TYPES OF GEOGRAPHIC COORDINATES AND THEIR TRANSFORMATION METHODS

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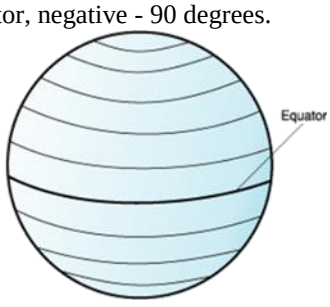
Abstract. *Currently, we are surrounded by technology, and with a single click we can find out the exact location where we are. This is possible thanks to a precise navigation system called GPS (Global Positioning System) which through a network of 24 satellites and radio waves can accurately determine where we are in real time. The position of an object, a target, or a reference point on the planet can be represented in several ways, the most well-known way is through the angular coordinate reference system, which is, latitude and longitude. The geographic coordinate system (GCS) uses a sphere to define locations on Earth, using angles measured in degrees from the center of the Earth to any point on the surface. These coordinates can be found in several formats, depending on the way of writing, the classical representation of latitude and longitude being in degrees, minutes and seconds (DMS), but in everyday life, through navigation applications we find them in another form, that is degrees and decimal places (DD) or decimal degrees and minutes (DDM). The relationship between the three ways of writing coordinates is simple, and through a few calculations we can transform in minutes, even seconds from one format to the other.*

Keywords*: Global Positioning System, geographic coordonate system , latitude, longitude, degrees*

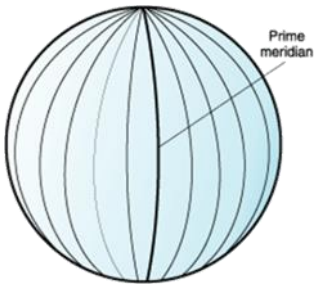
INTRODUCTION

In order to understand how with a single click we can find out the exact location where we are, we need to have some knowledge about the geographic coordinate system. A geographic coordinate system is a reference system that uses a three-dimensional spherical surface to determine locations on Earth. Any point on Earth can be defined precisely by a point of angular coordinates, latitude and longitude.

The Earth globe is divided into imaginary lines that form a coordinate system, including latitude and longitude. Horizontal lines are called parallel lines, they are equidistant and form concentric circles around the Earth. The globe is divided by the Equator in half and divides it into two equal hemispheres: the northern hemisphere and the southern hemisphere, being considered the latitude 0 degree. Locations north of the Equator have positive values +90 degrees, and those south of the equator, negative - 90 degrees.



Vertical lines are called meridians, they form circles of the same size around the Earth and intersect at the poles. The meridian considered the place of longitude 0 is the Greenwich Meridian, which divides the globe into two hemispheres: the eastern emissary and the western hemisphere. Locations to the east are positive + 180 degrees, and those to the west of the meridian are negative - 180 degrees.



The geographic coordinate system is based on two main coordinates: latitude and longitude, which are actually two numerical values that help to locate a point on the globe.

Latitude is the angular distance of a point on the globe from the equator, measured on the meridian passing through that point and expressed in degrees, minutes and seconds, and the longitude is distance in degrees, minutes, and seconds, measured on the equator, between the meridian passing through a certain point on the globe and the first meridian. (DEX)

How to find out these two coordinates in real time with a single click is through GPS. GPS (Global Positionyng System) is a precise navigation and positioning system based on a network of 24 satellites orbiting the Earth and providing radio waves with information necessary to accurately determine the position of points on the terrestrial surface. Initially, it was created and used as a defense system used by the United States military, but it became available to civilians because of its need.

The latitude and longitude coordinates come in the form of numerical values, but they actually represent degrees, minutes and seconds. They can be found in various formats, such as:

DMS (Degree, Minute, Second) is a traditional system of scoring geographic coordinates and we usually find it on maps. Each line that is represented with 1° is divided into 60 minutes, and each minute is divided into 60 seconds.

Example: 45°45'13.39" N 21°13'32.56" E – city coordinates Timisoara, expressed in degrees, minutes and seconds, where N/S and E/W indicate direction (North/South for latitude and East/West for longitude).

DD (Degree, Decimal) is a simpler format, used in applications using GPS. Each line that is represented with 1° is divided and expressed in decimal places.

