A Web Interface For Generating Image-Based Models

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ABSTRACT

Image-based construction of 3D models has become a sizable topic of research in the computer graphics community. Many approaches and variations of these have been proposed, all requiring varying balances of user input with automation of mesh generation. Most implementations of these advanced techniques serve mainly as either money-making ventures or SIGGRAPH demo content, so everyday users who may be interested in utilizing software never get the chance to.

As modern technologies become increasingly more web-based, more helpful modeling tools can become accessible without the hassle and space required in downloading them. The goal of this project is to create a user interface that allows for basic mesh generation of objects from user-provided images. The result will be in the form of a web-based application and will serve as an easily accessible foundation for developing more complex models.

Project Blog: http://webdimensional.blogspot.com

1. INTRODUCTION

A majority of models we create are fully based on, or at least partially inspired by, objects that exist in real life. Complex models build upon the most basic, simplistic, and entirely essential shapes and geometry. There are various technologies that allow people to convert an object from three dimensions in the real world to three dimensions in a computer, but one of the most convenient and multi-purpose ways of doing so is taking photographs of objects and generating models from them. Such methods are convenient for the purposes of texturing as well; they can easily be lifted from the photograph and applied to the generated model. While many papers address these techniques for generating mesh data from images, this type of technology is not normally easily accessible in a browser.

This project aims to adapt the techniques of different papers that effectively perform this 3D model extraction. It will explore various balances of user interaction and model generation to create an aesthetically pleasing and intuitive application. This application will be web-based and explore translating these techniques into web-friendly programming languages such as JavaScript. The end result will yield an accessible and easy to use product that makes the process of less challenging by providing a basic working geometric foundation.

Contributions.

This project makes the following contributions:

- A convenient and easily accessible application for generating 3D models from user-provided images.
- A translation of well-researched and common image-to-model techniques to a web-compatible programming language.

1.1 Design Goals

The target audience for this project consists of those in the computer graphics community who frequently create 3D models; this can consist of more "everyday" users. This group can benefit from both its accessibility as well as its offering of a technique that is not as frequently used in modeling but can be incredibly convenient and time-saving. The application will provide a usable and intuitive interface for performing the extracting of the 3D model so these users can have an easier time with creating models based in reality.

1.2 Projects Proposed Features and Functionality

The following features and functionality will be provided:

- 3D model generation for basic geometry, such as cube-like or spherical objects, based on user-uploaded images.
- Web-based user interface for facilitating the process of generating these models.

2. RELATED WORK

A multitude of research has been done on various methods for creating 3D models from images. This project will be influenced by a various number of these sources and attempt to reconcile differences based on the project design goals.

2.1 Silhouette-Based Modeling

A technique that bears most similarity to the project at hand utilizes a single image as a guide for deforming existing 3D models to fit the general shape of an object specified in the image. The process requires user-guided segmentation of the object in the provided image so as to detail the core structure of it, such as in a sketch-based fash-

ion. A 3D candidate is then selected to automatically deform to the silhouette of the image's object. This silhouette guides the deformation via a silhouette correspondence, so that segments of the candidate object can mimic the shape of its corresponding segments in the silhouette [XZZ*11]. Unfortunately, this requires a set of several candidate models – which is not entirely flexible for the case in which a user does not have an object that is easily defined. However, as most objects can be composed of multiple basic geometric shapes, this is less of a problem.

The silhouette approach defined in the previous technique took a silhouette based on the three dimensional form of the image object. Another approach utilizes multiple orthographic silhouettes in order to automatically generate segments of a 3D model. To piece these portions together, multiple Boolean operations are performed [RDI10]. While this approach is tested to be robust, it is not well suited for organic shapes. However, it handles most uniform shapes well.

2.2 Freehand Sketch-Based Modeling

Multiple sketch-based modeling techniques have been proposed. A prominent one is an interface referred to as "Teddy," which allows for organic, freeform modeling based on user-generated strokes. In this approach, the model begins as a closed, planar mesh, whose endpoints are dictated by the endpoints of the user's initial strokes. Users are able to model via subsequent strokes through various forms of cutting, which requires projecting drawn lines onto the mesh in order to create new cut vertices, and extrusion, which requires a determination of a base section and an user's extrusion stroke [IMT07]. This is a great technique for organic shapes, which previously mentioned techniques are less able to account for. It, however, requires continuous manipulation of the mesh when cutting and extruding, and is not at its core image-based. An extension to Teddy allows for the generation of smooth solid shapes via inference from drawn contour lines, and also infers non-visible areas; however, this functionality is beyond the scope of the goal of the project [KH90].

