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ABSTRACT

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Example of an abstract: A biometric sample collected in an uncontrolled outdoor environment varies significantly from its indoor version. Sample variations due to outdoor environmental conditions degrade the performance of biometric systems that otherwise perform well with indoor samples. In this study, we quantitatively evaluate such performance degradation in the case of a face and a voice biometric system. We also investigate how elementary combination schemes involving min-max or z normalization followed by the sum or max fusion rule can improve performance of the multi-biometric system. We use commercial biometric systems to collect face and voice samples from the same subjects in an environment that closely mimics the operational scenario. This realistic evaluation on a dataset of 116 subjects shows that the system performance degrades in outdoor scenarios but by multimodal score fusion the performance is enhanced by 20%. We also find that max rule fusion performs better than sum rule fusion on this dataset. More interestingly, we see that by using multiple samples of the same biometric modality, the performance of a unimodal system can approach that of a multimodal system.

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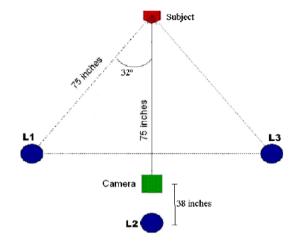


Fig. 1. Studio setup for capturing face images indoor. Three light sources L1, L2, L3 were used in conjunction with normal office lights.

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 - 2...1 A subentry
- 3. The last entry
- A bulleted list item
- Another one

Table 1. Summary of different works pertaining to face and speech fusion

DB Size | Covariates of interest | Top individuals of the control o

Study	Algorithm	DB Size	Covariates of interest	Top individual per-	Fusion
	used			formance	Performance
UK-BWG	Face, voice:	200	Time: 1–2 month	TAR* at 1% FAR#	_
(Mansfield et	Commercial		separation (indoor)	Face: 96.5%	
al., 2001)				Voice: 96%	
Brunelli	Face:	87	Time: 3 sessions, time	Face:	TAR =98.5%
(Brunelli	Hierarchical		unknown (indoor)	TAR = 92% at	at 0.5% FAR
and Falavigna,	correlation			4.5% FAR	
1995)	Voice:			Voice:	
	MFCC			TAR = 63% at	
				15% FAR	
Jain (Jain et al.,	Face:	50	Time: Two weeks (indoor)	TAR at 1% FAR	Face + Voice
1999)	Eigenface			Face: 43%	+
	Voice:			Voice: 96.5%	Fingerprint =
	Cepstrum			Fingerprint: 96%	98.5%
	Coeff. Based				
Sanderson	Face: PCA	43	Time: 3 sessions (indoor)	Equal Error Rate	Equal Error
(Sanderson and	Voice: MFCC		Noise addition to voice	Face: 10%	Rate 2.86%
Paliwal, 2002)				Voice: 12.41%	
Proposed study	Face, voice:	116	Location: Indoor and	TARs at 1% FAR	TAR = 98%
	Commercial		Outdoor (same day)	Indoor-Outdoor	at 1% FAR
			Noise addition to eye	Face: 80%	
			coordinates	Voice: 67.5%	

^{*}TAR-True Acceptance Rate

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$$S'_{pg} = \frac{S_{pg} - \min(S_{pG})}{\max(S_{pG} - \min(S_{pG})}$$
 (1)

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Acknowledgments

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References

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Newman, M.E.J., Girvan, M., 2004. Finding and evaluating community structure in networks. Phys. Rev. E. 69, 026113.

Vehlow, C., Reinhardt, T., Weiskopf, D., 2013. Visualizing fuzzy overlapping communities in networks. IEEE Trans. Vis. Comput. Graph. 19, 2486–2495.

Supplementary Material

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[#] FAR-False Acceptance Rate