Generalized Single-Image-Based Morphing Attack Detection Using Deep Representations from Vision Transformer: Supplementary Material

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1. Complete tables of MAD performances

In this section, detailed results of quantitative MAD performance are included. Statistical analysis and discussions are in the main body of the paper. In each table, the intra-dataset testing case with the same training and testing dataset is marked with blue colour. Within each cross-dataset testing case (e.g., trained with Landmarks-I in the digital type of images, tested with Landmarks-II in the digital type of images), the best-performed value is marked in bold.

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Table 1. Quantitative performance of MAD on FRGC morph database. Training morphing type: Landmarks-I [4].

Testing Morphing Type	**MAD Algorithms**	**Digital**			**Print-scan**			**Print-scan with compression**		
		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =	
			5.00%	10.00%		5.00%	10.00%		5.00%	10.00%
Landmarks-I [4]	Ensemble Features [9]	**0.00**	**0.00**	**0.00**	2.35	1.45	0.96	2.58	1.71	1.54
	Hybrid Features [6]	0.16	**0.00**	**0.00**	1.85	0.85	0.34	2.25	1.12	0.51
	Deep Features [5]	**0.00**	**0.00**	**0.00**	2.85	1.25	0.17	2.05	1.02	0.17
	Steerable Features [7]	5.48	6.12	3.60	23.59	62.90	46.48	27.14	71.52	57.28
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	0.52	1.42	0.71	0.17
	Residual AutoEncoder [2]	**0.00**	**0.00**	**0.00**	0.86	**0.00**	**0.00**	0.69	**0.00**	**0.00**
	Multi-level Deep Features [8]	**0.00**	**0.00**	**0.00**	1.37	0.51	0.17	1.53	0.51	0.17
	Proposed Method	0.51	**0.00**	**0.00**	2.23	0.86	0.52	1.89	1.03	0.69
Landmarks-II [1]	Ensemble Features [9]	49.55	92.22	88.85	41.93	81.45	76.25	42.15	83.88	77.64
	Hybrid Features [6]	49.16	99.31	97.59	44.17	86.48	80.24	46.49	88.38	81.95
	Deep Features [5]	42.36	88.46	77.28	41.90	85.04	72.30	41.58	91.17	71.11
	Steerable Features [7]	50.00	99.48	98.45	50.00	93.89	88.13	47.39	92.14	83.68
	Multi-Modality [3]	41.51	80.61	71.86	35.37	79.64	73.92	37.86	84.46	76.96
