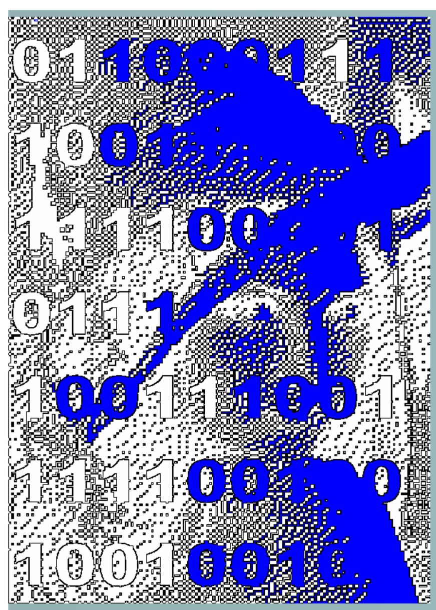

AUTOMATIC APPROACH FOR RECTIFYING BUILIDNG FACADES FROM A SINGLE UNCALIBRATED IMAGE

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1. Introduction

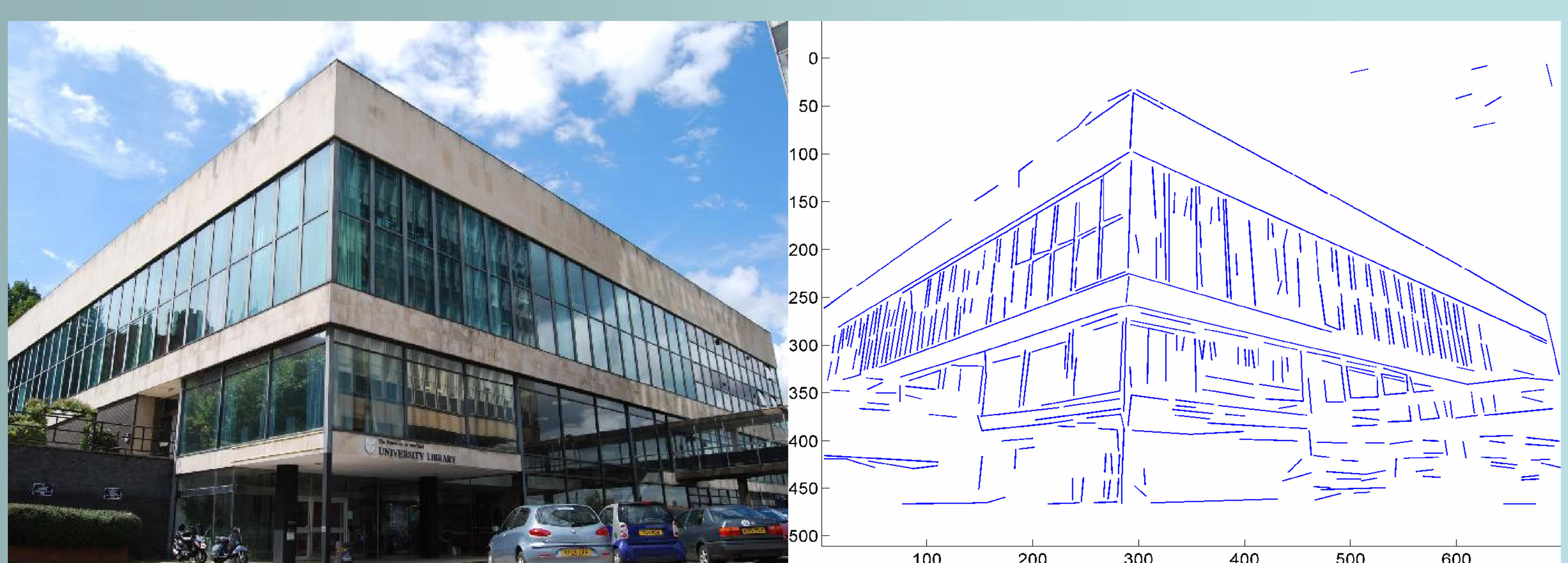
The rectification of main building facades to their frontal-parallel view is of importance in building recognition, photogrammetry and other 3D reconstruction applications. It can simplify the extraction of metric information from the building image and recover the canonical shape of a building. Hence, the rectified view will be almost free from perspective distortion.

For my PhD project — building recognition, which is about matching an unidentified building image against a large image database; our work of automatic rectification enables us to pre-compute building images so that more regular shape features and their repetition can be selected for the task of recognition.

