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Perspective correction of building facade images for architectural applications

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ABSTRACT

In this study, a geometric method used to obtain rectified photographs that will form a base for drawings of building facades are examined. Mathematical model is presented by informing briefly about the method evaluated. The subject is exemplified by a test study. In the test study, firstly, the behavior of the related methods on the created artificial image was examined and the applications on the real photographic sets of the models obtained with different types and different cameras were performed. The obtained results were evaluated statistically and various conclusions were drawn and the suggestions were made for those who want to apply the method and want to do the study in this subject.

1. Introduction

The benefits of imaging for urban rebuilding are generally the simple capture process and the fact that there is a tremendous amount of knowledge about the treatment. It has been very actively researched in the last decades [1]. The development of various modeling methods has become one of the most interesting topics in computer graphics and GIS. The concept consists of processing the modeling of all objects in the city, such as terrain, road network, wired building structures and street furniture [2]. In architectural studies, realistic building facade models are beneficial to various fields. The research presenting in this paper has been investigated by several studies in the recent but also in the far past decades. In these studies it has been achieved satisfactory results [3–8].

The measurement of architectural works is also important when it is examined from the perspective of the historical background of architectural structures. Architectural photography includes all photographic techniques used to demonstrate the geometry and aesthetics of architectural structures. In professional architectural photography, the perspective and therefore the control of horizontal architectural features, especially the aesthetic settlement, is very important for the purpose of making architectural photographs suitable and correct. The main tasks of architectural photographers are to present three-dimensional architectural themes in a realistic and impressive way in two-dimensional photography. In this respect, specializing in this area also requires having technical knowledge and experience, as well as general photographic information. There are two different approaches to architectural photography. The first approach is that architects and photographers can gain a different view and perspective on the architectural structure by using their original perspective and photographic techniques. This approach expresses artistic side in a sense of the matter. The second approach is to document the technically important features and functions of the architectural work being drafted. On the other hand, in commercial sense, architectural photography works seem to have been applied within a broad perspective. These shootings are performed for different purposes.

One of the most important issues that should be paid attention to architectural photography is the reflection of the perspective of architectural structure and the effect of the third dimension correctly on the photo. The ability to deliver these effects in a technically correct way depends primarily on the point of view the photographer will prefer during shooting, the height of the point of view, and the distance between the subject and the camera. However, it is important in technical tools such as cameras and lenses that the photographer will use. When photographs of architectural structures are taken, the most common problem is the occurrence of deformations due to the height of the structures, the lack of suitable angled places and the use of wide angle lenses. In such a photograph, the vertical lines of the architectural

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structure are not parallel to the vertical edge lines of the photograph but are inclined inwards. To avoid from this mistake, you need to use a technical camera, use a perspective-controlled (PC) lens, and shoot at an appropriate angle and height. Furthermore, the camera is positioned so that the architectural object surface to be documented looks as close to the center as possible. Correction of the building planes is possible with the development of digital photography technology and software today, these mistakes can also be eliminated through processing software.

A manual reconstruction process can be rather time-consuming and inaccurate. The operators need to interpret the reference data, draw boundary represented models using some modeling software, select and undistort all the texture parts, and finally apply corresponding textures to each face of the model. Creating building facade models for a whole city requires considerable work [9]. For these purposes, complicated techniques such as laser scanning, orthophotography, classical or modern photogrammetric approaches and stereo drawing can be used today if a model is needed for objects with more complex details. Traditionally, photogrammetric processing techniques based on close range images have been commonly used for building facade reconstruction because they contain plentiful optical information which can be easily acquired. There are several approaches that are able to extract building structures from 2D images [9]. In particular, for the documentation, reconstruction and visualization of building scenes, scaled-rectified photography is the one of the important tool for the representation of plane surfaces with no appreciable distortion of scale in any selected direction. Although this method is normally applied to flat surfaces, it is also possible to provide an adequate representation of some curved surfaces [10]. The geometric transformation is still an essential process of this process for perspective correction of captured images [11].

The geometrically corrected (rectified) facade photographs are a cost-effective method for drawing details on objects such as relatively flat structures, facades of building, floors, glass windows and wall paintings. According to the all approaches described above, rectified photographs have the potential to provide much more information than the drawings obtained with other conventional approaches. However, it can be said that the approach is only an effective method for relatively flat structures and objects. Such photographs can be used to create a multipurpose drawing and are considered a data source that can be easily read and interpreted for different disciplines in architectural works. It also provides detailed photo recording of the object or structure and serves as an important inventory record.