	Residual AutoEncoder [2]	44.86	82.82	82.82	**29.65**	99.48	94.85	30.63	97.94	87.97
	Multi-level Deep Features [8]	26.08	59.86	46.31	30.22	**65.44**	**55.32**	**30.07**	**64.93**	**54.51**
	Proposed Method	**23.50**	**49.57**	**40.99**	40.10	85.59	75.35	37.26	88.21	79.03
StyleGAN [10]	Ensemble Features [9]	0.22	**0.00**	**0.00**	13.36	27.44	16.46	14.77	27.27	19.38
	Hybrid Features [6]	0.16	**0.00**	**0.00**	44.96	83.70	75.47	9.44	14.57	9.14
	Deep Features [5]	0.16	**0.00**	**0.00**	1.08	0.17	**0.00**	8.92	12.00	8.17
	Steerable Features [7]	7.16	9.77	4.63	3.46	2.42	1.54	38.91	87.30	79.58
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	5.34	**5.35**	3.21
	Residual AutoEncoder [2]	0.17	**0.00**	**0.00**	6.36	8.76	4.64	6.03	6.19	3.78
	Multi-level Deep Features [8]	0.32	**0.00**	**0.00**	3.95	2.05	0.51	**5.32**	5.83	**2.74**
	Proposed Method	2.57	1.37	0.34	12.35	23.16	14.75	12.35	25.56	14.07
MIPGAN-I [11]	Ensemble Features [9]	39.16	73.14	65.35	9.45	14.57	8.74	8.95	15.26	9.26
	Hybrid Features [6]	46.82	86.62	81.64	12.32	19.72	13.20	9.74	15.95	8.91
	Deep Features [5]	44.94	84.59	74.47	3.73	2.40	1.02	23.83	66.55	49.22
	Steerable Features [7]	50.00	99.82	97.59	3.26	2.22	2.15	28.82	79.24	60.20
	Multi-Modality [3]	41.39	78.79	72.55	**0.00**	**0.00**	**0.00**	**8.14**	**10.89**	**7.14**
	Residual AutoEncoder [2]	16.42	29.21	20.45	33.33	96.05	90.03	25.49	98.11	89.00
	Multi-level Deep Features [8]	20.97	46.65	34.13	11.35	29.84	14.57	23.47	62.60	47.34
	Proposed Method	**11.15**	**23.16**	**12.35**	19.38	40.31	28.82	27.62	62.95	48.89
MIPGAN-II [11]	Ensemble Features [9]	34.13	70.49	61.57	5.32	6.68	2.57	6.72	8.16	4.14
	Hybrid Features [6]	44.96	83.7	75.47	5.90	8.42	3.23	5.67	6.18	2.91
	Deep Features [5]	40.37	60.32	50.36	1.36	**0.00**	**0.00**	8.37	24.69	16.17
	Steerable Features [7]	50.00	98.77	97.25	6.84	7.54	6.12	31.16	85.42	73.75
	Multi-Modality [3]	35.86	66.72	56.43	**0.00**	**0.00**	**0.00**	**4.47**	**3.57**	0.35
	Residual AutoEncoder [2]	13.92	21.82	17.01	8.80	77.66	1.03	5.60	8.06	**0.17**
	Multi-level Deep Features [8]	19.20	39.79	29.50	3.95	2.05	0.51	8.73	26.07	6.34
	Proposed Method	**8.40**	**12.52**	**6.35**	5.15	5.49	0.86	8.58	24.01	3.77

