2D HUMAN TRACKING BY EFFICIENT MODEL FITTING USING A PATH RELINKING PARTICLE FILTER (PRPF)

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INTRODUCTION: Automatic visual analysis of human motion is an active research topic in Computer Vision and its interest has been growing in the last decade. Visual analysis of human movement is used in the fields of Medical, Occupational and Sports Biomechanics. The main purpose of this staudy is to present a 2D model-based Path Relinking Particle Filter (PRPF) algorithm for human motion tracking and analysis applications.

METHODS: PRPF algorithm hybridizes both Particle Filter (PF) and Path Relinking (PR) frameworks. The algorithm increases the performance of general Particle Filter by improving the quality of the estimate, by adapting computational load to problem constraints and by reducing the number of required evaluations of the weighting function. Path Relinking Particle Filter (PRPF) algorithm was introduced to be applied to estimation problems in sequential processes that can be expressed using the state-space model abstraction. The PRPF algorithm is centered on a delimited region of the state-space in which it is highly probable to find new better solutions than the initial ones. PRPF starts with an initial population of N particles drawn from a known pdf. Each particle represents a possible solution of the problem. Particle weights are computed using a weighting function and a measurement vector. PR stage is later applied improving the best obtained solutions of the particle filter stage. A *RefSet* is created selecting the b ($b<<N$) best particles. New solutions are generated and evaluated, by exploring trajectories that connect all possible pairs of particles in the *RefSet*. In order to improve the solution fitness, a local search from some of the generated solutions within the PR procedure is performed. PR stage ends when the news generated solutions do not improve the quality of the *RefSet*. Once the PR stage is over, the "worst" particles are replaced with the *RefSet* solutions. Then, a new population of particles is created by selecting the individuals from the whole particle set with probabilities according to their weights. In order to avoid the loss of diversity, a diffusion stage is applied to the particles of the new set. At the end, particles are projected into the next time step by making use of the update rule. PRPF estimator quality is improved with respect to PF and the required number of evaluations for the weighting function is also reduced. PRPF is time-adaptive since the number of evaluations of the weighting function changes in each time step. If the initial solutions in the *RefSet* are far away one from each other, then paths connecting solutions became long enough, and the number of explored solutions increases. It is not possible to have any estimate of the previous state of the system at the beginning of the visual tracking, therefore the particle filter is usually randomly initialized. PRPF algorithm reduces the total required number of evaluations of the weighting function when increasing the number of total time steps.

RESULTS: In order to analyse the performance of the proposed model-based PRPF system, people performing different activities were recorded in different scenarios. PRPF algorithm was implemented using MATLAB 6.1. to track a subject performing planar movements like running (ten segments full-body model) and counter-movement jumping (five segments). The obtained results confirmed that the model adjustment is accurate.

CONCLUSIONS: The main contribution of this work is the application of the Path Relinking Particle Filter (PRPF) algorithm to model-based human motion tracking and analysis. Experimental results have shown that this model-based PRPF framework can be very efficiently applied to the 2D human pose estimation problem.

REFERENCES: Wang, L., Weiming, H., Tieniu, T. (2003). Recent developments in human motion analysis. *Pattern Recognition* 36 (2003) 585–601.