A Systematic Literature Review on 3D Reconstruction Methods from a Limited Number of X-ray Images

Eveling Gloria Castro Gutierrez – Nancy Hitschfeld-Kahler
Academic Track
Noviembre 2015
A Systematic Literature Review on 3D Reconstruction Methods from a Limited Number of X-ray Images


The Review Process

Conducting
- Search Strategy
- Inclusion / Exclusion Criteria
- Primary Studies Selection Process
- Data Extraction
- Search Space

Planning

Reporting
### A. Research Questions

<table>
<thead>
<tr>
<th>RQ1</th>
<th>Is it possible to do the reconstruction of a 3D model from a limited number of X-ray images?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ2</td>
<td>Which methods exist to reconstruct 3D models from a limited number of X-ray images?</td>
</tr>
<tr>
<td>RQ3</td>
<td>What is the maturity level of these model reconstruction methods with respect to the following criteria: scope, programming level (prototype or end-product), programming approach, scalability, correctness, robustness and theoretical and empirical performance (CPU, space memory).</td>
</tr>
<tr>
<td>RQ4</td>
<td>How are these reconstruction methods evaluated?</td>
</tr>
<tr>
<td>RQ4.1</td>
<td>Which is the obtained quality after this evaluation? Do the researchers compare their results with the ones of others researchers?</td>
</tr>
<tr>
<td>RQ4.2</td>
<td>Which kind of data is used to evaluate these methods?</td>
</tr>
<tr>
<td>RQ5</td>
<td>Do these reconstruction methods present a form of validation?</td>
</tr>
<tr>
<td>RQ5.1</td>
<td>Which is the obtained quality after this validation? Do the researchers compare their result with the ones of other researchers</td>
</tr>
<tr>
<td>RQ5.2</td>
<td>Which kind of data is used to validate the methods?</td>
</tr>
</tbody>
</table>
B. Keyword

3d transformation, 3d geometric transformation, 2d/3d reconstruct or 2d-3d reconstruct, x-ray images

C. Search String

((3d geometric transformation) or (2d/3d reconstruct or 2d-3d reconstruct))

and (x-ray images)

D. Libraries

Elsevier

Scopus

IEEE

ScienceDirect

SpringerLink

ACM Digital Library

Wiley
Inclusion / Exclusion Criteria

Primary Studies Selection Process

1) Identify the relevant studies from the Search Databases

2) Apply the inclusion/exclusion criteria

3) Analyze and synthesize the knowledge corpus

4) Build the review
...conducting...
TABLE IV: Amount of Articles Retrieved from each Database

<table>
<thead>
<tr>
<th>Source</th>
<th>Retrieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus</td>
<td>121</td>
</tr>
<tr>
<td>IEEE Xplore</td>
<td>402</td>
</tr>
<tr>
<td>ScienceDirect</td>
<td>56</td>
</tr>
<tr>
<td>ACM Digital</td>
<td>101</td>
</tr>
<tr>
<td>Springer</td>
<td>20</td>
</tr>
<tr>
<td>Wiley Online Library</td>
<td>71</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>771</strong></td>
</tr>
</tbody>
</table>

Fig. 1: Representativeness of the literature sources
Systematic Review PROTOCOL for 3D Reconstruction Methods from a Limited Number of X-ray Images

Eveling Gloria Castro Gutierrez, Research Grant, Fondecyt-CONCYTEC-PERU, ecastrog@ucsm.edu.pe
Nancy Hitschfeld-Kahler, Department of Computer Science, FCFM Universidad de Chile, nancy@dcc.uchile.cl

I. STUDY MOTIVATION

In this document, we present the protocol, we have designed to start a Systematic Review(SR) in Computer Vision and Medical Imaging areas. This study focused on peer-reviewed articles.

- 3d model
- 2d/3d reconstruct or 2d-3d reconstruct
- X-ray images
A Systematic Literature Review on 3D Reconstruction Methods from a Limited Number of X-ray Images.

Eveling Castro, Research Grant. Fondecyt-CONCYTEC (PERU), and Nancy Hitzfeld, PhD, Universidad de Chile (CHILE)

Abstract—With recent advances in the areas of computer vision and medical imaging, the growing need to reconstruct 3D models of bone structures from medical images is observed. These models are used in the diagnosis, treatment, and some clinical research.

The acquisition of medical imaging are usually made by CT, MRI, X-ray images. X-rays, have a low cost and the patient is not exposed to more radiation as occurs with CT and MRI. X-ray images are very useful in the diagnosis of fractures urgent emergencies.

In this work, we are interested in solving the following research questions: Is it possible to reconstruct a 3D model of bone structures from a limited number of X-ray images? Which methods are raised?, and research that focus on the subject have corresponding verification and validation? 7.

To provide answers to these questions we conducted a systematic review. With this methodology, we can review existing evidence and identify gaps in current research.

The majority of the primary studies selected were in conference proceedings (25 studies 72%) and only 14 studies (36%) were journal publications.

The results of the first question are 95% of studies have proposed methods of reconstruction of 3D model from using a priori information. Meanwhile 5% only uses input information provided by X-rays.

We also analysis that more than half of these works has been published between the 2003 and 2009, and the rest between 2010 until April 30th, 2015.

We proposed a complementary classification 3D reconstruction according to the information used for the reconstruction.

Keywords—2D-3D reconstruction, X-ray images, systematic review, systematic literature review, 3D geometric modeling.

The efficient reconstruction of a 3D model starting from different sources such as CT, MRI, X-rays can be possible using a priori knowledge of the shapes of the bones that are inherent and universal patterns known.

Most of the studies proposed for 3D reconstruction has incorporated a priori informations about the geometrical shape and its morphological variability [12]. 3D modeling can be more efficient and effective if we know something about the objects we are trying to reconstitute, hence the integration of prior knowledge is required for successful 3D reconstruction.

The CT and MRI system are generally large and very costly. Nevertheless, X-ray imaging is widely available, it is not expensive and it produces less radiation compare to CT, MRI and other images acquisition methods. There are a few studies focused on reconstruct 3D images from a limited X-ray images.

Therefore in this paper we wonder about the possibility to do the reconstruction of a 3D model of bone structures starting from a limited number of X-ray images.

Evaluation and validation is hard to do, but in this review we select the papers which have this approach.

For these reasons we have addressed a systematic literature review (SLR) or systematic review (SR), (hereafter SR), to determine the answer of five research questions that guide our study.

The methodology proposed by Kitchenham [1], [3], is applied to a case study and the results is showed in the next sections. The last section describes the debate and conclusions that emerged from the analysis and synthesis of relevant studies.

I. INTRODUCTION

II. LITERATURE REVIEW METHODOLOGY
Other Types of Review

- Systematic Mapping Studies
  Allows the evidence in a domain to be plotted at a high level of granularity.
- Tertiary Reviews
  In a domain where a number of systematic reviews exist already it may be possible to conduct a tertiary review, which is a systematic review of systematic reviews.
REFERENCES


