Perform Measuring by using Image Processing

Sundus Khaleel Ebraheem
Department of Computer Sciences, College of Computer Sciences and Mathematics, Mosul University, Iraq

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ABSTRACT

The development of ability of the computer leads to improve the abilities of digital image processing, because of the traditional measuring work needs much effort in the site for different fields, and has its difficulties and shortcoming points; therefore this paper introduces improvement for the method to solve the measuring problem, by using digital image processing. This paper improved the system of perform measuring of material for buildings by calculating the volume furthermore the area and dimensions for any position was pointed by the user. The improvement involved in addition to that correction the position of pointed point in case of zooming. The system was designed by using MATLAB R2012b language. The system has implemented on different images and different dimensions as well as on video, it showed accurate results in calculating specific dimensions, areas and volume which defined by the user in the image

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Corresponding Author:

Sundus Khaleel Ebraheem
Department of Computer Sciences,
College of Computer Sciences and Mathematics,
Mosul University, Iraq

1. INTRODUCTION

The huge development in the computer techniques and digital image processing helps to get images without chemical treatments [1]. And The revolution of the informatics changes the work in various fields and the digital image becomes used in wide rage [2]. The operations applied on the digital images are much according to required treatments [3].

The digital image processing is used in many application of computer vision which inspired by the real biological systems [4]. Where The image is converted to matrix of data, it is called digital image [5].
Nowadays, searching in the database about digital images or on the internet by using searching engine to get similar image is used widely [6]. The digital image processing gives ability to adjust, refine, manipulate and forgery the images [7]. The development of ability of the computer leads to improve the abilities of digital image processing, and this in its role encouraged the researchers in the computer vision field to innovate new algorithms, methods and techniques for image analysis and pattern recognition. So, many new studies and ideas introduced to apply image processing in many fields, the following are some recent researches in this field:

In 2010 Abdullah used countourlet transformation coefficients to determine the edges in the image and then to use it in segmentation process [3]. Also, Ebraheem proposed a method to find the object dimensions in the digital images by using two index point lights applied on the object by two parallel sources fixed with the camera to find the scale [8]. In 2011, Etewi introduced a method for traffic signs recognition based on the color and shape properties [7]. In 2012, Usman presents a novel automated approach for preprocessing of colored retinal images. The proposed technique improved the quality of input retinal image by separating the background and noisy area from the overall image [9]. While In 2013, Albasha used the countor transformation to improve the image color [10]. Three different color models (RGB, HIS, YCbCr) for extracting the damaged image from cotton leaf images were implemented by Qinghai and et al. in the same year. The ratio of damage was chosen as feature to measure the degree of damage which caused by

diseases or pests [11]. In 2014, Ebraheem and et al. were designed system to perform measuring of material for buildings in the civil engineering field [12] by using digital images, this system is improved in this paper.
The measuring work needs much effort in the site in the various fields. It needs some persons, measuring tapes, reflectors, and the ability to reach high and difficult positions such as high trees or the elevation of the building. The measuring team should be at the site for long time during measuring and re_visit the site many times to collect the data that needed for calculating the dimensions and amounts in the next step.
Because of that the existed measuring programs need to collect the input data from the site or from other drawing program for each length, therefore this paper introduces improvement for method to solve the measuring problem, by using digital image processing, where the method introduced in [8], [12] are the starting point of using the digital image processing for measuring in the various fields.
The idea of this paper is to make integrated system for a computerized measuring in the various fields based on the digital image processing, reduces the need of the user to be at the site for measuring every length.

2. RECENT DEVICES

This section states some of most important and recent devices used by civil engineering for measuring the lengths, areas and volumes [12]:

1) Total station device: is using for survey to find horizontal and vertical angles, heights and distances. This device uses signal and need to use reflector for each point. There are many types of this device the recent one supplied with Global Positioning System (GPS) which need to connect with the satellite; there is another type replaces the reflector with Bluetooth system. This device can connect to the computer.
2) Laser distancemeter: this new device is used laser to measure length. It is very simple and easy to use in the site comparing with traditional methods, but it needs the civil engineer to be at the site and measure every length needed to calculate the lengths, areas and volumes. The device after entering all needed length calculates the needed length or area or volume.

