The 4th International Conference
"Advanced Composite Materials Engineering "
COMAT 2012
18- 20 October 2012, Brasov, Romania

INTERACTIVE AUTOLISP SOFTWARE FOR AUTOCAD MADE TO CALCULATE THE TOTAL SOLAR RADIATION DURING A DAY STARTING FROM LATITUDE AND LONGITUDE VALUES FOR A GIVEN POSITION

P. Vasiluta[1], N. Cofaru[1], D. L. Popa[2]
[1] University Lucian Blaga, Sibiu, ROMANIA, petrevasiluta@gmail.com, cofaru@ulbsibiu.ro
[2] University of Craiova, Craiova, ROMANIA, popadragoslaurentiu@yahoo.com

Abstract: *The mathematical model presented in this paper takes into account all these parameters, less than the quantity of vapor and dust in the atmosphere that has a random evolution. The mathematical model developed for the determination anytime and anywhere in the world for the next values and parameters: apparent solar time, solar declination, solar altitude, solar azimuth and incidence angle, zone angle, angle of sun elevation, solar declination, solar constant, solar flux density, diffuse solar radiation, global radiation, soil albedo, total radiant flux density and relational links of these values.*
Keywords: *solar radiation, mathematical model, geomembranes, AutoLISP, ecological landfill*

1. INTRODUCTION

In one minute the Sun produces enough energy to cover the annual energy needs worldwide and in one day produce more energy than the global energy needs for a period of 27 years.
Sun has a radius equal to 695,000 km and a volume of $1.42 \cdot 10^{18}$ km^3 and develops into space from the reaction of thermonuclear conversion of hydrogen into helium flow of radiant energy of $8.8 \cdot 10^{25}$ cal / sec . Since over 50% of the solar mass consists of hydrogen requires the same intensity of solar activity for another 5 billion years.
Approximately 90% of the energy generated by the Sun in its central part is transmitted to the surface and then radiated into space through a series of complex radioactive and convective emission processes, absorption and subsequent radiation of different wavelengths in the spectrum continuous or discontinuous [1].
The objective of this study is to develop a software, working in AutoCAD, which can determine the evolution and the level of the solar radiation during a day in every place on Earth.

2. AUTOLISP – A PROGRAMMING LANGUAGE FOR AUTOCAD APLICATIONS

To develop a computer program to calculate the total solar radiation the AutoLISP language was used for the following reasons:
- AutoLISP is a programming language that allows to write specific applications in AutoCAD;
- Allows access to core AutoCAD AutoLISP, so you can easily use coordinates, angles, coordinate systems;
- Permits any kind of calculus and the developed applications can make decisions.

Language LISP (List Processing) was created in the 1950s (John McCarthy - 1958), for the field of artificial intelligence. Its logical-mathematical model is based on the lambda calculus (developed in 1941 as a tool in the study of computability theory). AutoLISP is a dialect of the language XLISP (experimental LISP - David Betz). Autodesk chose the programming language LISP in AutoCAD for having the opportunity to work with lists. For example, the coordinates of a point are contained in a list. LISP can manipulate the structures as complex data structures that are built dynamically during program execution [3].
AutoCAD authors have found a way to associate the language with aided design system proposed by them because they looked to the multitude of languages and found that it fits best to the needs of such a system. What is wanted from the language in such a case is to allow the creation and manipulation of homogeneous

heterogeneous entities. They wanted to treat the unit as numbers and strings, geometric entities with this crowd. Easily reach the conclusion that all this can be included in the list on which you can do various processing (so LISt Processing). If it is added to the ease of implementation of the LISP language, recognized by everyone, it is found that, indeed, is a suitable language for computer aided design.
The major disadvantage is that it is a language unknown to the general public. Many programmers known, perhaps, BASIC, FORTRAN, PASCAL, COBOL, even C, but less LISP [4].

