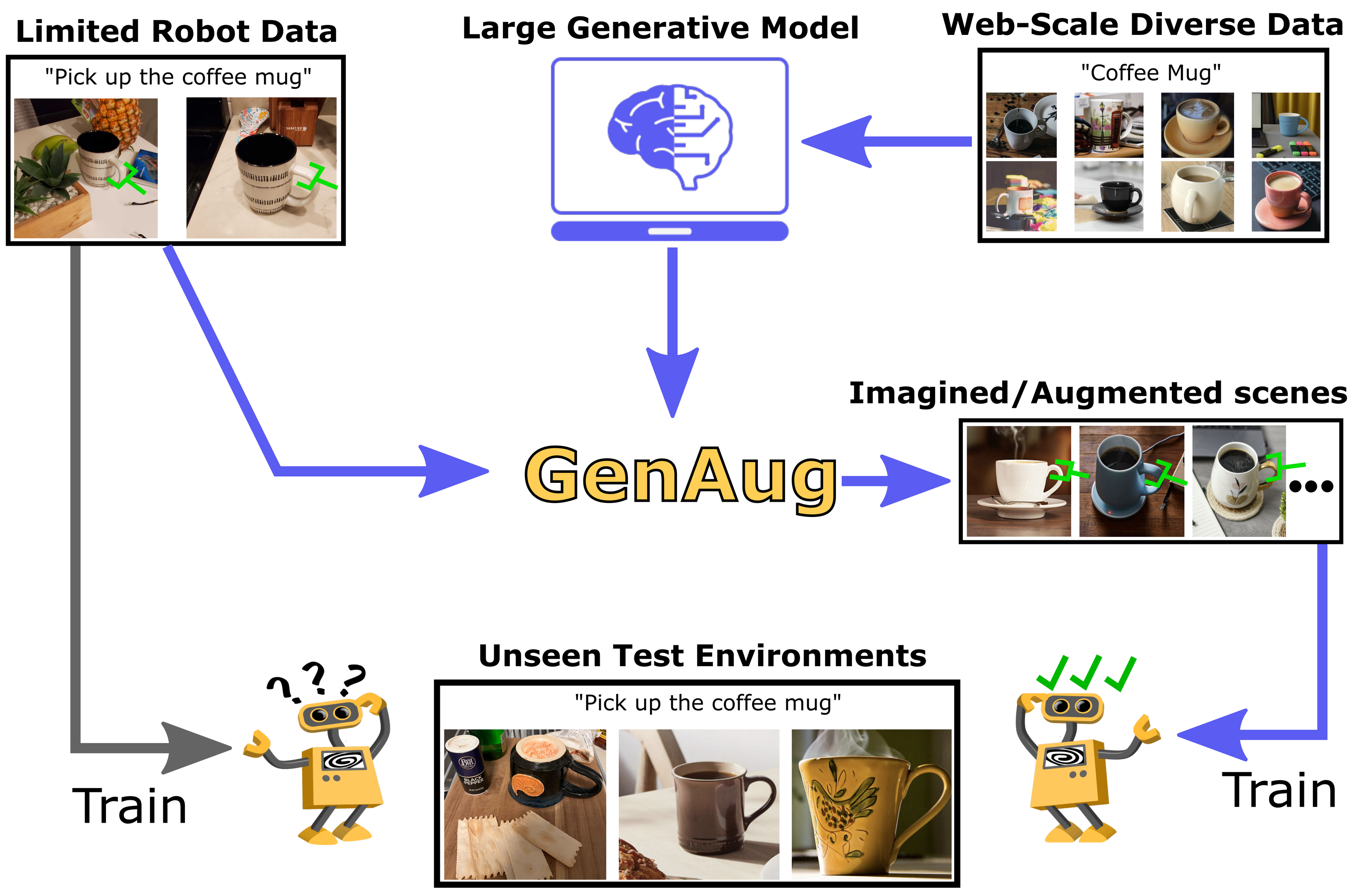
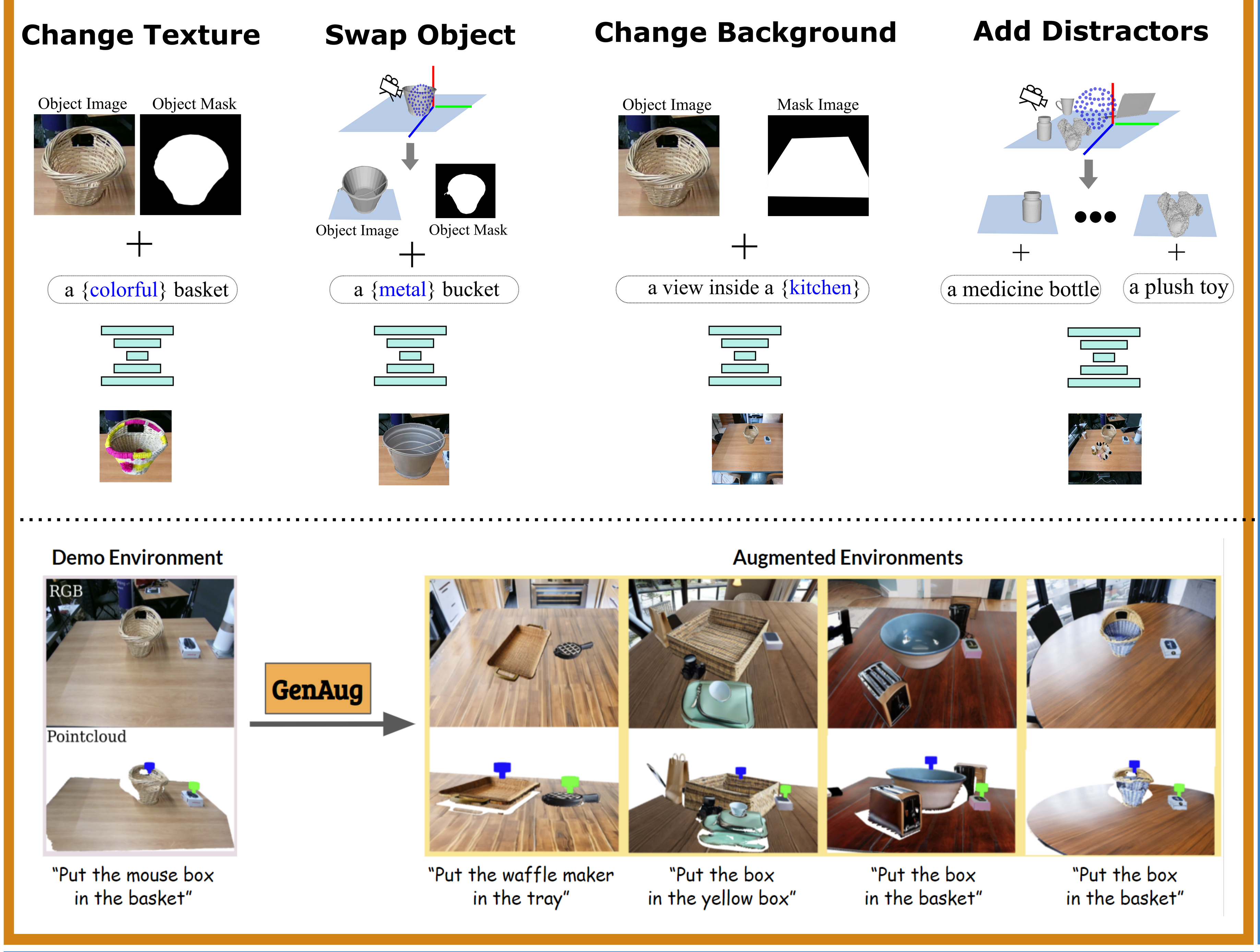
Training Robots With Limitd Data