2. Rectification of building facade images

Images are perspective in nature. Today's world requires the perspective rectified image for applications like image based rendering and metrology from single view. The applications require parallel view image for photorealistic results. The perspective distortion occurs due to the perspective projection of a 3D scene onto a 2D surface. Correcting the distortion of an image is a difficult task in the field of computer vision [12]. In practical applications, standard image correction procedures are recommended for correcting oblique photographs. On the other hand, conventionally, in architectural photogrammetric applications, rectification is needed to create an image record in the object coordinate system. Rectification is the process of subtracting the angles of rotation from the image to leave the image aligned with the image orthogonal axis [13]. It can also be considered as the work of transforming images into geometrically distorted images with numerical methods. As a result of the geometric transformation, the pixel values (gray level, brightness, radiometric or color values) must be resampled to obtain the brightness values of the pixels in the new image. In the literature, it is seen that various methods of rectification are used. Much work has been done towards the rectification of perspective distortion depicted in document images and also based on multiple images. Recent focus has been on recovery based on single image, a problem that is more challenging than the multiple- view variety and has good potential applications in image based rendering, image mosaicing, machine vision, 3D Reconstruction [12]. Polynomial rectification, projective rectification and differential rectification are three commonly used methods. The first two of these techniques are performed with analytical transformations that are thought to exist between image and orthophoto, without adding the array of sensor arrays, the projection geometry, and the external orientation of the sensor systems. These are considered approximate solutions of the problem. However, these approximate solutions are sufficient for processing images of some applications. However, the latest technique models the physical reality of the imaging system with the colinearity equations and corrects the relief displacement due to height differences [8,14].

In this study, we focused on the geometric image transformations with several examples. The well-known transformation type are illustrated in Fig. 1.

The similarity transformation are used when shapes in the moving image are unchanged, but the image is distorted by some combination of translation, rotation, and scaling. Straight lines remain straight, and parallel lines are still parallel. Affine transformation is useful when shapes in the moving image exhibit shearing. Straight lines remain straight, and parallel lines remain parallel, but rectangles become parallelograms. If the scene appears tilted, straight lines remain straight, but parallel lines converge toward a vanishing point; projective transformation will be more convenient for rectification. Alternative methods such as polynomial, radial basis functions, piecewise linear, local weighted mean and etc. can be used for more complex geometric defects and distortions. These can be considered when objects in the image are curved, parts of the image appear distorted differently or the distortion varies locally and the other methods are not sufficient. On the other hand,

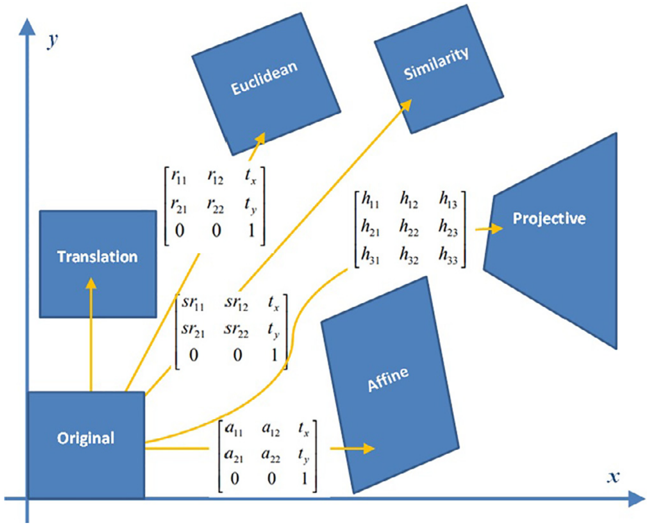

Fig. 1. Different types of geometric transformations on an input image (original).

the translation and Euclidean are very simple operations for rectification as to others. The selection of appropriate model plays a crucial role in reducing the error and in registering the images accurately for rectification of building facade images [15–17].

3. Removing perspective distortion from an architectural plane

Architectural objects are made up of a series of large planes. A single perspective view is enough to obtain a corrected and scaled view, even if the plane of the object being examined is oblique to the image or the photograph. However, sometimes an object may appear different in appearance than it actually looks. The reason of this discrepancy is perspective deformation. Images of the same object captured from different camera distances and viewing angles may exhibit different perspective distortions. Using a wrong lens or the camera's trembling can cause the perspective in the photographs to deteriorate. As it may be a perspective deformation, vertical continuous lines or geometric shapes may become more prominent in photographs. Distortions in the vertical lines due to the lens used in some photographs (especially wide angle) or gaze height appear to be a technical flaw. Especially in architectural photographs, this problem is solved by using a technical camera or tilt-shift (perspective control lens) lens, but these defects can also be corrected by software. In architectural photography, the fact that the vertical columns are not curved or the horizontal symmetry can be preserved is a more beautiful element in a photograph. It is also possible to arrange these perspective distortions later with Photoshop or similar photo editing programs, since it is not possible to adjust the framing in situations where the photograph needs to be drawn quickly.