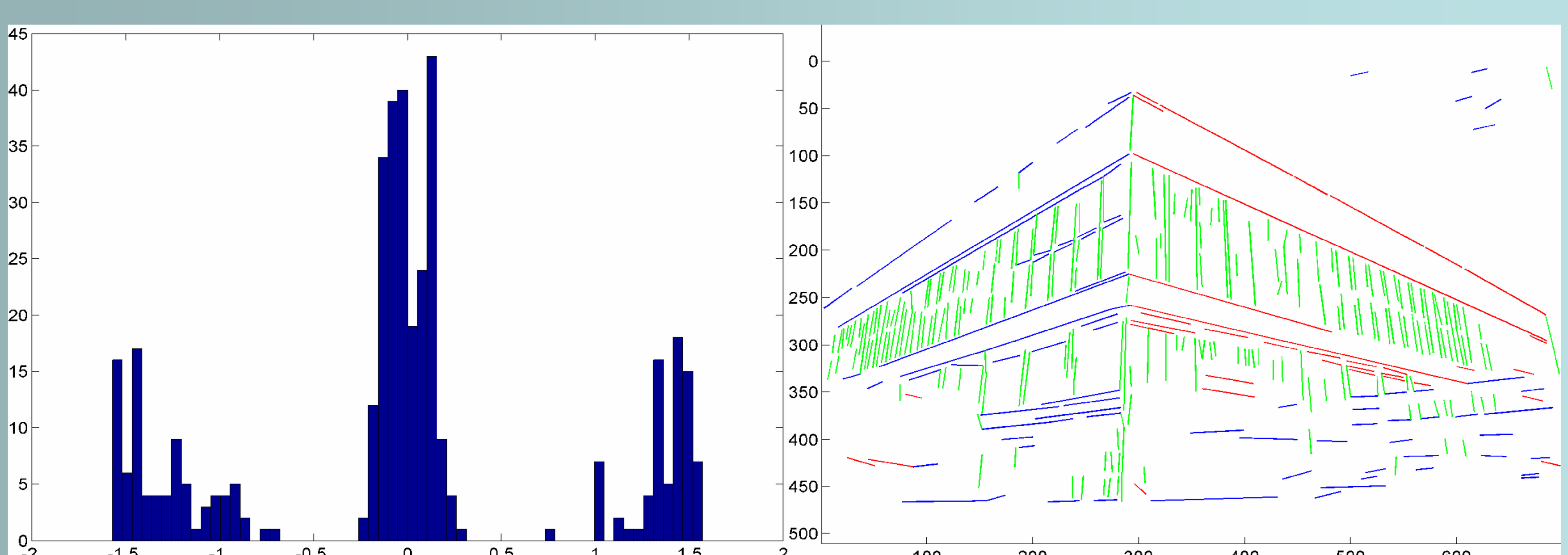
2.Method

To properly warp each main building facade appearing in the image to their frontal-parallel view without providing external information (i.e. no human-interaction during processing), it requires the accurate location of the vanishing points and grouping lines that are aligned to the three principal axes. These three axes are associated with the 3D orthogonal real-world axes.

- **<u>Initial grouping and estimation of vanishing points</u>**



Under projective transformation, the parallel lines of buildings intersect at vanishing points in the image. The line segments were detected, short segments were eliminated since they are more likely to be clutters.