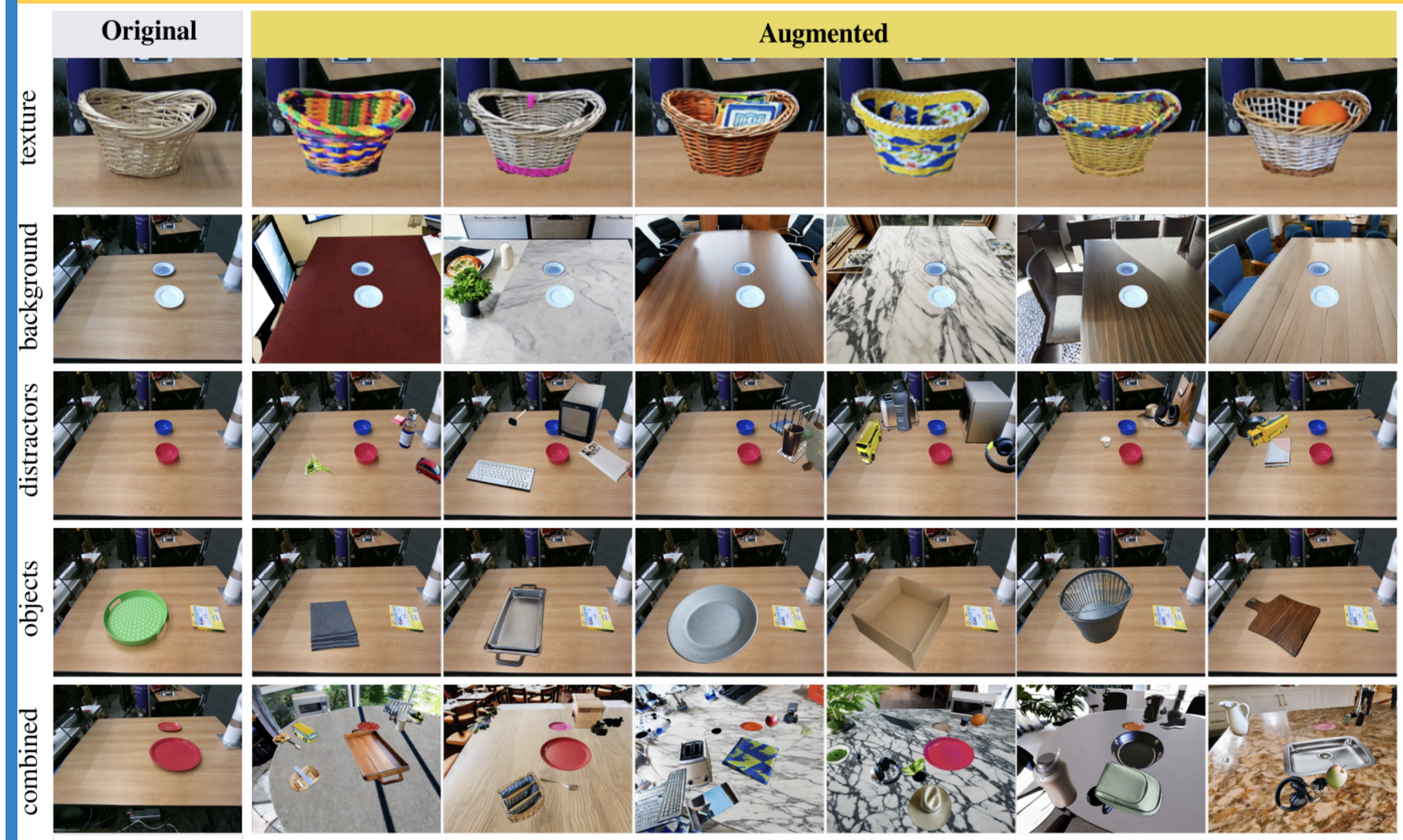
Can robots get **huge**, **free** and **diverse** data via large generative models?