3. COMPONENTS OF THE PROPOSED SYSTEM

The System is composed from two components: the first is the hardware which represented by the device and the second is the software which represented by the algorithm of the measuring. The two components are detailed as follows:

3.1. Hardware Part

The device is modified from the device in the paper[8]and its frame made from metal, there are two parallel sources of circular laser beam fixed in the frame at distance 26 cm between them, in the middle of the frame there is a digital camera, as shown in the Figures (1,2,3).

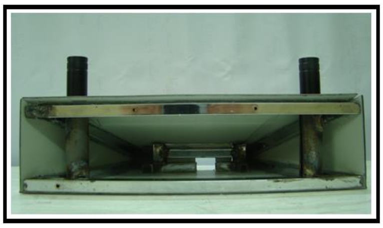

Figure 1. Bottom view of the device

Figure 2. Front view of the device

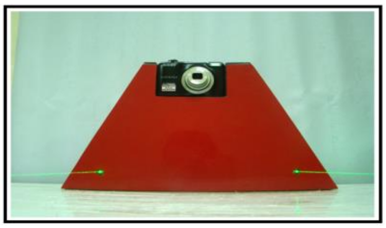

Figure 3. Top view of the device

3.2. Software Part

The software is modified from the software in the paper [12]. To measure or calculate the object dimensions and/or area and/or volume in an image it should at first the scale be known, which will be found by the system.

The algorithm of finding the scale needs to find the center of the two light points (circles) that applied on the object in the image, to do that, Point Search Circle Detection Algorithm (PSCD) used to find the circles. Then apply the steps of the measuring. See Figure 4.

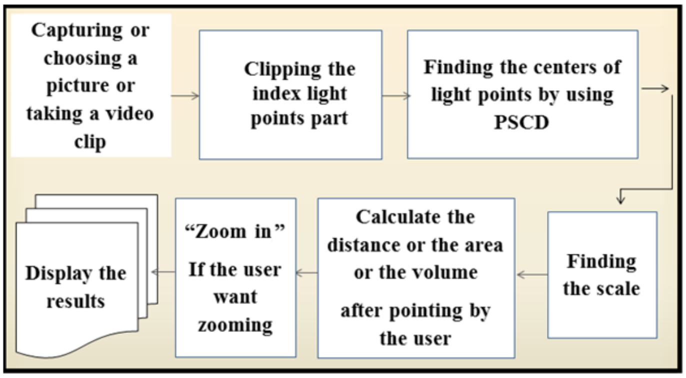

Figure 4. Block diagram for the measuring system

3.2.1 Point Search Circle Detection Algorithm (PSCD)

Point search circle detection algorithm (PSCD) is used to find the centers of light points. This algorithm [12], [13] is used after made some modification:

1) Begin
2) Begin scanning pixel by pixel horizontally from upper left side of the image line by line until finding an illuminated pixel and consider it as (P1).
3) Begin scanning pixel by pixel vertically from P1(X1, Y1) until finding an illuminated pixel, if this pixel is exist, it will consider as P2(X2, Y2).
4) Find the distance (d) between (P1&P2) which represents the diameter of the circle and then find the radius (r). see the following equations:

$$d= SQR\ (\ (X1 - X2)^2 + (Y1 + Y2)^2\ ) \tag{1}$$

$$r=d/2 \tag{2}$$

5) Find the coordinates of the center of circle (Xc, Yc). See Figure 5, because of X2=X1 therfore Xc=X1, Yc=Y1+r.

