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# Digital Image Processing based Surface Area Calculation

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***Abstract:** The objective of current work is nondestructive measurement of surface area of regular or irregular shape just from image. Surface area calculation is mathematical part which needs to remember number of formulas and all for regular shape. It becomes more tedious if the shape whose area is to be calculated is irregular. In some cases such as mountain or lake measurement of dimension is also cumbersome task. To find the solution for such cases in today's world of automation, the proposed work describes reference object based area calculation system which is based on different techniques of digital image processing. In this we have to click an image of object (whose area is to be calculated) along with one reference object with known surface area. Then the proposed system will perform image enhancement and segmentation operation and finally calculate the surface area of any 2-D surface. It is observed that the values obtained are having with good correlation with actual surface area values.*

***Keywords:** Digital Image Processing, Image Segmentation, Matlab, Surface area.*

## I. INTRODUCTION

Surface area calculation is needed in many cases of day today's life mainly in case of cost estimation. In various fields such as building construction, painting, furniture etc. such regular work as well as performing many task in agriculture field such as packaging, transportation, water adsorption/desorption, heat, pesticides etc. needs surface area calculation. [1]. Many other businesses also rely on the concept of surface area. If the surface whose area is to be calculated is regular shapes such as circle, square, triangle, rectangle etc. then fixed formulas are available which can be used directly but needs to be remembered. This also requires the length measurement of specific parameter which is used in formula. The different formulas used are;

| | |
|---|---|
| Square | = side$^2$ |
| Rectangle | = length × width |
| Parallelogram | = base × height |
| Triangle | = base × height / 2 |
| Regular n-polygon | = (1/4) × n × side$^2$ × cot (pi/n) |
| Trapezoid | = height × (base1 + base2) / 2 |
| Circle | = pi × radius$^2$ |
| Ellipse | = pi × radius1 × radius2 |
| Cube (surface) | = 6 × side$^2$ |

In case of irregular shape, the task is more tedious as no any direct formula can be applied to it.
The traditional way to calculate the area of irregular shape includes following steps.

i. Subdivide the irregular shape into number of regular shape such as square, triangle.
ii. Calculate the area of each regular shape separately using formulas.
iii. Add the area of all regular shape to get area of complete irregular shape.

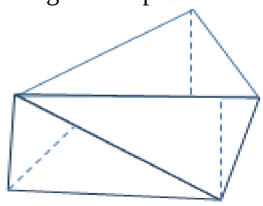

**Fig 1 Irregular shape subdivided into regular shapes**

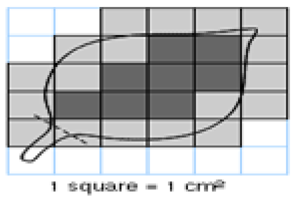


**Fig 2 Area calculation of irregular shape [2]**

But doing all these things is time consuming and may have human error. Now a days rapid and non-destructive techniques for measurement of physical attributes such as density, surface area, surface roughness, volume is preferred for size sorting, quality grading etc. Machine vision and image processing techniques are found more useful for this purpose. [3]. It provides accuracy, speed, simultaneous data collection and analysis as well as being noncontact and nondestructive it provides less disturbance to the physical state of object [4].

Brent Baker, David M. Olszyk and David Tinge stated that Digital Image processing technique with reference may provide a valuable tool for estimating leaf area nondestructively [5].

Rehan Adil and Sarah Jamal Khan developed a prototype of surface area measurement system for leather sheet placed on conveyer belt based on image processing and Bersoft image measurement software [6,7].

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Hsien Ming Easlon and Arnold J. Bloom used the color ratios of each pixel to distinguish leaves and calibration area from their background and compares leaf pixel counts to a red calibration area to eliminate the need for camera distance calculations or manual ruler scale measurement. They also stated that the calibration area should be kept in the same plane as the leaves to avoid perspective distortion. Leaf area and calibration area should also be located in similar regions of the image to minimize errors from lens distortion. [8].
C. M. Sabliov, D. Boldor, K. M. Keener & B. E. Farkas developed method for determination of surface area and volume of axisymmetric agricultural products using machine vision and image processing and stated that more accuracy can be obtained than the traditional methods such as tape method for area calculation [9].
Zhichen Li, Changying Ji, Jicheng Liu used digital image processing for calculation of leaf area relative to the rectangular paper sheet on which leaf is to be placed for image acquisition [10].

## II. MATERIALS AND METHODS

The proposed system is as shown in Fig 3.