3. THE STAGES OF PROGRAM DEVELOPMENT

To develop the program, the next stages were followed:
- in AutoCAD is loaded a map of Romania that has been scaled using scale grid so that 1 unit is equal to 1 km (Figure 1);

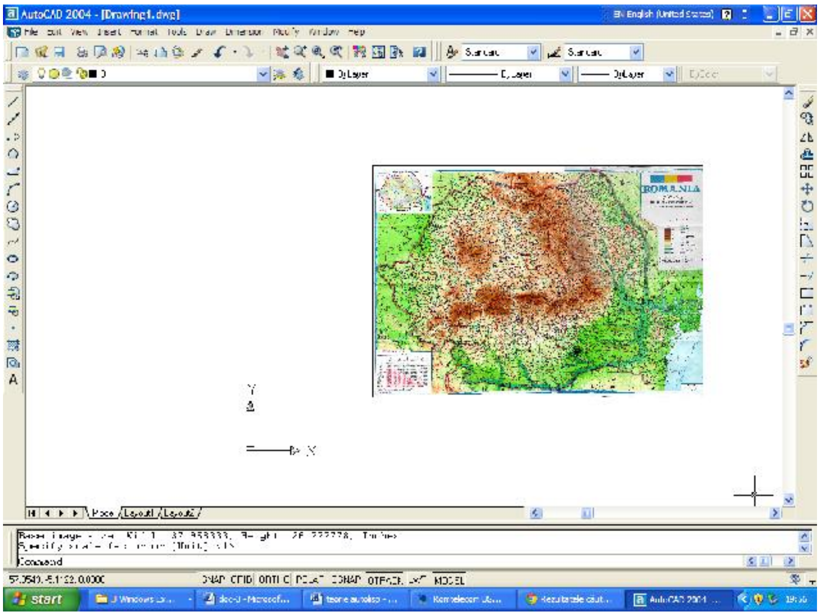

Figure 1: The Romania map imported to AutoCAD

- Over the map, the contour of the Romania map using PLINE command was drawn. This outline was processed turning straight lines into *Spline* segments (Figure 2);

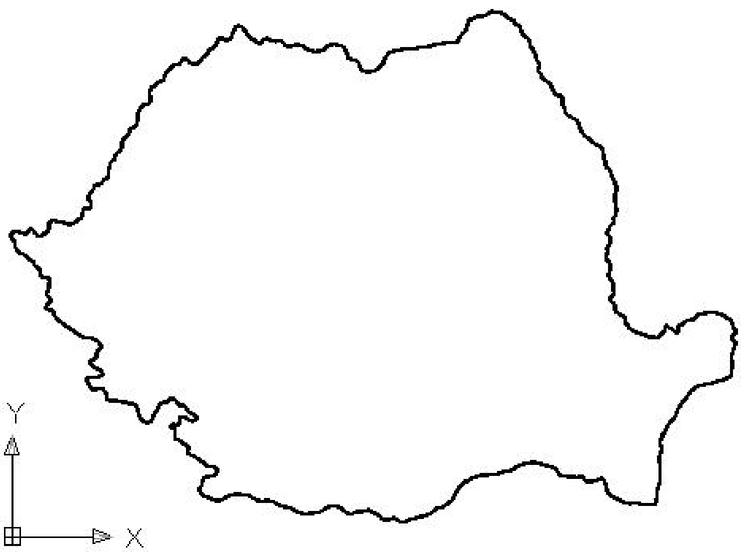

Figure 2: The drawing of the borders of the map and the approximation Spline curves

- Over contour map were drawn parallels and meridians approximated by straight lines and arcs (Figure 3);

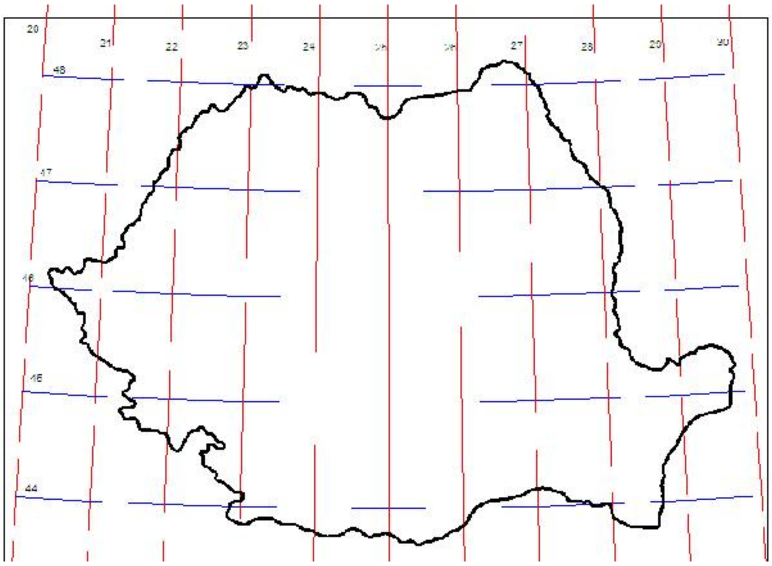

Figure 3: The drawing of the parallels and meridians

- At the intersection of meridians, approximated by straight lines was determined the geographic North Pole position (Figure 4);

