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MEASUREMENT OF THE FIELDS AREAS WITH THE DIGITIZER

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Abstract The digital planimeter (Figure 1) is used to measure the production areas of hydrocarbon deposits in the oil industry. Until the beginning of the 2000s to measure these surfaces at the desired scale, the analogue planimeter was used (Figure 2). We are currently proposing a state-of-the-art method for measuring these productive surfaces (which are included in the calculation of oil / gas geological resources) by scanning them and scaling them automatically using a specialized software called digitizer. **Key words:** digital planimeter, analog planimeter, surface, petroleum industry, scale, geological resources.

1. DESCRIBE THE METHOD OF MEASUREMENT - DIGITAL PLANIMETER

The *digital planimeter* is a tool used to measure flat surfaces (*oil industry*) by covering their accounts. It is also widely used in the petroleum industry.

The digital planimeter features by a system in which you can set various ladders to scale the map respecting the map scale (Figure 1).



Fig. 1 The measurement of a productive area with digital planimeter

For example if the scale of a map for measuring the productive area of the oil structure is 1:10.000, will be chosen a scale of 1:10.000. It is used on a large scale for the measurement of the surface for the calculation of the geological oil and gas resources through two methods:

- the *material balance method* - a method that uses only the parameters of the deposit. It is used in the first phase in the life of a field;
- the *volumetric method* - a method that uses the measurement of the area of productive scale of the map and also the calculation using the parameters of field (thickness effectively saturated ($h_{ef} = m$), effective porosity ($m = \%$), initial saturation of gas ($S_{ig} = \%$), initial pressure ($P_i = \text{bar}$), temperature reservoir ($T_z = ^\circ K$), reference temperature ($T_{ref} = ^\circ K$), the factor of deviation of gas (Z)) of geological hydrocarbon resources This method is used in the second phase in the life of a field;

This article highlights the measurement of a productive area of a gas field (*hypothetical case*), (Figure 1) using the volumetric method based on selected parameters of the oil industry:

$$R_g = A_p * h_{ef}(m) * m(\%) * S_{ig}(\%) * P_i * T_z * \frac{1}{T_{ref} * Z}$$

In this case the geological resources is measured in mil.Stm^3 .

The digital planimeter is an enhanced version of the classic planimeter which represents an analog system on which petroleum engineer calculates the areas concerned on the same principle (Figure 2).

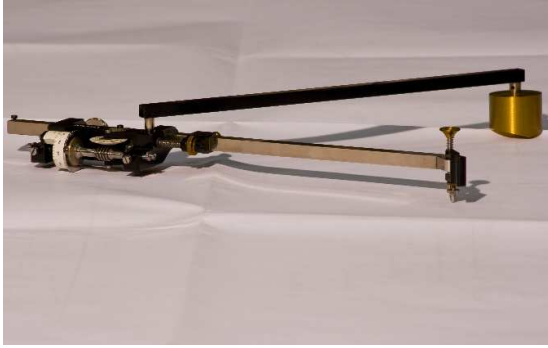


Fig. 2 The measurement of a productive area with analog planimeter

In this article we proposed to simplifying procedures for measuring the productive areas by digitizing surface and automatic calculation (gas field) using the oilfield parameters. Currently in the oil and gas industry from our country is used specialized software (*petrel*, *eclipse*) which automatically calculates the geological model and also the geological hydrocarbon resources based on the operational data from wells inserted [1].

Although the version proposed in this article (a digitizing surface applications productive and automatic calculation of the resource geological gas) is not entirely accurate, represents a first step to develop a new software that simplifies the task of a geologist engineer.

2. THE PROPOSED ALGORITHM FOR AUTOMATICALLY GEOLOGICAL RESOURCES IDENTIFICATION

In this paper a new sampling algorithm is developed to automatically compute de geological basin surface. Nowadays, the traditional methods used to investigate the geological resources existence, but also to identify the basin (the area) with deposits

involves a complicated process. As mentioned in paper [3] where a review regarding the heterogeneity in sedimentary deposits is presented, there are multiple methods to create approaches based on interpolations between data values and geologic, hydrogeology and geophysical information. Usually, the map regarding the geological basin describes an approach surface of the area. The measurements are provided with a dedicated device: digitizer. This kind of instrument is used to manually acquire different curves by scanning the map after a local calibration process. The price for this instrument involves at least 1500 USD, so it becomes inaccessible for the most part of students. For this reason, we propose a new software tool with the same ability.

