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# **GAMIVAL: VIDEO QUALITY PREDICTION ON MOBILE CLOUD GAMING CONTENT**

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# Background and Motivation

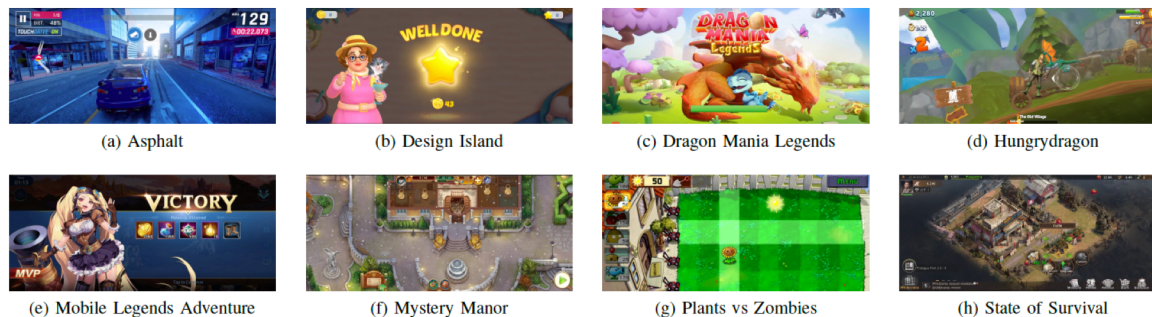
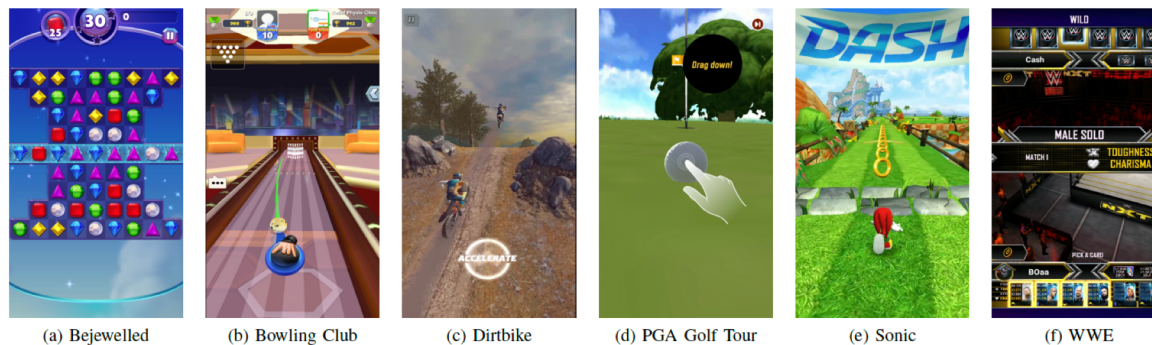