Perspective rectification can be referred to as image correction to measure from digital or traditional photographs. With geometric correction it is possible to define horizontal lines and correct and scale a flat surface photograph with two scale-defined scale information. Two dimensional projective transformation is the most common method of rectification. Essentially the projective transform creates linear functions to map the picture coordinates into ground coordinates [13]. Projective transformation is used to eliminate the perspective effect resulting from the central projection in the images. It is a popular geo-referencing technique used worldwide. It is based on quite complex geometric and mathematic concepts, known as "homogeneous coordinates" and "projective planes". An orthogonal image is obtained by removing the perspective effect in the images. That is, the object is rendered parallel to the plane as if it were obtained by parallel projection. This method is usually used to retrieve defects found in aerial photographs of flat areas and images of building surfaces, applying homographies to remove perspective distortion, homographies for bird's-eye views and homographies for mosaicking.

Application of the method is possible through the use of precise reference points on the surface being photographed and on the ground. These reference points must be defined points on the building surface or must be mounted to the surface. The precision of the final results is completely dependent upon the precision of the control work [10]. In the geometric correction process with the reference points, it is necessary to make measurements with the topographical instruments directly for the correction and scaling of the photographs. Thus, images expressed in corrected, scaled, and even geographic coordinate systems can be edited for further processing, drawing, framing or archiving, and can even be used as a background for future work on CAD software. Although measurement with topographical instruments is not always necessary, it is one of the most ideal options for perspective correction, distortion modeling, scaling and geo-referencing. Because they can be used directly with the data they provide without the need for other procedures and applications.

4. Solution of the transformation by 2D homographies

2D homography can be defined as a projective transformation h is an invertible mapping from P^2 to P^2 that preserves collinearity between points (x_1, x_2, x_3 on same line0 h(x_1), h(x_2), h(x_3) on same line) [18]. Given a set of points x_i in IP^2 and a corresponding set of points $x_i^{'}$ likewise in IP^2, compute the projective transformation that takes each x_i to $x_i^{'}$. In a practical situation, the points x_i and $x_i^{'}$ are points in two images (or the same image), each image being considered as a projective plane IP^2. In this scenario every 2D point can be projected in any other plane in the space. Based on these concepts, it is defined the "homography between 2 planes" which, simply speaking, means that given 4 points in a plane, there always exists a relationship that transforms them into the corresponding 4 points in another plane. A two-dimensional point in an image can be represented as a 3D vector, it is called the homogeneous representation of the point [19].

The homography transformation method has been used to rectify a perspective image, for example to generate a "plan" view of a building from a "perspective" photo (Fig. 2). The transformation equation can be defined Eq. (1) for x,y source system from X,Y target for in this type of process the homography (projective transformation/projectivity/collineation). This transformation is called a perspective transformation (or plane-to-plane homography). A homography is represented by a 3*3 homogeneous matrix H. Points on the image plane, x, are mapped to points on the world plane, x', as $x' = H.x$, where × is a homogeneous column 3-vector $x = (x,y,1)^T$ with (x,y) the Euclidean position on the plane. Note, for equations between homogeneous quantities '=' is equality up to an overall scale factor. The homography matrix has eight degrees of freedom — there are nine matrix elements, but the overall scale is not significant. A line l is also represented by a homogeneous column 3-vector, such that if a point x lies on l then $l^T x = 0$ [20].

$$\begin{vmatrix} x'_1 \\ x'_2 \\ x'_3 \end{vmatrix} = \begin{vmatrix} h_{11} & h_{12} & h_{13} \\ h_{21} & h_{22} & h_{23} \\ h_{31} & h_{32} & h_{33} \end{vmatrix} \begin{vmatrix} x \\ y \\ 1 \end{vmatrix} \tag{1}$$

Setting $h_{33} = 1$.

$$x' = \frac{x'_1}{x'_3} = \frac{h_{11}.x + h_{12}.y + h_{13}}{h_{31}.x + h_{32}.y + 1}, y' = \frac{x'_2}{x'_3} = \frac{h_{21}.x + h_{22}.y + h_{23}}{h_{31}.x + h_{32}.y + 1} \tag{2}$$

If the Eq. (2) multiplying through by denominator, and then rearrange as Eq. (3).

$$\begin{aligned} h_{11}.x + h_{12}.y + h_{13} &= x'.(h_{31}.x + h_{32}.y + 1) \\ h_{21}.x + h_{22}.y + h_{23} &= y'.(h_{31}.x + h_{32}.y + 1) \end{aligned} \tag{3}$$

$$\begin{aligned} h_{11}.x + h_{12}.y + h_{13} - h_{31}.x.x' + h_{32}.y.x' &= x' \\ h_{21}.x + h_{22}.y + h_{23} - h_{31}.x.y' + h_{32}.y.y' &= y' \end{aligned} \tag{4}$$