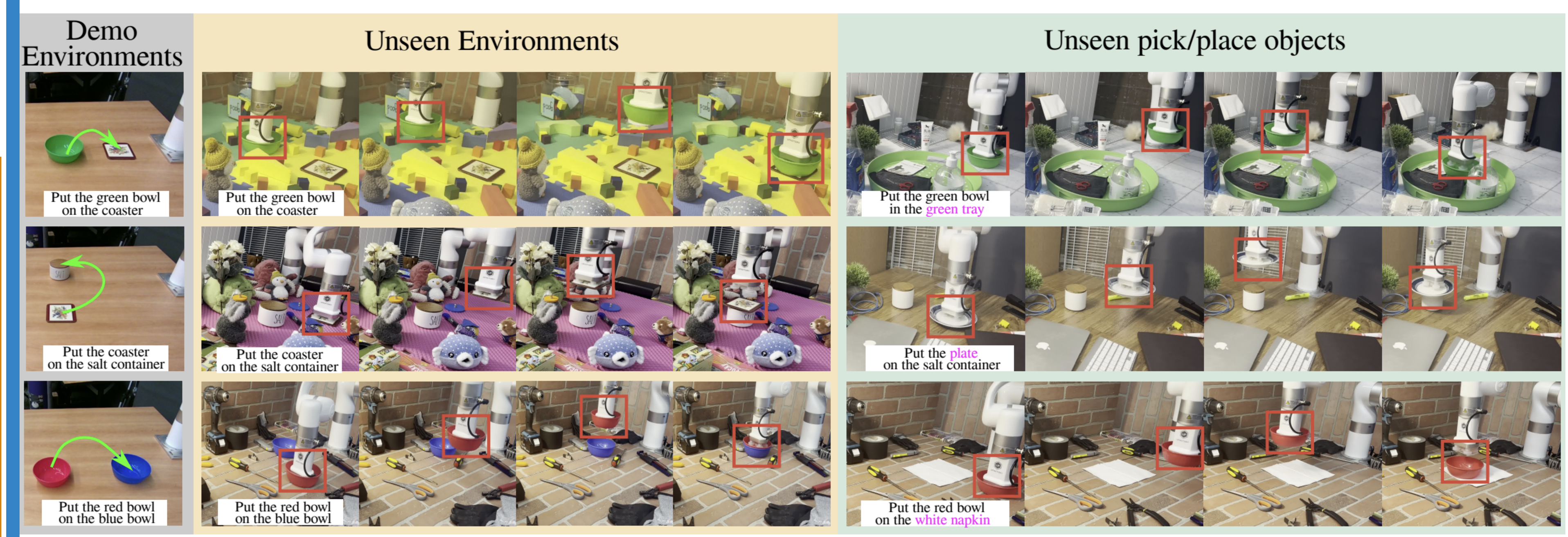
GenAug: A Controllable RGBD Data Augmentation Method



