A Manual on How to Use the *BuildingTextureExtractor* Version 1.2

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Initial Notes

The present manual provides a thorough explanation of how to use the *BuildingTextureExtractor* tool. This manual will guide the user through the installation and usage of its web interface and implemented functionalities. The theoretical background behind the implemented functions is available on the project homepage at GitHub. The present version of both, tool and manual are under development and expected to improve in many aspects. If you have any suggestions, please don't hesitate to contact us by email.

The tool has been developed in the context of the project *Vistas Situadas do Rio de Janeiro* at FGV-RJ *imagineRio* project, a collaboration between Rice University and Instituto Moreira Salles. The long-term goal is to create a historical 3D model of the city of *Rio de Janeiro* based on antique pictures of the town.

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1 Source Code and Installation

The main objective of the *BuildingTextureExtractor* is to convey a semi-automatic method that, given a single image of a scene that contains a building of interest, creates a 3D model of the visible facades. The model is composed of a set of adjacent textured rectangles. Two conditions are required for input images: (1) no lens distortion and (2) two or more visible orthogonal directions, required for the camera calibration step. After a model is created, we can define a scale to the entire model and recover any desired object dimension if a measurement from the real-world object is known.

1.1 Installation

The source code is written in Javascript using Node's runtime, supported by the HTML's page structure. If you find any bugs or issues, please report them at our GitHub issues page. The tool is open source and therefore all current progress is readily available at our GitHub page, although this manual is dedicated for the release v1.2-alpha.

1. Download all files from this release. For the tool to run correctly it is also needed two add-ons, `node.js` and `three.js`. Below follows the instructions on how to install both of them in Windows operational systems.

2. Node is used for loading and saving files through a browser. Node has several versions. A good practice is to maintain multiple Node versions on your computer through Node Version Manager (NVM). However, its installation is optional and you can use only the basic Node. If you wish to install NVM here is the current release. Follow this link to download and install Node.

3. Three is used for several computer graphics functions. There is no need to install `three.js`, only download its local files. To download the main compressed file access the official site website. The directory named `three.js-master` must be under *public/packages/*.

4. With both Node and Three installed, you will have to run the Node server. For this you can open Windows Prompt through *Windows+R* and type *cmd*. Then you can switch folders to the project and run the server through the command *node nodeServer.js*.

5. If everything is fine, a message will pop up saying *listening at http://localhost:8000*. This is the link of access to the local server where the project is hosted. In case any file is updated, you can just refresh this link to check the changes.

2 Tool Functions

This section details every function available in the web interface so far, explaining carefully each step of the framework.

2.1 Interface

The primary interaction done by the user is clicking and pressing specific keys. In Figure 1 we can observe a screenshot of the interface with several highlighted parts indicated with letters. Let us explain each one of them:

- **(A)**: The main canvas which fills almost the entire screen of size 1200×800. Before calibration, it only shows the current loaded image and all the line segments defined so far. After calibration, the user can press the key "T" to swap between the current image and the model on 3D;
- **(B-E)**: These options appear when you hover over the green options. Only one can show at a time. The user interacts with them by clicking. Every single function will be later explained in this section as they represent each step of the project;
- **(F)**: This text block shows the calibration information, such as variables and results. In the example we do not have the camera calibrated;
- **(G)**: In this area, short messages regarding the current progress and what the user executed so far are displayed;
- **(H)**: Another canvas of size 300×300. After calibration, the current selected mapped texture is shown in its rectangular form.

Figure 1: The web interface and all of its options highlighted.

2.2 How to Load Images and Previous Progress

When hovering over the green text "Files", the user can choose between 5 options. Let us describe each one of them in particular:

Load Image (web) Used for loading images from the web, this function when clicked allows the user to enter a link to an online picture, saving it as the new image. When loading photos this way, you can not save your progress;

Load Image (local) Being the ideal way to load an image, when pressed it asks for the complete file name of the desired photo (name plus extension). These must be under "public/images/" to load;

Download Image (canvas) This button allows the download of the current image in the canvas. It asks for a file name to save under your PC download's folder;

Save Progress (.json) When dealing with loaded local photos, the user can save their current progress on the current image. Being linked to the image's name, this function creates a file named "cab-imagefilename.json" under "calib" folder which contains all the data so far (needs at least a camera calibration to save);

Load Progress (.json) For loading, one must have a saved progress of the current local loaded image. The detection and loading of the file is automatic and may take a while if the model is too big.