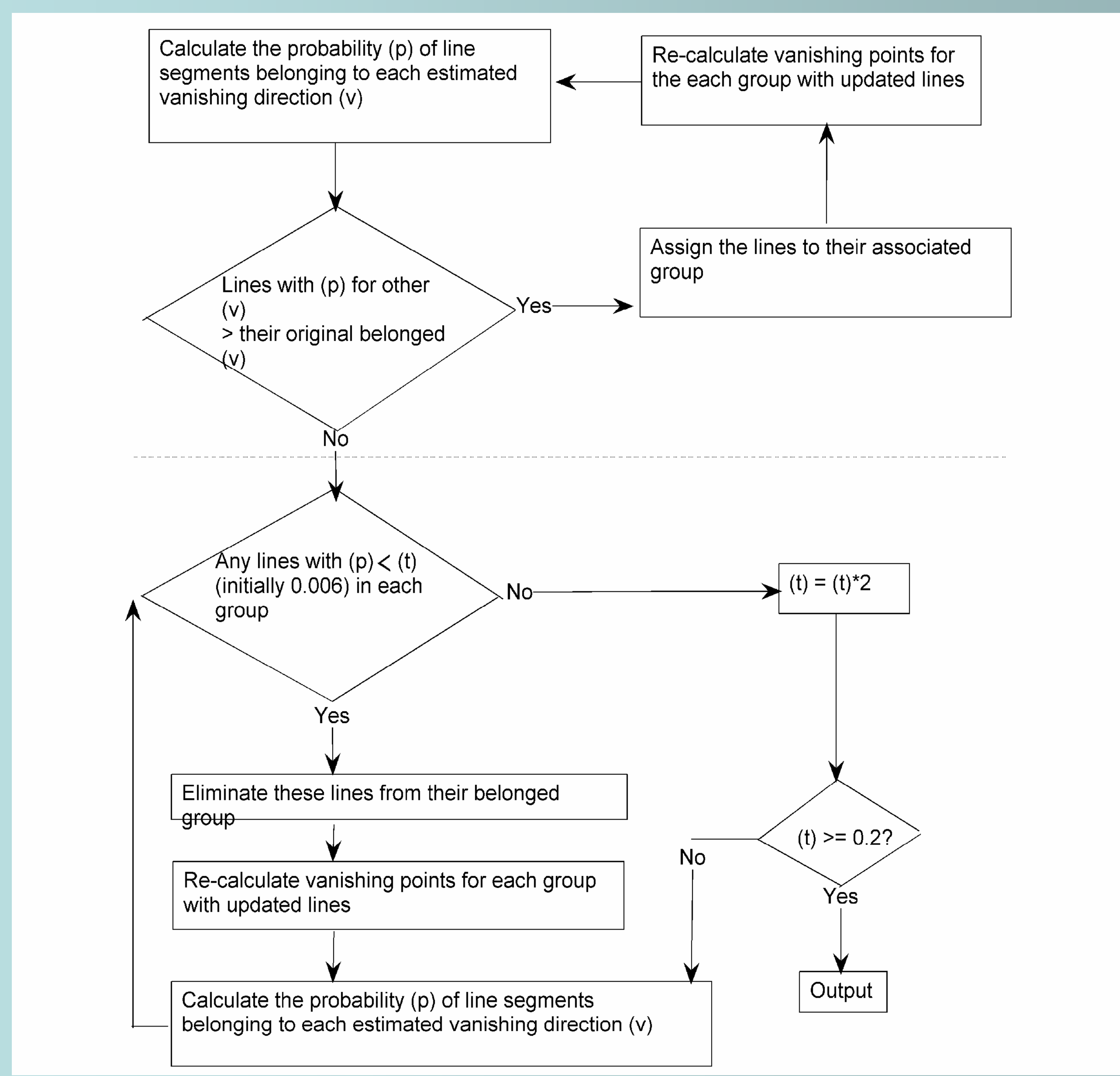
After fitting a curve to the orientation histogram of the line segments, three highest and well separated peaks were selected. Line segments with orientation in the range of [-pi/8 pi/8] around each peak were grouped together. Initial vanishing points location within each group were calculated using:

$$\min_{v} \sum_{i=1}^{n} (l_i^T v)^2$$

- **<u>Further Refinement of Vanishing Points Locations</u>**

The refinement method was used to adjust the location of the vanishing points and re-group lines according to the evaluated line probability (i.e. the probability of a line belonging to a particular vanishing direction). It iterates until certain criterion were met as shown in the flow chart.

$$p(l_i \mid v_k) \propto \exp\left(\frac{-(l_i^T v_k)^2}{2s_1^2} \right)$$



- **Automatic Parameterisation for Rectification**

With estimated vanishing points location, the vanishing line can be calculated for projective transformation matrix, enabling the parallel lines (affinity) to be recovered.

$$P = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ l_1 & l_2 & l_3 \end{bmatrix}$$

Since these line groups are aligned with three principal axis, the lines belonging to the approximately vertical group are orthogonal to the other two groups of lines. This offers the constraint for deciding the parameters in the affine transformation.

$$A = \begin{pmatrix} \frac{1}{b} & -\frac{a}{b} & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

The last similarity transformation was used to adjust the rectified image to the desired size.

3. Results and Conclusion

Our approach for building facade rectification is generally robust to occlusions, different illuminations, wide changes in viewpoint and different camera settings. The method has been shown to work successfully on 96% of images from the Zubud-Zurich building database. The failed cases were mainly of buildings with non-planar facades.

References

W, Duan and N, M, Allinson, "Automatic approach for rectifying building facades from a single uncalibrated image", 6th International Conference on Informatics in Control, Automation and Robotics (ICINCO), 2009.

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