GenAug Results



Robot Results



Real World: Language-guided policy trained with and w/o GenAug on 10 pick and place tasks

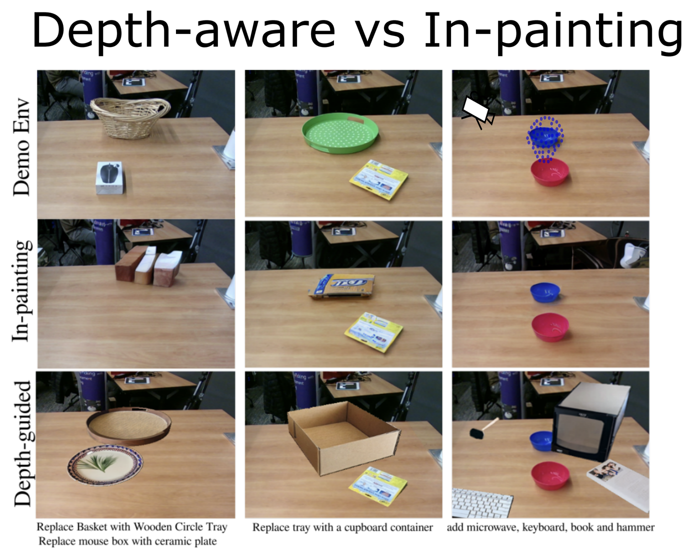
	box to tray			box to basket			coaster to dust pan			plate to tray			bowl to coaster		
	env	pick	place	env	pick	place	env	pick	place	env	pick	place	env	pick	place
No GenAug	0.8	0	0	0.2	0.2	0	0.8	0.4	0.4	0	0	0	0	0	0
GenAug	**1**	**0.6**	**1**	**0.6**	**0.6**	**0.8**	**1**	0.4	0.4	**1**	**0.4**	**0.2**	**0.6**	**0.6**	**0.6**
	plate to plate			box to box			plate to box			coaster to salt			bowl to bowl		
	env	pick	place	env	pick	place	env	pick	place	env	pick	place	env	pick	place
No GenAug	0	0	0.2	0.2	0	0	0.6	0.2	0	0.2	0	0.2	1	0.2	0
GenAug	**1**	0	**0.6**	**0.8**	**0.4**	**0.4**	**1**	**0.8**	0	**1**	**0.4**	**0.4**	1	**0.4**	**1**

Simulation: GenAug shows notable improvement on unseen test environment baselines

