

INVESTIGATION OF MEANS OF MAKING GEODETIC CALCULATIONS IN MODERN GEOINFORMATIC SYSTEMS

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Formulation of the problem

Modern geoinformatic systems (GIS) offer a wide range of tools for working with a variety of geodata. One of the important features of modern GIS is the ability to expand its own functionality by creating new software scripts, extensions, geo-processing models, etc. The purpose of this work is to investigate the possibilities of creating a new GIS' functional to perform geodetic calculations and visualize their results. This kind of task is relevant given by the existing diversity of output data, the changeless improvement of computing methods, necessity of transferring results to users in the GIS-data formats.

The main material

The modern market of geoinformatics is saturated with a large number of instrumental GIS equipped with software tools for performing geodetic tasks. GIS, both commercial and open source, are common in the world and in Ukraine: ArcGIS, MapInfo, Digitals, GIS6, QGIS. Almost all of them have the means of developing a new functional. The results presented in this article are derived from the ArcGIS instrumental GIS environment that uses the high-level scripting language Python. The user-created programs are placed in the standard ArcToolbox toolbar (Fig. 1).

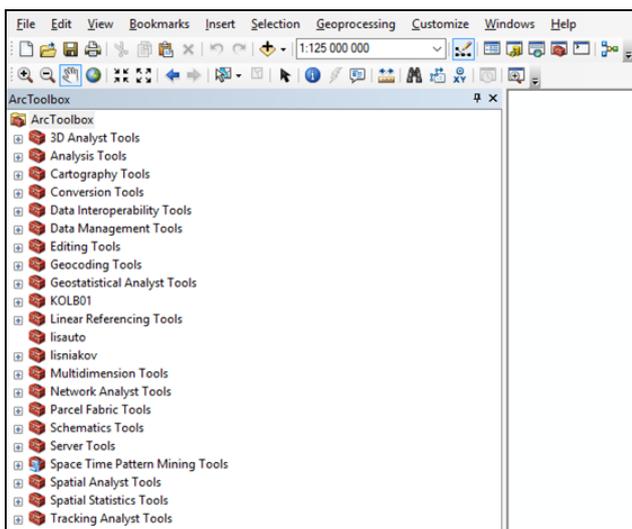


Fig. 1. ArcGIS software environment and ArcToolbox application

The ArcGIS environment and its application ArcToolbox combines many geodatabase tools, and most importantly, it allows you to create the tools you need by yourself as an interface for inputting source data and help and information windows.

To study the possibilities of development, we have programmed a number of traditional geodetic problems: determination of convergence of meridians on a plane, determination of point's coordinates by direct angular intersection and inverse angular intersection and other tasks. Python program code that implements the definite formulas for calculating these tasks and graphical user interface for input/output is created using a text editor (Fig. 2).

```
import arcpy
import sys
import math

import ErrorUtils as ERROR
import SSUtilities as UTILS
import SSDataObject as SSDO
import locale as LOCALE
LOCALE.setlocale(LOCALE.LC_ALL, "")
import datetime

Bg = float(arcpy.GetParameterAsText(0))
Bm= float(arcpy.GetParameterAsText(1))

Lg = float(arcpy.GetParameterAsText(2))
Lm = float(arcpy.GetParameterAsText(3))

B = (Bg+(Bm/60))*(3.1415926/180)
L = (Lg+(Lm/60))*(3.1415926/180)
n = math.radians(6)
N = math.floor((L/n)+1)
L0 = n*N-(n/2)
l = L-L0
```

Fig. 2. Script program code (shown incomplete) in the Python programming language

Examples of data that are used for educational purposes at the Institute of Geodesy are used for testing these programs.

Also, for each application, there is an electronic help that is displayed in the user interface in the right window. You can use the keyboard or the electronic map or external files to enter the input parameters and get the results of the calculations. The window of the developed tool for determination of point's coordinates by direct angular intersection is shown in Fig. 3

To determine the convergence of the meridians at a certain point on the plane, we set the fields for entering such data: geographic latitude and geographic longitude.

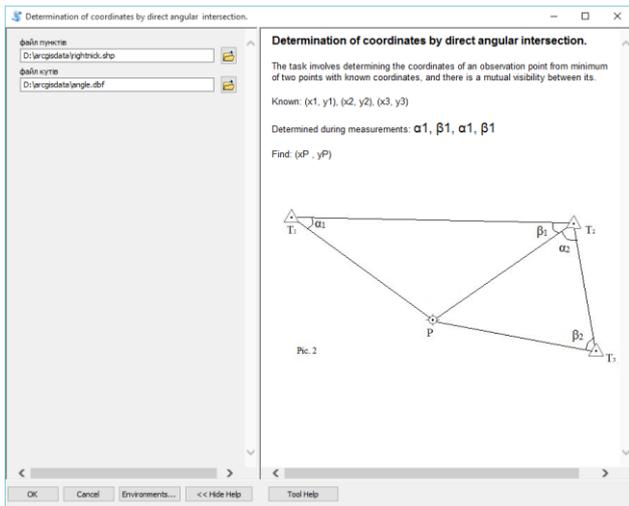


Fig. 3. Developed tool window: on the left - field for input data, on the right - electronic help

The input data for determination of point's coordinates by direct and inverse angular intersection are contained in measurement files from tacheometers or GPS receivers. In the GIS environment, they are presented as attribute tables in dBASE IV format as shown in Fig. 4a. Separately, a table of measured angles is created in accordance with the intersection scheme (Fig. 4b).