Where x'-y' are the coordinates to be calculated in the second reference system (target), given coordinates x-y in the first reference system (source) in function of 8 transformation parameters h_{11}, h_{12}, h_{13}, h_{21}, h_{22}, h_{23}, h_{31}, h_{32}. So, having these 8 unknowns (2 scale, 2 rotation, 2 translation, 2 line at infinity), at least 4 known points in both systems are required [21]. If the number of points is more than 4, it can be realized by least squares. The matrix system of transformation equations can be defined as;

$$\begin{vmatrix} x_1 & y_1 & 1 & 0 & 0 & 0 & -x_1.x'_1 & -y_1.x'_1 \\ 0 & 0 & 0 & x_1 & y_1 & 1 & -x_1.y'_1 & -y_1.y'_1 \\ x_2 & y_2 & 1 & 0 & 0 & 0 & -x_2.x'_2 & -y_2.x'_2 \\ 0 & 0 & 0 & x_2 & y_2 & 1 & -x_2.y'_2 & -y_2.y'_2 \\ x_3 & y_3 & 1 & 0 & 0 & 0 & -x_3.x'_3 & -y_3.x'_3 \\ 0 & 0 & 0 & x_3 & y_3 & 1 & -x_3.y'_3 & -y_3.y'_3 \\ x_4 & y_4 & 1 & 0 & 0 & 0 & -x_4.x'_4 & -y_4.x'_4 \\ 0 & 0 & 0 & x_4 & y_4 & 1 & -x_4.y'_4 & -y_4.y'_4 \\ . & . & . & . & . & . & . & . \\ . & . & . & . & . & . & . & . \end{vmatrix} \cdot \begin{vmatrix} h_{11} \\ h_{12} \\ h_{13} \\ h_{21} \\ h_{22} \\ h_{23} \\ h_{31} \\ h_{32} \end{vmatrix} = \begin{vmatrix} x'_1 \\ y'_1 \\ x'_2 \\ y'_2 \\ x'_3 \\ y'_3 \\ x'_4 \\ y'_4 \\ . \\ . \end{vmatrix} + \begin{vmatrix} v_{x'_1} \\ v_{y'_1} \\ v_{x'_2} \\ v_{y'_2} \\ v_{x'_3} \\ v_{y'_3} \\ v_{x'_4} \\ v_{y'_4} \\ . \\ . \end{vmatrix} \tag{5}$$

$$\underline{A}.\underline{X} = \underline{L} + \underline{v} \tag{6}$$

where;

h_{11} = fixed scale factor in X direction with scale Y unchanged.
h_{12} = scale factor in X direction proportional to Y distance from origin.
h_{13} = origin translation in X direction.
h_{21} = scale factor in Y direction proportional to X distance from origin.
h_{22} = fixed scale factor in Y direction with scale X unchanged.
h_{23} = origin translation in Y direction.
h_{31} = proportional scale factors X and Y in function of X.
h_{32} = proportional scale factors X and Y in function of Y.

The unknown coefficients of the models with their covariance information are simply determined according to least squares principles which is minimizing the sum of squares of the residuals v_i, as follow with the equal weights.

$$\underline{X} = \left(\underline{A}^T.\underline{A}\right)^{-1}.\left(\underline{A}^T.\underline{L}\right), \underline{v} = \underline{A}.\underline{X} - \underline{L}, \sigma_0^2 = \left(\underline{v}^T.\underline{v}\right)/(2n - r) \tag{7}$$

L is the observation vector, which consists of coordinates in target reference system, $\underline{X}$ is the estimated value of the unknown transformation coefficients vector (h_{11}, h_{12}, h_{13}, h_{21}, h_{22}, h_{23} , h_{31}, h_{32}), $\underline{A}$ is the design matrix, $\underline{v}$ is the residual vector. Once calculated, these 8 parameters can easily be used to transform any point from the first reference system to the second. σ_0^2 is the unit weight of variance, q is the number of common points used for transformation, r is the unknown parameter number (number of transformation coefficient). The homography induced by a plane is unique up to a scale factor and is determined by 8 parameters or degrees of freedom. The homography depends on the intrinsic

Table 1
Test Data.

	Resolution	DPI	Bit depth	Camera	Focus Length
Artificial Image	3840*3840	600	24	–	–
Building facade	3072*4608	300	24	Nicon D3100	26.3 mm
Consecutive photographs	2592*1728	72	24	HTC C501e	4 mm