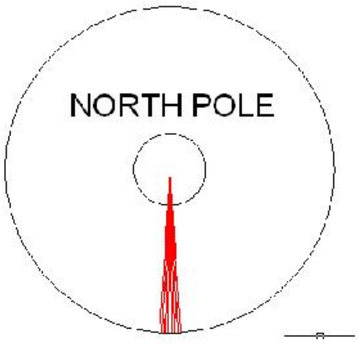

Figure 4: Determining the geographic North Pole

- On the virtual map the main cities were positioned (Figure 5);

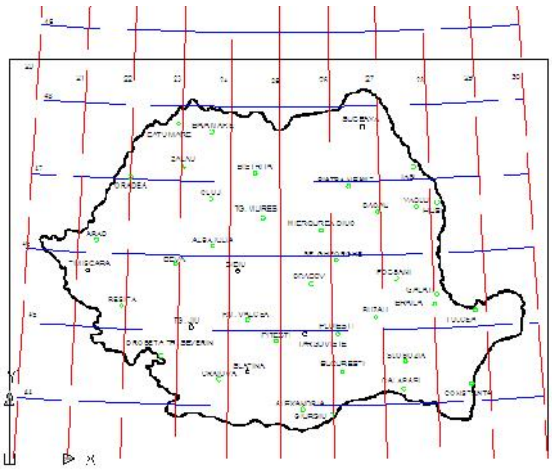

Figure 5: The main cities on the virtual map

- After the positioning of the main graphical entities core values, the important values necessary to write AutoLISP code were obtained:

  - Distance between two parallel on a meridian:

$\Delta r/°lat$ = 113.5399 km/°latitude

  - Value in geometrical degrees for a degree of longitude:

Δlong = 0.745 º / º longitude
From these two values and the reconstructed map in AutoCAD, following calculation subroutines were obtained:
a). a subroutine which, from the location given by latitude and longitude, the system determines the cartesian coordinates reported to the fixed coordinate system on the virtual map;
b). a subroutine that takes the coordinates of a location on the map and turn them into geographic coordinates expressed in degrees of latitude and longitude;
c). a subroutine that calculates the total solar radiation from latitude and longitude location and the date on which the calculation is made. This subroutine used a mathematical model for the total radiation which takes into account all parameters, less than the quantity of vapor and dust in the atmosphere that has a random evolution. The mathematical model developed for the determination anytime and anywhere in the world for the next values and parameters: apparent solar time, solar declination, solar altitude, solar azimuth and incidence angle, zone angle, angle of sun elevation, solar declination, solar constant, solar flux density, diffuse solar radiation, global radiation, soil albedo, total radiant flux density and relational links of these values [1], [2].
The core calculation was completed with the following subroutines:
- Code sequence of predefined locations calculation that calculates the total radiation for values x, z Cartesian values reported to the fixed coordinate system located in the lower left corner of the map;
- Code sequences for the determination of distances between two points on the maps or between a location and the geographic North Pole.
These subroutines are called from a pull-down menu stored in a .mnu file, which allows direct loading by displaying a custom menu shown in Figure 6.

Figure 6: The custom program menu for calculating total radiation

Also, the AutoCAD menu (acad.mnu file) was modified to allow direct access to the program for the calculation of total radiation by pressing CALCUL RADIATIE radio button (Figure 7).

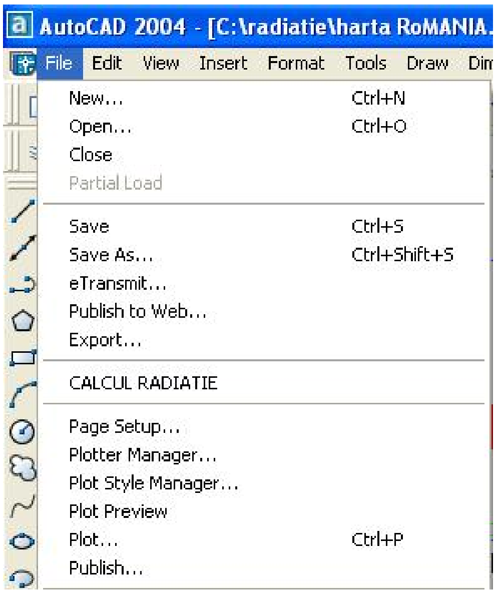

Figure 7: The modified AutoCAD menu

In Figure 8 was presented the menu HARTI which can access to the subroutines created in AutoLISP and direct functions in AutoCAD.