FID	Shape *	Num	X Coordinate	Y Coordinate
0	Point	1	94262	56031,5
1	Point	2	90053,3	54719
2	Point	3	86703,1	51537,6

Fig. 4a. Attributive table of input data

OID	Num	Degrees	Minutes	Seconds
0	1	30	50,2	0
1	2	77	21	0
2	3	128	48,1	0
3	4	63	13,8	0

Fig. 4b. Attributable table of angles data

After adding these data to the ArcGIS environment, the program visualizes them on the working surface in accordance with the attribute table. Results of the program - the calculated coordinates of the point are reported on the screen and displayed on an electronic map (Fig. 5). These coordinates create a new shape-file with the appropriate attribute table (Fig. 6).

Conclusions

Analyzing the results of experimental investigations, we affirmed: ArcGIS software tools allow users to extend the standard GIS functionality. The calculations are performed by using convenient programs that work correctly and quickly and have new graphical visualization capabilities. The direction of our further

research is to improve the programs, which will make the use of these tools more effective and allow them to solve these and other, more complex tasks. Another area is adaptation of the developed software for using in mobile versions of ArcGIS.

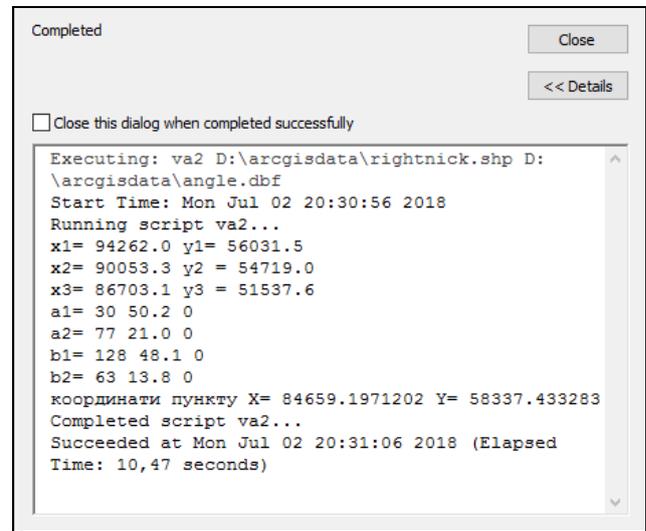


Fig. 5. Message window with results of calculations

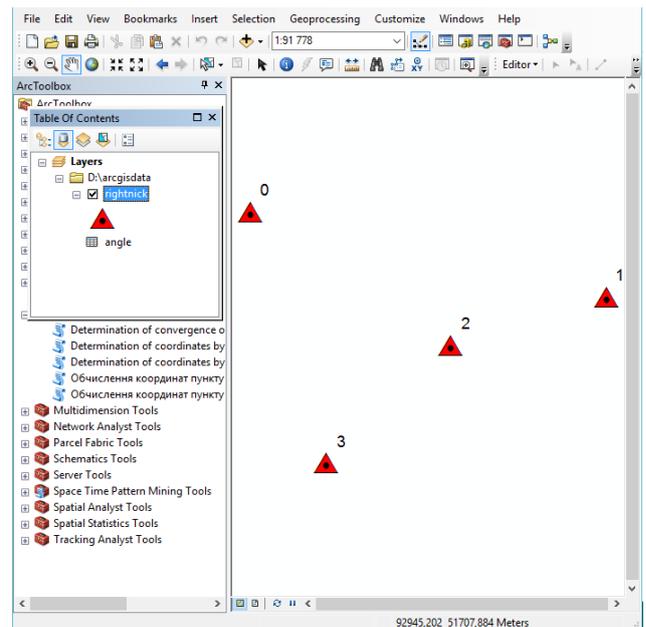


Fig. 6. Visualization of final results

References

- [Електронний ресурс]. – Режим доступу: <https://www.esri.com/ru-ru/arcgis/products/arcgis-pro/overview>
- Збірник задач з топогеодезичної підготовки/ Я.Ц. Весельський, В.І. Пащетник, О.Д. Пащетник, О.П. Полець та ін. – М: Львів, 2014. – С. 84-102.

3. Де Мерс М. Географические информационные системы. Основы: пер. с англ. / Де Мерс М. – М.: Дата+, 1999. – 490с.
4. McCoy J. ArcGIS 9. Geoprocessing. New-York, 2004. - P. 101-173.
5. Інструкція Python [Електронний ресурс]. – Режим доступу: <https://docs.python.org/3/tutorial/index.html>
6. Справка ArcGIS 10.1: короткий огляд роботи з базами даних в ArcGIS [Електронний ресурс]. – Режим доступу: <http://resources.arcgis.com/ru/help/main/10.1/index.html#na/003100000040000000/>

Investigation of means of making geodetic calculations in modern geoinformatic systems

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Means of making geodetic calculations in modern geoinformatic systems were investigated in this experiment. We created ArcGIS software that performs and visualizes results of geodetic tasks. This aspect allows the creation of special tools for automatic computing and their using in compatibility with the GIS environment.