

Anomaly detection experiments

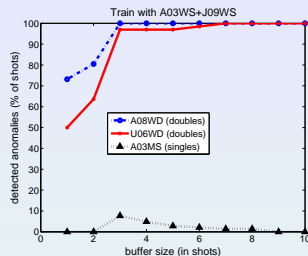
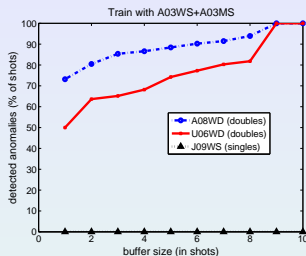
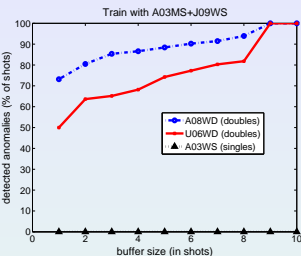
T. de Campos, W. Christmas, J. Kittler, I. Almajai et al.

CVSSP – Centre for Vision Speech and Signal Processing
University of Surrey

ACASVA project meeting
University of East Anglia, Norwich
20 January 2012

- 1 Anomaly detection based on player detection
- 2 Anomaly detection based on events detection
- 3 A closer look at the results
- 4 Future work

Anomaly detection based on player detection



Noise measure

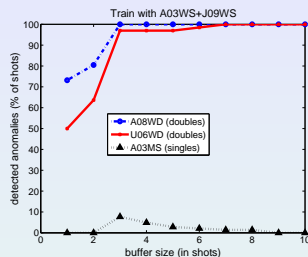
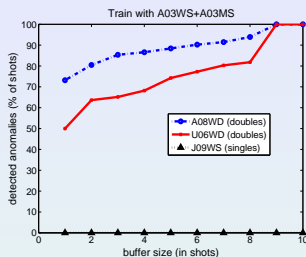
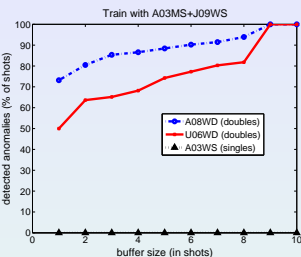
Video	mean \pm std ^a
TSWA03	1.92 \pm 0.09
TSMA03	3.07 \pm 2.33
TSWJ09	1.57 \pm 0.06
TDWA08	1.29 \pm 1.00
TDWU06	1.54 \pm 1.94

$$^a \text{noise} = \frac{1}{D} \sum_d^D \sigma(\mathbf{m}_d)$$

Conclusions

- All anomalies are detected if enough time is given.
- The noisiest game gives the poorest results.

Anomaly detection based on player detection



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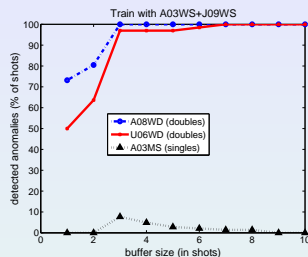
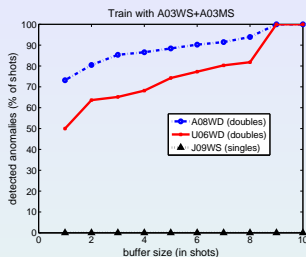
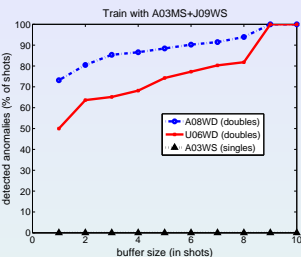
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Anomaly detection based on events detection

An event e at time t is anomalous if

- $e_t = \text{bounce out of the (singles) court area}$
- $e_j \neq \text{end of play}, \forall j = t, \dots, t + 4$
- $P(\mathbf{x}_t = \text{bounce}) > \tau$, where \mathbf{x} is the position of the ball¹
- $C_j > \theta$ for $j = t - 1, t, t + 1$, where C is the HMM confidence measure defined by

$$C = \frac{1}{3} \sum_{i=2}^4 \frac{1}{1 + \frac{L_1}{L_i}},$$

where L_i is the i -th highest log-likelihood given by the HMMs

¹With the chosen τ , the distance between the ball and the court lines ≥ 30 pixels.

Anomaly based on events detection – results

Anomalies

Training video	TMSA03			TWSA03			TMSA03		
Validation video	TWSJ09			TWSJ09			TWSA03		
Validation threshold θ	0.584			0.557			0.579		
Test video:	TP	FN	FP	TP	FN	FP	TP	FN	FP
Singles	0	0	0	0	0	0	0	0	0
TWDA08	2	42	0	10	34	3	6	38	0
TWDU06	1	6	0	6	1	1	3	4	0

