Corso: **REVERSE MODELING**

Docente: PROF. GABRIELE GUIDI

Semestre: 1°

Lingua di erogazione: INGLESE

N° max studenti ammessi: 55 POLITECNICO + 5 ERASMUS

Modalità d'esame per non frequentanti: NO

Note:

In caso di assoluta necessità (malattia e altre assenze giustificate da documentazione), le prove teoriche in itinere, essendo organizzate come test on-line, possono essere fatte in remoto via web. Al contrario le prove laboratoriali richiedono necessariamente la presenza fisica.

In case of strict necessity (illness or other serious and justified absence reasons) the ongoing theoretical exams, being organized as on-line tests, can be done remotely via web. Contrarily the practical tests require necessarily the physical presence of the students.

Prodotto	Interni	Comunicazione	Fashion	D&E	PSSD
✓	✓	✓	✓	✓	✓

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Introduction

The course introduces the functioning principles of the different range sensing technology nowadays available, categorizing them in a general framework accordingly their working principles. The course provides a set of rules for properly employing this kind of equipment in the 3D digitization of an object surface, giving the skills needed for planning a 3D acquisition project keeping into account possible artifacts due to different light-to-material interactions produced by the operating conditions. The course shows also the 3D pipeline for digitally manipulating the raw 3D data up to the final mesh model through registration, merge and mesh editing.

In order to effectively provide these skills, the course foresees the execution of an exercise for capturing geometric elements on a real 3D object/scene starting both from a set of 2D images (passive approach) or from 3D laser scanners (active approach). Students will be asked to produce a substantial amount of practical work both in a 3D lab and on computers in order to post-processing their own images and range maps with specific software packages for transforming them in a digital 3D replica of the acquired 3D object/scene.

Course Goals and Objectives

- Analyze an operating scenario in terms of geometry and materials in order to 3D acquiring it
- Define and implement a 3D acquisition project
- Post-process the acquired 3D data for generating a 3D mesh model, including orientation and texturing
- Optimize the mesh for possible further processing (CAD redrawing, rendering, animation, web publication, 3D printing, Virtual Reality, etc.)

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Topics covered

- Reverse Modeling based on active sensors (i.e. laser scanning)
  - Working principle of the various 3D sensors
  - How to optimize their use depending on the technology used
  - Planning of a 3D acquisition project; errors to avoid
  - Theoretical analysis and best practice of the 3D data generated by active sensors
  - Processing pipeline for generating a polygonal model starting from a set of acquired 3D data
- Reverse Modeling based on passive sensors (i.e. digital photogrammetry)
  - Theoretical elements of photography
  - Principles of photogrammetry (camera calibration; resection; triangulation)
  - Operator-based photogrammetry vs. automatic photogrammetry (Structure from Motion/Image Matching)
  - 3D data acquisition based on images (sparse and dense point clouds)
  - 3D modeling from 3D information originated by images
  - Editing and optimization of 3D model originated by photogrammetry
  - UV mapping and texturing of edited models with photogrammetric images
  - Export and publishing on the web of reality-based 3D models

References

- Gabriele Guidi, **Reverse Modeling course slides**, 2016 edition (Mandatory – visual presentation of the program)
- Gabriele Guidi, Fabio Remondino, **3D Modeling from real data**, *Intech*, 2011, ISBN: 978-953-51-0012-6 http://www.intechopen.com/books/modeling-and-simulation-in-engineering/3d-modeling-from-real-data (Mandatory - short synthesis of the theoretical topics)
- Gabriele Guidi, Michele Russo, Angelo J. Beraldin, **Acquisizione 3D e modellazione poligonale**, *McGraw-Hill,* 2010, ISBN: 9788838665318 (Optional - in depth explanation of all topics, including a chapter of applicative examples)

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Teaching modalities

•Theoretical lessons on the principles behind laser scanning and digital photogrammetry
•Training on specific software packages for processing 3D data
•Lab activity in groups of 2/3 persons for developing two different Reverse Modeling projects