The advantages of the proposed algorithm are:

- make a low cost measurement using sampling algorithm;
- use PC limited performances;
- benefits from the unique advantages of a single device usage.

Figure 3 presents the current process and the proposed process where it can be seen the great advantage of the proposed algorithm. Figure 3a presents the current process divided by 3 steps: firstly the map is scanned using the digitizer instrument, next the resource is manually computed and finally the map is digitized in order to compute the geological resource. The second diagram (Figure 3b) presents the proposed process which is fully computerized.

At the beginning, the map is imported in the developed application. Next, the user selects different points from the curve in order to reconstruct the basin surface area.

The algorithm automatically computes the resource and finally, the user can export the map without intermediary intervention.

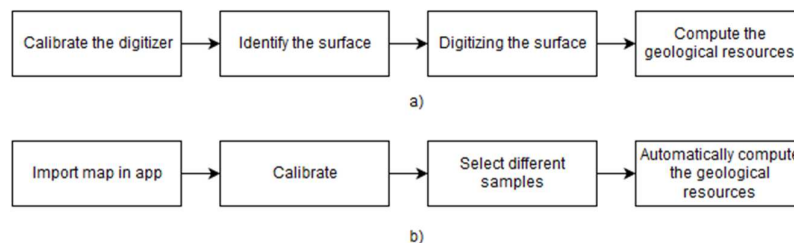


Figure 3 a – The classical process. b – The proposed process

The proposed process will reduce the human operator effort, but also will reduce the

measurement costs and will increase the speed of the geological resource measurement. The

algorithm is implemented in MATLAB [2] and it involves the following important steps:

- Load the map to begin the process;
- Because the loaded map is not within the original dimensions, the user has the ability to insert the initial width and the original height. Next, the map will be rescaled. For instance, if the original map has the following dimensions: width = 1600 and height = 1400, but the loaded map has only 600x400 pixels, the algorithm will resize the image in order to keep the original coordinates.
- Next, the calibration process will decide a correlation between pixels and real surface by selecting two points. The distance between selected points is known and it will be inserted in the graphical user interface as it can be seen in Figure 4. In this way, the algorithm will compute the *rescale_val* variable using the following relation:

$$rescale_val = \frac{user_inserted_val}{\sqrt{(x_1-x_2)^2+(y_1-y_2)^2}}, \quad (1)$$

where (x_1, x_2) and (y_1, y_2) are the selected points coordinates.

- In the next step, the user will select the pixels from the contour. All selected pixels are computed for the resulted area of the surface using the interpolation between every two consecutive points.

The block diagram is presented in figure 4. At the beginning the map is loaded into SAP GUI interface of the application [4]. The variables *current_width* and *current_height* are initialized with the current size of the map. Next, if the user defines another width and height for the original map, the *new_width* and *new_height* are initialized with user defined values. If not, the *new_width* becomes *current_width* and *new_height* becomes *current_height*. The rescale factor are computed as *scaleX* and *scaleY* variables. In figure 4 it can be seen that *currentX* and *currentY* get the user selected samples and these values are rescaled and translated in centimeters coordinates. The resulted values are stored in *X* and *Y* variable. Finally, the algorithm computes the geological resources such as basin area.

Besides the huge advantages already presented, there are a few algorithm limitations such as:

- The user needs to select the samples, so the accuracy of the measurement is affected by the interpolation, but also because of the user selection. There are situations when some important areas are omitted and their contribution to the geological resources is not computed.
- The complexity of the map will increase the graphical computational effort, so the PC performance should be increased.

These limitations will be avoided in future if a new algorithm for contour detection will be developed and the user will not be involved in the selection process. Excluding the human intervention from the measurement process will definitely increase the accuracy of the measurement.