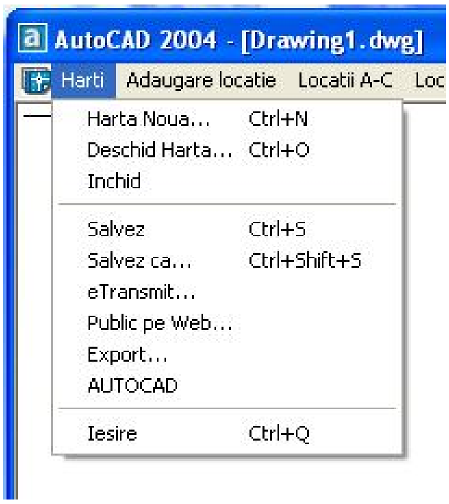

Figure 8: The submenu HARTI

The AutoLISP subroutines call and load different menu files recognized by AutoCAD. These files can add new locations, can use a predefined location or can calculate different distances (Figure 9).

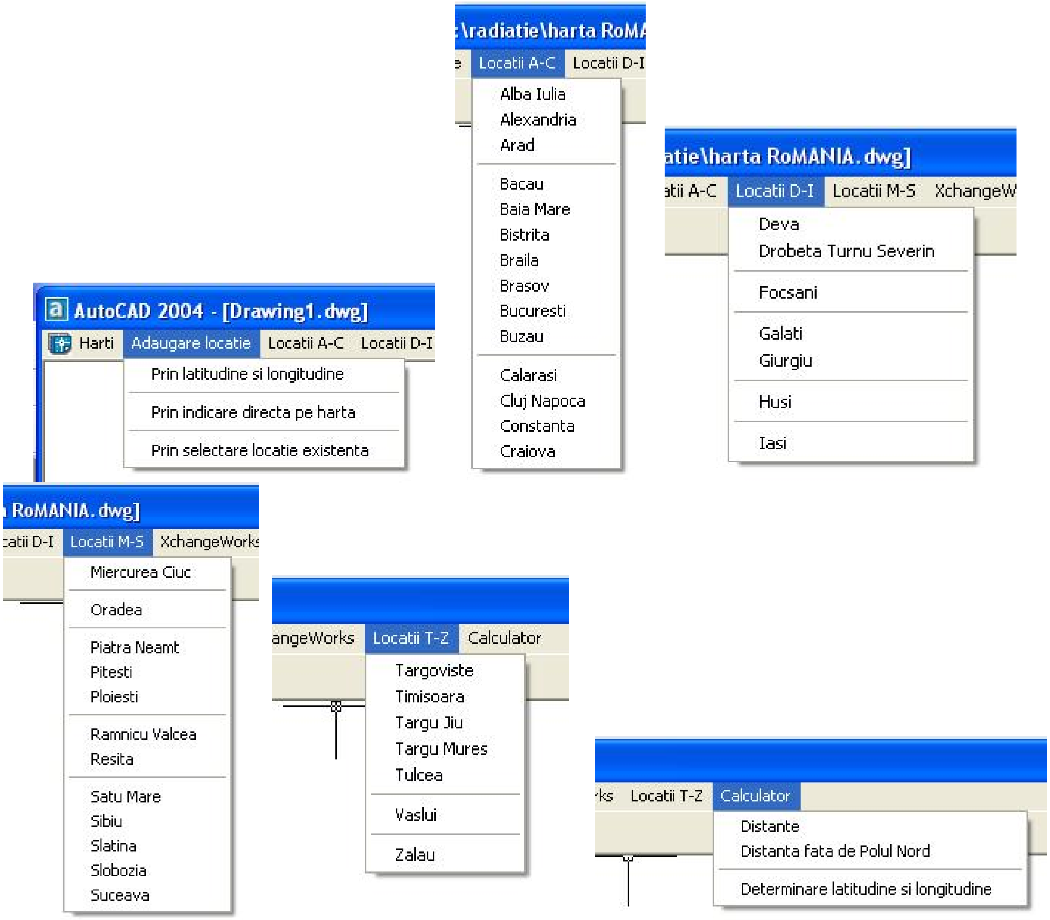

Figure 9: The menus of the AutoLISP program

4. CONCLUSIONS

The AutoLISP program can give the evolution of total radiant flux density at any time of the day and at any position. In Figure 10 are presented the results for Brasov on 1st of July, 19st of October and 1st of December 2012.