Table 2. Quantitative performance of MAD on FRGC morph database. Training morphing type: Landmarks-II [1].

Testing Morphing Type	**MAD Algorithms**	**Digital**			**Print-scan**			**Print-scan with compression**		
		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =	
			5.00%	10.00%		5.00%	10.00%		5.00%	10.00%
Landmarks-I [4]	Ensemble Features [9]	48.57	97.77	95.36	24.19	52.48	43.22	21.64	47.51	36.19
	Hybrid Features [6]	45.67	96.91	94.16	32.26	77.87	66.55	24.51	50.94	40.65
	Deep Features [5]	47.22	89.94	68.98	26.66	55.40	42.53	25.24	51.80	40.99
	Steerable Features [7]	50.00	95.12	91.25	37.72	93.48	82.84	37.13	92.62	83.71
	Multi-Modality [3]	19.54	42.36	31.21	34.29	84.28	73.32	38.19	81.42	71.25
	Residual AutoEncoder [2]	**3.59**	**2.58**	**1.72**	**9.85**	**19.97**	**9.72**	**13.82**	**44.44**	**21.01**
	Multi-level Deep Features [8]	14.92	33.10	22.64	29.40	61.57	51.11	24.02	54.71	44.94
	Proposed Method	14.92	33.10	22.64	37.29	80.41	67.01	26.63	63.75	52.92
Landmarks-II [1]	Ensemble Features [9]	3.62	2.22	0.68	6.32	7.97	2.42	5.57	6.41	2.42
	Hybrid Features [6]	1.53	0.17	**0.00**	5.21	5.19	3.14	5.37	5.71	3.46
	Deep Features [5]	6.16	6.51	3.94	6.65	9.94	4.88	7.13	12.50	5.55
	Steerable Features [7]	27.78	69.46	53.68	30.55	79.75	68.05	29.54	76.41	63.19
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**1.61**	**0.53**	**0.35**	**1.82**	**0.35**	**0.17**
	Residual AutoEncoder [2]	2.58	2.06	1.72	7.99	12.15	5.73	9.38	19.97	9.2
	Multi-level Deep Features [8]	10.63	25.21	11.66	5.39	5.93	2.09	6.19	7.46	3.29
	Proposed Method	10.63	25.21	11.66	11.46	19.62	12.15	10.92	25.65	11.96
StyleGAN [10]	Ensemble Features [9]	29.67	61.92	52.48	27.18	61.57	50.60	29.18	62.14	52.48
	Hybrid Features [6]	34.76	74.44	62.95	34.80	67.23	58.14	23.17	49.22	38.25
	Deep Features [5]	30.13	35.19	40.29	1.37	0.17	0.17	26.65	57.10	46.31
	Steerable Features [7]	50.00	98.28	96.56	1.21	0.34	**0.00**	35.52	85.31	50
	Multi-Modality [3]	25.4	62.09	49.91	**0.16**	**0.00**	**0.00**	15.53	31.96	23.21
	Residual AutoEncoder [2]	**9.15**	**16.84**	**8.59**	8.16	13.19	6.25	**8.09**	**11.81**	**6.25**
	Multi-level Deep Features [8]	22.64	51.97	35.51	4.64	4.45	1.37	25.55	51.28	42.53
	Proposed Method	22.64	51.97	35.51	25.21	60.72	45.97	34.48	73.07	60.38
MIPGAN-I [11]	Ensemble Features [9]	30.23	65.35	53.17	43.92	87.65	79.24	44.24	89.23	82.33
	Hybrid Features [6]	46.29	84.04	77.01	34.16	71.18	64.66	35.50	76.84	65.52
	Deep Features [5]	38.18	77.53	67.92	1.20	0.34	0.17	27.41	65.69	52.65
	Steerable Features [7]	36.51	86.96	76.51	2.61	0.85	**0.00**	32.73	87.13	74.19
	Multi-Modality [3]	24.75	72.14	42.88	**0.37**	**0.00**	**0.00**	40.51	82.14	73.92
	Residual AutoEncoder [2]	**12.89**	**22.51**	**15.46**	6.45	7.81	3.82	**1.44**	**0.52**	**0.17**
	Multi-level Deep Features [8]	23.67	55.75	42.71	4.10	3.08	0.51	28.58	62.26	51.80
	Proposed Method	23.67	55.75	42.71	19.04	47.86	36.36	23.16	57.29	45.80
MIPGAN-II [11]	Ensemble Features [9]	27.13	58.83	45.45	33.57	77.35	65.52	40.46	84.9	75.47
	Hybrid Features [6]	46.82	83.53	75.81	35.91	77.18	65.24	36.50	79.24	68.78
	Deep Features [5]	36.71	78.73	68.61	1.04	**0.00**	**0.00**	34.40	71.18	59.69
	Steerable Features [7]	36.87	90.33	79.41	3.19	1.88	0.34	34.12	89.19	78.91
	Multi-Modality [3]	20.92	33.27	43.05	**0.91**	**0.00**	**0.00**	33.33	77.85	67.5
	Residual AutoEncoder [2]	**8.93**	**14.43**	**8.59**	4.51	4.51	2.60	**2.26**	**1.04**	**0.17**
	Multi-level Deep Features [8]	29.67	67.92	51.11	1.73	**0.00**	**0.00**	34.46	68.95	58.14
	Proposed Method	29.67	67.92	51.11	30.53	78.22	63.46	28.47	68.95	55.06

