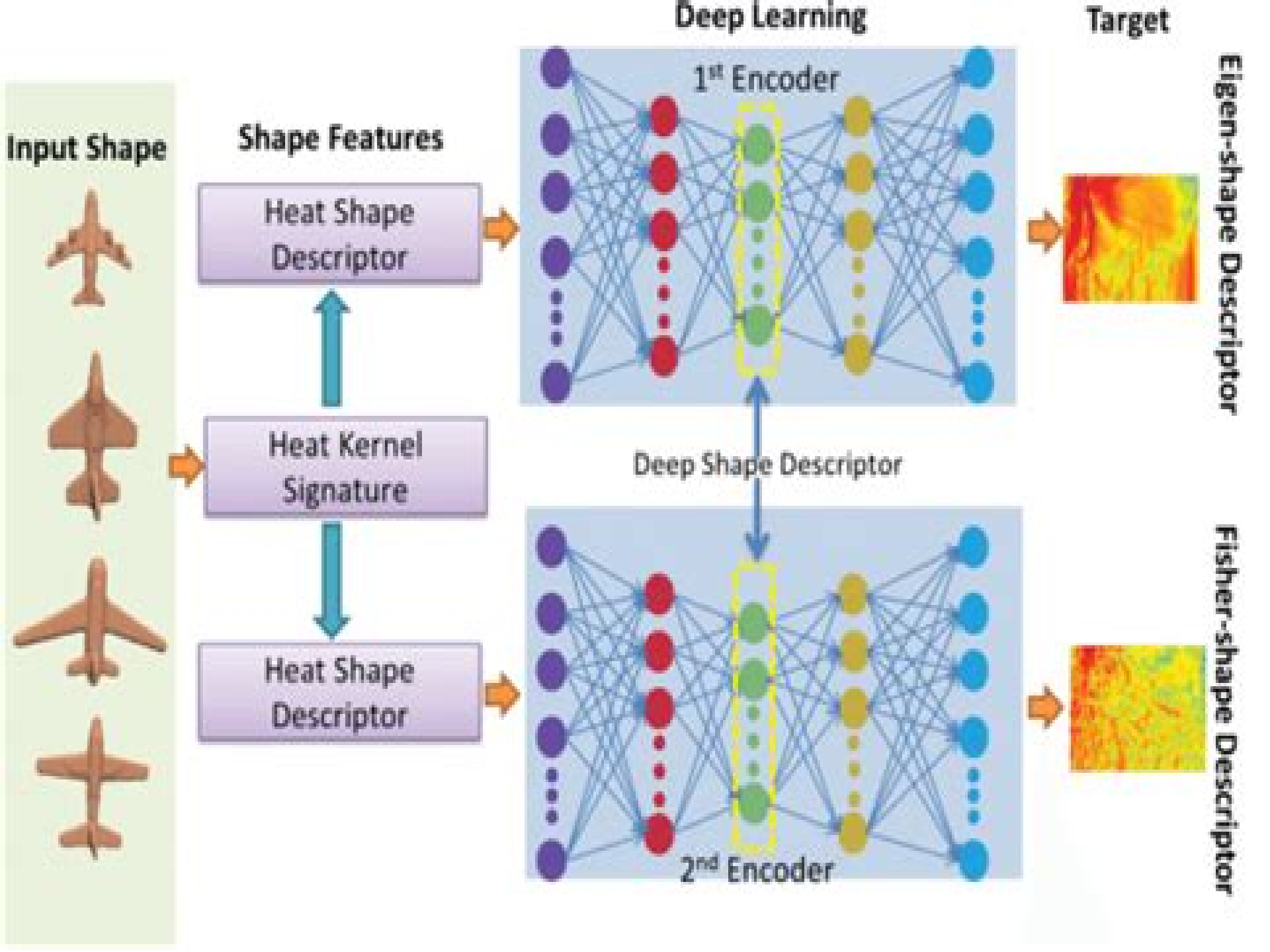
Deep Learning
Target
Input Shape
Shape Features
Heat Shape Descriptor
1st Encoder
Eigen-shape Descriptor
Heat Kernel Signature
Deep Shape Descriptor
Heat Shape Descriptor
2nd Encoder
Fisher-shape Descriptor