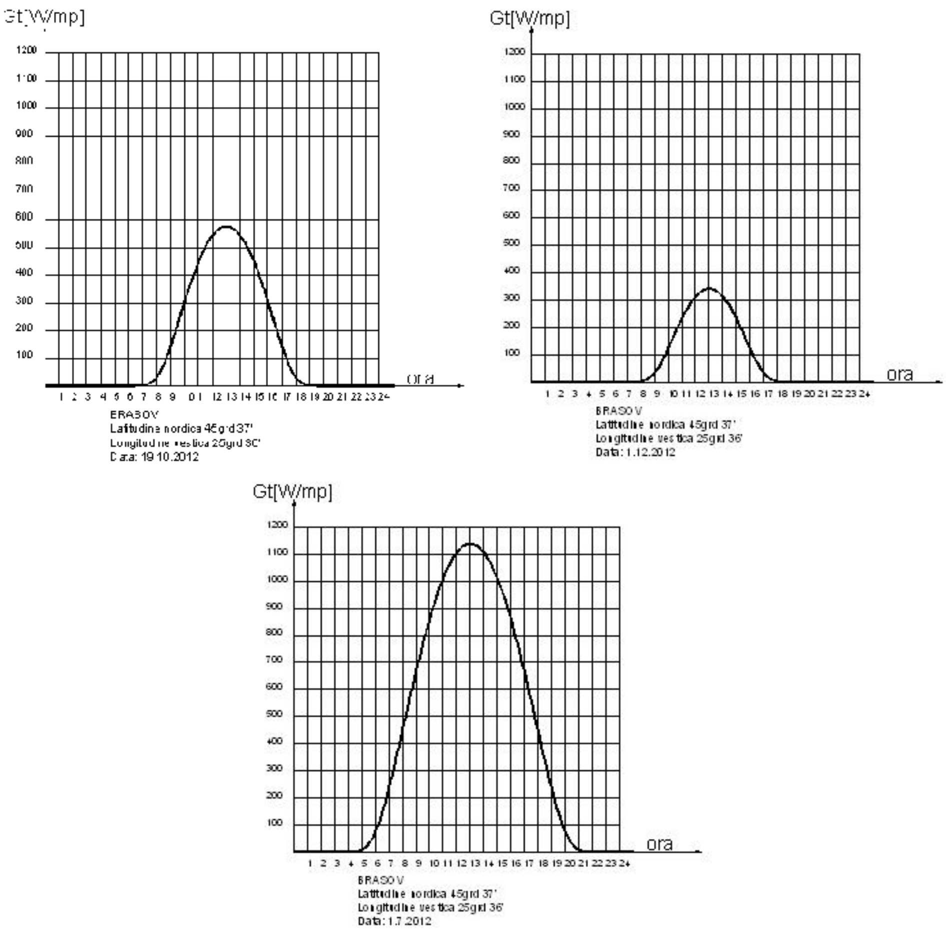

Figure 10: The results of the program for Brasov on 1st of July, 19st of October and 1st of December 2012**.**

As we know, the geomembranes, used for ecological landfill during the assembly process, are exposed to the sun radiation. These elements due to thermal expansion may be folded and after exploitation of the ecological landfill, may have undesirable effects on ground water protection.

In that case, the program presented in this paper can be a good tool for the evaluation of the total solar radiation flux during the assembling process. Also, this program can be installed on a mobile computer and the initial data can be obtained from a GPS device and can be improved with many other maps and predefined locations.

REFERENCES

[1] Danescu A., Bucurenciu S., Petrescu S., Utilizarea energiei solare, Ed. Tehnica, Bucuresti, 1980.

[2] Luminosu Ioan, Lucrări de laborator la cursul de Sisteme Termosolare, Masterul „Energii regenerabile – energia solară", Departamentul independent "Bazele fizice ale ingineriei", Facultatea de Electrotehnica si Electroenergetica, Universitatea Politehnica Timisoara, 2009.

[3] Popa D., Gherghina G., Tutunea D., Grafica asistata de calculator pentru constructii. Desenare, modelare, programare, Ed. Sitech, ISBN 978-606-530-726-1, pp.343, Craiova 2009.

[4] Stancescu C., Autolisp manual de programare, Ed. Fast 2000, Bucuresti 1996.