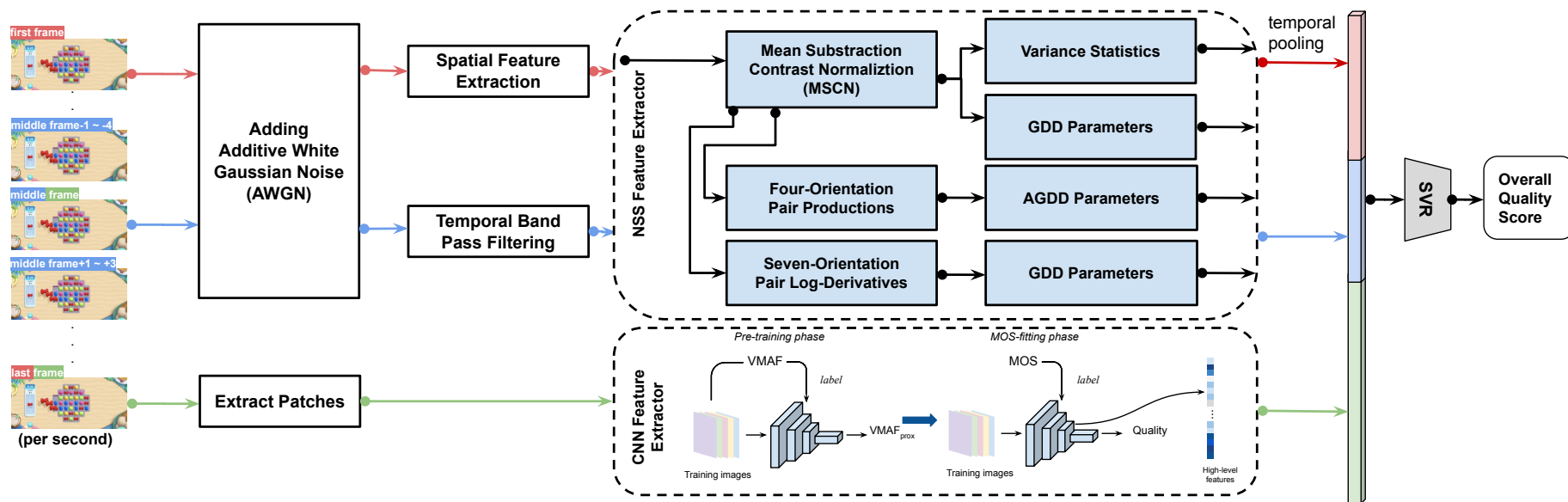
Fig. 2. Sample frames of landscape gaming videos in the LIVE-Meta Mobile Cloud Gaming Database.