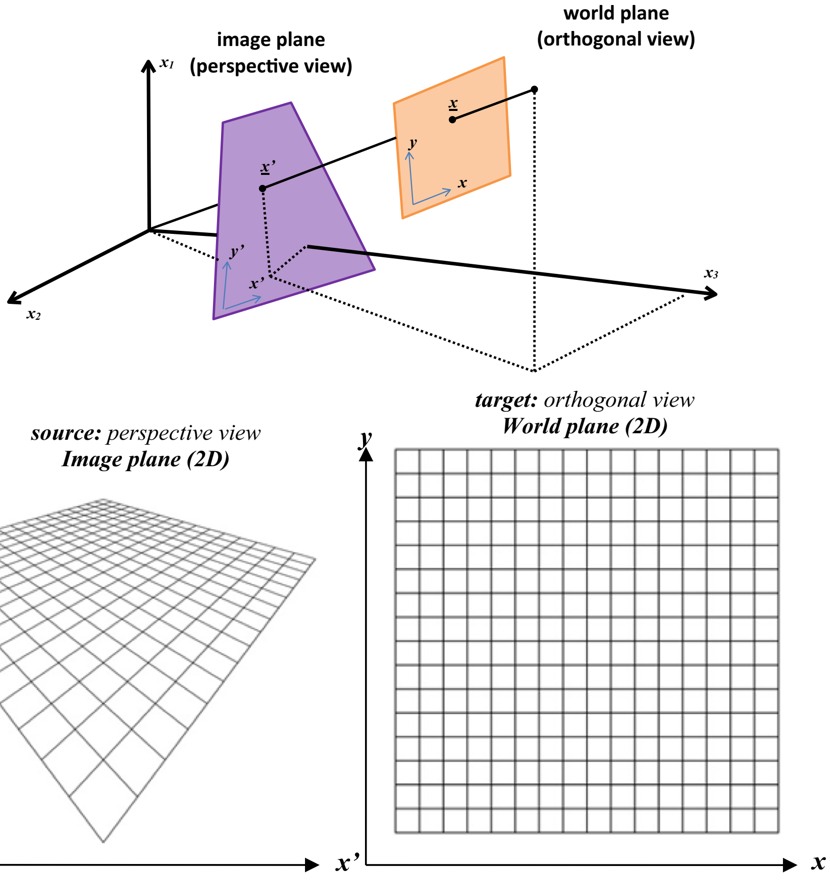

Fig. 2. Transforming from a perspective image plane to the orthogonal world plane.

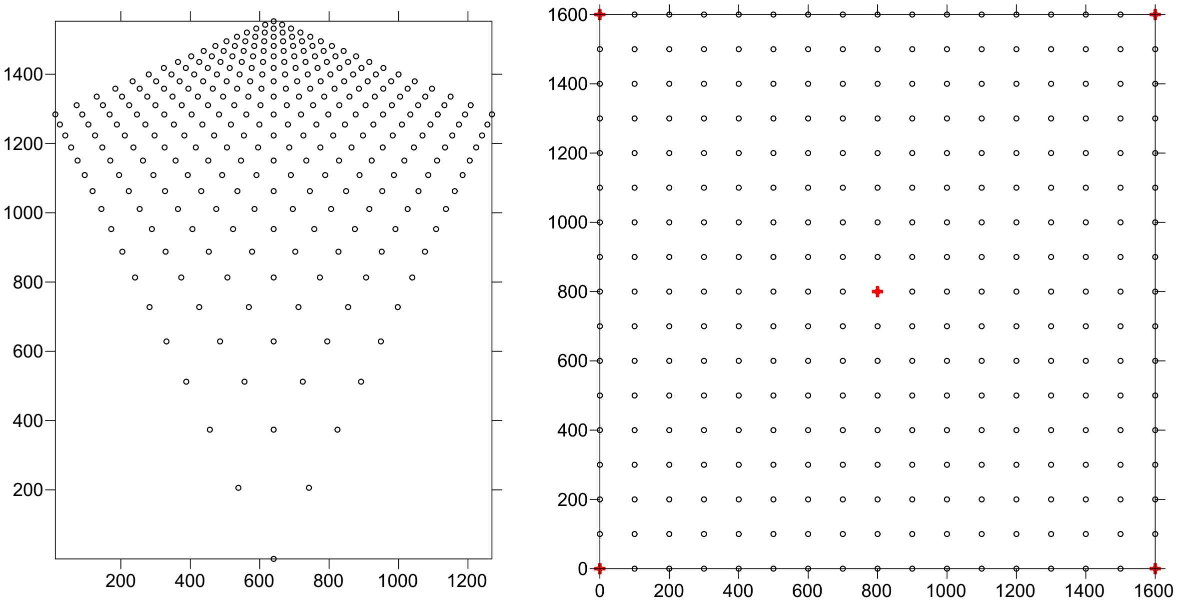

Fig. 3. Grid positions in source and target coordinate systems.