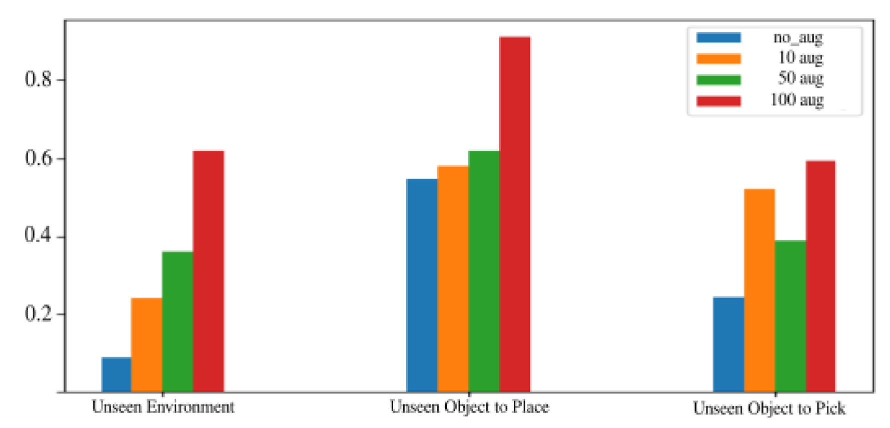
	Unseen Environment						Unseen to place						Unseen to pick					
	TransporterNet			CLIPort			TransporterNet			CLIPort			TransporterNet			CLIPort		
Method	1	10	100	1	10	100	1	10	100	1	10	100	1	10	100	1	10	100
No Augmentation	4.8	8.1	9.8	11.7	14.3	14.4	15.1	30.4	52.6	39.4	40.8	44.6	8.5	34.6	54.9	46.0	67.0	64.1
Spatial Augmentation	11.0	12.2	8.3	23.3	16.1	26.7	44.3	50.5	65.3	26.1	36.9	50.7	53.6	57.2	66.4	38.2	56.9	80.3
Random Copy Paste	**53.1**	67.0	73.5	38.2	39.8	64.3	55.1	65.4	**84.9**	39.7	55.9	73.9	48.3	67.0	76.1	52.5	65.0	81.0
Random Background	53.0	75.3	79.1	33.6	62.2	55.4	24.5	22.1	35.5	7.6	9.9	17.9	44.4	40.7	35.9	19.2	52.7	72.3
Random Distractors	10.1	9.7	13.7	15.4	36.2	35.8	28.2	60.7	66.0	27.5	51.8	54.3	42.5	47.4	62.3	31.0	64.0	69.1
R3M Finetune	4.1	6.0	4.8	22.2	16.8	20.9	43.5	40.6	41.9	30.9	43.5	57.5	45.6	45.7	41.1	46.7	50.7	72.7
GenAug	43.9	58.5	77.6	46.6	57.0	71.9	**69.1**	**76.5**	83.6	62.6	**83.9**	**86.3**	**75.3**	75.6	**87.2**	**61.5**	**77.7**	**83.1**
***GenAug* (w Depth)**	47.8	**83.8**	**91.2**	**47.2**	**60.9**	**73.4**	39.9	67.2	74.2	**64.8**	73.8	84.6	71.2	**83.4**	87.1	56.2	67.3	81.5