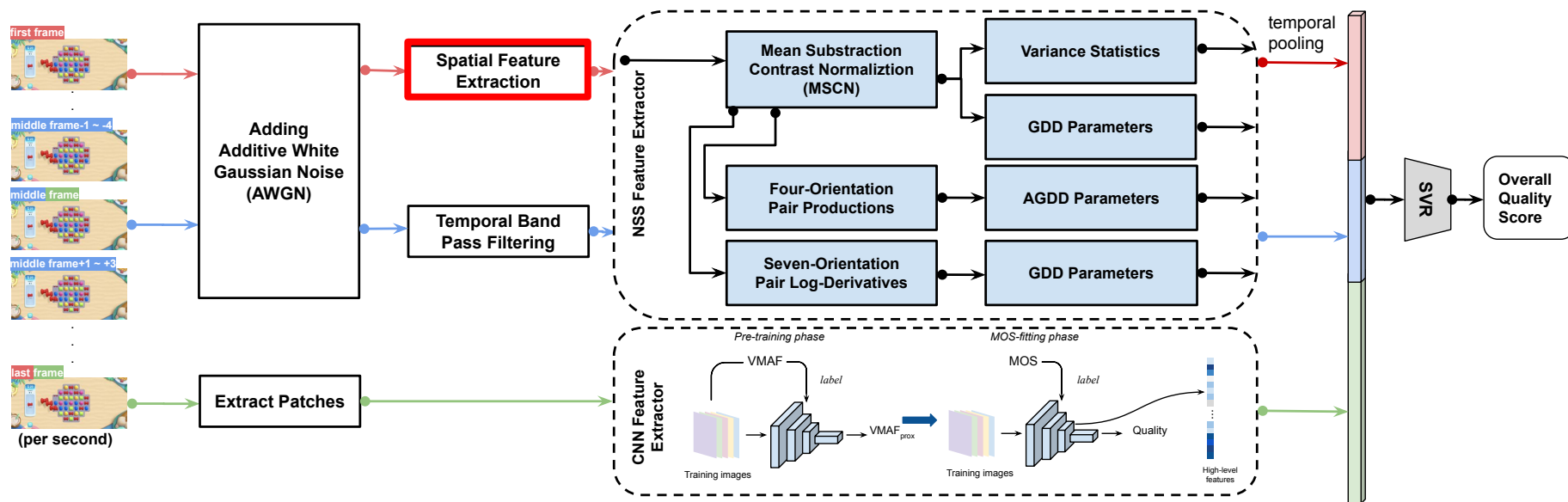
# LIVE-Meta Mobile Cloud Gaming dataset

Database	# Videos	# Source Sequences	Pristine Source Sequences	# Ratings per Video	Public	Resolution	Distortion Type	Duration	Display Device	Display Orientation	Study Type
GamingVideoSET	90	6	Yes	25	Yes	480p, 720p, 1080p	H.264	30 sec	24" Monitor	Landscape	Laboratory
KUGVD	90	6	Yes	17	Yes	480p, 720p, 1080p	H.264	30 sec	55" Monitor	Landscape	Laboratory
CGVDS	360 + anchor stimuli	15	Yes	Unavailable	Yes	480p, 720p, 1080p	H.264 NVENC	30 sec	24" Monitor	Landscape	Laboratory
TGV	1293	150	No	Unavailable	No	480p, 720p, 1080p	H.264, H.265, Tencent codec	5 sec	Unknown Mobile Device	Landscape	Laboratory
LIVE-YT-Gaming	600	600	No	30	Yes	360p, 480p, 720p, 1080p	UGC distortions	8-9 sec	Multiple Devices	Landscape	Online
LIVE-Meta Mobile Cloud Gaming	600	30	Yes	24	Yes	360p, 480p, 540p, 720p	H.264 NVENC	20 sec	Google Pixel 5	Landscape, Portrait	Laboratory

# Gaming Video Quality Evaluator (GAMIVAL) model



# Components of the GAMIVAL model



# Components of the GAMIVAL model

## A. Spatial Domain Features + Neural Noise

$$\hat{I} = \frac{I(i, j) - \mu(i, j)}{\sigma(i, j) + C} \quad (1)$$

$I(i, j)$  - the input image (or feature map)

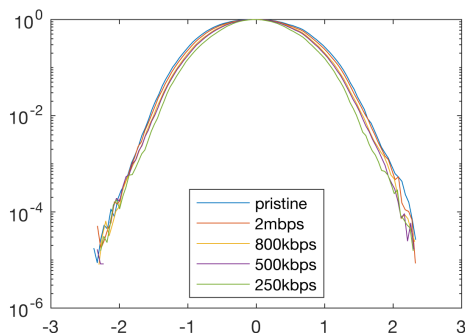
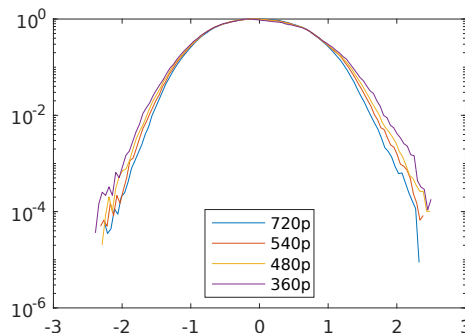
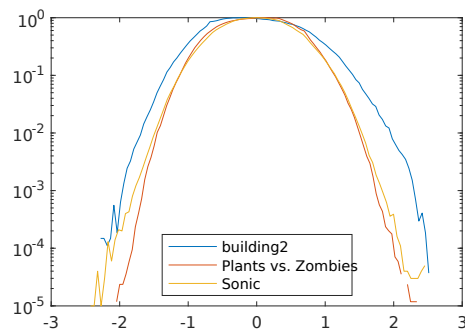
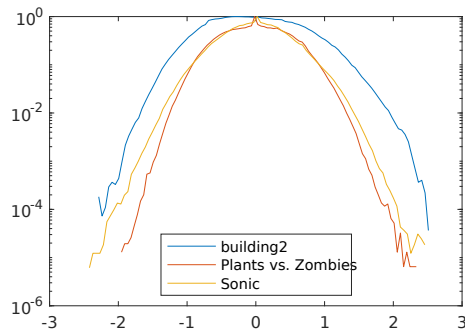
$(i, j)$  - spatial indices