Table 3. Quantitative performance of MAD on FRGC morph database. Training morphing type: StyleGAN [10].

Testing Morphing Type	**MAD Algorithms**	**Digital**			**Print-scan**			**Print-scan with compression**		
		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =	
			5.00%	10.00%		5.00%	10.00%		5.00%	10.00%
Landmarks-I [4]	Ensemble Features [9]	0.32	**0.00**	**0.00**	16.60	28.13	19.89	13.89	22.12	17.66
	Hybrid Features [6]	0.42	**0.00**	**0.00**	15.26	**26.41**	**17.66**	14.37	22.81	16.92
	Deep Features [5]	0.16	**0.00**	**0.00**	24.67	55.74	41.80	13.36	34.30	18.69
	Steerable Features [7]	6.17	7.71	3.94	33.92	81.81	69.46	35.62	83.87	74.19
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	20.00	41.96	29.64	11.97	17.85	12.85
	Residual AutoEncoder [2]	0.17	**0.00**	**0.00**	15.02	36.08	22.34	8.93	17.35	7.90
	Multi-level Deep Features [8]	0.16	**0.00**	**0.00**	**1.37**	**0.51**	**0.17**	**1.53**	**0.51**	**0.17**
	Proposed Method	5.15	5.15	2.74	14.95	30.24	21.31	12.71	24.74	15.81
Landmarks-II [1]	Ensemble Features [9]	44.72	89.53	80.61	38.31	78.50	69.15	38.84	83.70	74.17
	Hybrid Features [6]	45.65	90.22	84.56	34.18	81.95	70.53	32.93	78.50	64.12
	Deep Features [5]	43.43	95.31	83.12	45.34	96.10	88.48	30.19	65.45	54.68
	Steerable Features [7]	50.00	99.65	99.10	40.81	83.42	72.60	39.13	84.89	74.82
	Multi-Modality [3]	42.69	88.50	78.38	**26.72**	**73.21**	**56.25**	27.87	68.75	57.14
	Residual AutoEncoder [2]	38.94	74.40	**58.25**	34.72	99.66	93.13	**27.32**	92.10	83.85
	Multi-level Deep Features [8]	**32.17**	**69.46**	60.89	30.22	65.44	55.32	30.07	**64.93**	**54.51**
	Proposed Method	37.91	87.48	77.02	43.23	92.53	85.07	40.73	88.03	78.51
StyleGAN [10]	Ensemble Features [9]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Hybrid Features [6]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Deep Features [5]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Steerable Features [7]	3.75	3.43	1.54	**0.00**	**0.00**	**0.00**	20.66	56.69	43.39
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Residual AutoEncoder [2]	**0.00**	**0.00**	**0.00**	0.08	**0.00**	**0.00**	0.34	**0.00**	**0.00**
	Multi-level Deep Features [8]	**0.00**	**0.00**	**0.00**	3.95	2.05	0.51	5.32	5.83	2.74
	Proposed Method	**0.00**	**0.00**	**0.00**	1.03	0.17	**0.00**	1.20	**0.00**	**0.00**
MIPGAN-I [11]	Ensemble Features [9]	39.97	75.98	68.78	20.21	42.14	33.44	20.73	45.28	36.53
	Hybrid Features [6]	46.45	86.79	77.87	29.34	59.19	47.51	24.87	51.62	41.18
	Deep Features [5]	23.95	48.19	38.25	**0.00**	**0.00**	**0.00**	26.40	63.97	44.57
	Steerable Features [7]	50.00	98.45	96.91	**0.00**	**0.00**	**0.00**	31.76	82.33	69.46
	Multi-Modality [3]	33.73	69.53	61.69	**0.00**	**0.00**	**0.00**	**20.07**	**39.46**	**30.39**
	Residual AutoEncoder [2]	**16.61**	**27.66**	**20.45**	50.00	99.83	99.66	41.20	81.44	75.95
	Multi-level Deep Features [8]	27.21	62.43	48.19	11.35	29.54	14.57	23.47	62.60	47.34
	Proposed Method	21.61	49.91	35.68	37.56	79.07	72.90	32.76	65.87	56.43
MIPGAN-II [11]	Ensemble Features [9]	39.93	73.58	66.89	15.78	28.14	19.38	13.72	28.98	16.63
	Hybrid Features [6]	44.72	82.16	73.75	19.36	43.22	28.64	16.98	32.93	23.84
	Deep Features [5]	42.19	70.42	60.48	**0.00**	**0.00**	**0.00**	9.98	20.41	9.94
	Steerable Features [7]	50.00	98.28	95.38	**0.00**	**0.00**	**0.00**	31.07	79.41	63.46
	Multi-Modality [3]	37.56	75.98	65.86	**0.00**	**0.00**	**0.00**	**7.85**	**12.67**	**5.17**
	Residual AutoEncoder [2]	**15.09**	**26.63**	**19.76**	10.85	95.53	62.89	11.53	58.42	21.82
	Multi-level Deep Features [8]	25.04	57.46	45.28	3.06	0.51	0.17	8.73	26.07	6.34
	Proposed Method	18.01	44.43	32.42	13.72	64.67	30.02	12.52	38.94	17.67

Table 4. Quantitative performance of MAD on FRGC morph database. Training morphing type: MIPGAN-I [11].

