Salient Object Detection in 360 videos

#	Title	Year	Venue	Description
1	Salient Object Detection: A Survey [8]	2014	Computational Visual Media	A review of SOD methods before 2014.
2	A Review of Eye Gaze in Virtual Agents, Social Robotics and HCI: Behaviour Generation, User Interaction and Perception [54]	2015	Comput.Graph.Forum	A report introduces exhaustive concepts of human eye; a review of eye-gaze-related researches edifies future CV development.
3	Saliency Prediction in the Deep Learning Era: Successes and Limitations [7]	2019	TPAMI	A review of deep learning-based models and datasets/metrics for 2D saleincy prediction.
4	Salient Object Detection in the Deep Learning Era: An In-Depth Survey [64]	2020	arXiv	A review of SOD methods before 2020.
5	VR content creation and exploration with deep learning: a survey [62]	2020	Computational Visual Media	A review of deep learning-based methods for VR images/videos processing.
6	On the Synergies between Machine Learning and Stereo: a survey [47]	2020	arXiv CVPR2019(tutorial)	A review of deep learning-based models for monocular depth estimation in panoramas.
7	Deep Audio-Visual Learning: A Survey [91]	2020	arXiv	A review of audio-visual learning methods before 2019.

Table 1: Summary of previous reviews.

No.	Model	Year	Pub.	Task	SL.	Base	Label	Loss	Metric	Training Set	# training	code
1	360-spatialization [43]	2018	NIPS	SS	Sel.	STFT/UNet	Non	STFT-distance	STFT/ENV/EMD	REC-STREET YT-ALL	123k 0.1s samples 3976k samples	py-o
2	AVE/AVOL-Net [4]	2018	ECCV	cmR/L	Sel.	CNN/FC	Non	AVC [3]	nDCG/heatmap [44]	AudioSet [26]	263K 10s clips	py-n/o
3	DMRFE/AVDLN [59]	2018	ECCV	EL/cmL	S/W	CNN/LSTM	Tem.	MCE/L_c	heatmap/accuracy	AVE [59]	4K(T.) $\geq$2s clips	py-o
4	PixelPlayer [87]	2018	ECCV	SS/L	Sel.	ResNet/STFT	Non	SCE/L1	NSDR/SIR/SAR	MUSIC [87]	500 videos	py-o
5	SoundLoc [55]	2018	CVPR	L	W	CNN/FC	bbox	SSL [55]	cIoU [55]	Flickr-SoundNet [5]	144K frames	Non
6	**A/V-CoSeg** [53]	2019	ICASSP	Seg/SS	Sel.	UNet/ResNet	pol.	BCE	IoU/SDR/SIR	AVE [59]	3,339 $\geq$2s clips	Non
7	VehicleTrack [21]	2019	ICCV	Track	Sel.	YOLOv2	bbox	Rank [6]/OD [52]	AP	AudioVideoTrack [21]	227K 1s clips	Non
8	DDT [86]	2019	ICCV	L/SS	Sel.	I3D [9]	Non	BCE(on spec.)	SDR/SIR/SAR/HE	MUSIC-21 [86, 87]	1,065 videos	Non
9	CO-SEPARATION [24]	2019	ICCV	SS	Sel.	UNet/STFT	Non	CE [24]/L1	SDR/SIR/SAR	[26, 87]/AVBench [22]	122K 10s clips	py
10	MONO2BINAURAL [23]	2019	CVPR	m2b/SS	Sel.	UNet/STFT	Non	L2/L1	STFT/ENV-Dis. SDR/SIR/SAR	FAIR-Play [23]	1,497 10s clip	py-o
11	VSLNet [81]	2020	ACL	NLVL	S	CNN	mom.	CE	IoU	[81]	60K moments	py-o
12	IMGAUD2VID [25] IMGAUD-SKIMMING [25]	2020	CVPR	AR	U	LSTM/R21D distillation	cls	L1/KL	mAP	Kinetics [29]	300K 10s clips	py-o
13	Music-Gesture [20]	2020	CVPR	SS	U	CNN/GCN	KP	SCE	SDR/SIR	MUSIC	mix-2/3 samples	-