$C$  - saturation constant that prevents instabilities

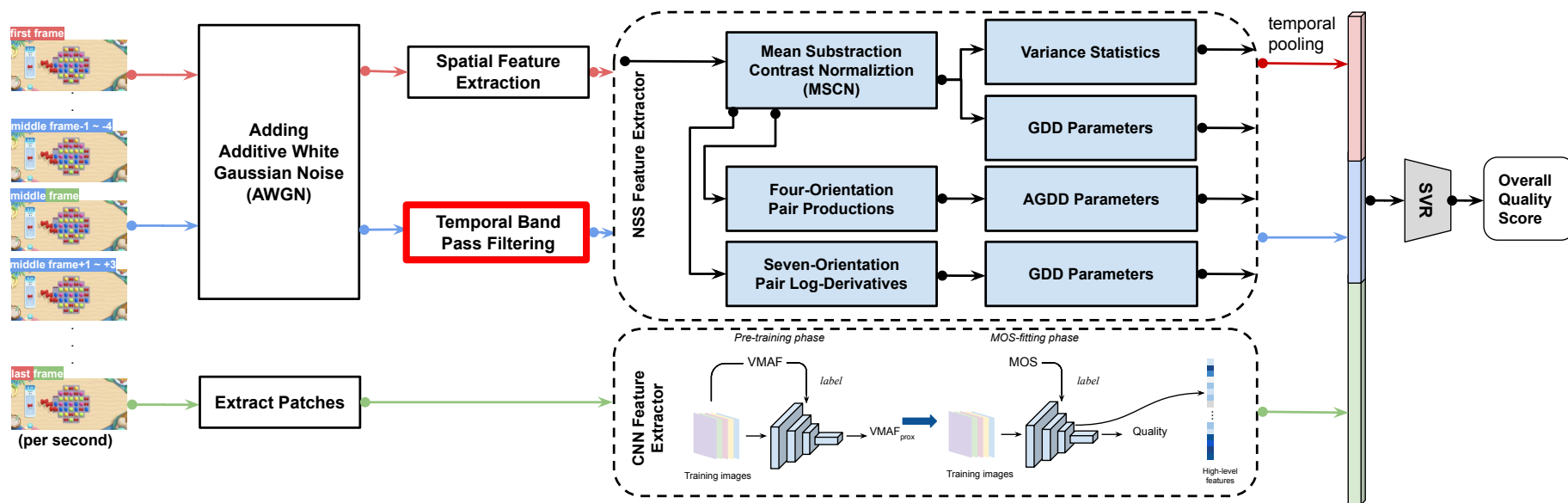
$\mu, \sigma$  - weighted local means, standard deviations

$$\tilde{I}(i, j) = I(i, j) + W_s \quad (2)$$

$W_s \sim N(0, \sigma_{W_s}^2) =$  white Gaussian noise



# Components of the GAMIVAL model



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## B. Temporal Domain Features + Neural Noise

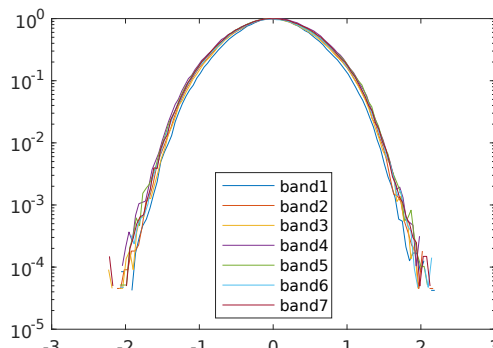
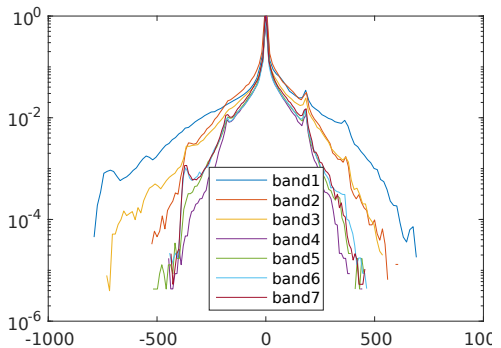
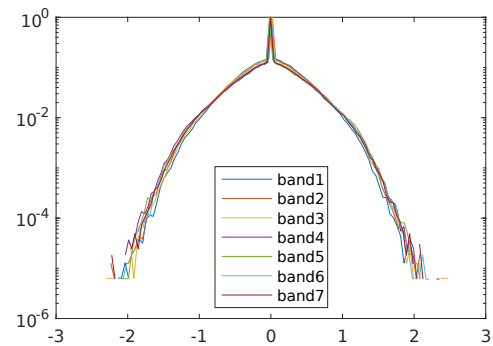
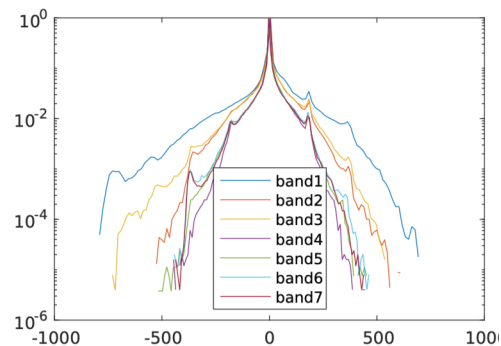
$$\tilde{Y}_k(\mathbf{x}, t) = Y_k(\mathbf{x}, t) + W_t \quad (3)$$