2.3 Using the Camera Calibration System

The first step into the calibration process is to choose an axis and trace two or more lines segments that are parallel to the chosen axis. To choose an axis simply click on the desired one. To trace a line segment, click the canvas on the segment's endpoints.

Figure 2: Drawing a line segment for the X axis. Endpoints highlighted.

Two methods of calibration are present. The user can either specify line segments for two axes or three. After all the line segment specifications are done, click calibrate to run the calculations and get the parameters for the extraction process (Figure 3).

Figure 3: Line segments for all axes were specified. After executing the calibration, camera parameters (right side of the screen) will be available, and the approximate optical center (pink dot).

2.4 Creating a 3D Model

The extraction menu has two modes: Extract and New Plane Type. To enter a mode click on it. This menu also contains a list of planes for extraction.

New Plane Type The tool initializes with 3 basic planes: XY, XZ, and YZ. It is possible to add more planes that are parallel to a calibration axis. In New Plane Type mode, select the endpoints of a segment belonging to the new plane. A pop-up box will show up. Fill up the plane's name and the respective parallel axis (X, Y or Z) and it is done!

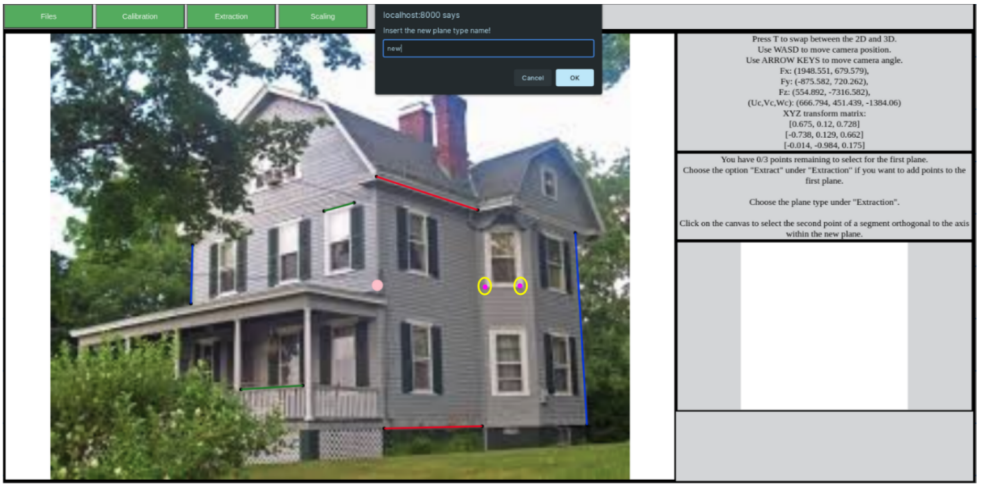

Figure 4: The image contains planes that are not the 3 basic ones. The endpoints of a new plane are highlighted on the image.

Extract Enter on Extract mode and choose an initial basic plane to extract (XY or XZ or YZ).

To extract an initial plane first trace a segment parallel to the Z axis (for the planes XZ and YZ), or parallel to the X axis (for plane XY), then select an extension point. The plane should be highlighted right

Figure 5: Extracting XZ plane. Yellow: endpoints of segment parallel to Z axis. Green: Extension point

Figure 6: Result of extraction. On the right side of the screen the extracted texture can be analyzed.

after these steps. The 3D model can be visualized by pressing "T".

More planes are added by extending the first one. Select a plane type on the Extraction menu. On the image, click near an extension edge that is parallel to the chosen plane type. Click on an extension point. If necessary, the user can drag the endpoints of the extension edge to expand or shorten the extension of the new plane.

Figure 7: Adding an extension to the XZ plane and an extension to the right using our recently defined plane.

