Dynamic Distance-based Shape Features for Gait Recognition

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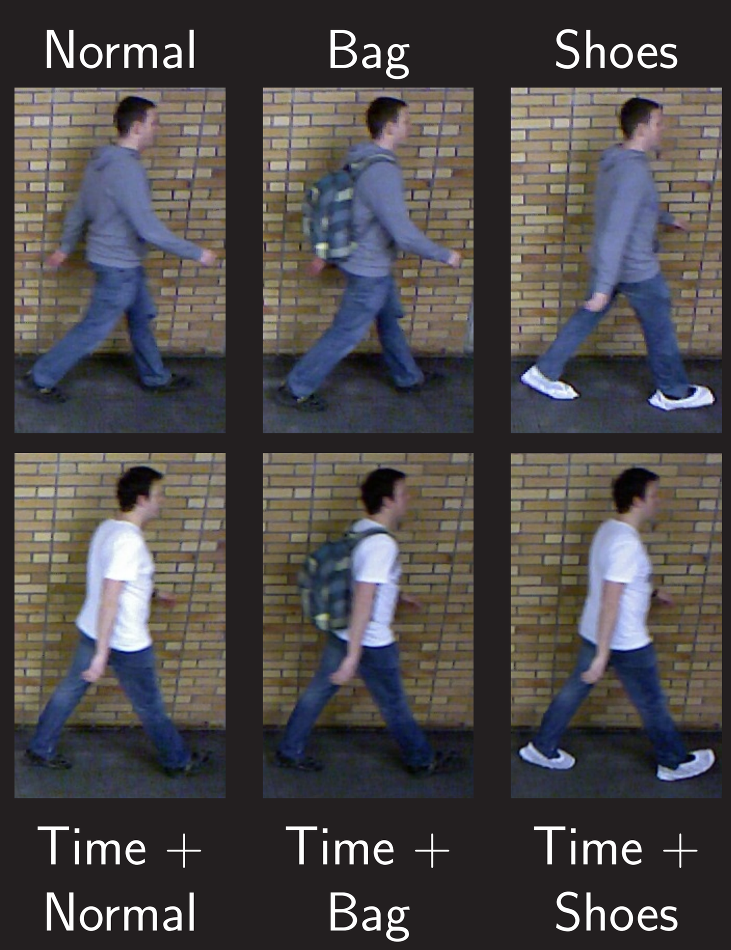
Gait Recognition

- recognising a person via walking manner and posture
  - medical and psychophysics fields show gait is unique
  - fundamental healthy walking pattern is similar across persons but subtle variations in magnitude and timing aid person discrimination
- applications include surveillance and access control
- gait is a behavioural biometric (compared to physical e.g. fingerprint)
  - no consent or cooperation, unobtrusive, capture at low resolution, distance

Motivation

- covariate factors decrease performance
  - clothing, shoes, bags
  - time between capture
  - occlusion, viewpoint
  - injury, drunkenness etc.
- causing pixel
  - addition e.g. clothing adds bulk
  - occlusion e.g. rucksack occludes arms
  - shifting e.g. leaning due to bag carrying
- robustness is imperative
- validation: TUM GAID database
  - largest (155 persons) and latest
  - training: 4 sequences (Normal)
  - test: 2 sequences (Bag, Shoes, Time)