3. THE PROPOSED ALGORITHM RESULTS

In this paper, a new sampling algorithm for geological resources was developed. The main purpose of the algorithm was to replace the digitizer instrument so the process of geological resources becomes fully computerized. At this moment, the algorithm cannot automatically compute the samples, but future research will disseminate this problem. As a first step in this area, the digitizer instrument was replaced with a software tool implemented in MATLAB based on presented algorithm. Figure 5 presents the SAP GUI interface of the application with the following facilities: *load image*, insert original width and height, *compute geological resources*, *zoom in* and *zoom out*, *pan* to move the image for zoom in and *data cursor* if you want to find a point coordinate. The samples selection is made by a simple click on the map. The selection session is finished when you right click on the map and select the last point.

Figure 4 presents the first step of the algorithm: the calibration process. The user selects the first point by double – click and the second point using the right click. Next, the user has to insert the real distance between the selected points and click the “Calibrate” button.

Next, the user has to select the closed contour by clicking different points. Figure 6 presents an

example of selection and the computed area. For this example, the area computed using the developed application was 236.9 ha (Figure 6) and the area computed using the digitizer was 238.3 ha. The result was validated using the digitizer. The difference between software tool and digitizer instrument was about 5% for this case.

Figure 8 presents another example where the error between measured value and computed

value is about 4 %. The error values show the good performances of the algorithm. This error cannot be lower than 2 or 3 % because the user cannot select perfectly the contour. Another reason why the algorithm presents amazing results is the simple idea of converting from low quality pixel images into huge areas (ha). As a result, the accuracy will never be increased up to this limit using a manually selection.