3d Deep Shape Descriptor Cv Foundation

Jing Hua,Zichun Zhong,Jiaxi Hu

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3D Shape Analysis Hamid Laga,Yulan Guo,Hedi Tabia,Robert B. Fisher,Mohammed Bennamoun,2019-01-07 An in depth description of the state of the art of 3D shape analysis techniques and their applications This book discusses the different topics that come under the title of 3D shape analysis It covers the theoretical foundations and the major solutions that have been presented in the literature It also establishes links between solutions proposed by different communities that studied 3D shape such as mathematics and statistics medical imaging computer vision and computer graphics The first part of 3D Shape Analysis Fundamentals Theory and Applications provides a review of the background concepts such as methods for the acquisition and representation of 3D geometries and the fundamentals of geometry and topology It specifically covers stereo matching structured light and intrinsic vs extrinsic properties of shape Parts 2 and 3 present a range of mathematical and algorithmic tools which are used for e g global descriptors keypoint detectors local feature descriptors and algorithms that are commonly used for the detection registration recognition classification and retrieval of 3D objects Both also place strong emphasis on recent techniques motivated by the spread of commodity devices for 3D acquisition Part 4 demonstrates the use of these techniques in a selection of 3D shape analysis applications It covers 3D face recognition object recognition in 3D scenes and 3D shape retrieval It also discusses examples of semantic applications and cross domain 3D retrieval i e how to retrieve 3D models using various types of modalities e g sketches and or images The book concludes with a summary of the main ideas and discussions of the future trends 3D Shape Analysis Fundamentals Theory and Applications is an excellent reference for graduate students researchers and professionals in different fields of mathematics computer science and engineering It is also ideal for courses in computer vision and computer graphics as well as for those seeking 3D industrial commercial solutions **Geometric Deep Learned Descriptors for 3D Shape Recognition** Lorenzo Luciano,2018 The availability of large 3D shape benchmarks has sparked a flurry of research activity in the development of efficient techniques for 3D shape recognition which is a fundamental problem in a variety of domains such as pattern recognition computer vision and geometry processing A key element in virtually any shape recognition method is to represent a 3D shape by a concise and compact shape descriptor aimed at facilitating the recognition tasks The recent trend in shape recognition is geared toward using deep neural networks to learn features at various levels of abstraction and has been driven in large part by a combination of affordable computing hardware open source software and the availability of large scale datasets In this thesis we propose deep learning approaches to 3D shape classification and retrieval Our approaches inherit many useful properties from the geodesic distance most notably the capture of the intrinsic geometric structure of 3D shapes and the invariance to isometric deformations More specifically we present an integrated framework for 3D shape classification that extracts discriminative geometric shape descriptors with geodesic moments Further we introduce a geometric framework for unsupervised 3D shape retrieval using geodesic moments and stacked sparse autoencoders The key idea is to learn deep

shape representations in an unsupervised manner Such discriminative shape descriptors can then be used to compute pairwise dissimilarities between shapes in a dataset and to find the retrieved set of the most relevant shapes to a given shape query Experimental evaluation on three standard 3D shape benchmarks demonstrate the competitive performance of our approach in comparison with existing techniques We also introduce a deep similarity network fusion framework for 3D shape classification using a graph convolutional neural network which is an efficient and scalable deep learning model for graph structured data The proposed approach coalesces the geometrical discriminative power of geodesic moments and similarity network fusion in an effort to design a simple yet discriminative shape descriptor This geometric shape descriptor is then fed into the graph convolutional neural network to learn a deep feature representation of a 3D shape We validate our method on ModelNet shape benchmarks demonstrating that the proposed framework yields significant performance gains compared to state of the art approaches **3D Imaging, Analysis and Applications** Yonghuai Liu,Nick Pears,Paul L. Rosin,Patrik Huber,2020-09-11 This textbook is designed for postgraduate studies in the field of 3D Computer Vision It also provides a useful reference for industrial practitioners for example in the areas of 3D data capture computer aided geometric modelling and industrial quality assurance This second edition is a significant upgrade of existing topics with novel findings Additionally it has new material covering consumer grade RGB D cameras 3D morphable models deep learning on 3D datasets as well as new applications in the 3D digitization of cultural heritage and the 3D phenotyping of crops Overall the book covers three main areas 3D imaging including passive 3D imaging active triangulation 3D imaging active time of flight 3D imaging consumer RGB D cameras and 3D data representation and visualisation 3D shape analysis including local descriptors registration matching 3D morphable models and deep learning on 3D datasets and 3D applications including 3D face recognition cultural heritage and 3D phenotyping of plants 3D computer vision is a rapidly advancing area in computer science There are many real world applications that demand high performance 3D imaging and analysis and as a result many new techniques and commercial products have been developed However many challenges remain on how to analyse the captured data in a way that is sufficiently fast robust and accurate for the application Such challenges include metrology semantic segmentation classification and recognition Thus 3D imaging analysis and their applications remain a highly active research field that will continue to attract intensive attention from the research community with the ultimate goal of fully automating the 3D data capture analysis and inference pipeline **Deep Shape Representations for 3D Object Recognition** Hamed Ghodrati Asbfroushani,2018 Deep learning is a rapidly growing discipline that models high level features in data as multilayered neural networks The recent trend toward deep neural networks has been driven in large part by a combination of affordable computing hardware open source software and the availability of pre trained networks on large scale datasets In this thesis we propose deep learning approaches to 3D shape recognition using a multilevel feature learning paradigm We start by comprehensively reviewing recent shape descriptors including hand crafted descriptors that