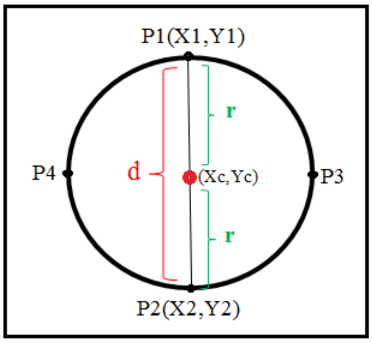

Figure 5. The points on the circle perimeter

6) Begin search about P3(Xc+r, Yc) and P4(Xc-r,Yc). If P3 or P4 is exist, then the circle (r,Xc, Yc) is detected.
7) Remove the detected circle to make the process of finding the second circle easier.
8) Repeat steps (1-6) to detect the center of the second circle.

3.2.2 Calculation Steps Measuring

To measure an object dimensions or areas or volumes in any image apply the following steps:

1) Capturing a picture for the elevation or taking a video clip.
2) Converting the chosen image to HSV system.

3) Clip part of image that contains the index light points.
4) Converting the image to the binary system by using threshold range for green laser light, (0.0-0.48) for hue, (0.0-0.42) for saturation and (1.00-0.89) for value.
5) Apply thinning process to eliminate the unwanted points.
6) Finding center's coordinates for both circles by using the modified point search circle detection algorithm.
7) Finding the scale by using the following steps:
   a) Find the distance between the two index light points in the image *(ImageLightDistance)* by using equation (1).
   b) Find the scale by using the following equation:

$$Scale = ImageLightDistance \,/\, ActualLightDistance \tag{3}$$

   Where: *ActualLightDistance* =26 represents the real distance between the two beams in the device frame.

8) Pointing the distance or the area or the volume on the original image by using the mouse and the curser.
9) Choosing addition or subtraction operation for new distance or new area or new volume with that result in step (8).
10) Printing the value of the final result.
11) Repeating steps (8, 9) in case of other measuring.
12) End.

4. IMPLEMENTATION STEPS

This section illustrates how the system works, as in the following steps:

1) Figure 6 represents the new interface of the system (main interfaces).

Figure 6. Main interface screen

2) Choosing either "Open Image" icon and then choose an image, or "Open Video" icon and then choose a video.
3) The system will find the scale to determine the scale and the result will print on the right part of the main interface screen. See Figure 7.
4) To measure a specific distance or area in the image click "Find Distance" for distances, or click "Find Area" icon to find areas, then the cursor will appear with the X and Y coordinates to determine and point the beginning point and opposite point on the image, the result will print on the main interface screen in addition to store it in the "History" screen which shows the previous results. See Figure 8.
5) To find the volume, click "Find Volume" icon, then the user points an area, after that the system will request from the user to choose another scene that should be overlab with the previous scene to point line in this new scene. The system will find the area from the first scene and multiply it with the length of the line from the second scene to produce the volume.
6) To add or subtract any distance or area or volume from other use (+) or (-) icon then (=) icon.

7) In case of choosing video use "Play/Pause" icon to play or pause the video, ">>" and "<<" icons for moving forward and backward 10 frames and ">","<" icon for moving 1 frame.
8) "Zoom" icon is using for zooming in, the system will implement the algorithm in the section "zoom in operation".
9) To choose an image from a video, click pause on the chosen image. Then do step (4).

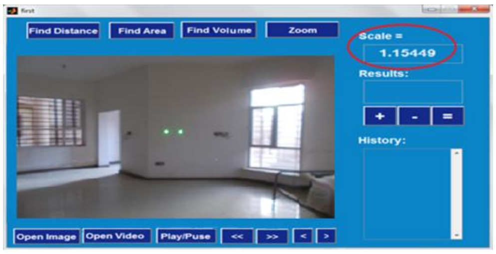

Figure 7. The Position of Scale

Figure 8. Positions of Results

5. ZOOM IN OPERATION

The zoom in operation that it uses in this paper is very simple method. It uses mask with size 3×3, where each pixel in the image will become 3×3 pixels in the magnified image, therefore the ration of zooming is 3:1, See Figure 9.