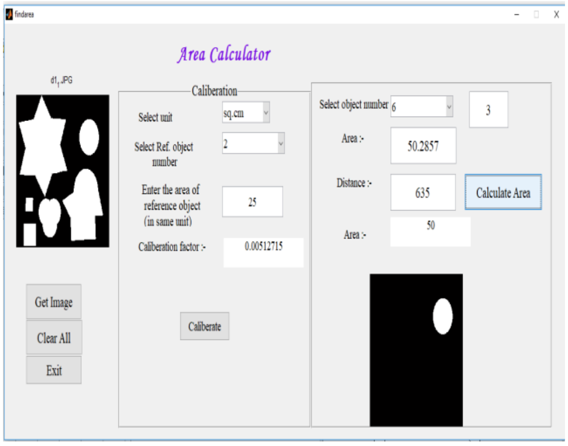



**Fig 3Proposed System**

In the proposed system, initially for easier cross evaluation of result we have started the work by designing some regular shapes such as square, circle, triangle, rectangle etc. for which fixed formulas are available to get the area value. In this properly scaled shapes are designed and their surface area has been calculated. Such 4-5 shapes are arranged on a sheet as shown in Fig 4.

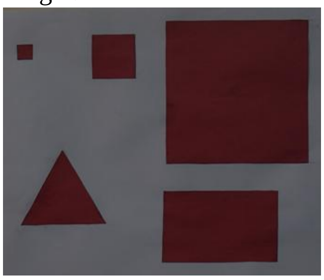


**Fig 4 Sample Shapes-Regular**

Then the images were captured with Nikon D5300 24.2MPcamera having resolution 6000*4000 and focal length 300mm arranged on a tripod with fixed height of 150 cm and camera focus exactly perpendicular to the plane of object and centrally focused. The acquired images were then stored to laptop and feed to the proposed system developed in Matlab R2013a (8.0.1.604). System converts the image into black and white with threshold value obtained by gray thresholding so as to separate the object from background and then some preprocessing operations performed. After specifying the reference object and entering the area of reference object in real unit system will find the calibration factor and calculate the area of said object in same unit. When proper match between system calculated and actual are of regular shape is found, then number of irregular shapes were designed from combination of regular shapes as shown in Fig 5.

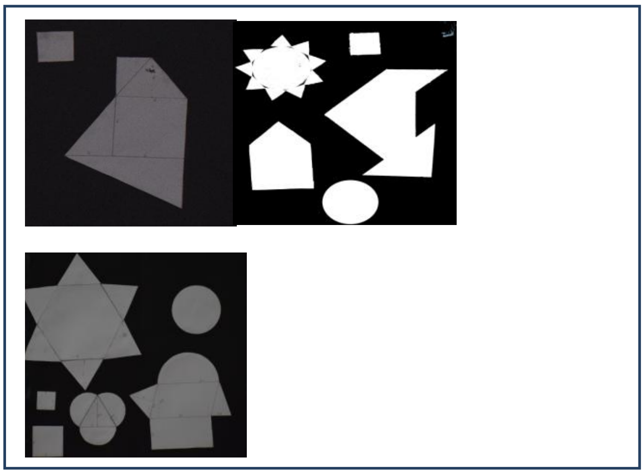


**Fig 5 Different samples of Irregular shapes**

The same process of thresholding based segmentation is applied to irregular shapes, a regular shape is considered as reference object and area of different irregular shapes is observed. As a next step a group of 4-5 irregular shapes collected on drawing sheet are considered for studying the effect of distance on the area calculation. This sheet is fixed on the board and the Nikon D5300 24.2MP camera having resolution 6000*4000 and focal length 300mm arranged on a tripod with fixed height of 150 cm and camera focus exactly perpendicular to the plane of object and centrally focused. Keeping all these things constant, only the distance between object and camera is changed every time by equal interval of 10 feet. Different set of images(as shown in Fig 6) were obtained by just increasing the distance between object and camera setup while remaining things were kept constant. These images were then stored to laptop and feed to the proposed system developed in Matlab R2013a (8.0.1.604).