Example: 45.75372°N, 21.22571°W - Timisoara city coordinates, expressed in decimal degrees (where N/S and E/W indicate the direction (North/South for latitude and East/West for longitude) or sign +/-, if the latitude is positive, represents the northern part of the equator, if it is negative, then the southern part; this is also true for longitude, if the latitude is positive, positive - eastern part of the meridians axis , negative – the west side.

DM (Degree, Decimal Minutes) this format is a combination of degrees and minutes, minutes being expressed in decimal values. Each line that is represented by 1° is divided into 60 minutes, and each minute is divided and expressed in decimal places.

Example: 45.22317′ N, 13.54267′ W - the coordinates of Timisoara, expressed in decimal degrees and minutes, where N/S and E/W indicate the direction (North/South for latitude and East/West for longitude).**MATERIAL AND METHODS**

To find out the coordinates of the point where we are, it is very simple, all we have to do is to enter an online map application, such as : Google Maps or Bing Maps, etc.

In the search bar we choose the location we want, or if we are somewhere we select the location in real time.

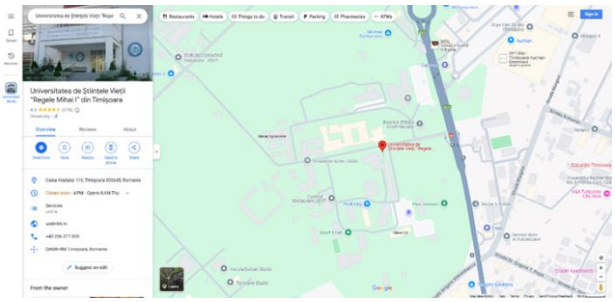


Figure 1. Google Maps

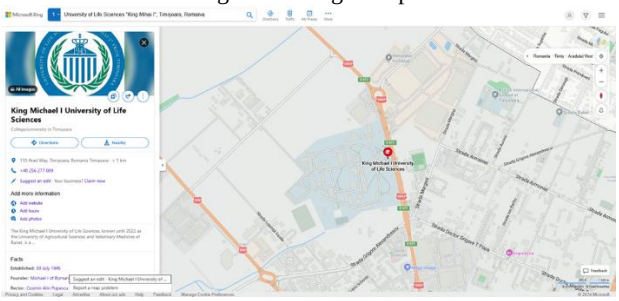


Figure 2. Bing Maps

Then, with one right click on the map we will see a border where the coordinates are located, we can copy them, then we can enter them where we want. Coordinates vary because it depends on where you choose to click. We can see that the coordinates are in the DD format, if we want to change the format, we can easily use an online converter, or with the help of simple calculations we can transform them ourselves.

