Vinay R. Balakumar

Personal Information

Status:	**MS Student**
Program:	**Computer Science and Engineering**
School:	**Tandon School of Engineering, New York University**
Website:	**https://www.linkedin.com/in/vinayram2711/**
RA Period:	**From 2016-01 to 2016-12**

Biography

I'm a software engineer at Magic Leap. Before that, I was a research assistant in NYU Multimedia and Visual Computing Lab, advised by Professor Yi Fang. I am broadly interested in 3D Computer Vision, Pattern Recognition and Deep Learning.

M.S. Thesis: Embedded Space Guided Feature Representation For Shape Correspondence

1 Description

Recent times have seen increased familiarity with 3D shapes. This, coupled with the surfeit of data on the same, gives added motivation and encouragement to leverage one with the other. Naturally so, the use of 3D shapes has extensive applications in data visualisation fields be it animation or medical imaging. Among the various 3D shape implementations, the problem of accurate shape correspondence has received sufficient interest. Despite the advancements of research in the field, issues in symmetry and deformation plague the accuracy of shape correspondence. In this paper, we aim to leverage the surplus of 3D data by first establishing an optimal shape correspondence over a class of objects. The result of multi-shape correspondence is then input to a neural network to parametrize the process of multi-shape matching. In addition, the neural network aims to embed the input data to an n-dimensional space whilst preserving the topology of the points in the input data. The topological knowledge circumvents the use of a cost minimization function utilized in defining the target layer. The resultant network weights obtained are a more globally stable and aware descriptor set. The significance of a globally aware descriptor has far-reaching consequences in several domains of 3D computer vision, namely scene reconstruction and robust alignment to state a few. The proposed shape correspondence has been evaluated on characteristic data sets that contain a collection of 3D shapes shown in various poses but share the same mesh topology i.e., SCAPE dataset. Lastly, experimental results conducted demonstrated how the performance of the proposed approach surpassed the state-of-the-art techniques which implement locally aware pairwise shape correspondence metrics. and a state-of-the-art convolutional-neural-network object detector. Experiments show that our framework significantly improves the accuracy of GPS localization and is capable of providing semantic labels in the 3-D domain at real-time.

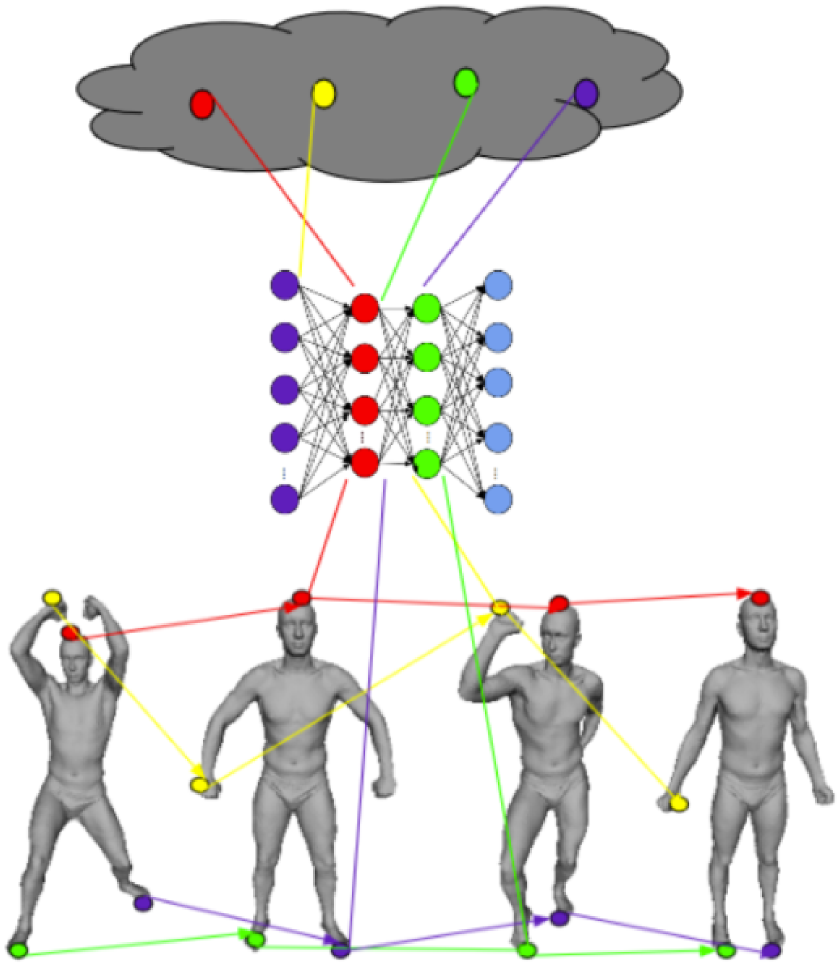

Figure 1: The framework for our proposed method.

