Color Segmentation Based Technique to Measure the Dimensions of A Building

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Abstract- When the construction of building is accomplished, the process to examine and match the dimensions of constructed building with the approved layout of building is done through manual methods. It is tiresome and time consuming process. Moreover, nowadays the buildings are built very tall and their structures are very complex. This paper presents an automatic technique based on color segmentation to measure the dimensions of the building. The foremost step is to capture images of building which serves as input for the system. Ridges of the different colors in image are detected using Ridge based Distribution Analysis (RAD) method. The building is segmented out availing this technique. An object of known dimensions is placed in the view of building while capturing images. It is also processed during segmentation process. A ratio method is used to calculate the final dimensions of the building which is derived from triangle similarity theorem. Measurement of dimensions of building was found to be capable considering experimental results with acceptable error.

Keywords - *Dimensions measurement; Object size; RAD; Site management*

I. INTRODUCTION

Nowadays most of the buildings are multi storied, skyscrapers and complex. Measuring their dimensions manually is a tedious process. Government architectural agencies set some standards for the buildings. The owners, engineers, architects have to take care of these standards in order to prevent forge constructions, collapses or other losses in the building due to wrong structural designs. Moreover, a building can have some specific number of stories only, based on the width and strength of its foundation. If the architect tries to build the buildings inappropriately without considering the standards, then in the long run or in situations of natural calamities like earthquake, floods, hurricane etc. the chances of collapse of building become quite high. So measuring dimensions of a building is an important task for construction and maintenance purpose. In most of the countries, these standards remain unchecked as it's very difficult and tedious task to visit each house or building in person and measure dimensions manually. So, there is need of an automated system that can reduce the workload of the government agencies. There will be increased probability that each building can have a check. By implementing this idea, it will not be necessary for government agencies to hire highly experienced engineers to monitor the measurements and the construction progress or to do the measurements single handily. A number of trainers can be supervised by a single engineer. They can capture a couple of pictures of the building from different viewpoints. Also people can themselves capture images and submit for the approval to match construction standards. The dimensions calculated with automatic system are expected to be more accurate than manual measurements.

In this project, we proposed to utilize Ridge based Distribution Analysis method to accurately segment out the buildings in view. After that calculations are done on the basis of triangle similarity theorem. Building size identification is very useful in building construction, maintenance and in autonomous system navigation. Numerous works have been noted which multiple vision sensors or cameras for a number of applications. Some of them are 3D image constructions, occlusion detection. As the cameras are comparatively cheaper and easy to deploy and avail, multiple cameras system has become more popular. The proposed measurement system consists of object detection in the images, particularly buildings and their size calculation. This methodology will be implemented on buildings with vast dimensions and diverse shapes.

II RELATED WORK

Hui *et. al*(2013) presented a technique to count number of bricks in brick façade. They used Laplacian of Gaussian filter to accurately to generate the edge map of the frames. Video frames and images were used as input to the system. Color of the bricks was considered while selecting the color thresholds. Zhang *et. al*(2009) used digital image processing technology to calculate height of the trees with digital camera. Marker points were set on the root of the tree and one meter higher. From root and calculations were made using triangle similarity theorem. Vazquez *et. al*(2010) proposed a histogram based image segmentation method named Ridge based Distribution Analysis (RAD) method. It worked exceptionally in the presence of shadows and highlights.

III METHODOLOGY

The proposed algorithm has been divided into four steps as shown in Figure 1.1. In the first step, building's images will be acquired from the digital camera or computer system. In

second step, images are preprocessed and enhanced. Third step is to segment the images to find out the region of interest. Pixels of the objects of interest are extracted in third step based on their colors. Finally, the dimensions are calculated. Details of each step are explained further in this section.