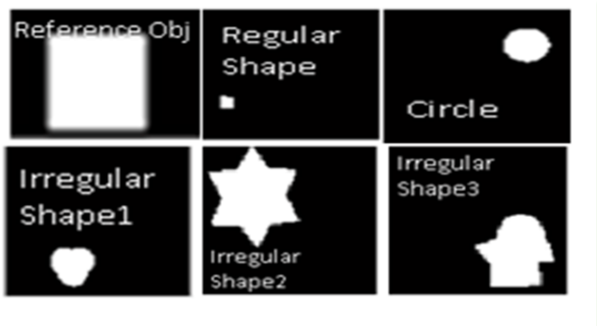



**Fig 6 Individual Shapes after Image Segmentation**

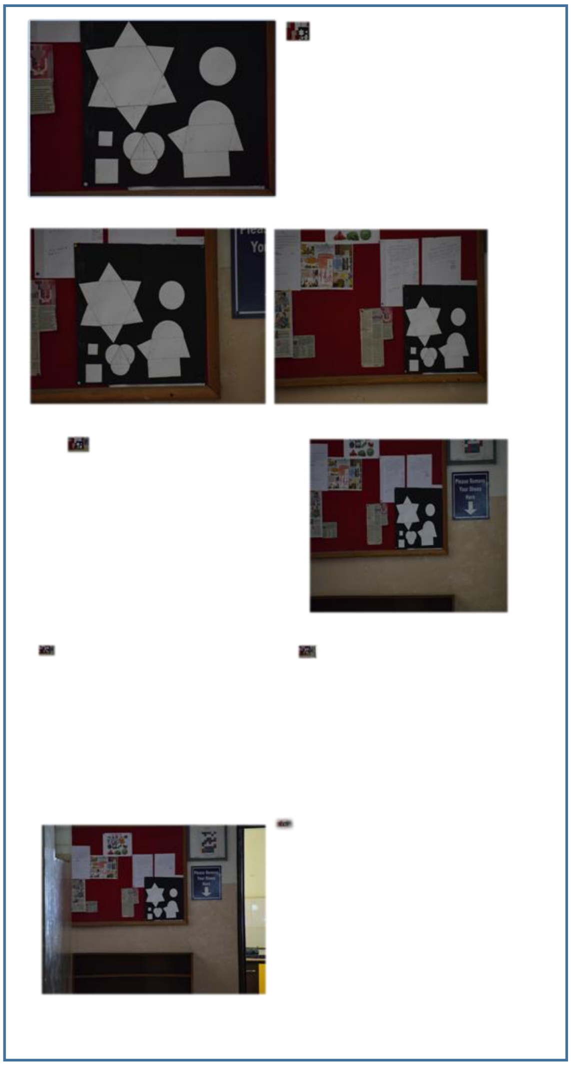


**Fig 6 Images captured by varying distance between object and camera**

The proposed system converts the image into black and white with threshold value obtained by gray level thresholding so as to separate the object from background for further operations. The image after threshold based segmentation is as shown in Fig 7. Then operations such as border clearing, filtering was performed for image enhancement. Labeling is also done just to refer different object separately .After specifying the reference object and entering the area of reference object in real unit system will find the calibration factor and calculate the area of said object in same unit. Slight deviations in the reading are due to paper cutting errors at the border of object. But overall it is observed that distance factor does not affect the actual area calculation.

## III. RESULT AND DISCUSSION

The results obtained are studied in two different points of view.

**3.1.** Initially readings are observed in case of regular shapes such as square, circle, triangle, rectangle etc. and then for irregular shapes which are formed by combination of these regular shapes. The obtained results are tabulated as shown in table 1.

**Table 1 Readings for regular and irregular shape**

| Sr. No | Shape | Actual area | System calculated Area |
|---|---|---|---|
| 1 | Square | 9 | 7.9396 |
| 2 | Square1 | 25 | 25 |
| 3 | Triangle | 15.6 | 15.0511 |
| 4 | Rectangle | 40 | 38.12 |
| 5 | Large square | 100 | 94.6401 |
| 6 | Irr_obj1 | 45 | 44.191 |
| 7 | Irr_obj2 | 96.75 | 93.8293 |
| 8 | Sun | 39.0278 | 41.6477 |
| 9 | Irr_obj3 | 91 | 91.9302 |
| 10 | Circle | 50.2857 | 50 |
| 11 | Irr_obj4 | 58.0286 | 58.6136 |
| 12 | Star | 232.31 | 240.8685 |
| 13 | Irr_obj5 | 164.9607 | 167.6527 |

The system calculated area values obtained for various regular and irregular objects are compared along with its actual manual area values obtained from mathematical formulas. A graph is then plotted among those values as given in Fig 8. It is observed that system calculated values are showing good correlation with actual values.

