Baby-Posture Classification from Pressure-Sensor Data

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Summary

• The posture classification problem is formulated as the design of features that describe the pressure patterns induced by the child in combination with generic classifiers.

• Novel rotation invariant features are constructed from high order statistics obtained from the concentric rings with constant cell area around the center of gravity.

• A vote fusion of various generic classifiers is used for classification.

Context

• The posture of the child during his daily activity can provide valuable information on his development.

• Knowing the posture of the child can be useful during sleep to correct the sleeping posture and help to prevent SIDS .

• The posture of the child can also give an indication on the child's mental activity or status.

Figure 1. play area (baby mat) equipped with pressure-sensor mat.

Method

• A polar, order-invariant representation with the gravity center of the pressure pattern as a reference.

• The pressure sum per cell was computed and subsequently higher-order statistics of these summed pressure values across cells were acquired for each ring.

• These statistics were the mean, standard deviation, kurtosis and skewness.

• Cells that are far from the center had larger areas and hence the extracted feature components have more weight than the others.

• Cell areas A_k are made constant by varying the rings' radius R_k as follows

$$R_k = \sqrt{k+1}\,R_0,\ A_k = \frac{1}{2}\theta R_0^2$$

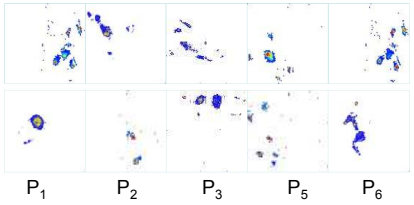

Figure 2. First row: Intra-class pressure frame samples from posture P_4: lying on belly. Second row: inter-class samples from postures P_i resp. sitting, standing, lying on back, crawling and lying on side.

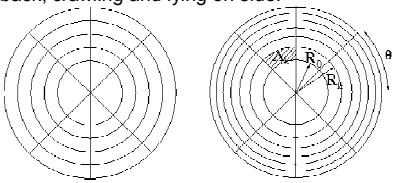

Figure 3. Polar grid with constant ring widths (left) and constant cell area (right).

Results

• The data was obtained from a one-year-old baby with recordings of pressure data that were acquired at 3 different dates (S_i).

• The proposed features accomplish a good trade-off between invariance properties and robustness to distortion and occlusion.

• The majority of errors occurs for the belly, back and side postures. This can be explained by the high similarity of the two postures.

• A temporal voting was used. First, single frames were classified. The dominant posture classes were determined from a sliding time window.

	P_1	P_2	P_3	P_4	P_5	P_6	P_7	Total
S_1	1579	642	214	157	1067	50	139	3848
S_2	1511	959	95	428	5637	388	47	9065
S_3	530	2172	328	812	4468	301	64	8675

Table 1. Number of frames per posture P_i for the different datasets. P_i

	S_1	S_2	S_3
S_1	1.82±0.3	11.7±0.6	14.8±0.7
S_2	21.8±1.8	1.7±0.2	18.7±1.2
S_3	30.2±2.2	19.2±1.4	1.74±0.3

Table 2. Classification error with constant ring radii.

	S_1	S_2	S_3
S_1	**1.65±0.3**	12.2±2.2	**13.4±0.7**
S_2	**19.5±2.4**	1.92±0.1	**11.6±1.3**
S_3	34.2±4.0	**9.71±0.7**	1.77±0.2

Table 3. Classification error with non-constant ring radii (constant cell areas).

	S_1	S_2	S_3
S_1	0.64±0.1	9.77±3.1	13.07±1.6
S_2	17.37±2.3	1.28±0.2	11.10±0.6
S_3	21.66±4.1	6.58±1.8	1.53±0.2

Table 4. Classif. error with non-constant radii and temporal voting.

Conclusion

• We formulated the posture classification as a problem of the feature design from the pressure patterns in combination with generic machine learning classifiers.

• The proposed features provided good results with average error rates of about 12%.

• The incorporation of temporal information allowed an improvement of the performance to 9% classification error.

• As future work, we are interested in a better modeling of dynamic postures such as walking, crawling and the transition between postures in order to improve the classification performance.

References

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