Step 1: Image Acquisition

The images were acquired using Canon EOS 60D DSLR camera, f f/22, exposure time 1/125sec., focal length 19mm, aperture 3.625 and ISO 3200. Each building sample

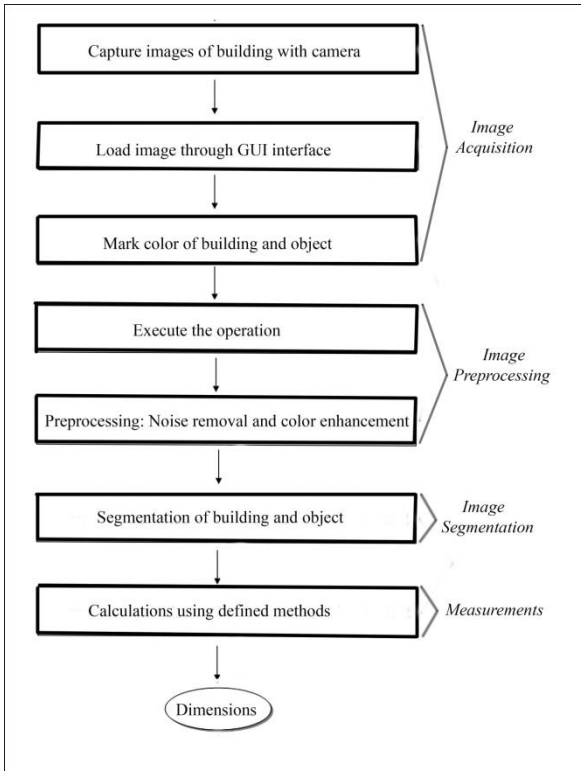

Fig.1 Work flow of the dimension measurement system

was captured after manually placing an object in front of it, which has different color from building. Dimensions of the object were already known. Camera was settled on a tripod of fixed height, which equalizes the height of object. The resolution of the image is 500x1000. The images captured manually were stored in a personal computer and will be used for further processing.

Images of buildings were obtained from Punjab region of India in the period of July 2016 to August 2016. Samples of different buildings were collected from Guru Nanak Dev Engineering and Polytechnic College (Ludhiana). A total of 9 images of buildings were collected and were measured under the supervision of the experienced civil engineer and faculty members of the college. The index used for buildings was the external color, shape and size. In this study, rather than collecting samples randomly, building of different sizes and shapes are selected intentionally so as to cover the full range of irregularities.

Step 2: Preprocessing

Firstly, colors of image are brightened using color enhancement method. Image is enhanced to highlight the different portions of image. Acquired images are preprocessed before segmentation to remove different type of noise such as dots, stains etc. To remove noise, median filter from MATLAB 2010 is used. These filters use median values of pixels instead of average or weighted value. These filters firstly arrange all the values of pixels in increasing order and then take middle value as median.

Step 3: Image Segmentation

Image segmentation is the technique to analyze the image and can be defined as a processing technique used to segment or cluster an image into several similar parts by grouping the pixels to form a region of homogeneity. This technique relies on the characteristics of the pixels such as grey level, color, intensity, texture etc.[11]. There are numerous techniques parameters like region, edge, thresholding, clustering and histogram considered for segmentation but in this study, Ridge based Distribution Analysis (RAD) segmentation technique is used to make segments of images on the basis of colors. RAD segmentation is the method for a d-dimensional feature space to find dominant structures (DS). In this process, dominant structures are considered as dominant colors of the 3D chromatic histogram. This segmentation method is carried out in following main steps.

- In First step, to represent dominant structures ridges are extracted by finding those points having meaningful information about DS. Points of ridges are extracted using Multi-local Creaseness.
- After that a flooding process is performed on ridges to retrieve the dominant structures from it. Ridges are detected.
- This process calculates the landscape region of each ridge. Then different colors are segmented out, two of them represent object and building.

