ACTA AGRICULTURAE SERBICA

original scientific paper

The „Surface and Distance Measuring" Program

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Abstract: The "Surface and Distance Measuring" program is presented in this paper. The values of polygon surfaces and distances between the desired macro and micro objects are obtained by this program, using the computer-graphic methods.

Key words: surfaces, computer-graphic (CG) methods, polygons

Introduction

Computer-graphic methods are also applied in biotechnical sciences. Up to now, the planimeter and curvimeter mechanical instruments have been mostly used for measuring the values of surfaces and lengths, i.e. distances and analytical methods have been rarely applied. Despite the positive sides and usability of the mentioned methods, by the application of computer-graphic methods, in this case, more concretely, by the application of the "Surface and Distance" program, the measuring speed has been considerably increased compared to the analytical methods of the polygon surfaces measuring and the precision of the obtained results is higher than that obtained by the use of planimeter and curvimeter mechanical instruments.

Material and Method

This program is written in the *Borland Delphi* program language under the *Windows* operating system. The principle of the calculation of surfaces is based on the calculation of polygon surface by the formula:

$$P = \sum_{i=1}^{n} x_i y_{i-1} - x_{i-1} y_i$$

where: n - is the number of the polygon corners

x_i, y_i - are coordinates of the polygon corners ($x_0 = x_n$; $y_0 = y_n$);

Because of its scope, the program is not presented here in its entirety. Only a small part of the listing, which shows the principle of the line length calculation, as well as the polygon surface calculation is presented.

Results and Discussion

The data obtained by the *"Surface and Distance"* program were compared to those obtained by means of the planimeter and curvimeter *mechanical instruments, analytically,* by calculating the polygon surfaces, as well as by comparing the values obtained by *microscoping,* in a classical way by means of the objective and ocular micrometers.

The values of surfaces and distances obtained by the "Surface and Distance" program are identical to the results obtained *analytically,* while the reading of coordinates as well as the later calculation by the formula is up to several dozens of times faster compared to the analytical method, depending on the number of corners, which points to the advantages of the CG-method use, as regards the speed and efficiency of work.

In most cases, the "real" surface cannot be measured by means of *mechanical instruments.* During the process of work, an incorrect surface is unconsciously measured, due to the deviation of mechanical instruments from desired direction. There were, therefore, minimal deviations in results compared to the previous two methods, the computer-graphic and analytical ones, which pointed out the advantages of the CG method application, as regards the precision and accuracy of the obtained results.

The CG method application may also lead to deviations from desired direction. Depending on the demands, the tolerance threshold should be introduced, by which, in an experimental or some other way, the conclusions as to whether the appropriate surface is calculated in a satisfactory way will be drawn.

The measuring, i.e. the "covering" of the route by the cursor trail is mostly satisfactory, because deviations may occur in some parts of the route. The program enables simple corrections in the part with incorrectly noted "trail".

The shrinking of maps is one of the problems, occurring during the use of the mentioned mechanical instruments. When the measuring on maps lasts longer than expected, the map becomes deformed, due to the drying of paper and it shrinks so that the measurings done in the beginning and at the end of the work are not identical. By the computer-graphic method, the map is scanned and saved at the beginning of work. The record about the size of the scanned surface in a digital form is the same at the beginning, during and at the end of work. Therefore, the shrinking, which occurred as a problem in previous methods, is avoided.

The program enables the loading of up to 1000 polygons, i.e. lines, with up to 4096 corners each. However, that possibiltiy is not used very often in practice, because it is not practical to simultaneously process too many elements in a clear way. Elements should be processed according to their similarity (set of all isohips, network of water currents with the I and II-class tributaries etc.).