Table 2: **Summary of recently proposed models for audio-visual learning.** cmR = cross-modal retrieval. L = (sound source) localization. EL = event localization. cmL = cross-modal localization. SL. = supervision level. S = supervised. W = weakly supervised. U = un-supervised. Sel. = self supervised. T = traditional method. CNN = convolutional neural network. FC = fully connected layer. py = python. n/o = non official. Tem. = temporally labeled segments (viusal/audio). MCE = multi-class cross-entropy loss. L_c = contrastive loss function. SS = sound separation. STFT = Short- Time Fourier Transform. NSDR = Normalized Signal-to-Distortion Ratio. SIR = Signal-to-Interference Ratio. SAR = Signal-to-Artifact Ratio. SCE = sigmoid cross entropy. SSL = semi-supervised loss. frm = frames. BCE = binary cross entrophy. pol. = polygon. OD = object detection. HE = human evaluation. CE = cross entrophy. m2b = mono to binaural. AR = action recognition. cls = class. NLVL = natural language video localization. mom. = moments annotations. KP = key points.

No.	Dim.	Model	Year	Pub.	Task	Base	Training Set	Label	# training	F_β	F_β^ω	M	S_α	E_ξ	code
1	2D-RGB	SAM [56]	2020	CVPR	r-SOD	CNN	-	o-pw							
2	360-RGB	DDS [36]	2020	JSTSP	SOD	CNNs	360SOD [36]	o-pw	400 images	.650	.652	.023	-	-	py-o
3	2D-RGBD	UCNet [82]	2020	CVPR	SOD	CVAE [57]	AugedGT [82]	o-pw	-	.855∼.919	-	.019∼.066	.864∼.934	.901∼.967	-
4	2D-RGBD	JLDCF [18]	2020	CVPR	SOD	VGG16 ResNet101	NLPR NJU2K	o-pw	2,2K images	.862∼.919	-	.022∼.078	.854∼.929	.893∼.968	-
5	2D-RGBD	SSF [84]	2020	CVPR	SOD	CIM CAU/BSU	DUT-RGBD NLPR	o-pw	1,485 images 700 images	.867∼.915	-	.025∼.044	.859∼.915	-	-
6	2D-RGB	F^3Net [67]	2020	AAAI	SOD	CFD/CFM MLS	DUTS-TR	o-pw	10,533 images	.766∼.925	-	.028∼.062	.838∼.924	.859∼.953	-
7	2D-RGB	DFI [38]	2020	arXiv	SOD ed./sk.	CNNs PPM [88]	DUTS-TR [61]	o-pw	10,533 images	.829∼.945	-	.031∼.100	.802∼.921	-	-
8	2D-RGB	SISO [31]	2019	WACV	SOD	3D FCN [30]	SESIV [31]	i-pw	58 videos (3,944 frames)	-	-	-	-	-	m.-o
9	2D-RGB	SVSNet [66]	2019	ACM MM	r-SOD	FCN	RVSOD [66]	o-pw	242 videos (7140 frames) DAVIS [46]/DUT [78]	.816 .745(DAVIS)	-	.089 .047(DAVIS)	-	-	py-o
10	2D-RGB	RSDNet [2]	2018	CVPR	r-SOD	ResNet101	Pascal-S [37]	o-pw	425 images	.880	-	.090	-	-	ca-o

Table 3: **Summary of recently proposed models for salient object detection.** SOD = salient object detection. F_β = F-measure [1]. F_β^ω = weighted F-measure [40]. M = mean absolute error [45]. S_α = S-measure [15]. E_ξ = E-measure [16]. (n/)o = (non) official. o(i)-pw = object(instance)-level pixel-wise annotations. m. = matlab. ca = caffe. py = python. ed. = edge detection. sk. = skeleton detection. r-SOD = ranking SOD.