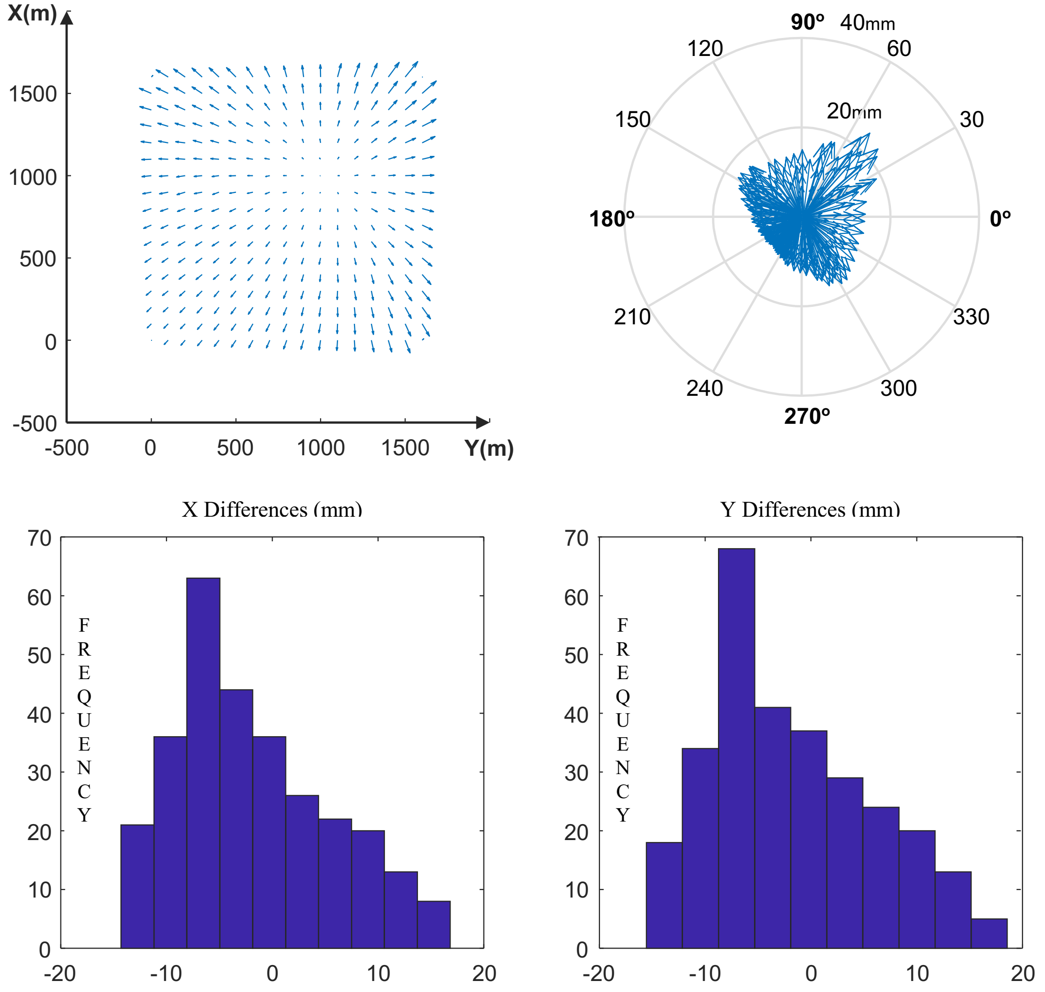

Fig. 4. Differences between the grid positions in the transformed and original orthogonal images.

and extrinsic parameters of the cameras used for the two views and the parameters of the 3D plane [22]. To attain best rectification accuracy, further to use an adequate number (more than four) of control points with acceptable accuracy (at centimeter level or better) [23].

5. Test study

In the test study, firstly, the behavior of the related methods on the created artificial image was examined and the applications on the real photographic sets of the models obtained with different types and different cameras were performed. The obtained results were evaluated statistically and various conclusions were drawn and the suggestions were made for those who want to apply the method and want to do the study in this subject. Software such as Photoshop ArcGIS, Surfer, Didger, Matlab have been used in the study for the purpose of editing photographs and so on. The technical details of the photographs in the datasets used in the study are given in Table 1.

Table 2
The statistics for grid position differences for first data.

	X Differences (mm)	Y Differences (mm)
Number of values	284	284
Minimum	−14.31	−15.40
Maximum	16.82	18.71
Mean	−1.81	−1.57
Standard deviation	7.29	7.69
Average deviation	6.03	6.39
RMS	7.50	7.84

At the first stage of the test study, an artificial image formed from the square grids. The artificial image has been transformed into perspective views and the success of geometric transformation methods in correcting these perspective views has been examined. The created image is of resolution and size in standard photograph features and is defined separately in orthogonal and perspective geometries as given in Fig. 2. The aim is to convert perspective view into orthogonal image with 5 defined control points. The differences between the squared positions in the transformed and original orthogonal images (Fig. 3) provides a significant comparison in terms of the suitability of the transformation model.