...

```
For I:=1 to BrojLinija do
  With Linija [I]^ do
    Begin

        ( Izracunavanje duzine linije )

    Duzina:=0;
    For J:=2 to BrojTjemena do
      Duzina:=Duzina+Sqrt (Sqr (1.0*X [J]-X [J-1])+Sqr (1.0*Y [J]-Y [J-1]));

        ( Izracunavanje povrsine poligona )

    Povrsina:=0;
      ( . . . )
    If (X [1]=X [BrojTjemena]) and (Y [1]=Y [BrojTjemena]) then
      Begin
        For J:=2 to BrojTjemena do
          Povrsina:=Povrsina+1.0*X [J-1]*Y [J]-1.0*X [J]*Y [J-1];
        ( . . . )
      End;
    Povrsina:=Abs (Povrsina)/2

  End;
```
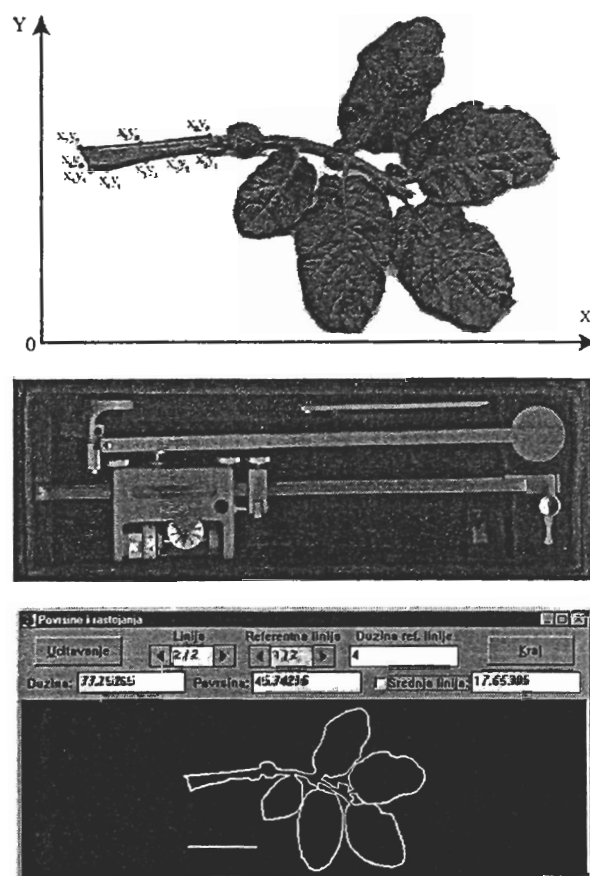
...

Fig. 1. Glavni Form

Fig. 2. «Surface and Distances« - Pro et contra calculation of surfaces - analiticaly, by planimeter and by «Surfaces and Distances« program

Another advantage of the CG-method is that the process of surfaces and distances measuring is at the same time the process of drawing, i.e. mapping (fig. 3).

At the end of each surface calculation, the map of elements is also obtained.

The advantage of this program over the programs that dealt with similar problems in other fields is that the "Surface and Distance" program is simple to use and does not require a high level of computer knowledge and can be, thus, widely applied. This is because this program has been, in a very short time, aplied not only in the field of soil and water conservation (Spalevic, 1999; Popovic et al., 1999; Fustic, 2000), but in other fields as well, e.g. for drainage, for determining the surfaces of soils endangered by superfluous waters (Knezevic, 2000), for leaf area and nerve length calculation (Maras Vesna, 2000; Rakocevic Jelena, 2000), in field crop growing for determining the skin thickness and eye depth (fig. 4) in potato (Jovovic, 1999, 2000), in forestry - for

