R&D

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Face anti-spoofing using Image Quality Assessment



• • • • • • e-payment services

Speakers









Outline





Image Quality Assessment

Proposed method

- General framework
- □ Feature extraction
- **Experimental results**





Outline



Face spoofing attacks

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Goal : evaluate face recognition technologies

- Targeted implementation: Mobile devices
- Maximum level of user control and privacy: Complied with GDPR (General Data Protection Regulation)
 - Record, storage and match on user device
 No database, no server



Selected SDK

Hybrid method
 Picture and face features

Limits

• Spoofing is far too simple...





Printed photo/digital photo/video



3D mask

Easy to reproduce

- 2 photos (frontal and profile)
- Online: <u>http://www.thatsmyface.com</u>
- Affordable (299\$)







State-of-the-art solutions

- Liveness detection techniques (eye blinking, facial expression changes, etc.)
- Motion analysis techniques
- Facial appearance analysis techniques

- Contextual information techniques
- User-interaction based methods
 - (eg. Turn head left/right, blink, smile, etc.)
- Multimodal biometric approaches

Our works

- Multimodal biometric authentication
 - Combining voice recognition and lip movement
 - Combining PIN, face and BioTyping

• Liveness detection based on Image quality assessment





State-of-the-art solutions

- Liveness detection techniques
 (eye blinking, facial expression changes, etc.)
 Motion analysis techniques
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- Contextual information techniques
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- Multimodal biometric approaches

Our works



•Liveness detection based on Image quality assessment





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Image Quality Assessment

Image Quality Measures (IQMs)







Image Quality Assessment

Image Quality Measures (IQMs)





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Proposed method • Calculation approach

Image Quality Measures (IQMs)

Reduced-Reference IQA

Using Only partial information from the reference image

e.g: *RRED* →Differences between the entropies of wavelet coefficients





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Frame extraction







Frame extraction



FBM=Motion(Face,F1,F2,th)/ Motion (Background, F1,F2,th) Motion(RoI,F1,F2,th)= $\sum x,y \uparrow m \delta(D(x,y)-th) /SD$

Relevant differences between the frames

- Liveness-related motion cues (face + throat)
- Computational efficiency

- th: Pixel-wise difference threshold
- δ : Dirac delta function
- F1 , F2: Two "consecutive" frames
- RoI: Face / Background
- SD: Pixel number of the considered RoI











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Gamma Feature extraction

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Proposed method • Feature extraction

IDIAP Research Institute, 2014 (1)

- 25 IQMs(21 FR & 4 NR) \rightarrow LDA classification: HTER 15.2%

IDIAP & GRADIENT Research center, 2016: (2)

- A subset of 18 IQMs (17 FR and 1 NR) \rightarrow LDA classification : HTER 9.78%

Our work

- Simulating other promising IQA metrics
- Combining the "best" ones with the 18-feature selection

(1)Galbally ,J.; Marcel, S.; Fierrez, J.: "Image quality assessment for fake biometric detection: Application to iris, fingerprint and face recognition," IEEE Trans. on Image Processing, vol. 23, no. 2, pp. 710–724, 2014

(2) Costa-Pazo, A. et.al.: "The replay-mobile face presentation-attack database," International Conference on Biometrics Special Interests Group (BioSIG), 2016.





(1) Xue ,W. et.al.: "Blind Image Quality Prediction Using Joint Statistics of Gradient Magnitude and Laplacian Features", Trans. on Image Processing, IEEE selben Jahr. Format-Verlag, 2014.

(2) Mittal, A.; Moorthy, A. K.; Bovik, A. C.: "No Reference Image Quality Assessment in the Spatial Domain", IEEE Transactions on Image Processing, 2011

(3) Moorthy, A. K.; Bovik, A. C.: "A Modular Framework for Constructing Blind Universal Quality Indices", submitted to IEEE Signal Processing Letters, 2009.



Proposed method • Feature extraction







Proposed method • Feature extraction

Our model



 \rightarrow For each video



Outline

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Proposed method

General framework
 Feature extraction

D Experimental results





Performance indicators:







- Replay Attack (1):
 - 1300 videos
 (320x240)
 - 50 subjects
 - Different scenarios



(1) Chingovska I. et.al.: "On the Effectiveness of Local Binary Patterns in Face Antispoofing", IEEE BIOSIG 2012





- Replay Mobile (2):
 - 1190 videos (1280 x 720)
 - 40 subjects
 - Different scenarios

→ Well suited to Mobile acquisition technologies

Screen, Screen, Print, Print, light on light off light on light off Phone Tablet

(2) Costa-Pazo, A. et.al.: The replay-mobile face presentation-attack database, Int. Conf. on Biometrics Special Interests Group (BioSIG) 2016





LDA classification on Replay Attack

IQMs	Video frames	FGR	FFR	HTER-f	HTER-v
	All	2,21	16,67	9,44	6,25
	Motion	3,15	16,40	9,78	7,91
Final 21 IQMs	All	8 ^e -04	0,009	0,005	0
	Motion	0,002	0,045	0,023	0





LDA classification on Replay Mobile

IQMs	Video frames	FGR	FFR	HTER-f	HTER-v
	All	3.26	8.15	5.71	4.13
	Motion	1.25	9.71	5.48	5.75
Final 21 IQMs	All	0.053	3.65	1.85	1.65
	Motion	0.07	1.66	0.86	0.79



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Conclusion







R&D

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Thank you!



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Appendix

LDA classification on Replay Attack

IQMs	Video frames	Scaling	FGR		FFR		HTER-f		HTER-v	
			LDA	SVM	LDA	SVM	LDA	SVM	LDA	SVM
Initial 18 feature-set	All	without	2.210	0	16.679	24.222	9.444	12.111	6.250	8.333
		Z-score	4.418	2.253	14.680	11.705	9.549	6.979	6.875	4.479
	Motion	without	3.155	0	16.407	26.362	9.781	13.181	7.919	9.338
		Z-score	5.820	0	15.065	26.362	10.442	13.181	9.338	9.338
Our 21 feature-set	All	without	8e-04	0	0.009	24.222	0.005	12.111	0	8.333
		Z-score	0.004	0	0.047	24.013	0.025	12.007	0	8.333
	Motion	without	0.002	0	0.045	26.362	0.023	13.181	0	9.338
		Z-score	0.008	0	0.006	26.362	0.007	13.181	0	9.338





Appendix

LDA classification on Replay Mobile

	Video frames	Scaling	FGR		FFR		HTER-f		HTER-v	
IQMs			LDA	SVM	LDA	SVM	LDA	SVM	LDA	SVM
Initial 18 IQMs	All	without	3.26	0.00	8.15	36.23	5.71	18.11	4.13	18.21
		Z-score	3.04	3.47	8.25	2.69	5.65	3.08	4.13	0.99
	Motion	without	1.25	0.00	9.71	31.85	5.48	15.92	5.75	18.05
		Z-score	0.52	1.63	11.29	4.73	5.91	3.18	7.34	2.18
Final 21 IQMs	All	without	0.05	0.00	3.65	36.23	1.85	18.11	1.65	18.21
		Z-score	2.50	41.07	1.46	0.00	1.98	20.53	1.49	20.03
	Motion	without	0.07	0.00	1.66	31.85	0.86	15.92	0.79	18.05
		Z-score	1.32	0.00	4.02	28.59	2.67	14.29	2.38	16.07