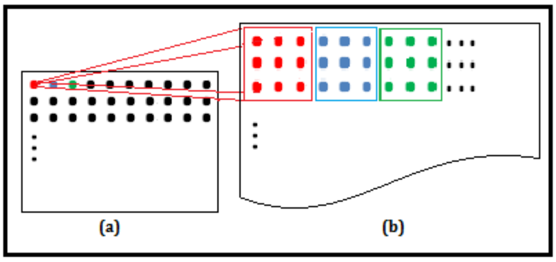

Figure 9. (a) The original image. (b) The image after zooming

If the user clicks "zoom" icon, the system will apply the following steps:
Step1 : Finding the scale.
Step2 : Magnifying the image.
Step3 : Save the number of times for zoom in (NoZ) that the user made it.
Step4 : Give value for the zooming operator (Z) according to the following equation.

$$Z=NoZ \times 3 \tag{4}$$

Where: 3 is the ratio of the zoom in operation.
Step5 : The user chooses one of the icons ("Find Distance", "Find Area", "Find Volume"), then pointing the points on the image.
Step6 : The system will modify position of each chosen point as shown in the section "Modifying the position".
Step7 : The system will find the distance according to the following equations:

a) Find the distance after zooming (DaZ) = distance between two modified points according to the equation (1).
b) Find the Real distance by using equation (5).

$$Real\ distance = DaZ\ /\ Z \tag{5}$$

Step8 : Repeat step 7 for each dimension was pointed by the user.

Step9 : The system will calculate the area or volume, if the user chose icons ("Find Area" or "Find Volume").
Step10 : Displaying the results.

6. MODIFYING THE POSITION

Each point is pointed by the user will be corrected to the center of the mask. See Figure(10). Where each point will compared with its 4-Neighbores, see Figure (11).

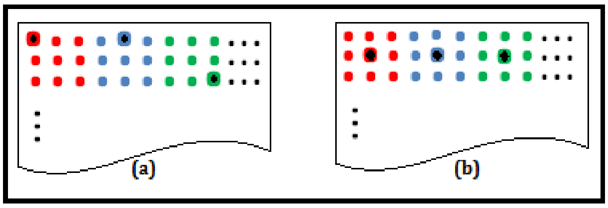

Figure 10. (a) The points were pointed by the user (b) The points after modifying operation

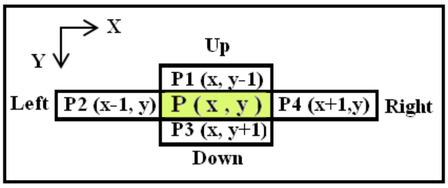

Figure 11. 4- Neighbors

The steps of modifying are:
1) Comparing the point (P which represents the point was pointed by the user) with the up neighbor (P1). If P=P1 then the point P will be kept at the same position (same coordinate), otherwise P will be moved to down by one position.
2) Comparing the output point from step1 (P) with the left neighbor (P2). If P=P2 then the point P will be kept at the same coordinate, otherwise P will be moved to right by one position.
3) Comparing the output point from step2 (P) with the down neighbor (P3). If P=P3 then the point P will be kept at the same coordinate, otherwise P will be moved to up by one position.
4) Comparing the output point from step3 (P) with the right neighbor (P4). If P=P4 then the point P will be kept at the same coordinate, otherwise P will be moved to left by one position.
5) The output point from step4 (P) is the new position for pointed point.
6) Repeat the steps (1-4) for each point was pointed by the user.

7. COMPARISION

Suppose V1 is the first version for the system in paper [12] and V2 is the new version for the system in this paper.
1) The system in V2 is using to determine the lengths and areas and volumes, while V1 was used to determine the lengths and areas only.
2) The scale in V2 is found automatically by the system. While in V1 the user will click "Find scale" icon to find the scale.
3) The zoom in operation in V2 system is improved to give ability to magnify the image many times, pointing the points on the magnified image and modifying the point position which pointing by the user to give more accuracy. While the zoom in operation in V1 is very simple without any process

8. APPLICATIVE EXAMPLE

The determinate of the work is that the two index lights should applied perpendicularly (in 90˚ angle) on the part or the wall that want to measure. The applicative example in this section is for a scene in interior part in a building to measure the area of the wall that the two index points are applied on it, see Figure 12.