A different technique utilizes the sketch-based approach in a different manner. A user specifies the general form of their desired object via sketching, and, searching through a database on models, the program uses a matching algorithm to determine the highest "retrieval score." This determines which object in the database most closely matches the sketch form [SI07]. While this is efficient for quickly building scenes, it again relies on building a database of very specific models, in hopes that a match is found.

A technique that allows for prototyping new objects out of existing ones in a photograph requires user sketching for drawing lines and annotating geometric properties about the object they desire to create. Different cases of shapes are handled, for rectangles, squares, circles, etc., and users can annotate their marks as right angles, straight lines, parallel lines, and various other useful properties. Using all the stored metadata, it parses the lines into vertices and edges [LSMI10]. This technique appears to be thorough with its information gathering, but also requires several types of annotations and storage of various forms of metadata.

3. PROJECT PROPOSAL

The goal of this project is to create a usable and accessible web-based interface for generating basic 3D models from user-provided images.

3.1 Anticipated Approach

It is first necessary to build an early working version of the interface, mapping out location of essential tools and basic styling for testing usability purposes. This will be necessary in order to house a viewport for the purposes of developing the model extraction functionality, and to be able to have a place to easily house basic user tools as the development process reveals its need for them.

It would then be necessary to incorporate Three.js, the WebGL JavaScript library, to establish a basic viewport for the application's main view. This will allow us to proceed to the next step, which would be to develop the core extraction functionality. This will require first settling on a basic method for extraction, and then implementing it on a simple cube image.

If time permits, accounting for more shapes to attempt to diversify the shape type compatibility is ideal.

Aesthetic refinement of the user interface will occur periodically, more so toward the end of the process.

3.2 Target Platforms

- *Software*: Three.js (WebGL, JavaScript), Pixastic (JavaScript), modern web browsers such as Chrome or Opera (Firefox and Safari only partially support WebGL in their current releases).

3.3 Demo Evaluation Criteria

The success of the project will be based on how accurately a basic object in an image can be captured as a 3D model, in terms of its overall shape. It is also important that the user-interface is fairly intuitive and overall complements the user's desired actions. A user should not struggle to figure out by means of the interface structure how the flow of converting and image to model works.

4. RESEARCH TIMELINE

Project Milestone Report (Alpha Version)

- Completed all background reading and have an understanding of techniques that can be utilized.
- Proposed technical approach decided for extraction of simple 3D models from an image.
- Prototype of user interface with beginnings of basic 3D model extraction for a single shape, such as a cube.

Project Final Deliverables

- A web application interface for extracting simple 3D models from user-uploaded images.
- Documentation on the full functionality of the web application and major techniques used.

Project Future Tasks

- OBJ exporting, so that models can be worked on in a more advanced modeling environment, such as Maya.
- Implement various basic modeling tools, such as extrusion, insert edge-loop, and the ability to select and transform individual vertices. These are convenient to make on the spot adjustments for things that may not go quite right in the interface.
- Extracting texture from the input image and applying it to the generated model.

5. Method

To be completed as the semester progresses.

6. RESULTS

To be completed as the semester progresses.

7. CONCLUSIONS and FUTURE WORK

To be completed as the semester progresses.

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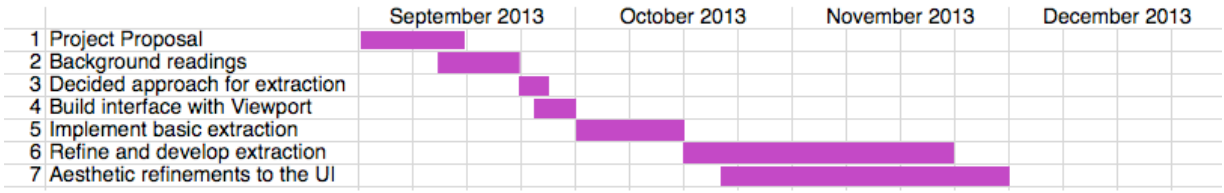

Figure 1: *Gant chart demonstrating estimated timeline of approach*