

Charla de Investigación: Recuperación de Información Multimedia en Datos de Patrimonio Cultural

Prof. Benjamin Bustos

Millennium Institute Foundational Research on Data
Departamento de Ciencias de la Computación
Universidad de Chile

Multimedia Information Retrieval

- Problemas principales
 - Representación de datos multimedia
 - Búsqueda
 - Clasificación y Clustering
 - Reconocimiento de patrones
 - “Gap semántico”

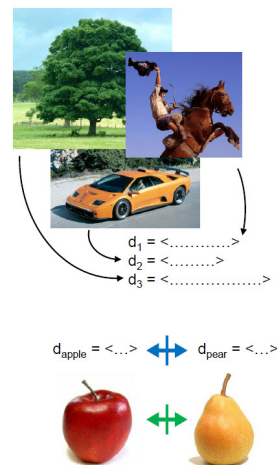
Búsqueda en datos Multimedia

- Problema: encontrar objetos “parecidos” o “relevantes”
- Contexto vs. contenido
 - Contenido
 - Anotaciones manuales
 - Anotaciones automáticas



Búsqueda por similitud

- Encontrar objetos similares
- Modelo de búsqueda
 - Extracción de características
 - Descriptor (*feature vector*)
 - Función de similitud
 - Compara descriptores
 - Usualmente basado en distancias



Daniel Keim and Benjamin Bustos. Similarity search in multimedia databases. In Proc. 20th International Conference on Data Engineering (ICDE'04), page 873. IEEE Computer Society, 2004.

Búsqueda por similitud

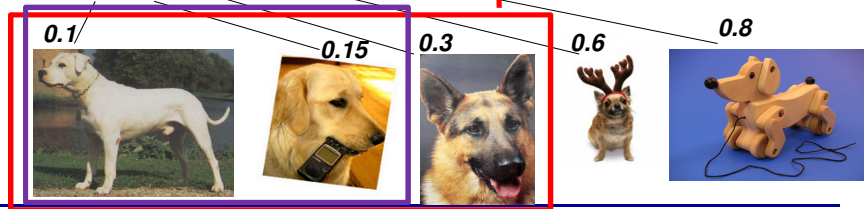
■ Tipos de consultas

- Query-by-example



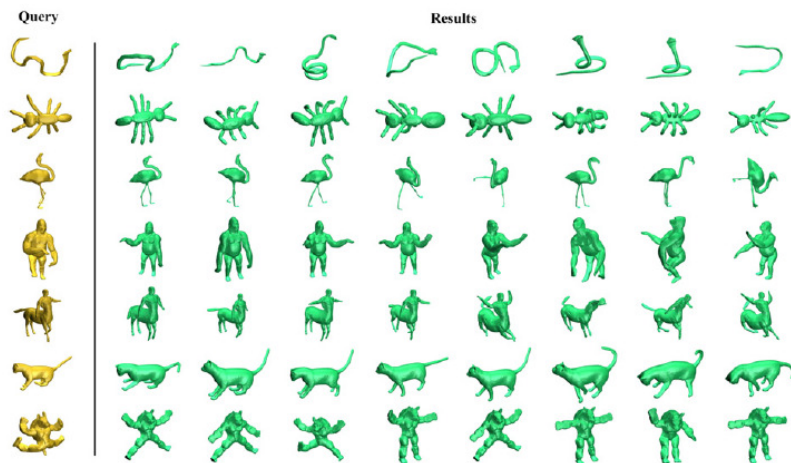
Búsqueda por rango
(encontrar los más similares – sobre 80% similitud)

k vecinos más cercanos (k-NN)
(encontrar los tres más similares)



5

Ejemplo: 3D object retrieval



Zhouhui Lian, Atzal Godil, Benjamin Bustos, Mohamed Daoudi, Jeroen Hermans, Shun Kawamura, Yukinori Kurita, Guillaume Lavoue, Hien Van Nguyen, Ryutarou Ohbuchi, Yuki Ohkita, Yuya Ohishi, Fatih Porikli, Martin Reuter, Ivan Sipiran, Dirk Smeets, Paul Suetens, Hedi Tabia, Dirk Vandermeulen. A comparison of methods for non-rigid 3D shape retrieval. *Pattern Recognition*, 46(1):449-461. Elsevier Science, 2013.

6

INVESTIGACIÓN INTERDISCIPLINARIA: PATRIMONIO CULTURAL

7

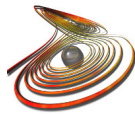
¿Por qué Patrimonio Cultural (CH)?