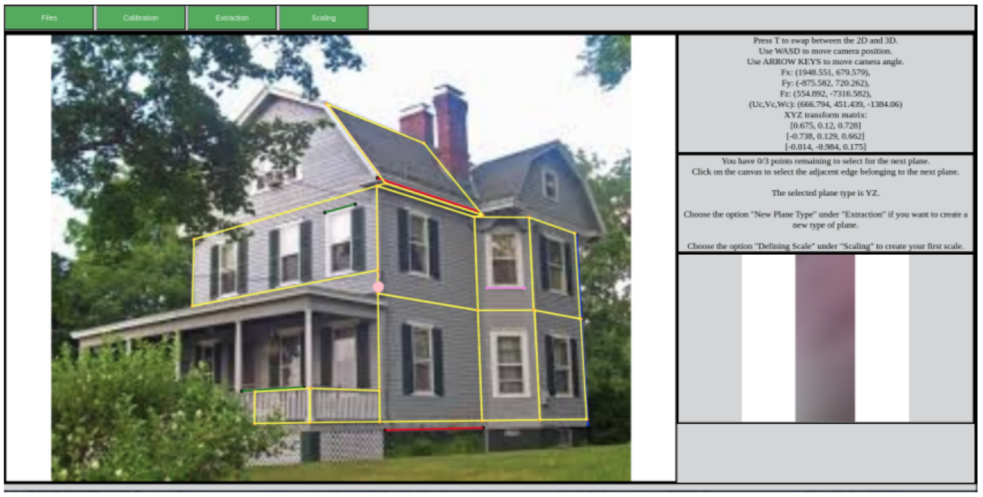

Figure 8: Adding more planes. Notice that some planes are shorter, result of dragging the endpoints of the selected edge.

Figure 9: Resulting 3D model.

2.5 Defining a Scale

Occasionally measurements from the real world object are known. This information can be used to define a scale to all extracted features. On the Scaling menu, select Defining Scale. Select the endpoints of a segment of known length.

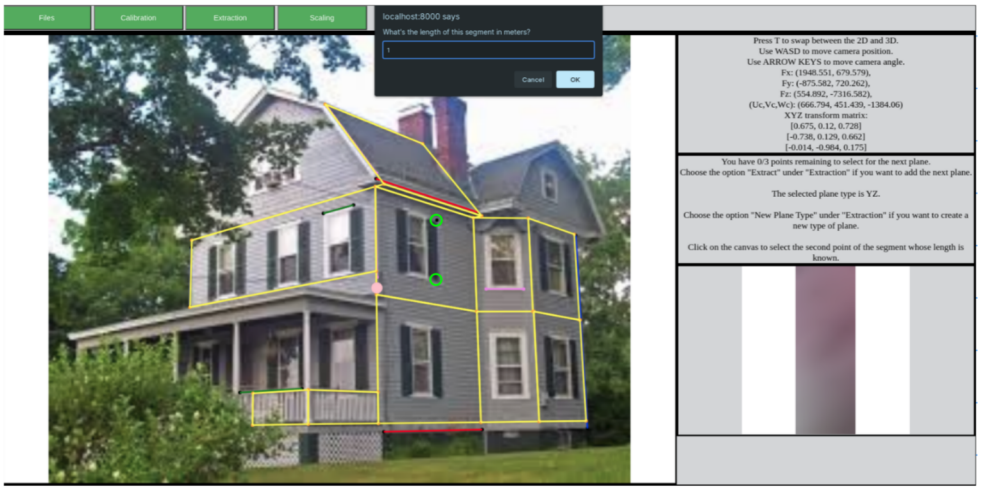

Figure 10: The window height is known to be 1 meter long. The green circles highlight the selected points.

Figure 11: Estimating the width of the first plane.

3 Examples

Below follow the link to multiple tutorial videos available on YouTube where a model is created as an example for various type of images.

- **Ministry of Agriculture - 1875:** Being a image with multiple plane types, this tutorial example will help you comprehend the thought process behind creating a 3D model. Here is the YouTube video;