Exam organization

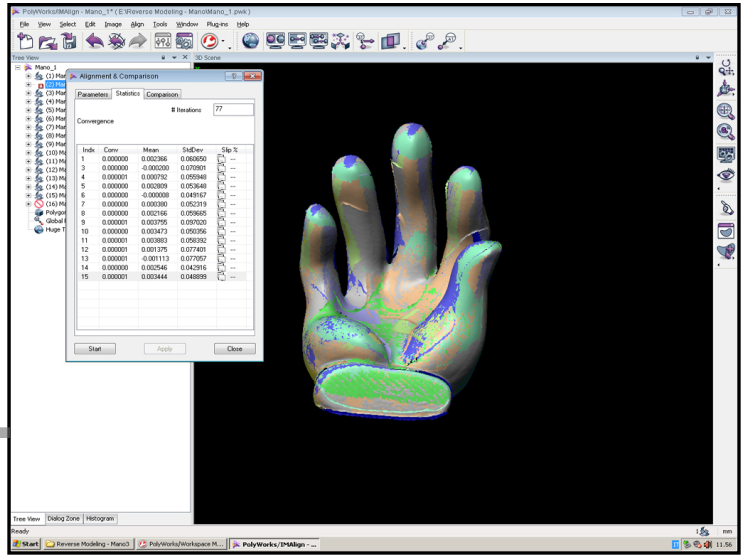
•Theoretical test of active 3D imaging and modeling (individual ongoing evaluation)
•Delivery of a 3D model acquired with laser scanning (group ongoing evaluation)
•Theoretical test on photogrammetry (individual ongoing evaluation).
•Delivery of a 3D model acquired with photogrammetry (group ongoing evaluation)
•Group presentation to the class as final evaluated trial, with possible professor's individual questions to each member of the presenting group

Evaluation criteria

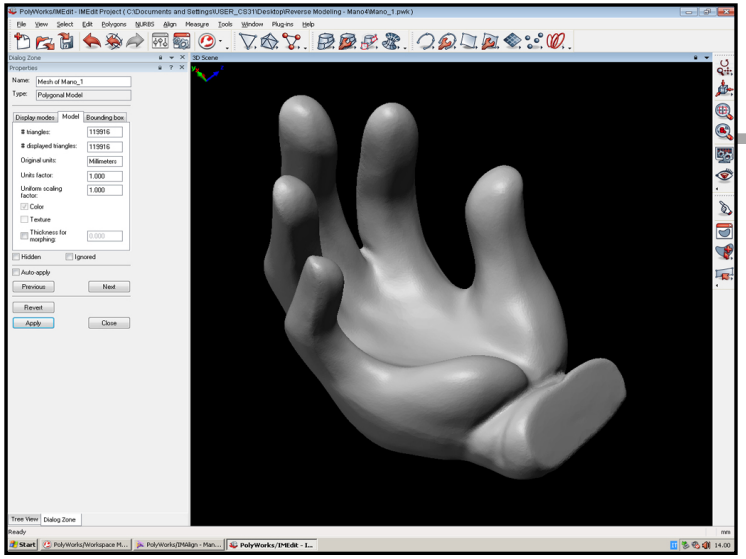
•Item evaluated: 2 theoretical tests; 2 practical works; 1 presentation
•Grade= weighted average of theoretical and practical tests + presentation increment
•Weights: theory 40%; practice 60%
•Presentation increment: from -1 to +1 on the weighted average
•Example:
  – 1st test: 27; 2nd test: 21; Active 3D model: 30; Photogrammetry model: 28; Presentation: +1 (outstanding)
  – Consequent grade: 0.4x(27+21)/2+0.6x(30+28)/2+1=28

Reverse modeling example made in a previous course

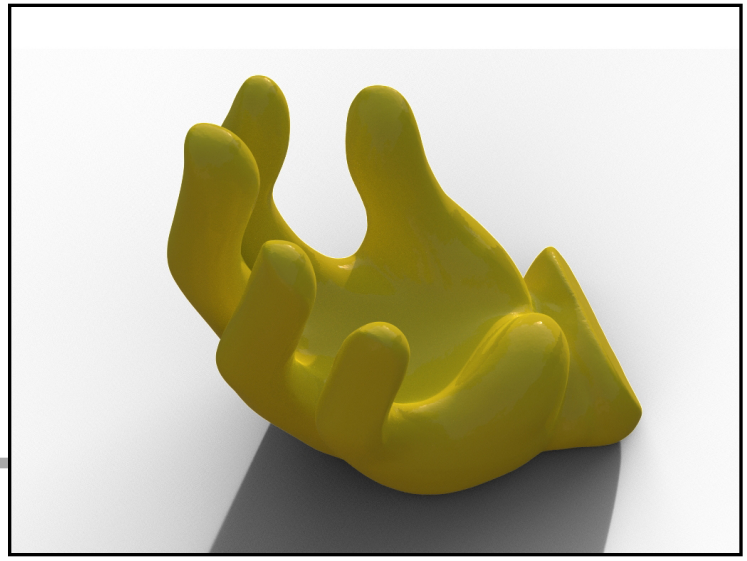
1
Original Object



2
3D acquisition and processing



3
Merged model



4
Edited model rendering with plastic shader