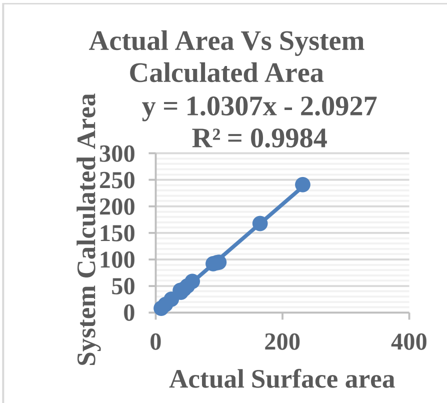
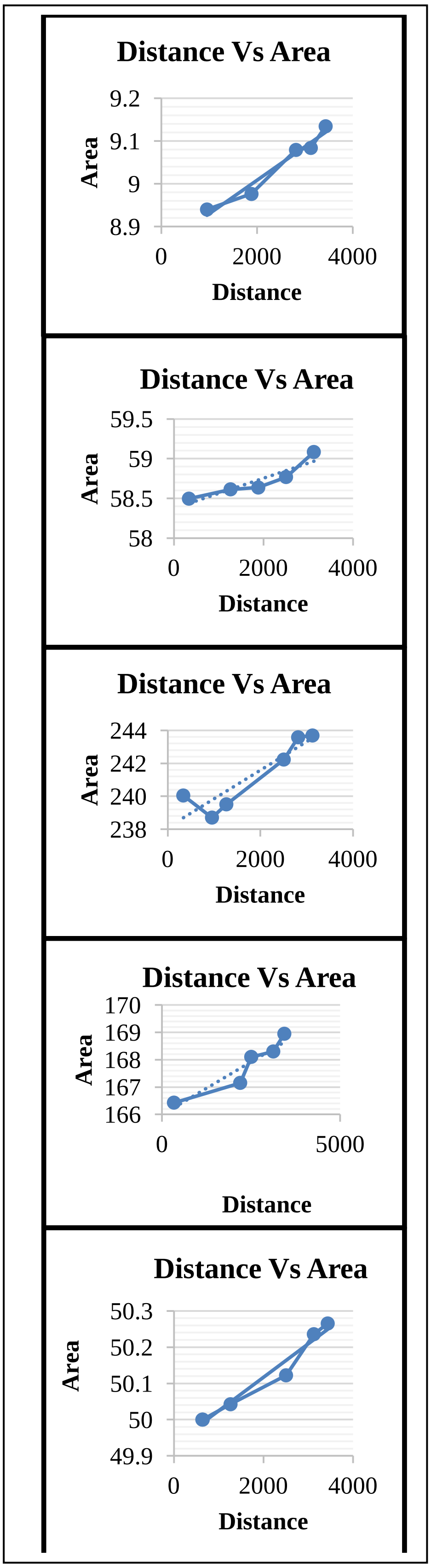



**Fig 6 Graph of Actual Area Vs System Calculated Area**

**3.2.** In the next step images of fixed 4-5 objects were captured from different twelve distances with fixed focal length and height. These values fordifferentobject are plotted separately against the distance between camera and object. The following graphs are obtained from which we can say that distance parameter does not influence the system calculated area values.




## IV. CONCLUSION

The above readings and graph shows that the proposed system is showing good corelation with the actual area values for regular as well as irregular shaped objects. Thus we can use it for area calculation.It alsoclearifies that the distance factor does not affect the accuracy of result. Thus it can be used for surfacearea calculation of irregular shapeand the onlycondition is the image should contain one object with priorly known area.

## REFERENCES


1. Omid Omidi Arjenaki, Asad Moddares Motlagh, Parviz Ahmadi Moghaddam, A New Method for Estimating Surface Area of Cylindrical Fruits (Zucchini) Using Digital Image Processing, AJCS 6(9):1332-1336 (2012) Issn:1835-2707
2. Pearson-the Biology Place, Pearson Education.
3. M. Khojastehnazhand, M. Omid and A. Tabatabaeefar, Determination of Orange Volume and Surface Area Using Image Processing Technique, Nt. Agrophysics, 2009, 23, 237-242
4. N.H. Furness, A. Upadhyaya, And M.K. Upadhyaya, Comparison of Three Nondestructive Methods for Determination of Vegetable Surface Area, Hortscience 37(3):550–553. 2002.
5. Brent Baker, David M. Olszyk, And David Tinge, Digital Image Analysis to Estimate Leaf Area, J. Plant Physiol. Vtj/. 148. Pp. 530-535 (996)
6. Rehan Adil and Sarah Jamal Khan, Surface Area Measurement of Leather System Based Image Processing Techniques Applied to The Automation Application 2010 The 3rd International Conference On Machine Vision (ICMV 2010)
7. Rehan Adil and Sarah Jamal Khan, Design and Development of LED Based Irregular Leather Area Measuring Machine, Proc. of SPIE Vol. 8349 83490G-2
8. Hsien Ming Easlon 2,3 And Arnold J. Bloom 2, Easy Leaf Area: Automated Digital Image Analysis for Rapid and Accurate Measurement of Leaf Area 1, Applications in Plant Sciences 2014 2 (7): 1400033
9. C. M. Sabliov, D. Boldor, K. M. Keener & B. E. Farkas, Image Processing Method to Determine Surface Area and Volume of Axi-Symmetric Agricultural Products, International Journal of Food Properties Vol. 5, No. 3, Pp. 641–653, 2002
10. Li, Z., Ji, C. and Liu, J., 2008, Leaf Area Calculating Based On Digital Image, in IFIP International Federation for Information Processing, Volume 259; Computer and Computing Technologies in Agriculture, Vol. 2; Daoliang Li; (Boston: Springer), pp. 1427–1433.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