are mostly developed in the spectral geometry setting and also the ones obtained via learning based methods Then we introduce novel multi level feature learning approaches using spectral graph wavelets bag of features and deep learning Low level features are first extracted from a 3D shape using spectral graph wavelets Mid level features are then generated via the bag of features model by employing locality constrained linear coding as a feature coding method in conjunction with the biharmonic distance and intrinsic spatial pyramid matching in a bid to effectively measure the spatial relationship between each pair of the bag offeature descriptors For the task of 3D shape retrieval high level shape features are learned via a deep auto encoder on mid level features Then we compare the deep learned descriptor of a query shape to the descriptors of all shapes in the dataset using a dissimilarity measure for 3D shape retrieval For the task of 3D shape classification mid level features are represented as 2D images in order to be fed into a pre trained convolutional neural network to learn high level features from the penultimate fully connected layer of the network Finally a multiclass support vector machine classifier is trained on these deep learned descriptors and the classification accuracy is subsequently computed The proposed 3D shape retrieval and classification approaches are evaluated on three standard 3D shape benchmarks through extensive experiments and the results show compelling superiority of our approaches over state of the art methods 3D Computer Vision Yu-Jin Zhang,2024-04-26 This book offers a comprehensive and unbiased introduction to 3D Computer Vision ranging from its foundations and essential principles to advanced methodologies and technologies Divided into 11 chapters it covers the main workflow of 3D computer vision as follows camera imaging and calibration models various modes and means of 3D image acquisition binocular trinocular and multi ocular stereo vision matching techniques monocular single image and multi image scene restoration methods point cloud data processing and modeling simultaneous location and mapping generalized image and scene matching and understanding spatial temporal behavior Each topic is addressed in a uniform manner the dedicated chapter first covers the essential concepts and basic principles before presenting a selection of typical specific methods and practical techniques In turn it introduces readers to the most important recent developments especially in the last three years This approachallows them to quickly familiarize themselves with the subject implement the techniques discussed and design or improve their own methods for specific applications The book can be used as a textbook for graduate courses in computer science computer engineering electrical engineering data science and related subjects It also offers a valuable reference guide for researchers and practitioners alike **3D Shape Descriptor Based on 3D Fourier Transform** Dejan Vranić,Dietmar Saupe,2013 **Feature Encoding of Spectral Descriptors for 3D Shape Recognition** Masoumi Majid,2017 Feature descriptors have become a ubiquitous tool in shape analysis Features can be extracted and subsequently used to design discriminative signatures for solving a variety of 3D shape analysis problems In particular shape classification and retrieval are intriguing and challenging problems that lie at the crossroads of computer vision geometry processing machine learning and medical imaging In this thesis we propose spectral graph wavelet approaches for the classification and