Analysis

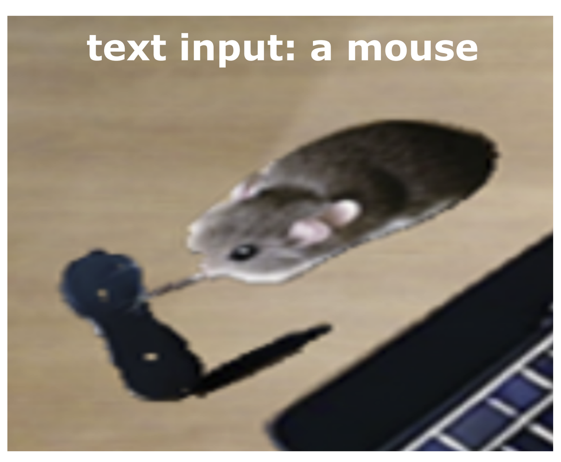
Depth-aware vs In-painting



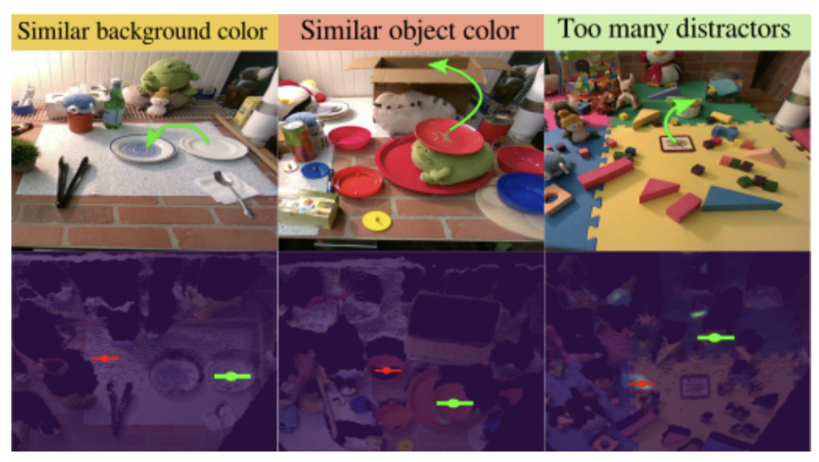
Performance vs Augmentation



Failure Cases

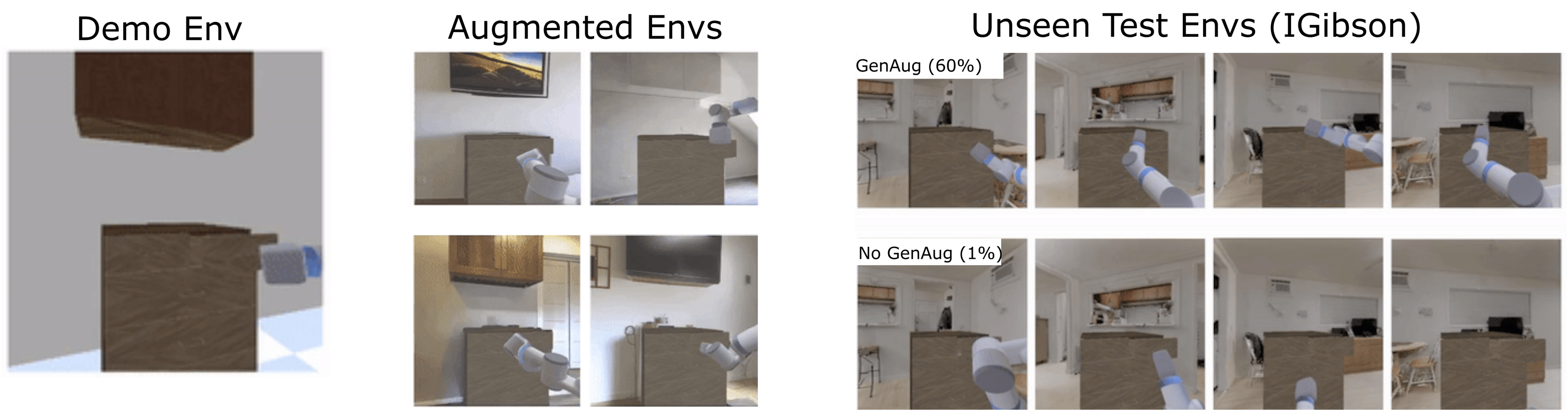


GenAug is based on text-to-image diffusion models, it cannot gaurantee the generated images are perfect.



Typical Failure cases occur when the background color is similar to the pick or place object. Or one of a few distractors has a very bright color or similar colors.

Beyond Pick-and-place Tasks



In addition,we test GenAug on a new task "close the top drawer" with a fetch robot. In particular, We tested on 100 unseen backgrounds using iGibson rooms and observed GenAug is able to achieve 60% success rate while policy without Genaug is only 1%.

Limitations

1. Assume the Same Action:

GenAug does not augment action labels and reason about physics parameters. It assumes the same action still works on the augmented scenes.

2. Augmentation & Speed:

GenAug cannot guarantee visual consistency for frame augmentation in a video. GenAug usually takes about 30 seconds to complete all the augmentations for one scene, which might not be practical for some approaches such as on-policy RL.

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