3D CORRIDOR MODELING USING A SINGLE IMAGE

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INTRODUCTION

Real-time, low resource corridor reconstruction using a single consumer grade RGB camera is a powerful tool for allowing a fast, inexpensive solution to indoor mobility of a visually impaired person or robot. Our approach uses the perspective and known geometry of a corridor is used to extract the important features of the image and create a 3D model from a single image which can be implemented on a basic smartphone. Multiple 3D models can be combined to increase confidence and provide a global 3D model. Our poster presents our results on 3D corridor modeling using single images.

Our methods include a simple but effective 3D corridor modeling approach which makes very few assumptions of the camera information. First the 3D information of the corridor and the floor plan is obtained by utilizing the vanishing point of all the feature lines in the image. Second, a perspective based Hough transform algorithm is introduced to detect surface feature lines in order to determine the edges of the corridor.

The most common way to extract the information on a corridor in computer vision currently is to use a range sensor and perform the computations necessary to find the walls of the corridor. Unfortunately, these methods require relatively expensive equipment, heavy processing, and high energy consumption. This makes the method impractical for a robot that needs to move quickly, a wearable system that need to be built cheaply, or a blind person who doesn't want to carry a laptop on their back processing data all day.
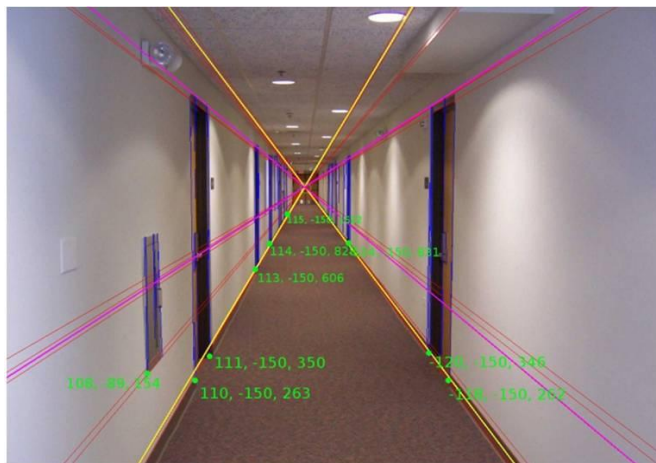

Figure 1: A processed image of a simple corridor.

METHODS

While most uses of 3D reconstruction require multiple viewpoints, a range sensor, or some other special imaging component, our methods can perform the task using a single image. This is due to the nature of a hallway. While there are plenty of differences from one hallway to the next, the property of having (mostly) straight walls makes the single image processing possible (Figure 1). From the camera's point of view, many of the lines found in an image run to a vanishing point. More specifically, the lines which define the boundaries between the floor to the walls and the walls to the ceiling are lines that go to the vanishing point. Furthermore, lines that are perpendicular to the axis of the hallway (e.g. doorframes, floor tiles, etc.) will appear as lines parallel to one another that do not go to the vanishing point. To perform the reconstruction, we begin by performing a canny edge detection and a Hough transformation to produce a map of lines. From here, we search for surface features, parallel lines which do not run towards the vanishing point. This is done using a perspective based Hough transform which retrieves line segments. The line segments found serve two purposes: We are able to both find where the floor is as well as feature lines on the walls, such as doors. From this information, a 3D wireframe model of the hallway can be built (Figure 2).

CONCLUSION

We have a presented a real-time, low resource 3D corridor reconstruction method from a single camera. We have also proposed the perspective based Hough transform algorithm which allows for the fast reconstruction found in this paper. We have shown that by exploiting the characteristics of a corridor, accurate 3D models can be generated quickly with low resources.

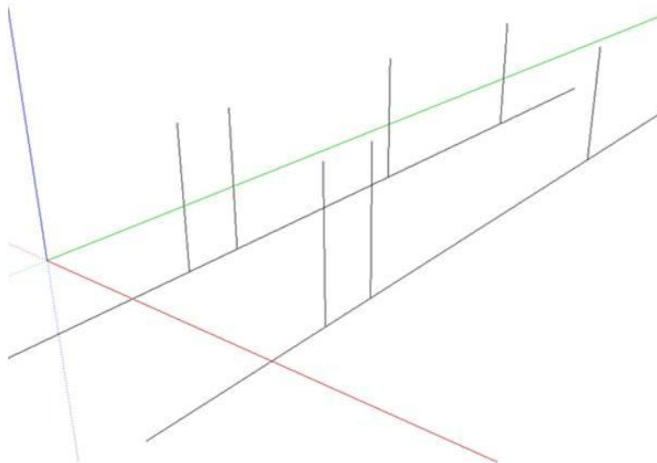This method is being implemented on a mobile device to allow visually impaired users the ability to navigate without burdensome assistance.

Figure 2: A wireframe model of the corridor.