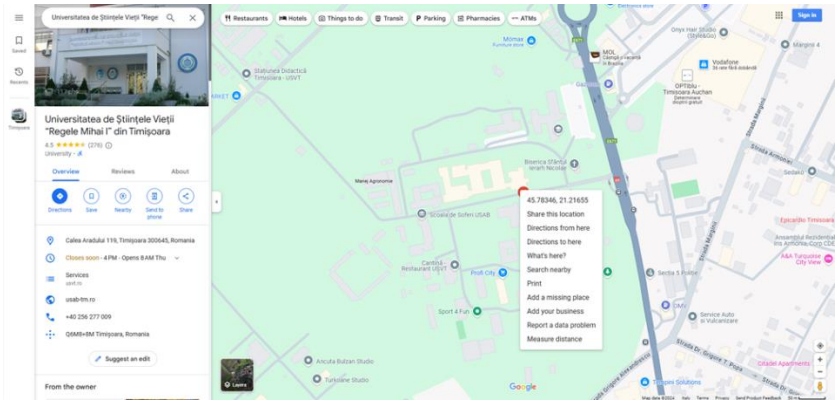


Figure 3. The coordinates from Google Maps

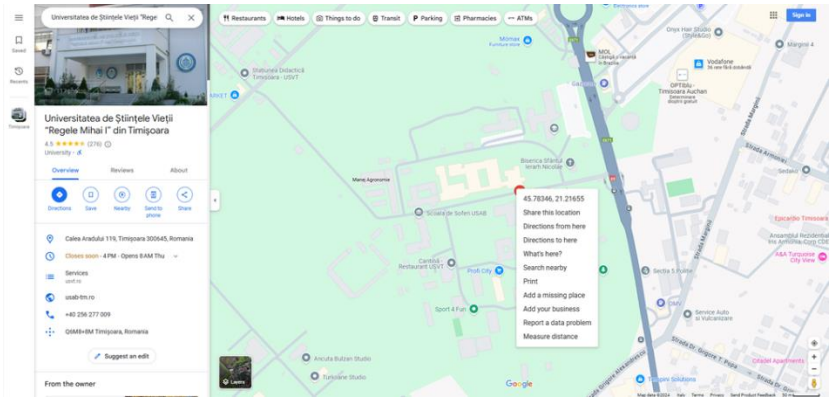


Figure 4. The coordinates from Bing Maps

RESULTS AND DISCUSSIONS

I will enter the coordinates in an Excel table to make it easier to calculate.

Format		DMS			DD	DDM	
		Degree	Minute	Second	Decimal Degree	Degree	Decimal Minutes
Latitudine	N				45.78346129		
Longitudine	E				21.21654767		

Figure 5. Coordinates table DD

Transformation from DD to DMS

To transform the coordinates from DD to DMS I will follow these steps: the degrees are represented by the value before the comma, the minutes are calculated by multiplying the value after the comma 0.78346129 by 60, the, and for longitude.

Format		DMS			DD	DDM	
		Degree	Minute	Second	Decimal Degree	Degree	Decimal Minutes
Latitudine	N	45	47.007677		45.783461		
Longitudine	E	21	12.992880		21.216548		

Figure 6. Coordinates table DMS

To calculate the seconds, you multiply the value after the comma obtained in minutes, 0.007677 by 60, respectively for longitude. And I will get the result :45°47' 0" N, 21°12'59"W.

Format		DMS			DD	DDM	
		Degree	Minute	Second	Decimal Degree	Degree	Decimal Minutes
Latitudine	N	45	47.007677	0.46062	45.783461		
Longitudine	E	21	12.992880	59.5728	21.216548		

Figure 7. Coordinates table DMS

Transformation from DMS to DD

To convert the coordinates from DMS to DD I will use the following formula:

$$DD = Degree + \left(\frac{Minute}{60}\right) + \left(\frac{Second}{3600}\right)$$

Exemple:

$$45°47'0"\ \mathrm{N} = 45 + \left(\frac{47}{60}\right) + \left(\frac{0.460662}{3600}\right) = 45 + 0.783461 + 0 = 45.783461$$

$$21°12'59"\ \mathrm{W} = 21 + \left(\frac{12}{60}\right) + \left(\frac{59}{3600}\right) = 21 + 0.2 + 0.016388889 = 21.21638889$$

Transformation from DMS to DDM

To convert the coordinates from DMS to DDM, the degrees remain the same and the minutes add the seconds divided by 60**.**

$$47 + \left(\frac{0.46062}{60}\right) = 47 + 0.007677 = 47.007677$$

$$12 + \left(\frac{59}{60}\right) = +0.992880 = 12{,}99280$$

Transformation from DDM to DMS

In order to convert the coordinates from DDm to DMS, the degrees remain the same, the minutes represented by the whole part before the comma, and the seconds are calculated by multiplying the value after the comma by 60.

$$0.007677 \times 60 = 0.460662$$

$$0.992880 \times 60 = 59.5728$$

Format		DMS			DD	DDM	
		Degree	Minute	Second	Decimal Degree	Degree	Decimal Minutes
Latitudine	N	45	47.007677	0.46062	45.783461	45	47.007677
Longitudine	E	21	12.992880	59.57280	21.216548	21	12.992880

Figure 8. Coordinates table DDM

CONCLUSIONS

Understanding and knowing the geographic coordinates and their formats is essential not only to be able to use them, but also to ensure that localization, navigation, and other processes, mapping and analysis of geospatial data are accurate and efficient. They facilitate the efficient use of modern technologies such as GPS and digital maps.

One of the most important things when using geographic coordinates is to check that the formatting is correct to ensure that a place or geographic point is accurately represented.

If we use the wrong format, in the case of navigation systems or digital maps, it can lead to significant location errors, this can lead to activities such as transport or rescue and intervention that can be adversely affected.

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