using $\theta = \max_{validation} \theta$

Test video:	TP	FN	FP
Singles	0	0	0
TWDA08	8	68	0
TWDU06	5	10	1

Conclusion

- Our framework is able to detect a significant number of anomalies.
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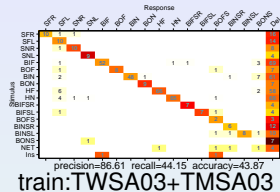
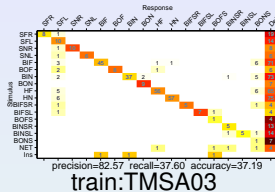
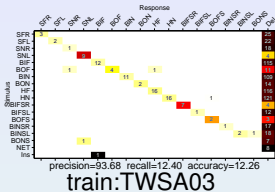
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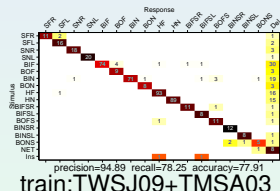
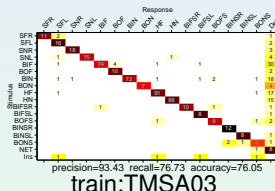
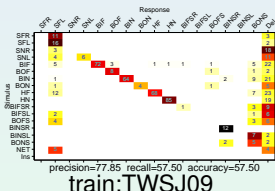
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Confusion matrices from event detector – singles

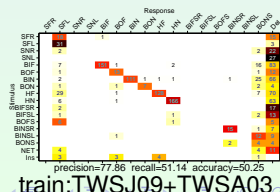
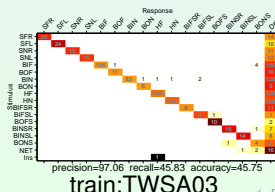
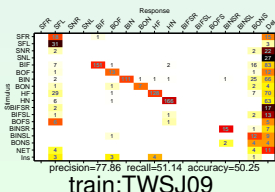
test:TWSJ09



test:TWSA03

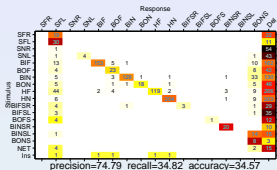


test:TMSA03

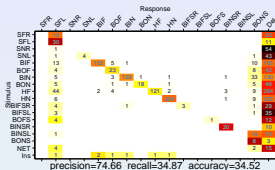


Confusion matrices from event detector – doubles

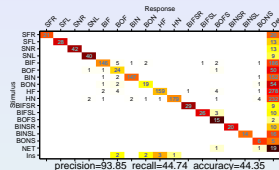
test:TWDA08



train:TWSJ09+TMSA03

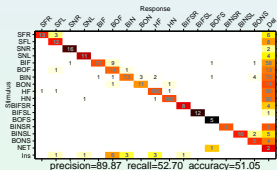


train:TWSJ09+TWSA03

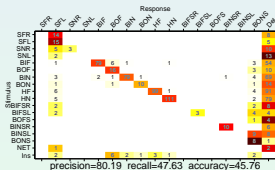


train:TWSA03+TMSA03

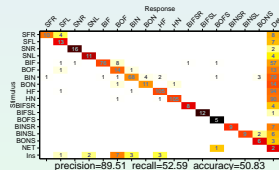
test:TWDU06



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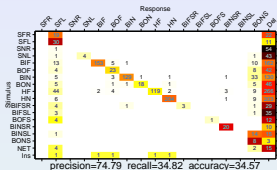


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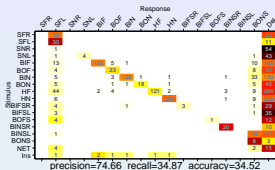
	best	worst
training sets	TMSA03	TWSA03
test sets	TWSA03	TWSJ09

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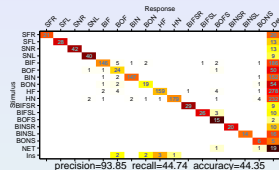
test:TWDA08



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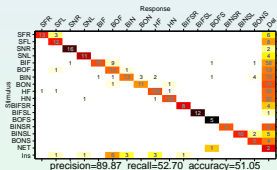


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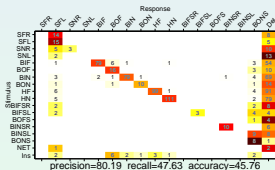


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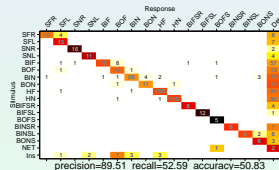
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Action classification results

			positive rate (%)			
	train	test	hit	-hit	srv	-srv
singles	TWSA03	TMSA03	45.3	86.7	79.5	96.6
		TWSJ09	<u>24.3</u>	91.9	<u>65.5</u>	94.1
	TMSA03	TWSA03	46.8	88.3	64.8	95.3
		TWSJ09	29.9	90.3	52.4	97.4
	TWSJ09	TWSA03	46.1	88.7	90.1	95.8
		TMSA03	46.4	84.1	73.0	97.9
combined and doubles	TWSA03	TWSJ09	28.5	90.6	63.1	94.8
	+	TWDA08	40.4	92.8	71.2	92.0
	TMSA03	TWDU06	39.2	93.8	72.7	92.6
	TWSA03	TMSA03	47.3	86.2	79.5	97.6
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	TWSJ09	TWDU06	30.5	92.9	76.6	93.6
	TMSA03	TWSA03	49.3	90.6	73.2	95.8
	+	TWDA08	41.6	91.4	81.1	92.3
	TWSJ09	TWDU06	35.1	93.7	75.3	95.3
	baseline			18.2 ± 6.5		26.8 ± 5.4

