Similar to the solutions of general gait recognition approaches, there are two ways to handle the cross-speed gait recognition issues. The first approach is model-based approach which is to model the walking action using static or dynamic body parameters [6]. The second class of cross-speed gait recognition approach is model free approach, also known as feature or appearance-based approach. It focuses on directly extracting holistic gait features from gait sequences [4, 5]. Our proposed method, Speed Invariant Gait Template (SIGT), belongs to the second category.

According to some recent studies, the walking action is considered as residing on a manifold which is topologically equivalent to a unit circle [1]. Thus, we can format the gait feature extraction issue as a gait manifold fitting issue. To address the cross-speed gait recognition issue, Thin Plate Spline (TPS) kernel based RBF interpolation is used to fit the gait manifold, since TPS has a desirable property [7] that it separates the manifold embedding space and the represented gait silhouette sequences. Firstly, the implicit function-based representation is used to represent each gait silhouette, since this representation is robust to the noise and contour smoothing term. According to the property of TPS, the static feature of TPS based interpolants and $S$ is a thin plate spline function and $S$ is a $l \times N_l$ coefficient matrix of TPS based interpolants and $S = [s^T]$ is a $l \times 3$ coefficient matrix of the smoothness term. According to the property of TPS, the static feature of gait manifold, which is robust to the speed variation, is embedded in the $l \times 3$ matrix $S$. Then, the proposed Speed Invariant Gait Template (SIGT) can be obtained by vectorizing this matrix.

Finally, in order to speed up the recognition and avoid the curse of dimensionality, an recent Improved Locality Preserving Projections (LPP) method named Globality-Locality Preserving Projections (GLPP) [2] is applied to reduce the dimensionality of SIGT. Compared to the state-of-the-arts methods such as LDA, PCA and LPP, GLPP obtains a much better recognition performance via taking geometric structures of both samples and classes into consideration.

The implementations of our method and related algorithms are described in this paper in detail. Our conclusion is that a novel gait template for cross-speed gait recognition is proposed and these gait templates are extracted by fitting the gait manifold via TPS kernel based RBF interpolation. The main contribution of this work is that it provides a natural way to separate the dynamic features and static features and such separation is very general to other computer vision issues.