retrieval of deformable 3D shapes First we review the recent shape descriptors based on the spectral decomposition of the Laplace Beltrami operator which provides a rich set of eigenbases that are invariant to intrinsic isometries We then provide a detailed overview of spectral graph wavelets In an effort to capture both local and global characteristics of a 3D shape we propose a three step feature description framework Local descriptors are first extracted via the spectral graph wavelet transform having the Mexican hat wavelet as a generating kernel Then mid level features are obtained by embedding local descriptors into the visual vocabulary space using the soft assignment coding step of the bag of features model A global descriptor is subsequently constructed by aggregating mid level features weighted by a geodesic exponential kernel resulting in a matrix representation that describes the frequency of appearance of nearby codewords in the vocabulary In order to analyze the performance of the proposed algorithms on 3D shape classification support vector machines and deep belief networks are applied to mid level features To assess the performance of the proposed approach for nonrigid 3D shape retrieval we compare the global descriptor of a query to the global descriptors of the rest of shapes in the dataset using a dissimilarity measure and find the closest shape Experimental results on three standard 3D shape benchmarks demonstrate the effectiveness of the proposed classification and retrieval approaches in comparison with state of the art methods

Spectral Geometry of Shapes Jing Hua,Zichun Zhong,Jiaxi Hu,2019-10-24 Spectral Geometry of Shapes presents unique shape analysis approaches based on shape spectrum in differential geometry It provides insights on how to develop geometry based methods for 3D shape analysis The book is an ideal learning resource for graduate students and researchers in computer science computer engineering and applied mathematics who have an interest in 3D shape analysis shape motion analysis image analysis medical image analysis computer vision and computer graphics Due to the rapid advancement of 3D acquisition technologies there has been a big increase in 3D shape data that requires a variety of shape analysis methods hence the need for this comprehensive resource Presents the latest advances in spectral geometric processing for 3D shape analysis applications such as shape classification shape matching medical imaging etc Provides intuitive links between fundamental geometric theories and real world applications thus bridging the gap between theory and practice Describes new theoretical breakthroughs in applying spectral methods for non isometric motion analysis Gives insights for developing spectral geometry based approaches for 3D shape analysis and deep learning of shape geometry Deep Learning For 3d Vision: Algorithms And Applications Xiaoli Li,Xulei Yang,Hao Su,2024-08-27 3D deep learning is a rapidly evolving field that has the potential to transform various industries This book provides a comprehensive overview of the current state of the art in 3D deep learning covering a wide range of research topics and applications It collates the most recent research advances in 3D deep learning including algorithms and applications with a focus on efficient methods to tackle the key technical challenges in current 3D deep learning research and adoption therefore making 3D deep learning more practical and feasible for real world applications This book is organized into five sections each of which addresses different aspects of 3D deep

learning Section I Sample Efficient 3D Deep Learning focuses on developing efficient algorithms to build accurate 3D models with limited annotated samples Section II Representation Efficient 3D Deep Learning deals with the challenge of developing efficient representations for dynamic 3D scenes and multiple 3D modalities Section III Robust 3D Deep Learning presents methods for improving the robustness and reliability of deep learning models in real world applications Section IV Resource Efficient 3D Deep Learning explores ways to reduce the computation cost of 3D models and improve their efficiency in resource limited environments Section V Emerging 3D Deep Learning Applications showcases how 3D deep learning is transforming industries and enabling new applications for healthcare and manufacturing This collection is a valuable resource for researchers and practitioners interested in exploring the potential of 3D deep learning **Three-Dimensional Model Analysis and Processing** Faxin Yu,Zheming Lu,Hao Luo,Pinghui Wang,2011-02-03 With the increasing popularization of the Internet together with the rapid development of 3D scanning technologies and modeling tools 3D model databases have become more and more common in fields such as biology chemistry archaeology and geography People can distribute their own 3D works over the Internet search and download 3D model data and also carry out electronic trade over the Internet However some serious issues are related to this as follows 1 How to efficiently transmit and store huge 3D model data with limited bandwidth and storage capacity 2 How to prevent 3D works from being pirated and tampered with 3 How to search for the desired 3D models in huge multimedia databases This book is devoted to partially solving the above issues Compression is useful because it helps reduce the consumption of expensive resources such as hard disk space and transmission bandwidth On the downside compressed data must be decompressed to be used and this extra processing may be detrimental to some applications 3D polygonal mesh with geometry color normal vector and texture coordinate information as a common surface representation is now heavily used in various multimedia applications such as computer games animations and simulation applications To maintain a convincing level of realism many applications require highly detailed mesh models However such complex models demand broad network bandwidth and much storage capacity to transmit and store To address these problems 3D mesh compression is essential for reducing the size of 3D model representation **2D and 3D Shape Descriptors** Carlos Andres Martinez-Ortiz,2010 *Sphere Intersection 3D Shape Descriptor (SID)* Kirill Pevzner,2014 An Improvement of Rotation Invariant 3D Shape Descriptor Based on Functions on Concentric Spheres Dejan Vranić,2013 *Spectral Geometric Methods for Deformable 3D Shape Retrieval* Chunyuan Li,2013 Geometric Modeling of Non-rigid 3D Shapes Mostafa Abdelrahman,2013 One of the major goals of computer vision is the development of flexible and efficient methods for shape representation This is true especially for non rigid 3D shapes where a great variety of shapes are produced as a result of deformations of a non rigid object Modeling these non rigid shapes is a very challenging problem Being able to analyze the properties of such shapes and describe their behavior is the key issue in research Also considering photometric features can play an important role in many shape analysis

