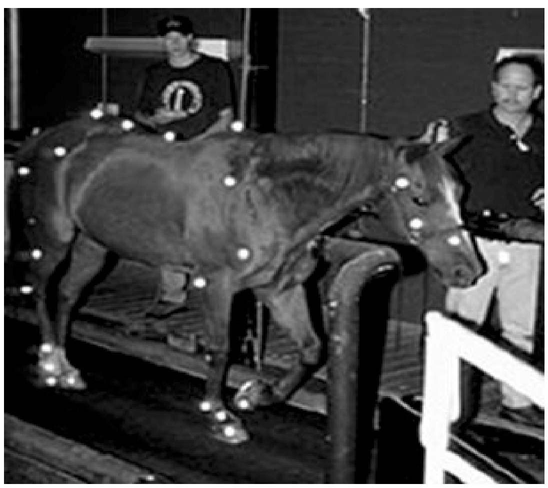
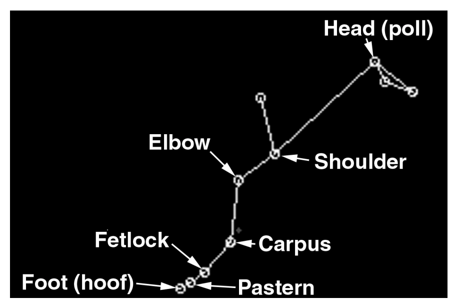
Equine Gait Analysis

Detection and evaluation of lameness and neurological dysfunction in humans and animals by subjective visual assessment is a difficult medical task. Subjective visual observation is the commonly used form of lameness and neurological evaluation in humans and animals. It is based on the examiner's ability to form a comprehensive image of how a normal subject moves and then how this movement is changed with lameness. Visual assessment is subjective and, as such, is difficult because the examiner needs to consider several different and rapidly changing bodily movement patterns.

We are studying objective computational methods for recognition and analysis of mild forelimb gait lameness. Our methods use a generalized approach to classify horse lameness into one of three classes: sound, right-sided forelimb and left-sided forelimb. Our data consists of signals representing horse key point body position information, such as hoses' polls (heads), front feet, fetlocks, carpus, and elbows. Body position information describing the gait of the horse is collected as the horse trots on a high-speed treadmill. The camera system captures 3-dimensional Cartesian coordinate positions from markers attached to several key points on the horses' bodies (Figure 1). This data is recorded and analyzed using computerized methods that extract features in order to capture the characteristics of the key points' position signals.



(a)



(b)

Figure 1

(a) A Horse trotting on the treadmill. Markers attached to the horse appear as white dots in the picture. (b) Diagram for a horse key points.

Here is a brief description of our method for computing feature vectors that are used for neural network classification. We extract features from horses' polls and front feet positional information using continuous wavelet analysis guided by a possibilistic entropy method for wavelet selection. A time-sequence composition process was used to create feature vectors that capture transitions of the transformed signals within a moving time window. A neural network was then trained via back propagation to classify the transformed signals. The method was successful at detecting mild lameness and for differentiating right forelimb from left forelimb lameness (Figure 2). Tests performed using this method showed that a horse's poll is needed for detecting lameness, and that adding one leg point to it can identify the side of lameness. These results encourage future investigation of feature extraction methods that are developed from information theory. Another goal of this study is to explore methods that suggest to medical practitioners the degree of horse gait lameness. Such investigation of lameness quantification may be assisted by methods known to manage uncertainty, such as fuzzy sets and fuzzy logic.

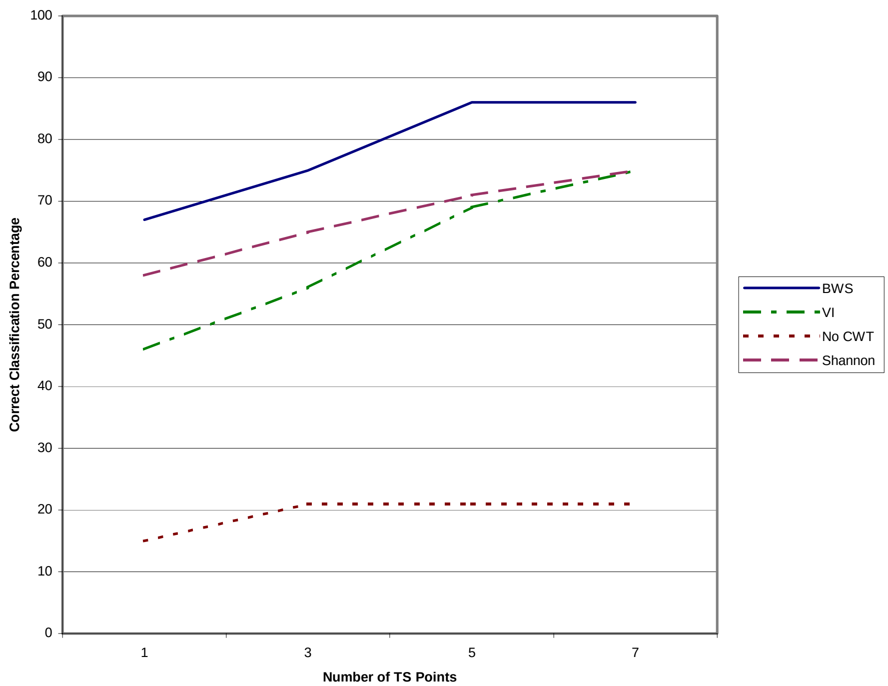


Figure 2

Correct Classification Percentage for 4 sets of preprocessing methods. The top curve shows results with wavelets selected using the possibilistic entropy method (BWS). The second curve (Shannon) shows results with wavelets selected using probabilistic entropy methods. The third (VI) curve shows results using visual selection of a mother wavelet. The lowest curve (NoCWT) shows results for training with the untransformed gait signals

Reference

S. Arafat, M. Skubic, K. Keegan, D. Wilson, "Wavelet Selection Methods for Kinematic Gait Analysis," Submitted to *IEEE Transactions on Neural Systems and Rehabilitation Engineering*.