determining the surfaces of areas, measured from the situational plan (Durovic et al., 1999), in medicine, for measuring the petechia surface and erosion of stretched stomach of mice, as well as for the measuring of surfaces and cross sections of microscoped objects (fig. 5) (Milin et al., 2000; Rakocevic Jelena, 2000). It is also used in other examples of CG planimetry.
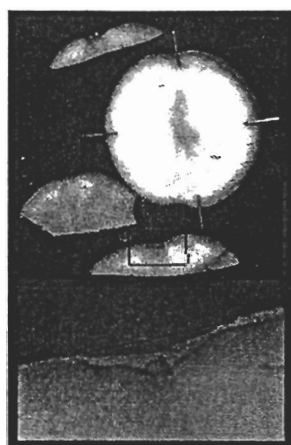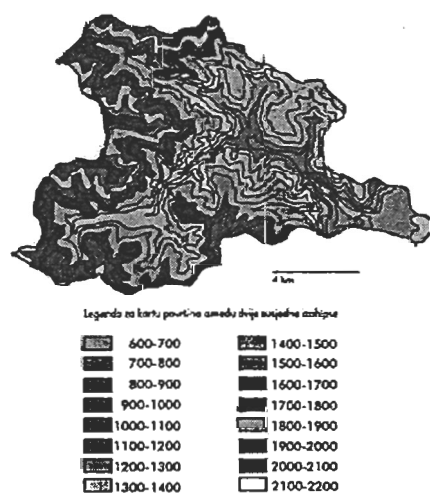

Legenda za kartu povrtine amedu dvije susjedne ezhipsa

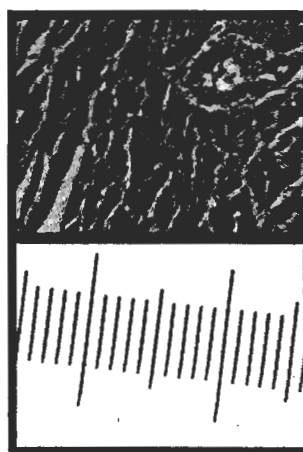|			
600-700		1400-1500
700-800		1500-1600
800-900		1600-1700
900-1000		1700-1800
1000-1100		1800-1900
1100-1200		1900-2000
1200-1300		2000-2100
1300-1400		2100-2200

Fig. 4. Determination of the eye depth in potato

Fig. 5. Calculation of surface of microscopes objects (muscular and connective heart tisse)

The program works in the following way:

Before the "Surface and Distance" program reads the values, it is necessary to copy the desired object in digital form to the computer's hard disc (to scan the map or microscope the object). On a scanned/microscoped part it is important to mark the familiar length based on which the program compares

lengths and surfaces. A reference line (a length scale line) should be simply dra-wn. In the microscopic measuring, a micrometer needs to be imported after the specimen under the same conditions (zooming).

The scanned/microscoped object is, then, imported into the *Corel Draw* program (*File/Import*).

When the object appears on the screen, polygons and lines are drawn by pencil (the *freehand* icon in *Corel Draw*).

In the surfaces calculation, the polygon needs to be enclosed, i.e. it is necessary to return to the beginning when moving around the border. If that is not the case, only the length value will be obtained.

The drawn picture is, then, exported (*File/Export*).

Two "windows" will appear on the screen - the one for the file name and the other for the file type (choose *.plt*).

After the first OK, another "window" will appear, then press OK. By activating the "Surface and Distance" program, surfaces and distances may be measured from the figure.
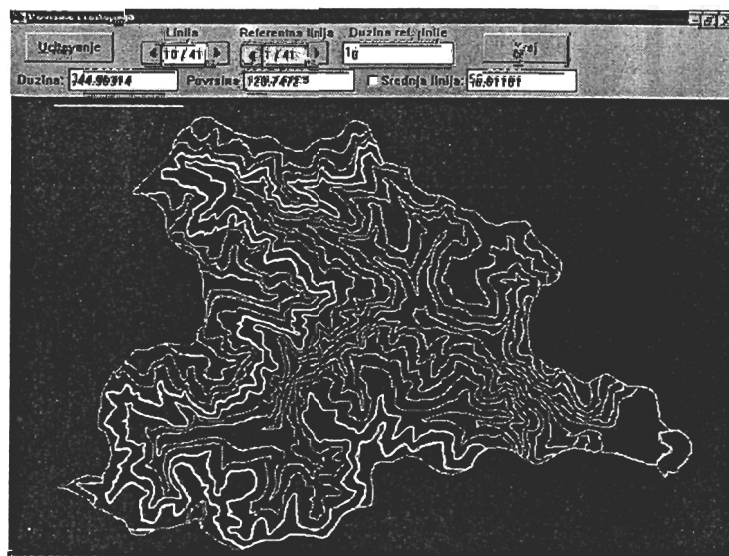