- Necesidad de digitalizar información de CH para su conservación
- Necesidad de crear datasets que permitan evaluar algoritmos para distintas tareas
- Automatizar tareas que consumen actualmente muchas horas
- Transmitir el conocimiento arqueológico a la sociedad, mejorar el entendimiento de las culturas del pasado

8

CrossSAVE-CH

- Crossmodal Search and Visual Exploration of 3D Cultural Heritage Objects (2019-2022)
 - Institute of Computer Graphics and Knowledge Visualisation (CGV), Technische Universität Graz, Austria
 - “Methods for searching, comparing, and visually exploring 3D cultural heritage objects”



<https://www.tugraz.at/institute/cgv/research/projects/crosssave-ch/>

9

Finding similar patterns on 3D shapes

- In collaboration with
 - CGV: Stefan Lengauer, Reinhold Preiner, Tobias Schreck
 - Universidad de Chile: Ivan Sipiran
- Problem
 - 3D models of ancient pottery objects
 - Task: analysis of motifs and patterns on these objects' surfaces

10

Examples of 3D ancient pottery models



Squares: annotated classes of surface patterns
Colored polygons: individual entities, vastly different levels of repetitiveness

11

Major problems

- Lack of a high quality ground truth
- Lack of tools that aids domain experts annotating this type of data
- Lack of methods that can effectively and efficiently solve this problem

12

Our contribution

- Annotated dataset of 82 different 3D models of painted ancient Peruvian vessels
 - Exhibiting different levels of repetitiveness in their surface patterns
 - Manually annotated by archaeologists who identified clearly definable pattern classes
 - Repetitive patterns occurrences also manually annotated

Stefan Lengauer, Ivan Sipiran, Reinhold Preiner, Tobias Schreck, and Benjamin Bustos. A Benchmark Dataset for Repetitive Pattern Recognition on Textured 3D Surfaces. *Computer Graphics Forum* 40(5):1-8. Wiley, 2021

13

Our contribution

- Evaluation benchmark
 - Tool for evaluating new pattern detection algorithms
 - It evaluates the methods based on the mean average precision of correctly segmented 3D mesh faces
 - Annotation tool for extending the benchmark with new 3D models and patterns

14

Textured 3D models of the dataset



15

Characteristics of the dataset

- 82 real-world scanned artifacts
 - Josefina Ramos de Cox Museum in Lima, Peru
 - Triangle meshes obtained with a structured-light scanner
- Polychromatic texture patterns
- Repetitive patterns
- Patterns and motifs in our dataset can appear anywhere on the model

16

Characteristics of the dataset

Classification by shape



Classification by culture



17

Data quality



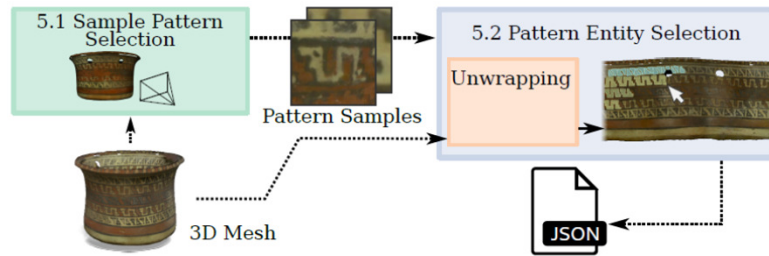
Top Left: geometric deficiencies like missing parts due to decay
Bottom left: chipped off parts

Top right: scanning errors
Bottom right: worn off surface parts

18

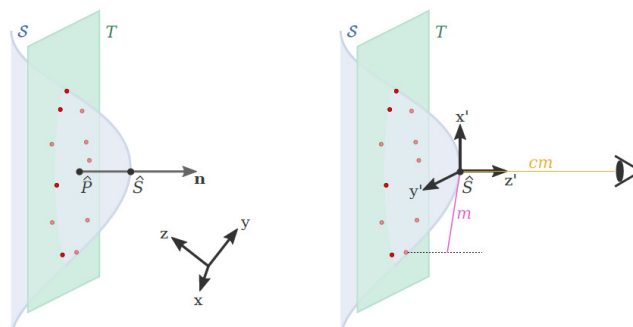
Annotation pipeline

- Two interacting software tools



19

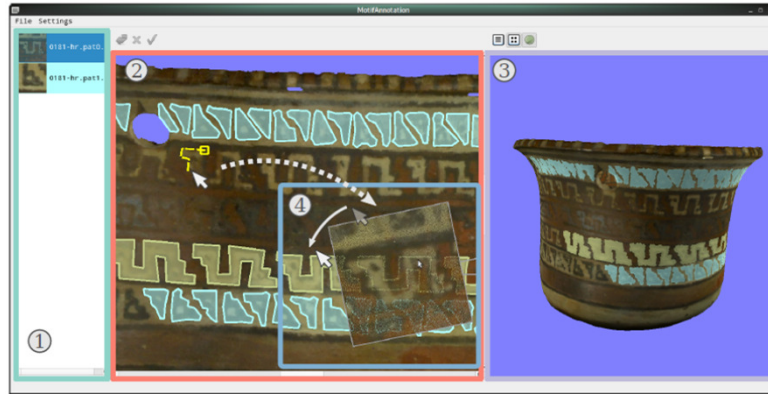
Sample pattern selection



We generate one sample image for each pattern archetype

20

Pattern entity selection



Select a pattern entity on the flat proxy surface with a polygonal lasso tool, edit orientation and scale of the pattern

21

Research project

- Multi-labelling of patterns
- Multi-modal search of patterns

22

Open problems

- Given an object, find appropriate textual labels that describes the patterns in its surface
- Searching (uni- and multi-modal)
 - Given a text, find the best matches in a CH object
 - Given a pattern, find the best matches in a CH object
 - Given a text and/or a pattern, find the best matches in a CH object

23



Charla de Investigación: Recuperación de Información Multimedia en Datos de Patrimonio Cultural

Prof. Benjamin Bustos

Millennium Institute Foundational Research on Data
Departamento de Ciencias de la Computación
Universidad de Chile