Testing Morphing Type	MAD Algorithms	Digital			Print-scan			Print-scan with compression		
		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =	
			5.00%	10.00%		5.00%	10.00%		5.00%	10.00%
Landmarks-I [4]	Ensemble Features [9]	23.66	51.45	39.96	5.82	7.22	2.92	6.17	7.54	3.94
	Hybrid Features [6]	47.15	87.16	79.41	6.50	8.23	4.15	7.91	10.29	6.34
	Deep Features [5]	11.63	23.11	12.56	19.91	34.10	31.38	18.66	37.75	28.64
	Steerable Features [7]	50.00	91.25	85.92	35.86	80.44	70.66	38.60	84.73	74.99
	Multi-Modality [3]	32.43	73.17	61.92	9.65	15.71	8.75	**5.01**	**5.00**	**3.14**
	Residual AutoEncoder [2]	18.70	31.62	25.43	4.12	3.95	1.89	8.02	11.51	7.39
	Multi-level Deep Features [8]	**6.01**	**6.86**	**3.43**	**1.37**	**0.51**	**0.17**	6.01	7.37	7.37
	Proposed Method	7.38	11.84	5.66	8.25	14.43	6.87	12.03	19.42	13.23
Landmarks-II [1]	Ensemble Features [9]	35.38	82.33	68.95	41.67	95.14	83.53	43.68	96.01	85.44
	Hybrid Features [6]	28.62	75.64	61.4	44.38	95.66	85.78	38.18	90.46	78.16
	Deep Features [5]	38.40	89.02	77.70	45.21	86.17	80.27	42.80	96.50	90.48
	Steerable Features [7]	50.00	97.94	93.82	44.36	87.26	81.15	43.92	92.36	86.55
	Multi-Modality [3]	**17.14**	**49.39**	**29.41**	**28.80**	87.14	**58.92**	29.65	88.21	67.50
	Residual AutoEncoder [2]	50.00	90.21	85.57	32.08	**82.82**	71.31	33.51	77.66	68.73
	Multi-level Deep Features [8]	40.49	86.27	74.27	30.22	65.44	55.32	**6.01**	**7.37**	**3.43**
	Proposed Method	32.76	83.53	73.41	39.06	89.41	79.86	35.70	87.69	76.08
StyleGAN [10]	Ensemble Features [9]	17.72	37.22	26.58	12.19	26.24	15.26	11.82	24.69	14.23
	Hybrid Features [6]	31.16	64.32	53.85	11.99	19.20	13.72	9.93	18.15	9.94
	Deep Features [5]	26.86	27.54	24.63	**0.00**	**0.00**	**0.00**	10.46	8.74	6.43
	Steerable Features [7]	50.00	92.45	87.15	**0.00**	**0.00**	**0.00**	44.12	92.45	86.79
	Multi-Modality [3]	22.81	48.37	37.22	**0.00**	**0.00**	**0.00**	5.34	**5.53**	4.15
	Residual AutoEncoder [2]	10.14	15.12	10.14	11.37	19.24	12.54	10.30	19.93	10.65
	Multi-level Deep Features [8]	**6.33**	**7.54**	**4.11**	3.95	2.05	0.51	**5.12**	5.66	**2.05**
	Proposed Method	8.92	16.30	7.89	7.89	10.98	6.69	9.09	14.41	8.58
MIPGAN-I [11]	Ensemble Features [9]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Hybrid Features [6]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Deep Features [5]	1.16	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Steerable Features [7]	29.83	84.21	68.95	**0.00**	**0.00**	**0.00**	25.92	72.72	60.14
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Residual AutoEncoder [2]	1.03	**0.00**	**0.00**	0.34	**0.00**	**0.00**	0.69	**0.00**	**0.00**
	Multi-level Deep Features [8]	1.36	0.17	**0.00**	11.35	29.84	14.57	1.04	1.17	0.17
	Proposed Method	0.51	**0.00**	**0.00**	0.86	0.17	0.17	1.20	0.17	0.17
MIPGAN-II [11]	Ensemble Features [9]	2.15	0.17	**0.00**	0.68	**0.00**	**0.00**	0.64	**0.00**	**0.00**
	Hybrid Features [6]	1.36	0.34	**0.00**	0.86	**0.00**	**0.00**	0.85	**0.00**	**0.00**
	Deep Features [5]	2.01	1.02	0.34	**0.00**	**0.00**	**0.00**	28.58	85.93	69.12
	Steerable Features [7]	34.56	88.16	78.38	**0.00**	**0.00**	**0.00**	28.58	85.93	69.12
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Residual AutoEncoder [2]	0.03	**0.00**	**0.00**	0.30	**0.00**	**0.00**	0.53	**0.00**	**0.00**
	Multi-level Deep Features [8]	1.04	**0.00**	**0.00**	3.06	0.51	0.17	0.48	0.34	0.17
	Proposed Method	2.57	0.69	0.34	0.34	0.17	**0.00**	0.51	**0.00**	**0.00**

Table 5. Quantitative performance of MAD on FRGC morph database. Training morphing type: MIPGAN-II [11].