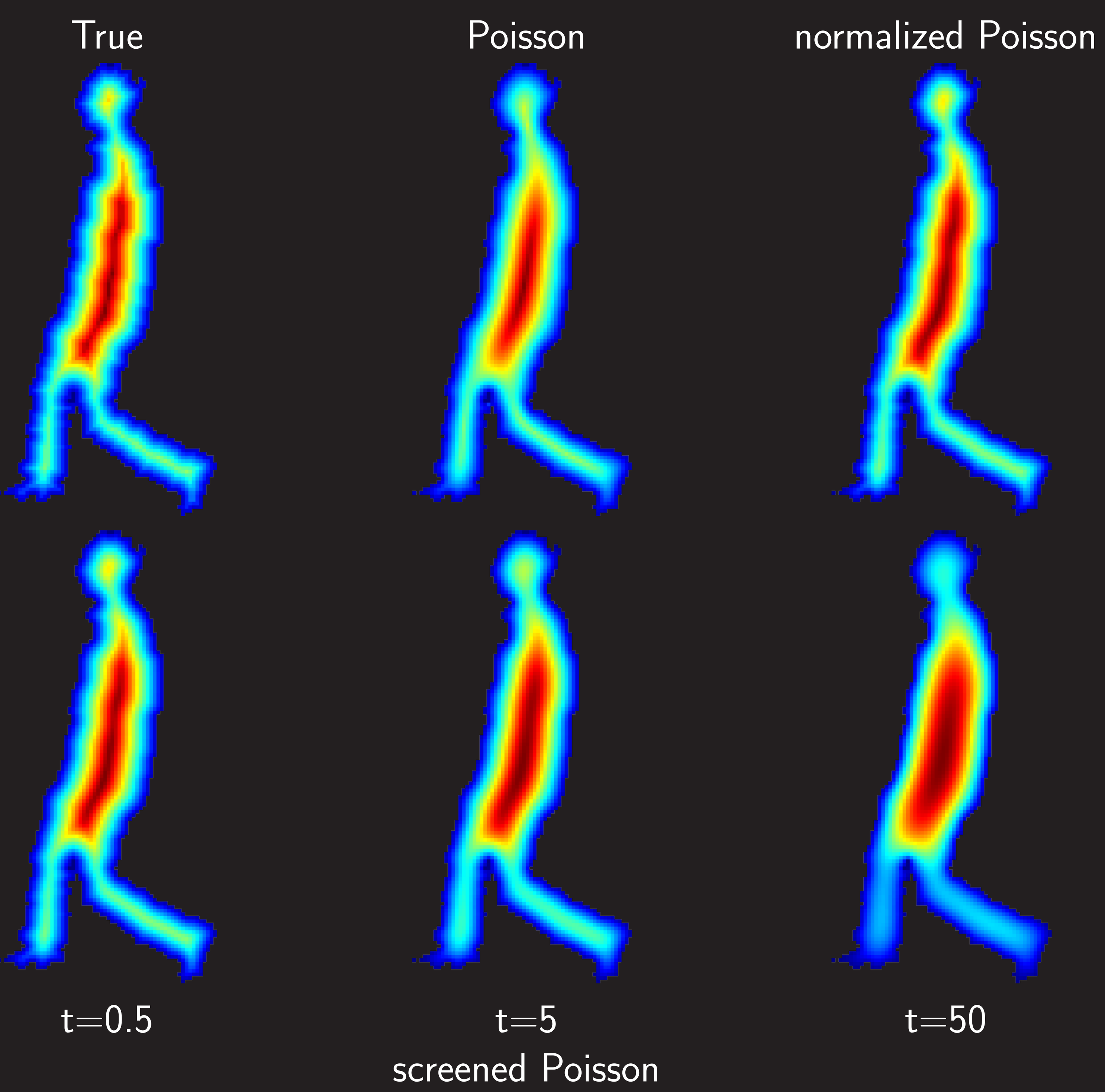


Skeleton Variance Image (SVIM)

- pre-skeletonisation
  - size normalisation
  - horizontal alignment
- post-skeletonisation
  - time normalisation
    - pixel-wise variance
    - single 2D image
- dimensionality reduction
  - representation = descriptor
  - PCA + LDA maximises variance and class separability
- classification
  - Nearest Neighbour
  - cosine distance