Step 4: Measurements

Building dimensions' measurement, proposed in this dissertation is based on the proportion transformation. An ordinary camera is required for this purpose. Moreover, an object of known dimensions is used to calculate proportions. A tripod is needed to fix the camera, so that a photo perpendicular to ground can be taken. Fig. 2 represents the positions of building and camera. Assume that ABC is the

building to be measured. Top of the building is considered to be A. An object is represented by points B and C. Whereas, abc is the image plane. So, dimension of the building is: H = AB + BC

Apart from this, if consideration of lens distortion is not assumed, then the dimension of the building in image plane is: h= ab+bc

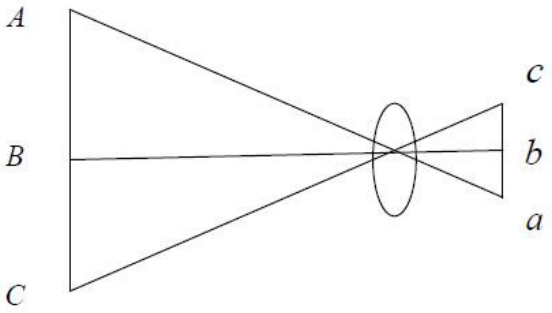

Fig 2. Schematic diagram of building and camera

Finally, dimensions of the building could be worked out using following ratio method which is derived from triangle similarity theorem: -

$$\frac{\text{Pixel value of building}}{\text{Pixel value of object}} \times \text{Dimensions of object}$$

IV IMPLEMENTATION

A GUI has been designed and implemented for the ease of use and to adorn the presentation. Pictures can be loaded and browsed from the system through 'Load Button'. An option of choosing color of building as well as object has also been provided. All the calculations run in the background once we click the 'Execute Button'. After execution, the segmented images of object and building get displayed on the GUI along with the results at the right side (in feet unit). Layout and design of GUI has been depicted in figure 3.

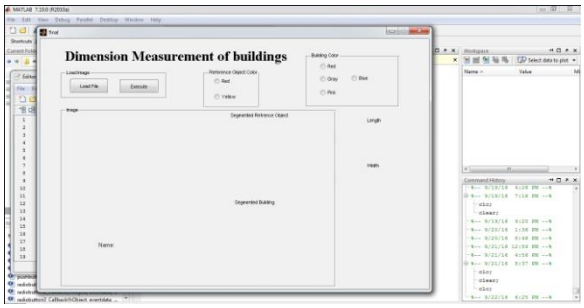

Fig.3 Pictorial view of Graphical User Interface

Out of nine buildings, four buildings were red, three were grey and other two were pink and blue respectively. The color of the object ought to be different from the building. Object of red and yellow color was used according to the color of building.

Firstly, the reference object is segmented out using Ridge based Distribution Analysis followed by segmentation of building. Following pictures depicts the implementation of Diploma three storey building of GNDEC, Ludhiana.