applications such as shape matching and correspondence because it contains rich information about the visual appearance of real objects This new information contained in photometric features and its important applications add another new dimension to the problem s difficulty Two main approaches have been adopted in the literature for shape modeling for the matching and retrieval problem local and global approaches Local matching is performed between sparse points or regions of the shape while the global shape approaches similarity is measured among entire models These methods have an underlying assumption that shapes are rigidly transformed And Most descriptors proposed so far are confined to shape that is they analyze only geometric and or topological properties of 3D models A shape descriptor or model should be isometry invariant scale invariant be able to capture the fine details of the shape computationally efficient and have many other good properties A shape descriptor or model is needed This shape descriptor should be able to deal with the non rigid shape deformation able to handle the scale variation problem with less sensitivity to noise able to match shapes related to the same class even if these shapes have missing parts and able to encode both the photometric and geometric information in one descriptor This dissertation will address the problem of 3D non rigid shape representation and textured 3D non rigid shapes based on local features Two approaches will be proposed for non rigid shape matching and retrieval based on Heat Kernel HK and Scale Invariant Heat Kernel SI HK and one approach for modeling textured 3D non rigid shapes based on scale invariant Weighted Heat Kernel Signature WHKS For the first approach the Laplace Beltrami eigenfunctions is used to detect a small number of critical points on the shape surface Then a shape descriptor is formed based on the heat kernels at the detected critical points for different scales Sparse representation is used to reduce the dimensionality of the calculated descriptor The proposed descriptor is used for classification via the Collaborative Representation based Classification with a Regularized Least Square CRC RLS algorithm The experimental results have shown that the proposed descriptor can achieve state of the art results on two benchmark data sets For the second approach an improved method to introduce scale invariance has been also proposed to avoid noise sensitive operations in the original transformation method Then a new 3D shape descriptor is formed based on the histograms of the scale invariant HK for a number of critical points on the shape at different time scales A Collaborative Classification CC scheme is then employed for object classification The experimental results have shown that the proposed descriptor can achieve high performance on the two benchmark data sets An important observation from the experiments is that the proposed approach is more able to handle data under several distortion scenarios noise shot noise scale and under missing parts than the well known approaches For modeling textured 3D non rigid shapes this dissertation introduces for the first time a mathematical framework for the diffusion geometry on textured shapes This dissertation presents an approach for shape matching and retrieval based on a weighted heat kernel signature It shows how to include photometric information as a weight over the shape manifold and it also propose a novel formulation for heat diffusion over weighted manifolds Then this dissertation presents a new discretization method for the weighted heat kernel induced by the