$Y_k(x, t)$  - temporal bandpass coefficients

$k = 1, \dots, 7$  denotes subband indices

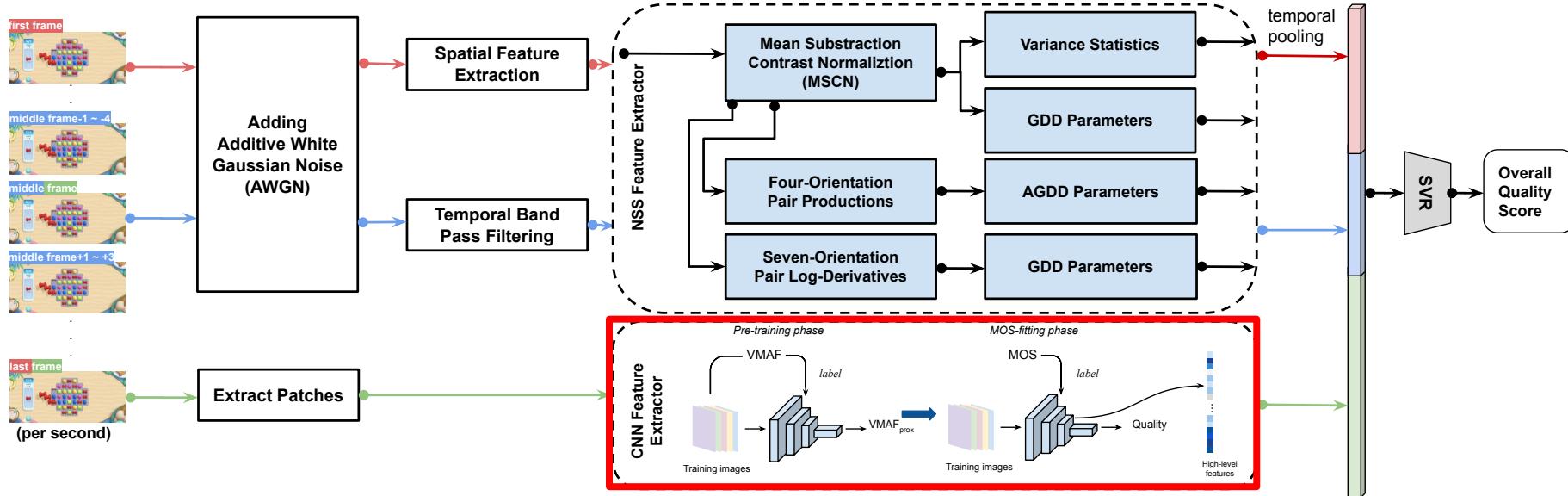
$\mathbf{x} = (x, y)$  and  $t$  are spatial and temporal coordinates