Fig.5**:** Original image

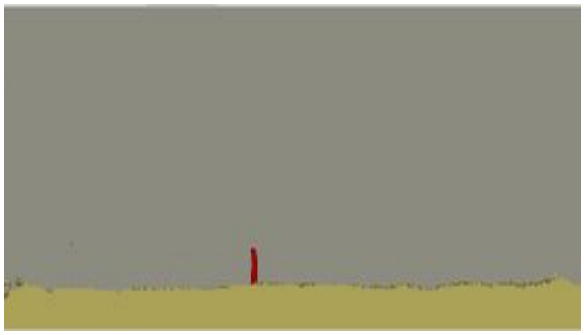

Fig.4: Segmentation of reference object

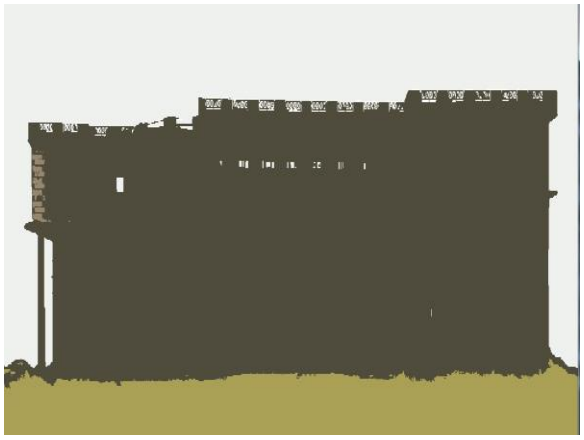

Fig.5 Segmentation of building

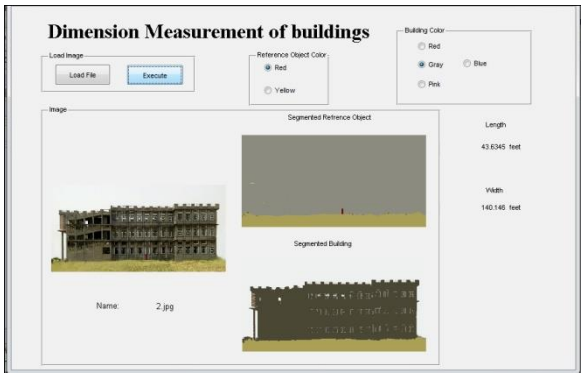

Fig.8 GUI depicting final results

Comparison of results of proposed method with verified dimensions depicted 98% accuracy with 0.02 error rate.

V. RESULT EVALUATION

Nine buildings were selected to the proposed method. It was compared with the verified data obtained from the respective college. Our comparison is depicted in the following tables where Table 1 compares the height and Table 2 compares the width of the buildings. The dimensions of building measured by proposed method approximates the verified dimensions.

Buildings	Actual Height	Measured Height
Diploma Canteen	13.9 "	13.1 "
Diploma New Three Story Building	44.0 "	43.6 "
Sports Complex	27.3 "	27.8 "
Dispensary (front)	13.5 "	13.2 "
Dispensary (back)	13.5 "	13.8 "
Coca-cola Happiness Station	11.5 "	10.9 "
Lipton (Canteen)	9.5 "	11.1"
Nescafe (Canteen)	11.0 "	12.1"
Servant Quarters	10.0 "	12.3 "

Table 1. Comparison of height of buildings

Buildings	Actual Width	Measured Width
Diploma Canteen	37.9 "	37.1 "
Diploma New Three Story Building	140.0 "	140.2 "
Sports Complex	61.0 "	60.8 "
Dispensary (front)	52.0 "	51.2 "
Dispensary (back)	52.0 "	51.3 "
Coca-Cola Happiness Station	18.8 "	19.9 "
Lipton (Canteen)	12.0 "	12.2 "
Nescafe (Canteen)	14.0 "	14.2"
Servant Quarters	33.0"	35.5"

Table 2. Comparison of width of buildings

Comparison of dimensions of building with the verified dimensions depicted that the best result for measurement of buildings was gained with a high overall accuracy rate of 98.4% and 99.5% corresponding to height and width respectively. Thus, it was concluded that images of building can be potentially used to measure the dimensions of the buildings with a proper probability.

VI. CONCLUSION

Many automated dimension measurement systems have been developed so far but there is however no such system developed for measurement of buildings yet. So, an automatic building measurement system is realized in this dissertation. Ridge based Distribution Analysis (RAD) method for segmentation of buildings is to measure dimensions of objects without getting distorted by the presence of shadows, shading, highlights and outer environmental conditions. This method belongs to the feature based segmentation. While capturing the pictures of the buildings, an object of known dimensions is placed in the view of the camera and it is captured along with the building. After the image is captured using digital camera, images are preprocessed and enhanced to highlight colors of buildings. Then, RAD segmentation is applied to segment out the pixels of building and object, so that dimensions of building, specifically height and width, are calculated on the basis of triangular similarity theorem. A Graphical Unit Interface has also been developed for the ease of users. Pictures can be loaded from the system and executed to obtain results. An option of choosing color of the known object (to be used while capturing images of building) is also provided. An extension to this research work would be to extract number of windows, doors or other elements of the building. Also, this dimension measuring system can be progressed into android application. Moreover, the approach can be used for largest data sets. Lastly, complex buildings with complicated

structures and buildings having a number of colors can be used as the dataset.

VII. REFERENCES

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