linear FEM weights Finally the weighted heat kernel signature is used as a shape descriptor The proposed descriptor encodes both the photometric and geometric information based on the solution of one equation Finally this dissertation proposes an approach for 3D face recognition based on the front contours of heat propagation over the face surface The front contours are extracted automatically as heat is propagating starting from a detected set of landmarks The propagation contours are used to successfully discriminate the various faces The proposed approach is evaluated on the largest publicly available database of 3D facial images and successfully compared to the state of the art approaches in the literature This work can be extended to the problem of dense correspondence between non rigid shapes The proposed approaches with the properties of the Laplace Beltrami eigenfunction can be utilized for 3D mesh segmentation Another possible application of the proposed approach is the view point selection for 3D objects by selecting the most informative views that collectively provide the most descriptive presentation of the surface 3D Shape Modeling Using High Level Descriptors Vedrana Andersen,Danmarks Tekniske Universitet. DTU Informatik,Danmarks Tekniske Universitet. Institut for Matematisk Modellering,2010 **Representations and Techniques for 3D Object Recognition and Scene Interpretation** Derek Hoiem,Silvio Savarese,2011-09-09 One of the grand challenges of artificial intelligence is to enable computers to interpret 3D scenes and objects from imagery This book organizes and introduces major concepts in 3D scene and object representation and inference from still images with a focus on recent efforts to fuse models of geometry and perspective with statistical machine learning The book is organized into three sections 1 Interpretation of Physical Space 2 Recognition of 3D Objects and 3 Integrated 3D Scene Interpretation The first discusses representations of spatial layout and techniques to interpret physical scenes from images The second section introduces representations for 3D object categories that account for the intrinsically 3D nature of objects and provide robustness to change in viewpoints The third section discusses strategies to unite inference of scene geometry and object pose and identity into a coherent scene interpretation Each section broadly surveys important ideas from cognitive science and artificial intelligence research organizes and discusses key concepts and techniques from recent work in computer vision and describes a few sample approaches in detail Newcomers to computer vision will benefit from introductions to basic concepts such as single view geometry and image classification while experts and novices alike may find inspiration from the book s organization and discussion of the most recent ideas in 3D scene understanding and 3D object recognition Specific topics include mathematics of perspective geometry visual elements of the physical scene structural 3D scene representations techniques and features for image and region categorization historical perspective computational models and datasets and machine learning techniques for 3D object recognition inferences of geometrical attributes of objects such as size and pose and probabilistic and feature passing approaches for contextual reasoning about 3D objects and scenes Table of Contents Background on 3D Scene Models Single view Geometry Modeling the Physical Scene Categorizing Images and Regions Examples of 3D Scene Interpretation Background on 3D Recognition

Modeling 3D Objects Recognizing and Understanding 3D Objects Examples of 2D 1 2 Layout Models Reasoning about Objects and Scenes Cascades of Classifiers Conclusion and Future Directions **A Study of 3D Point Cloud Features for Shape Retrieval** Hoang Justin Lev,2020 With the improvement and proliferation of 3D sensors price cut and enhancementof computational power the usage of 3D data intensifies for the last few years The3D point cloud is one type amongst the others for 3D representation This particularlyrepresentation is the direct output of sensors accurate and simple As a non regularstructure of unordered list of points the analysis on point cloud is challenging andhence the recent usage only This PhD thesis focuses on the use of 3D point cloud representation for threedimensional shape analysis More particularly the geometrical shape is studied throughthe curvature of the object Descriptors describing the distribution of the principalcurvature is proposed Principal Curvature Point Cloud and Multi Scale PrincipalCurvature Point Cloud Global Local Point Cloud is another descriptor using thecurvature but in combination with other features These three descriptors are robustto typical 3D scan error like noisy data or occlusion They outperform state of the artalgorithms in instance retrieval task with more than 90% of accuracy The thesis also studies deep learning on 3D point cloud which emerges during thethree years of this PhD The first approach tested used curvature based descriptor asthe input of a multi layer perceptron network The accuracy cannot catch state ofthe art performances However they show that ModelNet the standard dataset for 3Dshape classification is not a good picture of the reality Indeed the experiment showsthat the dataset does not reflect the curvature wealth of true objects scans Ultimately a new neural network architecture is proposed Inspired by the state ofthe art deep learning network Multiscale PointNet computes the feature on multiplescales and combines them all to describe an object Still under development theperformances are still to be improved In summary tackling the challenging use of 3D point clouds but also the quickevolution of the field the thesis contributes to the state of the art in three majoraspects i Design of new algorithms relying on geometrical curvature of the objectfor instance retrieval task ii Study and exhibition of the need to build a new standardclassification dataset with more realistic objects iii Proposition of a new deep neuralnetwork for 3D point cloud analysis **Geometric Approaches for 3D Shape Denoising and Retrieval** Anis Kacem,2013

Scale-dependent/invariant Local 3D Geometric Features and Shape Descriptors John Novatnack,Ko Nishino,2008

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