Fig. 4. "Surface and distance" mask of program

"Load" button opens a "window" in which *.plt file is selected from the hard disc. The line selector selects surfaces or lengths of lines. The selected line is colored yellow.

A reference line (scale line) is, then, selected by the selector and colored blue. If the measured line and scale line match, they will be colored green. The original length of line should be typed into the "Reference line lengths" field.

In the "Length", "Surface" and "Middle Line" fields, values for the line length (or the scope of a marked surface), surface and value of middle length of an object could be read.

In some cases, a line denoting middle length of an object-water basin should be drawn on the screen (turn off/on a "Middle Line" button).
After the values have been read, a new map or object can be loaded.
The "End" button obtains exit from the program.

Conclusion

Based on the obtained results, the following conclusions have been drawn:
- The "Surface and Distance" program, by which and applying the computer-graphic method, the polygon surfaces values and the values of distance between desired objects are obtained, is applied in biotechnical sciences. It can be used in the field of *soil and water conservation*, but also in other disciplines, where surfaces and distances are calculated, e.g. in *drainage*, for determining the surfaces of soils endangered by superfluous waters, for leaf area and nerve length calculation, in *field crop growing* for determining the skin thickness and eye depth in potato, in *forestry* - for determining the surfaces of areas measured from the situational plan, in *medicine and biology*, for the measuring of surfaces and cross sections of microscoped objects, as well as in other examples of CG planimetry.
- The program is very easy to use and does not require a high level of computer knowledge.
- The principle of surface calculation is based on the calculation of polygon surfaces.
- The advantage of the CG-method is that besides the calculation of surfaces and distances, it also enables the process of drawing, i.e. mapping.
- The "shrinking", which occurred as a problem during the classical methods of map using, no longer exists.
- The program enables the loading of up to 1000 polygons, i.e. lines, with up to 4096 corners each, which is not used very often in practice.
- The values of surfaces and distances obtained by the "Surface and Distance" program are identical to the results obtained analytically, while the reading of coordinates as well as the later calculation by the formula is up to several dozens of times faster than the analytical method, depending on the number of corners, which points to the advantages of the CG-method use, as regards the speed and efficiency of work.
- By the application of this CG method, the precision and accuracy of obtained results increased in comparison to the measuring by mechanical instruments.

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PROGRAM "POVRŠINE I RASTOJANJA"

-originalni naučni rad-

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Rezime

U radu je predstavljen program "Površine i rastojanja", pomoću koga se, primenom računarsko-grafičkih metoda, dobijaju vrednosti površina poligona i rastojanja između željenih makro i mikro objekata.

Program je rađen u programskom jeziku Borland Delphi pod Windows operativnim sistemom. Princip računanja površina se svodi na izračunavanje površine poligona po formuli:

$$P = \sum_{i=1}^{n} x_i y_{i-1} - x_{i-1} y_i$$

gde su: n-broj tretmana poligona
x_i, y_i - kordinate temena poligona ($x_o = x_n; y_o = y_n$)

Vrlo je jednostavan za korišćenje i ne zahteva visok nivo poznavanja rada na računaru, stoga je za vrlo kratko vreme našao primenu u oblasti biotehničkih nauka.

Primenom ovog programa, znatno je povećana brzina rada u odnosu na izračunavanje površine poligona analitičkim metodom, a preciznost dobijenih rezultata je veća u odnosu na korišćenje mehaničkih instrumenata planimetra i kurvimetra.