Testing Morphing Type	MAD Algorithms	Digital			Print-scan			Print-scan with compression		
		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =		D-EER(%)	BPCER @ APCER =	
			5.00%	10.00%		5.00%	10.00%		5.00%	10.00%
Landmarks-I [4]	Ensemble Features [9]	13.08	29.15	15.78	**4.28**	**3.94**	**2.22**	4.28	3.61	2.22
	Hybrid Features [6]	40.14	77.70	67.23	5.49	5.48	2.40	7.21	10.98	4.15
	Deep Features [5]	16.31	39.96	26.17	18.66	37.73	28.64	8.17	13.89	6.88
	Steerable Features [7]	50.00	91.25	86.27	35.86	80.44	70.66	39.09	89.87	79.75
	Multi-Modality [3]	23.82	54.20	37.90	6.18	8.21	3.21	**4.16**	**3.39**	**1.96**
	Residual AutoEncoder [2]	9.15	16.84	8.59	8.16	13.19	6.25	8.09	11.81	6.25
	Multi-level Deep Features [8]	**6.21**	**6.51**	**4.80**	14.25	30.70	18.86	6.70	8.06	3.94
	Proposed Method	7.20	10.12	5.66	11.51	24.05	14.43	36.77	1.12	21.13
Landmarks-II [1]	Ensemble Features [9]	32.37	84.90	70.32	39.20	90.12	82.32	44.17	95.49	88.73
	Hybrid Features [6]	23.88	63.80	45.62	40.22	88.90	79.20	38.96	94.28	82.14
	Deep Features [5]	41.10	90.92	83.87	42.81	96.50	90.40	35.12	76.56	70.13
	Steerable Features [7]	48.94	97.77	92.79	44.36	87.26	81.15	45.47	92.53	88.71
	Multi-Modality [3]	10.62	28.81	11.32	26.8	82.32	64.28	30.15	90.53	73.21
	Residual AutoEncoder [2]	**9.15**	**16.84**	**8.59**	**8.16**	**13.19**	**6.25**	**8.09**	**11.81**	**6.25**
	Multi-level Deep Features [8]	46.13	95.88	99.90	42.03	97.90	93.19	39.24	84.20	74.13
	Proposed Method	35.33	83.36	74.27	44.79	92.36	87.85	42.11	90.99	83.36
StyleGAN [10]	Ensemble Features [9]	12.51	22.29	15.78	13.72	29.67	18.18	14.25	31.73	20.41
	Hybrid Features [6]	24.70	49.74	41.85	12.87	26.58	14.75	11.86	26.92	15.09
	Deep Features [5]	21.70	33.49	23.72	**0.00**	**0.00**	**0.00**	7.18	9.43	4.45
	Steerable Features [7]	50.00	95.19	92.45	**0.00**	**0.00**	**0.00**	46.30	91.54	90.56
	Multi-Modality [3]	21.15	40.48	30.87	**0.00**	**0.00**	**0.00**	6.79	9.28	3.92
	Residual AutoEncoder [2]	9.15	16.84	8.59	8.16	13.19	6.25	8.09	11.81	6.25
	Multi-level Deep Features [8]	**5.52**	**6.51**	**3.25**	**0.00**	**0.00**	**0.00**	**6.01**	**7.03**	**3.25**
	Proposed Method	14.07	23.67	16.64	9.78	17.15	9.09	10.63	24.53	11.66
MIPGAN-I [11]	Ensemble Features [9]	1.56	0.68	0.34	2.14	1.22	0.53	2.57	0.85	0.34
	Hybrid Features [6]	2.27	0.85	0.17	4.79	4.80	3.43	4.30	3.60	2.22
	Deep Features [5]	2.41	0.55	0.17	**0.00**	**0.00**	**0.00**	7.85	10.97	5.31
	Steerable Features [7]	30.51	83.70	69.29	**0.00**	**0.00**	**0.00**	26.24	82.33	62.63
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Residual AutoEncoder [2]	9.15	16.84	8.59	8.16	13.19	6.25	8.09	11.81	6.25
	Multi-level Deep Features [8]	2.05	0.85	0.34	**0.00**	**0.00**	**0.00**	4.30	3.60	2.05
	Proposed Method	0.86	0.17	**0.00**	17.15	39.45	26.59	13.55	26.59	16.64
MIPGAN-II [11]	Ensemble Features [9]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Hybrid Features [6]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Deep Features [5]	2.57	1.02	0.51	**0.00**	**0.00**	**0.00**	3.58	1.20	**0.00**
	Steerable Features [7]	31.84	86.79	70.84	**0.00**	**0.00**	**0.00**	26.57	85.59	72.21
	Multi-Modality [3]	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
	Residual AutoEncoder [2]	**0.00**	**0.00**	**0.00**	0.86	**0.00**	**0.00**	0.69	**0.00**	**0.00**
	Multi-level Deep Features [8]	1.85	0.34	**0.00**	**0.00**	**0.00**	**0.00**	2.53	0.85	3.25
	Proposed Method	0.69	**0.00**	**0.00**	5.49	6.35	0.17	4.46	3.26	0.17

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