Smoothed Poisson-based Distance Functions

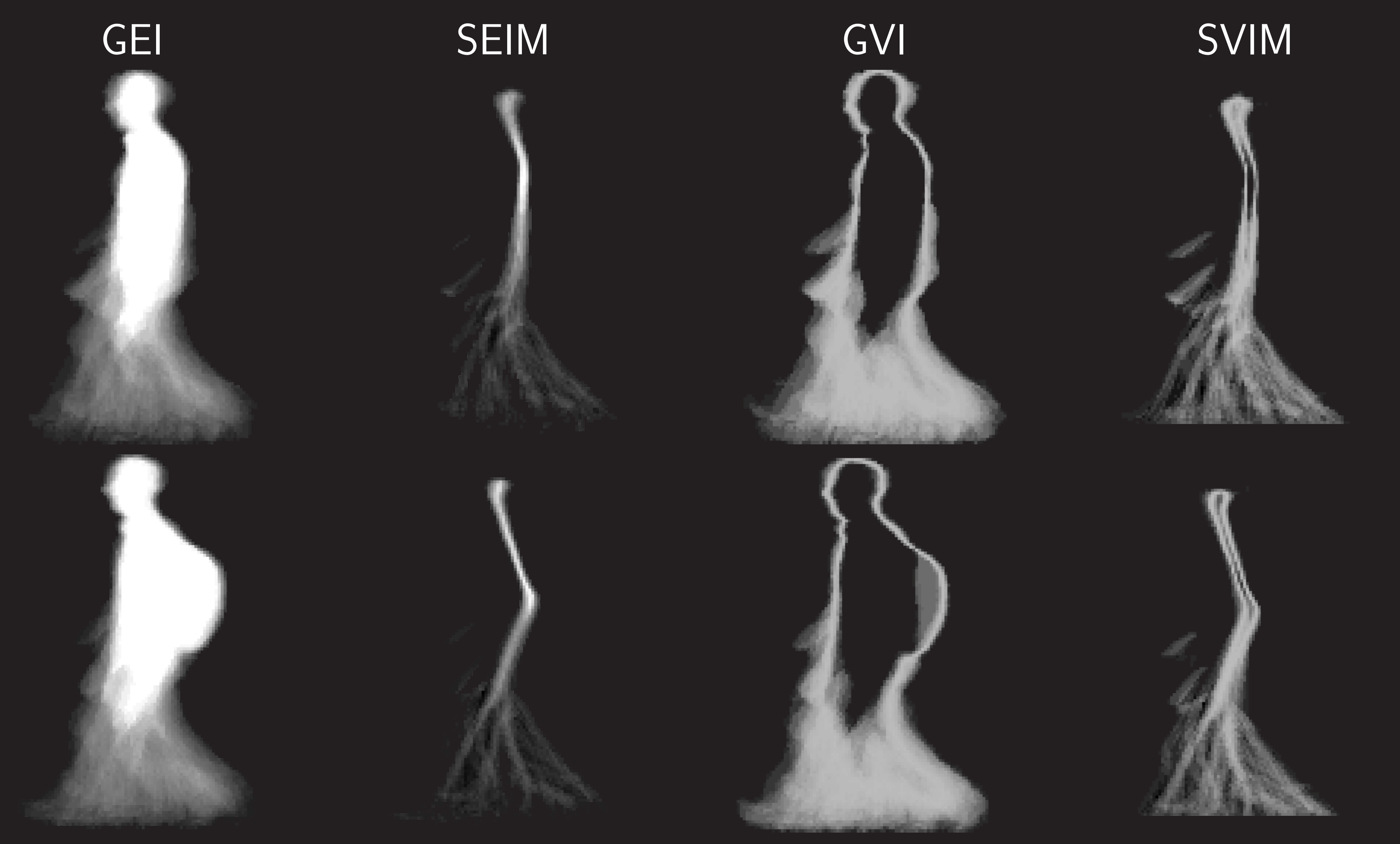
- Poisson, normalized Poisson
- screened Poisson
  - pros: tunable smoothness parameter t
  - cons: higher computational cost
- low boundary perturbation sensitivity (imperfect silhouette segmentation)
  - compared to true Euclidean distance function



Rough Skeletons

- classical medial axis sensitive to boundary perturbations
- smoothed distance function yields more robust skeletons
  - 3×3 Sobel kernels convolved with smoothed distance function is superior
  - screened Poisson skeleton thickness varies with smoothness parameter t

Results: TUM GAID database



	Descriptor	N (%)	B (%)	S (%)	TN (%)	TB (%)	TS (%)	Avg_w (%)
Appearance	GEI	**99.7**	19.0	**96.5**	34.4	0.0	43.8	67.5
	DGHEI	99.0	40.3	96.1	50.0	0.0	44.0	74.1
	SEIM t=0.5	96.1	8.7	84.8	21.9	0.0	18.8	58.6
	SEIM t=5	98.4	14.8	88.7	28.1	0.0	34.4	63.0
	SEIM t=50	99.0	17.7	93.9	28.1	0.0	28.1	65.4
	SEIM poisson	97.4	8.1	89.7	40.6	3.1	28.1	61.2
	SEIM norm. poisson	99.0	18.4	96.1	15.6	3.1	28.1	66.0
Motion	GVI	99.0	47.7	94.5	62.5	15.6	**62.5**	77.3
	SVIM t=0.5	98.1	63.9	86.8	62.5	34.4	50.0	79.7
	SVIM t=5	98.4	**64.2**	91.6	**65.6**	31.3	50.0	**81.4**
	SVIM t=50	97.7	51.9	93.9	59.4	**37.5**	53.1	78.3
	SVIM poisson	97.4	53.6	88.1	**65.6**	21.9	53.1	76.6
	SVIM norm. poisson	98.4	54.2	92.9	50.0	28.1	37.5	77.8

Discussion

- covariate factors significantly affect appearance
  - shoes e.g. heels or flip flops may decrease performance further
- SVIM more robust across the majority of covariate factors
  - emphasis on body motion compared to covariate factors
  - performance 10% better than existing state of the art
- screened Poisson distance function more robust
  - tunable smoothness parameter t (may be application dependent)
  - small t values risk skeleton segmentation at branch points
  - large t values cause thick skeletons like silhouettes

Conclusion

- efficient skeleton extraction via screened Poisson equation
  - includes tuning smoothness parameter t
- powerful and robust gait descriptor - Skeleton Variance Image
  - gait motion more consistent over time than appearance

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