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Homework 6: Similarity Matrix

TASK

To enhance the understanding of syntheses multiple motions, we need to implement the similarity matrix by hand and interpret the connections between different motions. By doing so, we need to
1) design a distance equation and,
2) applied it to construct the matrix by using different parameters.
3) After the matrix done, the information about the motions should be perceived intuitively from the matrix.

MY WORK

I wrote a Python script to perform the results of my equation choices since the numpy and scipy libraries are so powerful on matrices calculation.

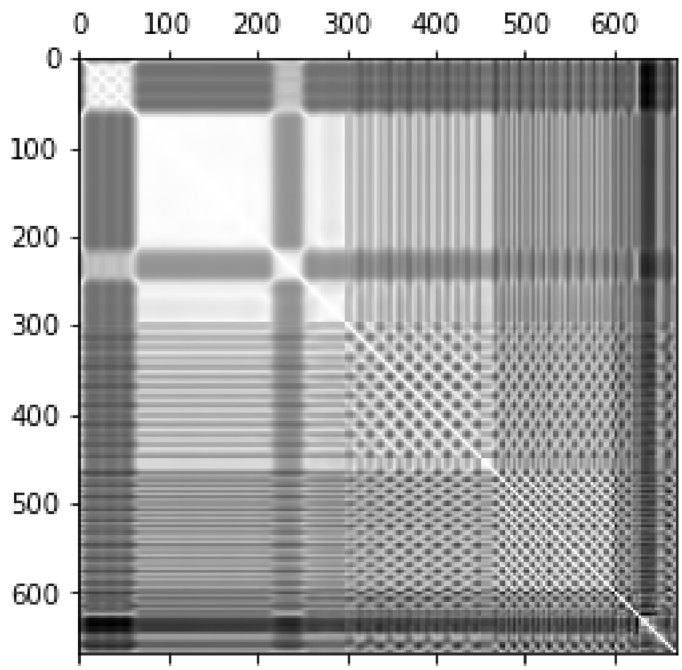

Figure 1: Only apply translation vector as parameter to construct distance matrix.

The easiest way to do this task is to involve only translation information as the parameter. By directly compute the Euclidean distance from one frame to another, we can get equation (1):

$$D_{s_i,t_j} = \left|T(s_i) - T(t_j)\right| \tag{1}$$

Here, s_i and t_j indicate the i-th and j-th frame of the s-th and t-th motion respectively. D_{s_i,t_j} means the distance from s_i to t_j. The length between them is represented by the module of the translation vector $|T(x)|$. And the matrix computed by equation (1) was drawn as Figure 1 shows.

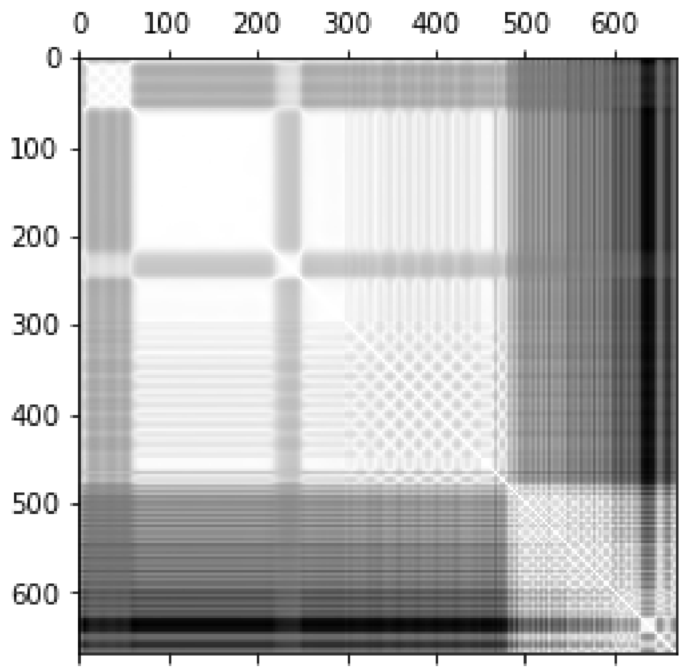

Figure 2: Combine translation and rotation vectors together as parameter to construct distance matrix.

The equation (2) is derived from [Okan Arikan and D. A. Forsyth 2002]. However, it is necessary in their equation to involve the original positions of head, legs and so on. Besides, a matrix constructed by rotation vector was needed as well. From this point, I simplified their equation and gained equation (2):

$$D_{s_i,t_j} = \left(|T(s_i)| - \left|T(t_j)\right|\right) \cos\left(R(s_i) - R(t_j)\right) \tag{2}$$

I applied cosine distance to rotation instead of the Euclidean distance, because the mean value of rotation distances computed by the Euclidean distance is so much bigger than translation distances' that it will mask the weights of translation distances. And from my perspective, a large translation will add more unreality than a sharp rotation. The matrix calculated by equation (2) is illustrated in Figure 2.

RESULT

We can easily tell the boundaries of motions in Figure 1 since it gain a strong contrast in greyscale. The boundaries are illustrated as Figure 3.

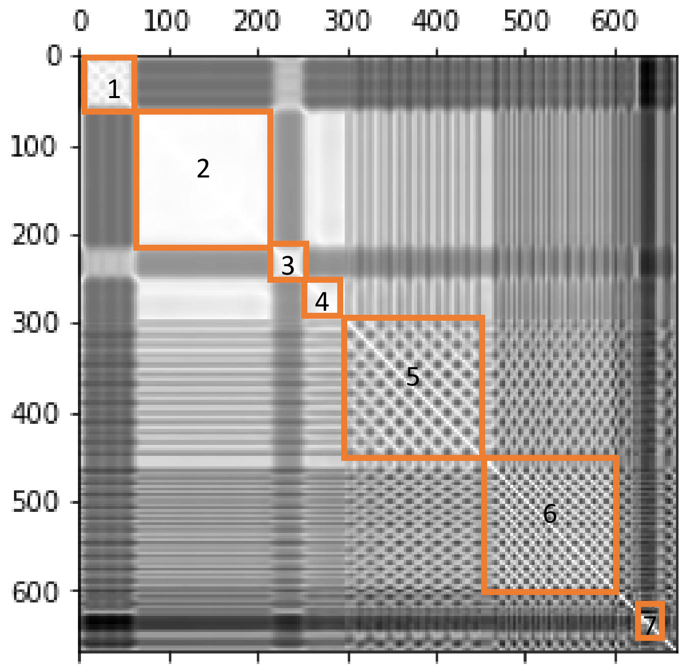

Figure 3: The box represents the boundaries of different motions.

As far as I can perceive, area 2 should be a standing position with little movement involved, such as breath, since this area is plain white with slightly changes. And for area 1, I believe this is the waving motion, for its periodic mesh lines and low contrary in grayscale. As the periodic changes in area 5 and 6, we can tell that they are walking and running respectively according to the density of mesh. It gains a lot of black in area 7, which means it differs with stand in a large scale. So area 7 stands for crawling or laying with high probability.

Although Figure 2 provides a relatively low contrast, we can gain more valid information about the transitional relationship in this figure. As area 6 is assumed as running and area 2 as standing, we can tell that the situation from standing to walking suffers much less change in color than to running along the abscissa 100, which indicates that it is more difficult to transit from standing to running.

REFERENCE

[1] Arikan O, Forsyth DA. Interactive motion generation from examples. ACM Transactions on Graphics. 2002;21(3):483-490.