For this purpose, the differences between the grid positions and the original positions were statistically analyzed. In addition, evaluations were made visually. The artificial image was created with 16*16 = 256 squares and 289 grid points. These points are expressed arbitrarily in a 2D plane coordinate system and 5 control points both image and world coordinate systems are selected

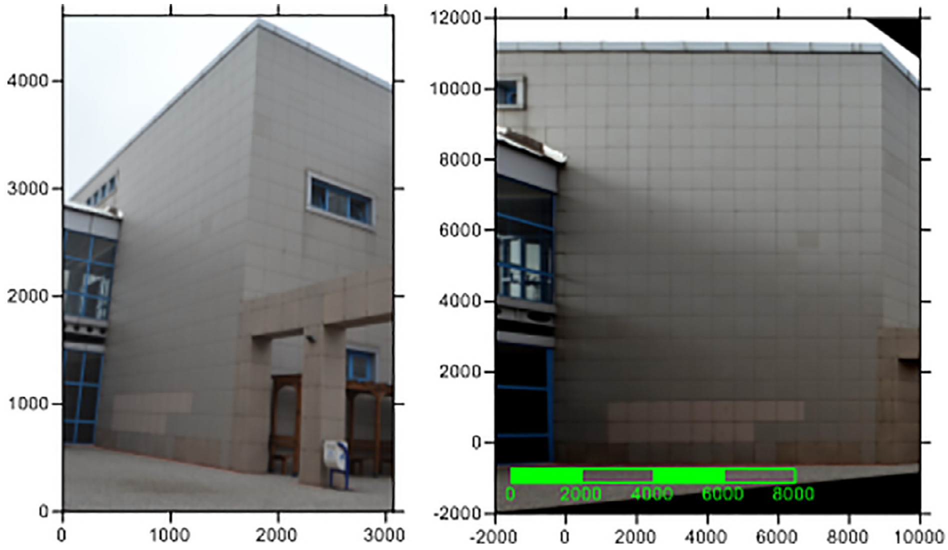

Fig. 5. Original and transformed building facade images.

Table 3
Analysis of second test data results (Units: mm).

Tile Size Comparison				
Number of Tile: 252	Min.	Max.	Avr.	Meas.*
Tile length	585.8	615.3	599.9	595
Perimeter	2365.5	2451.4	2407.6	2380
Tile areas (mm^2)	349,620	375,169	361,468	354,025
Facade Size Comparison				
Height	Left	Right	Avr.	Meas.**
	10704.2	10690.5	10697.4	10,710
Length	Top	Bottom	Avr.	Meas.**
	8321.5	8336.9	8329.2	8330
Diagonal	Bottom-Left to Top-Right	Bottom- Right to Top- Left	Avr.	Meas.**
	13541.3	13531.1	13536.2	13,568
Area (mm^2)	–	–	89100784.08	89,214,300

* Tape measurement.
** Laser distance meter measurement.

Fig. 6. Consecutive photographs for historic barrack building.

(units are mm.). The remaining 284 points are accepted as comparison points. The success of the geometric transformation methods discussed in the study was explored using various variations of the points in the control point group.

The vector plots for the differences between the grid positions in the transformed and original orthogonal images, the compass plots and the histograms for the distributions of the differences are given in Fig. 4. The results demonstrate that the differences are maximum 16.32 mm in the X-axis, minimum −14.31 mm, average 6.03 mm and RMS value is 7.5 mm. On the Y axis, maximum 18.71 mm, minimum −15.40 mm, average 6.39 mm, RMS value is 7.84 mm (Table 2).

Fig. 7. Panoramic image formed from the consecutive photographs for historic barrack building.

The RMS value obtained from statistical data can be considered as the most important value that gives an idea about the accuracy of the conversion models. The RMS is calculated by summing the mean squares of the errors for X and Y coordinate differences. RMS indicates how closely model estimates the measured values. The smaller this error, the better estimation could be performed.

The second data is the surface of a smooth building ceiling in the shape of a tile. Photos taken from different locations, different viewpoints and directions were used for this facade based on single photo resection. Since the tile sizes (about 595 mm) are also visible on this surface, the scaling is done using their dimensions. The locations of the junctions of the tiles are compared by calculating the dimensions and areas of the tiles (Fig. 5).

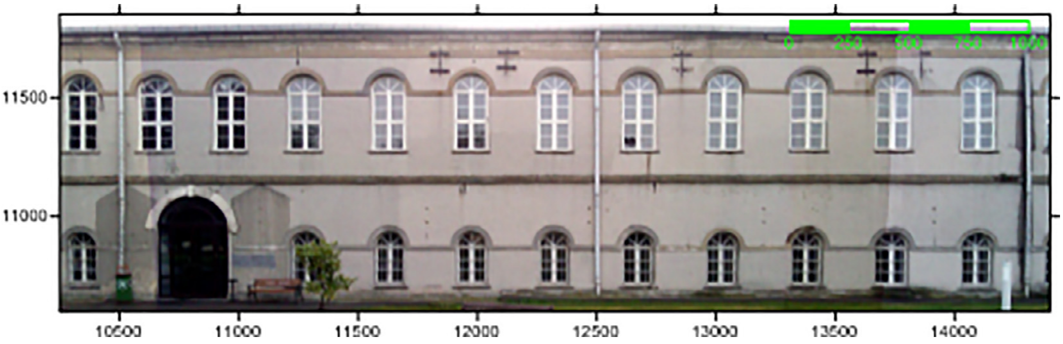

Fig. 8. Geo-referenced image for historic barrack building.

