

# Literature Review – 1

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Papers for review:

1. Detection of hierarchical intrinsic symmetry structure in 3D models (Primary)
2. A Part-Aware Surface Metric for Shape Analysis (Reference)

## **A Part-Aware Surface Metric for Shape Analysis**

This technical paper is a reference to Primary technical paper “Detection of hierarchical intrinsic symmetry structure in 3D models”. It was published in EUROGRAPHICS 2009 – Volume 28, Number 2 and the authors are – Rong Liu, Hao Zhang, Ariel Shamir and Daniel Cohen-Or.

Fundamental geometric representation of 3D objects in Computer Graphics is Surface based. Main purpose of their experiment is to bring together concepts of Shape parts and Surface Metric. Their design revolves around surface metric that is part-aware. Volumetric Shape Image (VSI) is introduced which is enclosed in Shape's Volume. Basically, they designed a new metric which can be useful in many applications including mesh segmentation, shape registration, part-aware sampling and shape retrieval. Authors define part-aware metric as a combination of appropriate VSI distance, geodesic distance and normal variation. One more strategy is used in the paper which says- by assigning attributes to primitives, distance can be calculated for mesh primitives. Then shortest path in the primal or dual graph of mesh can be calculated. This strategy satisfies positive definiteness, symmetry and triangle inequality.

Wide ranging use of surface distance function and importance of shape parts in object recognition motivated them to choose this topic and research. Though, there is concavity between the parts, its not limited to surface measurement. Surface measurement can be used for more global and volumetric views. This in turn results into Shape Concavity (VSI) can be enclosed into shape's volume.

Part Aware metric is a combination of Geodesic, Angular and VSI distances. For better capture part info, VSI is chosen. It consists of a graph which contains a dot inside shapes. When a dot is inside a shape, it should remain stable or keep moving gradually. Only volume is inadequate while measuring distance between visible regions. Hence, sampling approach is used in this project.

Their approach is not to generate an algorithm but to measure effectiveness for part-aware metric to other existing algorithms. Authors also checked how their experiment helps improve performance of shape segmentation algorithms. Spectral clustering to spectral mesh segmentation is used as it relies on quality of distance measure used. They also researched for benefits their experiment can offer to Shape Retrieval. In this experiment, ten models were used as objects (kangaroo, cat, camel, wolf, dinopet, etc.).

Authors used three shape functions – geodesic, D2 and part-aware distances. It was observed that, histogram of geodesic and D2 distances were relatively stable, while part-aware metric produced more discriminating results. They highlighted advantage of their system which is a combination of geodesic and VSI distance.

There are many metrics available like geodesic, isophotic and diffusion distances, though part is important in many aspects ranging from 2D to 3D, psychology and geometry. Isophotic and Diffusion distances do not take part info into consideration. Their key observation in this experiment was, point inside shape volume is sensitive to part boundaries. They further plan to expand their work into more applications using part-aware metric and indulge into shape retrieval.

### **Detection of hierarchical intrinsic symmetry structure in 3D models**

This paper is my Primary choice for Literature review which was published in journal “Computer and Graphics”, volume 70, February 2018. Authors are – Hui Liu, Jizhi Xia, Jianer Chen and Jianxin Wang.

In this technical paper on graphics literature, authors proposed a Hierarchical Intrinsic Symmetry Structure in 3D models. They used step by step approach to implement this system. First, extraction of skeletons of semantic parts and construction of skeleton graph. Secondly, Calculation of similarities between parts. Then, voting strategy for hierarchical structure centres among similar parts. In the end, construction of HISS based on skeleton graph, similar pairs and voting.

Symmetry can be divided into extrinsic and intrinsic depending on their behaviour. Intrinsic symmetry refers to homeomorphism which has broader theoretical connotations than extrinsic. Thus, intrinsic symmetry has ability to understand and express inner structures of complex objects and their generation. There are many challenges to construct a hierarchical structure. To overcome such issues, this paper provides representation and construction of HISS structure. Authors used tree to represent hierarchical structure of a 3d model.

There are difficulties to construct the HISS which includes: analysis of similarity relation between parts, analysis of hierarchical relation between parts. Authors here used vector cosine similarity measure. They used a method based on some observation. Connecting path between two symmetrical parts is symmetrical, higher level node is centre of more symmetrical parts. Hence, intrinsic symmetrical relation was used to represent hierarchical metric. Important notions they followed were: A new representation of hierarchical intrinsic symmetry structure and An automatic approach to construct HISS of models.

Authors mentioned reference paper “A Part-Aware Surface Metric for Shape Analysis” for their contribution towards their experiment success. Rong Liu who was responsible for combining Volume dependent metric Volumetric Shape Image with geodesic distance, angle and other factors was a key portion of their work. Their work is based on part which is similar to referenced paper.

Similar to previous paper, authors here used set of objects such as scorpion, dinosaur and octopus. Intrinsic deformation was applied on these models. Results show their work is capable of achieving identical hierarchy against deformation and scaling.

Still there are few limitations to their experiment such as, complicated topology can hardly be handled by their system, initial segmentation affects the analysis result, skeletons cannot be used for perfect shape of parts. Their future work will extend this approach to other representations of models, such as point cloud.

#### References:

- 1] [https://ac.els-cdn.com/S0097849317301280/1-s2.0-S0097849317301280-main.pdf?\\_tid=spdf-63e7aece-126b-47e0-8609-41a9880da62e&acdnat=1519799851\\_ace23cfa79073da74ffe55c64eba81e0](https://ac.els-cdn.com/S0097849317301280/1-s2.0-S0097849317301280-main.pdf?_tid=spdf-63e7aece-126b-47e0-8609-41a9880da62e&acdnat=1519799851_ace23cfa79073da74ffe55c64eba81e0)
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