2 Method

In this thesis, we aim to overcome the previously highlighted shortcomings of prior research by implementing an unsupervised discriminative neural network which takes as input a class of 3D objects and maps them onto a target vector containing topology preserved information. Once the network has been trained, the hidden features extracted for a queried 3D object give accurate correspondences which outperform the state-of-the-art techniques. To summarise, our approach has three main contributions: (1)Unsupervised learning implemented by performing multi-shape matching on the input class of objects. (2)Parametrisation of the multi-shape matching process by training it over a neural network. (3)Topology preserved embedding of the target vector which overrides the need for a cost minimisation term. Figure.1 shows the framework for our proposed method, mainly including three parts, input models, deep neural network and

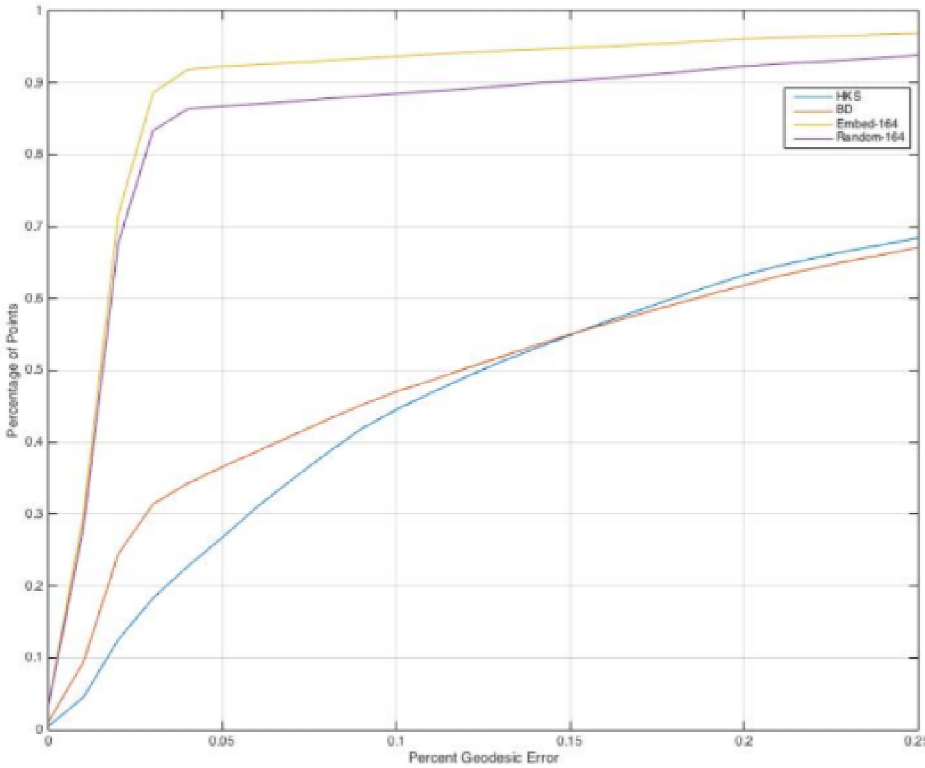

Figure 2: Plotting the Geodesic Error of Heat Kernel Signature and Biharmonic Distance along with the Trained Network Descriptors.

embedding space. The corresponding vertices from different shapes are mapped the same point in the embedding space

3 Results

In this section, we present the final experiment results. The dataset tested upon was the SCAPE dataset which contains 71 human objects in different poses and orientations, providing a good test for shape correspondence. For each shape, there are 12500 vertices. As mentioned in the earlier sections, we only select 500 vertices for matching, to save on computation time. From the Figure.2, it is evident that the graph of the 164 dimension target vector is the steepest, with the slope decreasing with decreasing dimensions. The primary factor for this occurrence is the loss in information with decreasing dimensions. Due to this, target feature vectors that are dimensionally rich which in turn are information rich, are more discerning of input features, thus leading to better shape correspondence. The expected variance in correspon- dence error in the embedded space approach is low and Figure.3 confirms that. In

Figure 3: The results of the colour correspondence map shown on a subset of the SCAPE dataset for the Shape Embedding Guided Feature Descriptor.

conclusion, the colour correspondence map can be used a tool along with the respective graphical depictions in the earlier sub-section to paint a more complete picture of the results.