Table 4
Analysis of third test data results (Units: mm).

Window Size Comparison				
1. Floor	Min.	Max.	Avr.	Meas.*
Perimeter	5923.5	6029.9	5973.8	5960
Areas	22105.8	22851.4	22469.1	22,550
2. Floor	Min.	Max.	Avr.	Meas.*
Perimeter	8229.5	8105.6	8171.6	8185
Areas	38089.6	37505.93	37836.6	38,215
Facade Size Comparison				
Height	Left	Right	Avr.	Meas.**
	11473.3	11419.9	11413.5	11,445
Length	Top	Bottom	Avr.	Meas.**
	37974.4	37983.3	37953.8	37,960
Diagonal	Bottom-Left to Top-Right	Bottom- Right to Top- Left	Avr.	Meas.**
	39715.2	39689.4	39702.3	39,689
Area	–	–	433185696.3	

[*] Tape measurement.
[**] Laser distance meter measurement.

It has been seen that the view has been transformed quite successfully in the examinations made on the facade due to the factors related to the vertical and horizontal control points, the tiles' overlaps, the tile sizes, facades and tile surface area (Table 3). RMS value is calculated as 2.5 mm for transformed image.

As the third data of test study, a panoramic image formed from the four photographs taken from the historic barracks building located in the Yildiz Technical University Davutpasa campus was used (Fig. 6). A geo-referencing approach based on the control points on the facade was used to rectify this image. The locations of the control points are determined by geodetic measurements.

The four superimposed photos taken from the inner garden of the historic barrack building were combined with the "image mosaic" approach (Fig. 7). In this approach, consecutive photographs are paired with each other and combined in the coordinate system of the first photograph. The image obtained from the combined 4 photographs was transformed based on the 6 control points measured geodetically on the surface (Fig. 8).

The result of this transformation is that the perspective errors found in the merged image are eliminated and an orthogonal view is obtained. The resulting RMS value is around 5 mm. Similar to other data sets, the edges defined in different directions and sizes on the facade were compared in terms of dimensions. In addition, the lengths between the detail points on the facade, the vertical and horizontal controls, and the results of the examinations made in the window details have resulted in a sufficient level of image in terms of architectural works (Table 4).

6. Conclusion

Generally, in the plans made within the scope of architectural works, front elevations, sections, profiles and, in some cases, the coordinates of certain regions and points of the structure are desired. Today, due to its easy and wide use, cameras are also included in other devices such as mobile phones and tablets. This digital technology has become widespread and, in a sense, an integral part of our daily lives. Digital technology, which finds itself as a concept that affects more individuals and society in everyday life, also comes with its problems as well as the solutions it creates. Today, research and development studies intensely ongoing to further develop digital photography technology. In practice, there are many factors to consider in the photo; Photo Techniques, Camera features, Lens types, Drag modes, Settings related to shooting environment, Photo Processing and Editing etc. The simplest way to edit a photo is probably to play the photos we take on or after the machine, and make adjustments as desired. This arrangement sometimes requires fine tuning, simple toning, and sometimes even more work. While basic adjustments can be made on the camera and/or via Mobile Photo Editing Applications, Photo Editing Software developed for more complex edits can be used.

Along with the developing computer and information technologies, conventional method has been replaced with digital photography and terrestrial photogrammetry method. This method has many advantages such as automatic directing and measuring processes, digital three-dimensional vector data, digital orthophoto, digital surface and the production of terrain models. The resultants are numerical, allowing these products to be used in different areas of application, such as three-dimensional modeling outside the photogrammetric survey, visualization of the three-dimensional data, management and presentation in the GIS environment. As an important component of terrestrial photogrammetry, the images obtained with this approach can provide significant benefits for the projects; Survey, Restitution and Restoration, Preparation of Environmental Plan, Landscape Projects and Urban Design, Street Health Projects and Preparation of Facade Rehabilitation, Preparation of photogrammetric silhouettes of straits and coastal areas, Preparation of Electrical, Mechanical, Static and Strengthening Projects of Historical Buildings, 3D City Modeling, Animation and Urban Modeling Preparation, Construction Application Services in terms of applicability, prevalence, sustainability and practicality.

It is obvious that the development of modern photogrammetry in the field of architectural studies will increase efficiency. The single image method is particularly important for accelerating the analytical documentation process.

The use of rectified digital images for providing 2D drawing plans is not a current trend since the generation of 3D textured models using commercial and also open source software is providing better results today. Ortho-images derived from 3D reconstruction software (using stereoscopic and convergent photogrammetric images) are better than single rectified images especially in close range photogrammetry and Structure from Motion. The production of rectified images has almost no cost but for a professional work orthorectification is the most appropriate approach. In any case, geometrical information on building façades has to be known by means of control points and these have to be measured by photogrammetric or topographic techniques.

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