The system implementation steps are:

1. Clip the part of image that holds the two index light points. See Figure 13.
2. Convert the image from HSV to binary. See Figure 14.
3. Apply thinning process to get the perimeter of the index light points.
4. Applying PSCD algorithm to find the centers coordinates of the index light circle.

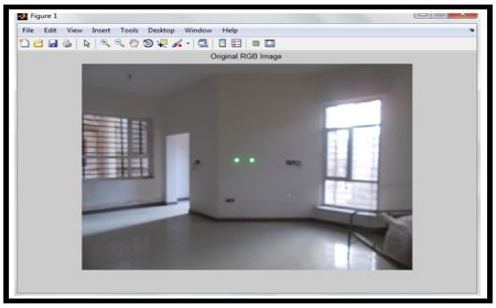

Figure 12. Interior scene in a building

Figure 13. Image of index light part

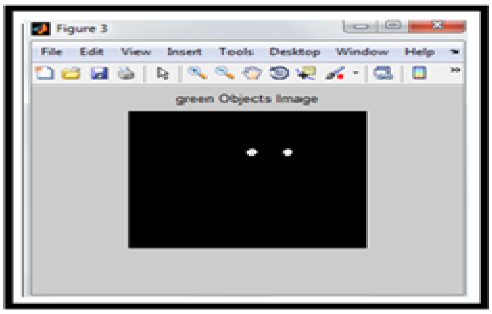

Figure 14. Binary image

5. Finding the scale by dividing the distance between the centers of the two index light circles in the image by the actual distance between the sources of the index light.
6. Pointing the first corner of the wall by the mouse and then pointing the second diagonally opposite corner of the wall in the image on the screen.
7. The result will printed on the chosen area in the image, as shown in Figure15.

Figure 15. Printing the result

9. THE FEATURES OF THE DEVICE AND THE SYSTEM

The following features are main advantages of the device and the system:
1) The device is very simple hand help easy to use without appendices parts, easy to carry.
2) It does need neither connection nor reflectors nor labors like traditional methods.
3) Using the device and the system is not difficult (the system is not complex) but contrary is very easy and there is no need to much effort for training.
4) The device and the system is low cost.
5) Comparing the results with the actual, the system gave very accurate results.
6) The system could be used in the different fields, such as study of plants, animals , civil engineering field, take the measurements to measure the glass to make the doors or windows.

10. CONCLUSION

1) From study of devices that used in civil engineering measuring field discern that there is no device used for measuring without need to be at the site for long time and measure each dimension individually by the measuring team. The best exist one is laser distancemeter device but it is also needs to be at the site for long time to measure every needed length, while the proposed system in this paper needs to be in the site for few time just to capture some pictures for each view or for each object in the building, then the measuring operation will be done, at the office quickly, accurately, reliability, easily and no need for site.
2) The purpose of the zoom in operation is to make facility for the user to point the border points of the objects in the image easily and accurately. While the purpose of the modifying the point position is to increase the accuracy of position of the pointed point. Therefore the mask 4-neighbors are sufficient for modifying the position whatever the number of zooming times.
3) It can use the images with the results in the documentation of the measuring.

FUTURE WORK AND RECOMMENDATIONS

We suggest making the system more perfect by connecting the measuring results with bill of quantities in Microsoft Excel program or any other accounting program, to make tenders.

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BIOGRAPHY OF AUTHOR

Sundus Khaleel Ebraheem received her B.Sc. 1996 in computer sciences and received her M.Sc. degree 2001 in computer Sciences field of image processing from university of Mosul. She is currently working as lecturer in Computer Sciences and Mathematics College in University of Mosul. She has 13 years experience in teaching field and has 17 published research papers in various scientific journals.