Generating Building Drawings Using Image Processing

1st Abhishek Chandra
Department Of Computer Science And Engineering
National Institute Of Technology Hamirpur
Hamirpur,Himachal Pradesh

2nd Dr. Kamlesh Dutta
Department Of Computer Science And Engineering
National Institute Of Technology Hamirpur
Hamirpur,Himachal Pradesh

3rd Dr. Hemant Kumar Vinayak
Department Of Civil Engineering
National Institute Of Technology Hamirpur
Hamirpur,Himachal Pradesh

***Abstract*—This study aims to investigate the impact of Implementation of image processing techniques for the purpose of documentation of existing buildings.**

***Index Terms*—Photogrammetry; Edge Detection; AutoCad; Elevation**

I. Introduction

Generating accurate drawings of existing buildings is often a time-consuming and costly process. In certain situations, such as with heritage structures, taking precise measurements can be challenging or even impossible. Thus, there is a pressing need for a novel, computer-aided approach to efficiently generate these drawings. This paper proposes a method that leverages image processing techniques to produce building drawings, significantly reducing both the time and cost associated with traditional methods.

II. Methodology

The proposed approach utilizes image processing techniques, including kernel-based edge detection and photogrammetry software, to generate building drawings. There are multiple cad softwares available like autocad, sketchup , freecad,achimedes and intellicad.In this research we chose Autocad as it is the most widely used cad software and provides a lot of functionality that are not present in it competitors. Autocad also supports DXF file format which is supported by python.

There are various file format used for engineering drawing purposes like dwg,svg and dxf.Among these dxf is most compatible with most of the drawig softwares present in the market. DXF stands for Drawing Exchange Format , this format is is supported by the modeling software autocad.Another reason for choosing DXF is the "ezdxf" library in python that can be used to create and modify dxf files using python language. Secondly ,in the previous approach the edge image of the building was first converted into a svg file using svg write library of python ,which was furthur converted to dxf format using a drawing software called inkscape.This was a 2 step process from contour image to dxf file.In the second approach the contour image is directly converted into a dxf file using ezdxf library thus converting a 2 step process into a single step while eliminating the need of inkscape software.

In the initial approach the perspective transformation function of the opencv library was used for obtaining projection of the building .The perspective transform function is good for obtaining projection when we have control points on the building ad the building facade is completely flat,as it not able to compensate for depth of windows or other objects presesnt on or within the surface of facade. This limitaiton was eliminated by using the Agisoft Metashape 3d modeling software that can produce 3d models of buildings using depth maps ,and is able to model pertrusions or cavities presesnt on the building facade.Also the view feature of metashape provides the othographic view of the building facade.

A. Proposed Approach

The process begins with capturing images of the building facade using a standard camera, resulting in jpg files.These images are then processed in the photogrammetry software Agisoft Metashape.This provides us with the orthographic projection of the building facade.A custom edge detection pipeline is then applied using Python-based image processing libraries, producing an image that highlights the building's contours. This contour image is subsequently converted into a Drawing Exchange Format(DXF) file employing the ezdxf library.All these operations are conducted on Google Colab.For the flow of the approach see figure 1.

B. Edge Detection

Obtaining sharp and clear edge image of the building is a crucial part of this approach , for this reason various edge detection techniques were tested. To keep the model simple and computationally efficient, only kernel-based techniques were chosen. Machine learning and artificial intelligence-based techniques were not considered due to lack of a proper training dataset and high computational cost. The results of the various techniques(Figure 2) were compared and Sobel in Canny was

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finalized for the model. Edge detection is done using a custom edge detection pipeline developed within the scope of this research. Various edge detection methods including traditional and deep learning methods were tested which included canny edge detector , laplacian, sobel , and CNN based edge detector.The results of the various techniques(Figure 2) were compared.From all these a combination of canny edge detector and sobel edge detector known as sobel on canny was finalized to be used in the pipeline.

1) Edge Detection pipeline: To further improve the quality of edges other image processing techniques were implemented along with the sobel on canny edge detector.A Gaussian filter is applied on the original image before using the edge detection algorithm in order to remove noise from the image.Thresholding is done on the resultant image followed by an Opening operation in order to sharpen the edges and removal of remaining noise.These steps are necessary to prepare the image for conversion to vector file.The output of this pipeline is an Edge image containing the contours of the facade of the building. The pipeline consists of five steps:

1) **Converting to grayscale:** In this step, we convert the RGB image to a grayscale image.
2) **Applying Gaussian blur:** This step is done to reduce noise present in the image.
3) **Sobel on Canny:** This is the chosen edge detector used to detect the edges in the image. This provides us with the contour image of the building.
4) **Thresholding:** This step is done to further improve the quality of the edge image by removing noise and increasing the intensity of detected edges.
5) **Opening:** Opening is an image processing technique used here to increase the width of the edges present in the image. This operation also removes some of the noisy fine edges in the image.

C. Obtaining Projection

Photogrammetry [?] is the technique of extracting accurate measurements and creating 3D models from photographs, typically by analyzing multiple overlapping images from different perspectives.This paper utilizes a branch of photogrammetry known as Terrestrial photogrammetry.Terrestrial photogrammetry is a method of obtaining accurate measurements and 3D models [?] using photographs taken from ground-level cameras, often for mapping, construction, or archaeological documentation [?]. This is done using a 3d modeling software called Agisoft metashape.Agisoft metashape is a 3d modeling software that uses point cloud generation and photogrammetry techniques to generate a 3D model of a building using photographs taken from various points.Agisoft Metashape was chosen due to its performance and ease of access.This is a 5 step process:

- Loading images
- Aligning images
- Generating Point Cloud model
- Building texture
- Capturing Orthographic view

D. Conversion to DXF

DXF stands for Drawing Exchange Format,it is one of the many formats that are supported by computer aided design (CAD) software.In the Proposed model the output of edge detection step is converted from Jpg format to DXF format to enable user to view and edit the building drawings in CAD software.This is done using Python Library called ezdxf.The output of this step is a DXF file containing the elevation of the Photographed building.This drawing can be then scaled in the CAD software to match the dimensions of the Photographed building.

III. Results

Elevation drawings of the building was obtained in DXF format as the output of proposed model.This drawing can be scaled in Computer Aided Design (CAD) to match the measurements of the building.This model was able to generate the elevation drawing of a building in DXF format by using a simple jpg format images taken by an ordinary camera by using minimal ammount of computational resources.The edge detection pipeline was able to extract large amount of contour data from the image while reducing the noise under a tolerable level.The use of photogrammetry techniques chosen in order to enable user to generate drawing using minimal hardware.

IV. Discussion

Although the model was able to generate good drawings of elevation still it has limitations due to its rigid nature as it is unable to deal with objects (like trees etc) obstructing view of building in image.Also the model requires the images to be captured in well lit conditions without shadows.All these limitations can be eliminated by using a Machine learning and Artificial Intelligence methodologies like Generative AI,these approaches were not used in the proposed model due to lack of the availability of suitable dataset.In practical application scenario edge detection methods can be replaced with CNN paired with generative AI to deal with shadows and obstructions.

V. Conclusion

The proposed model was able to generate drawings of building with great accuracy and with minimal computational requirements.As the model does not require very high quality images captured on a complex camera setup ,it can be fashioned into an application that can be used to generate drawings by any average user.Even with its limitations model was able to perform the given task and have potential to solve the problems faced by the professionals while generating drawings using traditional methods of drawing generation.

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