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- best results
- worst results
- best training sets: TMSA03 and TMSA03+TWSJ09
- worst training set: TWSA03
- best test set: TWSA03
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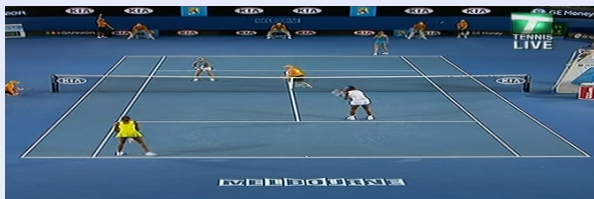
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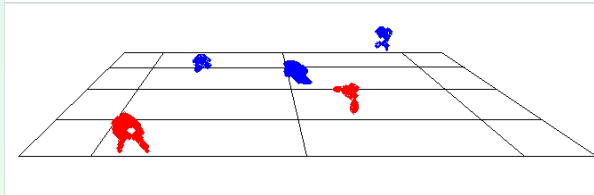
Ongoing work: improving the player detector



source image

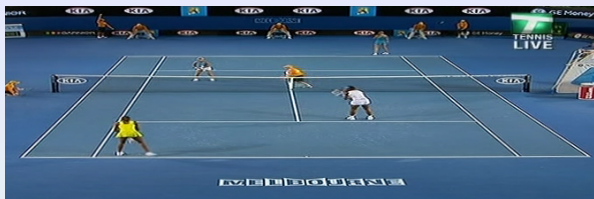


(1) background subtraction: 81 blobs



(2) apply constraints on motion, court location and blob size (as a function of player location): 5 people

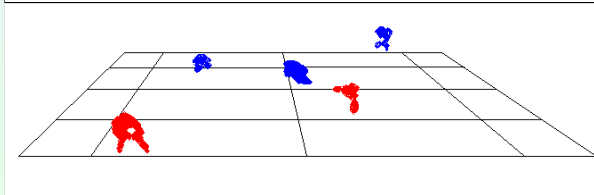
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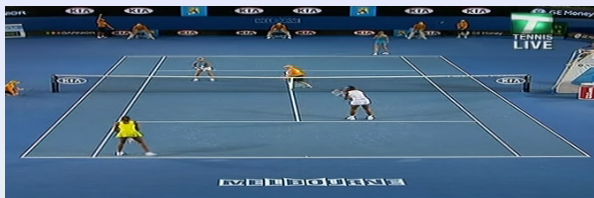


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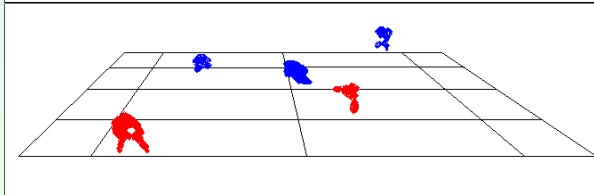
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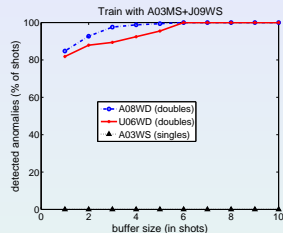
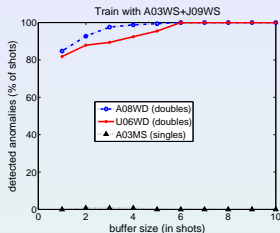
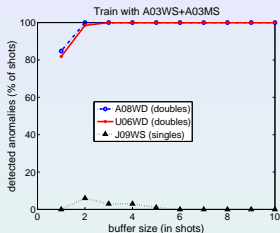
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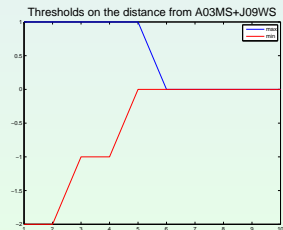
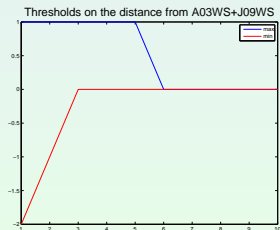
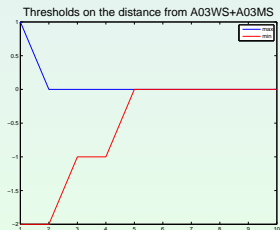
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Player detection anomalies: new results

anomalies



thresholds



See old results 3.

- Combine multiple cues as joint probabilities for player detection:
 - Background subtraction (not thresholded) as a saliency map
 - Court location prior
 - A generic person detector
- Use a proper tracker or a data association method
- Work on action classification using sparse matrix decomposition to identify salient features for each class (with Mark Barnard).