No.	Dim.	Model	Year	Pub.	Base	Training Set	# Training	Label	Code	Key Issue
1	2D	MD-SEM [17]	2020	CVPR	LSTM	-	-	-	-	multi-duration saliency prediction
2	2D	GradCAM [51]	2020	CVPR	-	-	-	-	-	class sensitive/meta-saliency
3	2D	STAViS [60]	2020	CVPR	-	-	-	-	-	audio visual saliency
4	2D	[80]	2020	CVPR	-	-	-	-	-	trajectory
5	2D									
4	360	MT-DNN [48]	2020	TMM	CNNs/convLSTM	[76]	65 videos (3,501 viewports)	SalMap	py-o	viewports influence fixations
5	2D	UVA-Net [19]	2020	AAAI	knowledge distillation	AVS1K...	1K aerial videos	SalMap	-	accelerating SP
3	360	DHP [76]	2019	TPAMI	DRL [42]	PVS-HM [76]	61 videos	HM map	py-o	-
4	2D	DAVE [58]	2019	arXiv	3D ResNet log mel-spectrogram	AVE [58]	150 videos	SalMap	py-o	visual-audio SP
5	2D	SKD-DVA [35]	2019	TIP	knowledge distillation	-	-	SalMap	-	accelerating SP
6	2D	TASED-Net [41]	2019	ICCV	3D FCN (S3D [75])	DHF1K [65]	700 videos	Fixations	-	3D-FCN for video SP
7	360	E/H-SalPredict [92]	2019	TMM	EMP, HMP	Salient360! [50]	85 images	SalMap	-	-

Table 4: **Summary of recently proposed models for saliency prediction.** SP = saliency prediction. HM = head movement.

No.	Task	Method	Year	Pub.	Components	Training Set	#Training	Label
1		GaugeMeshCNNS [12]	2020	arXiv				
2		Jiang						
3		Zhang						
4		gaugeIcosaCNNS						
5	Classification SS	tangent-360 [14]	2020	CVPR	-	-	-	-
6	D-epth Estimation	(waiting for paper...) [32]	2020	CVPR	-	-	-	-
7	Depth Estimation	OmniMVS [68]	2020	TPAMI	uncertainty prior	Weather/House/Thing	700/2048/9216 images	-
8	Depth Estimation	360SD-Net [63]	2020	ICRA	ASPP [10]	MP3D/SF3D	1602/800 images	-
9	Classification	SGCN [79]	2020	CVPR	GConv, HPool	ModelNet40 [71]	9843 samples	cls
10	VP	MDN [69]	2020	AAAI	s2cnn [69]	PanoUCF101 [69]	35 users records	cls
11	OD Evaluation	Rep R-CNN [90]	2020	AAAI	SphBB, SphIoU	ImageNet	-	bbox
12	VQA	V-CNN [34]	2019	CVPR	VP/VQ-Net	VQA-ODV [33]	432 impired videos	HM info.
13	OD/IS/SS	Pano-BlitzNet [27]	2019	arXiv	BlitzNet [13]	SUN360 [74]	400 images	i-pw
14	VQA	FAST-VQA [70]	2019	TMM	spatial quality degradation	-	-	tra.
15	Theory	[11]	2019	NeurIPS				

Table 5: **Summary of recent methods for 360 processing.** OD = object detection. IS = instance segmentation. SS= semantic segmentation. o(i)-pw = object(instance)-level pixel-wise annotations. cls = class. VP = viewport prediction. VQA = video quality assessment. tra. = salient trajectories.

No.	Task	Method	Year	Pub.	Data	Label	Training	Key issue
1	Pose/Seg	PoseSeg [85]	2019	CVPR				

Table 6: **Summary of recent human centric researches.**

ID	Description
MP	Multiple Persons
OC	Occlusions
MB	Motion Blur (Fuzzy boundaries)
BP	Busy Persons (Persons holding objects)
LR	Low Resolution (Small objects)
SV	Scale Variation
MC	Moving Camera
SD	Serious Distortion (Objects touching ERP boundaries)
PCO	Persons Cut-off under ERP (Objects behind the camera)

Table 7: **List of video attributes.**

Model	Year	Pub.	Data
FcnResNet101 + ER	-	-	Img
FcnResNet101 + TI [14]	2020	CVPR	Img(SS)
BasNet [49]	2019	CVPR	Img
CPD [72]	2019	CVPR	Img
EgNet [89]	2019	ICCV	Img
F3Net [28]	2020	AAAI	Img
PoolNet [39]	2019	CVPR	Img
ScribbleSaliency [83]	2020	CVPR	Img
SCRN [73]	2019	ICCV	Img
RCRNet [77]	2019	ICCV	Video

Table 8: **Benchmark models.**

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