$W_t \sim N(0, \sigma_{W_t}^2)$  - the noise added to the model



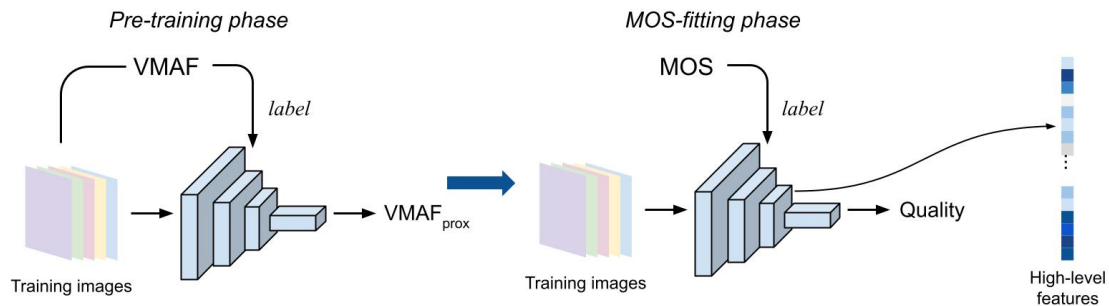


# Components of the GAMIVAL model



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C. CNN-based Features We used NNetGaming model as a useful quality indicator by training a shallow regressor on top of the simple feature vector of an fully connected layer.



# Performance comparison

DATASET	LIVE-Meta-Mobile Gaming (600 videos)			
	SRCC↑	KRCC↑	PLCC↑	RMSE↓
NIQE (1 features)	-0.3900	-0.2795	0.4581	16.5475
BRISQUE (36 features)	0.7319	0.5395	0.7394	12.5618
TLVQM (75 features)	0.6553	0.4777	0.6889	13.5413
VIDEVAL (60 features)	0.7621	0.5756	0.7763	11.7520
RAPIQUE (3884 features)	<b>0.8740</b>	<b>0.6964</b>	<b>0.9039</b>	<b>8.0242</b>
GAME-VQP (2088 features)	0.8709	0.6885	0.8882	8.5960
VSFA (4096 features)	<b>0.9143</b>	<b>0.7484</b>	<b>0.9264</b>	<b>7.1316</b>
Proposed Model (2180 features)	<b>0.9441</b>	<b>0.7963</b>	<b>0.9524</b>	<b>5.7683</b>

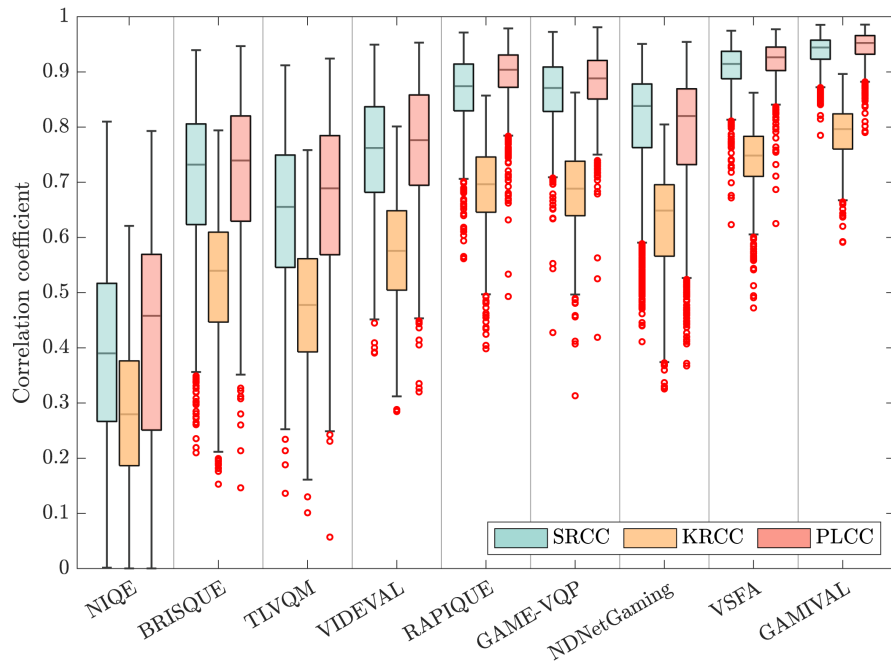
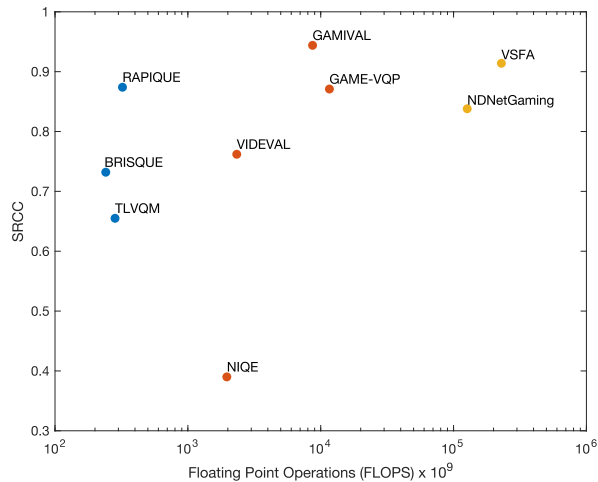
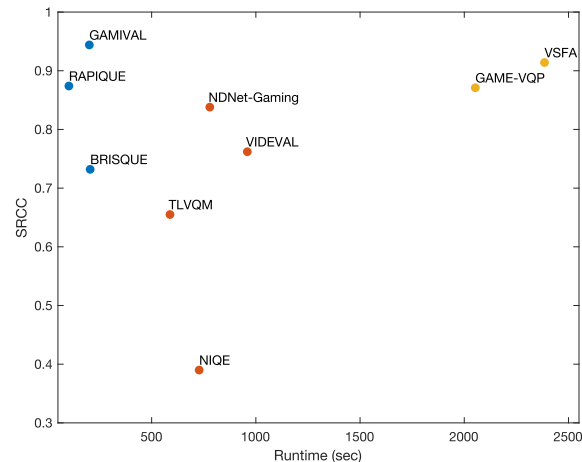


Fig. Box plots of PLCC, SRCC, and KRCC of evaluated BVQA algorithms on the LIVE-Meta-Mobile Gaming dataset over 100 splits. For each box, median is the central box, and the edges of the box represent 25<sup>th</sup> and 75<sup>th</sup> percentiles, while outliers are red circles.

# Computation complexity

Model	Platform	Time (seconds)	FLOPS ( $\times 10^9$ )
NIQE	MATLAB	728	1965
BRISQUE	MATLAB	<b>205</b>	<b>241</b>
TLVQM	MATLAB	588	<b>283</b>
VIDEVAL	MATLAB	959	2334
RAPIQUE	MATLAB	<b>103</b>	<b>322</b>
GAME-VQP	MATLAB	2053	11627
NDNet-Gaming	Python, Tensorflow	779	126704
VSFA	Python, Pytorch	2385	229079
<b>GAMIVAL</b>	Python, Tensorflow, MATLAB	<b>201</b>	<b>8683</b>



# Appendix

$\sigma_{W_s}, \sigma_{W_t}$	SRCC( $\uparrow$ )	KRCC( $\uparrow$ )	PLCC( $\uparrow$ )	RMSE( $\downarrow$ )
0	0.8949	0.7252	0.9108	7.5875
0.01	0.9371	0.7878	0.9496	5.9064
0.05	0.9376	0.7878	0.9490	5.8108
0.1	0.9374	0.7887	0.9520	<b>5.6773</b>
0.3	0.9407	0.7893	0.9521	<b>5.6177</b>
0.5	<b>0.9427</b>	<b>0.7955</b>	<b>0.9550</b>	5.7544
1	0.9392	0.7886	0.9505	5.7000
1.5	<b>0.9439</b>	<b>0.7962</b>	<b>0.9526</b>	5.6941
2	0.9366	0.7857	0.9493	5.8625
3	0.9387	0.7893	0.9494	5.7856



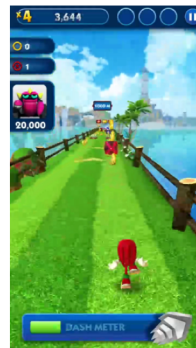
(a) MOS=73.96,  
RAPIQUE=67.14,  
GAMIVAL=77.08



(b) MOS=73.14,  
RAPIQUE=66.38,  
GAMIVAL=74.05



(c) MOS=51.57,  
RAPIQUE=59.55,  
GAMIVAL=54.69



(d) MOS=40.10,  
RAPIQUE=56.78,  
GAMIVAL=48.39