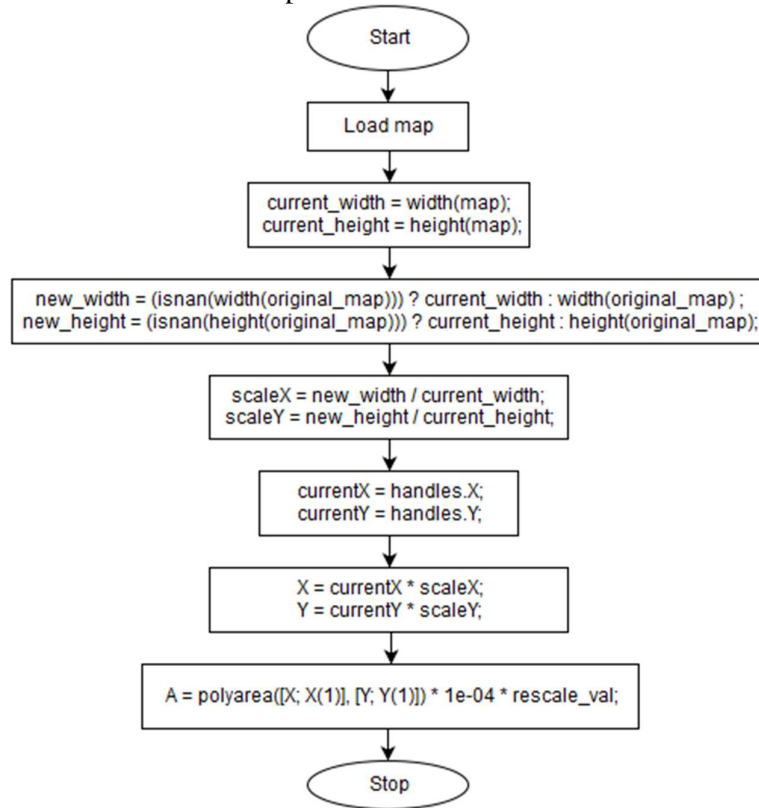


Figure 4 – Block diagram

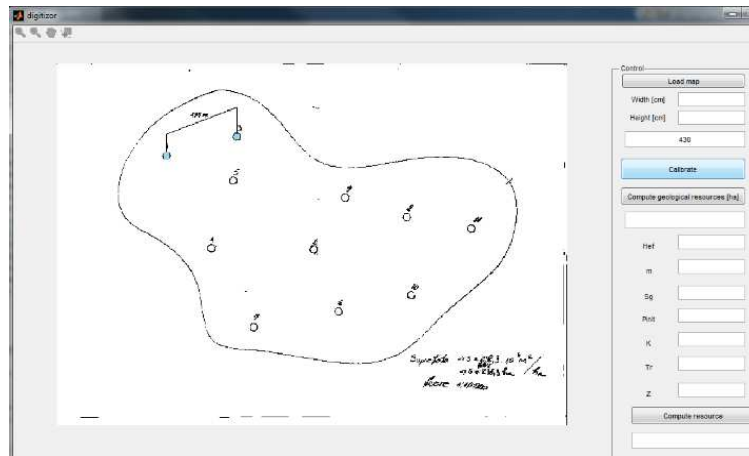


Figure 5 – Application SAP GUI and calibration process

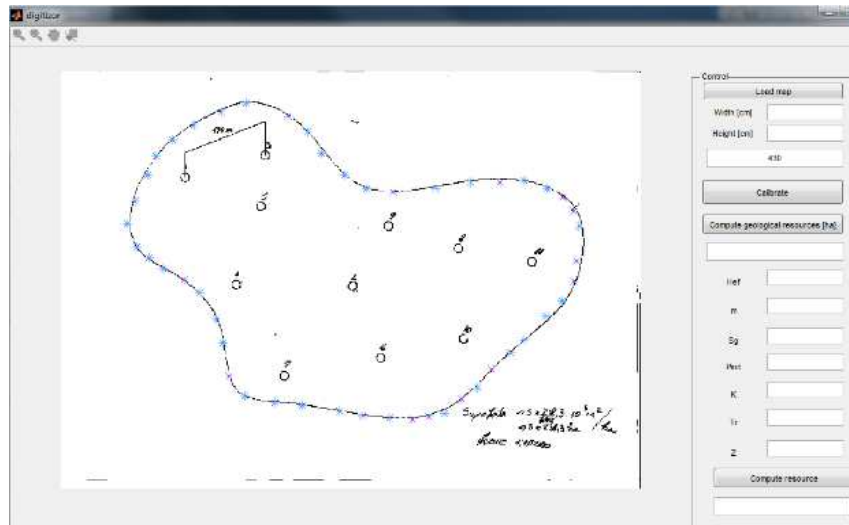


Figure 6 – The algorithm execution result

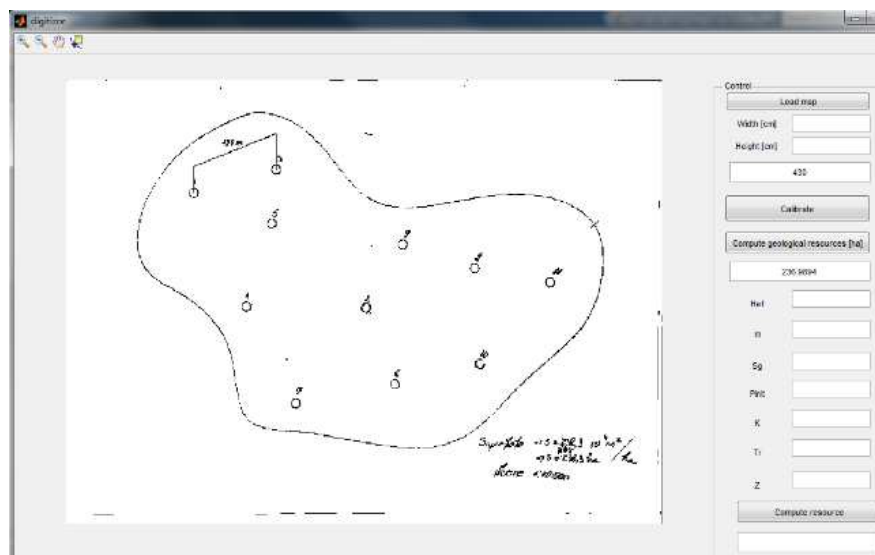


Figure 7 – The algorithm error example – 5%

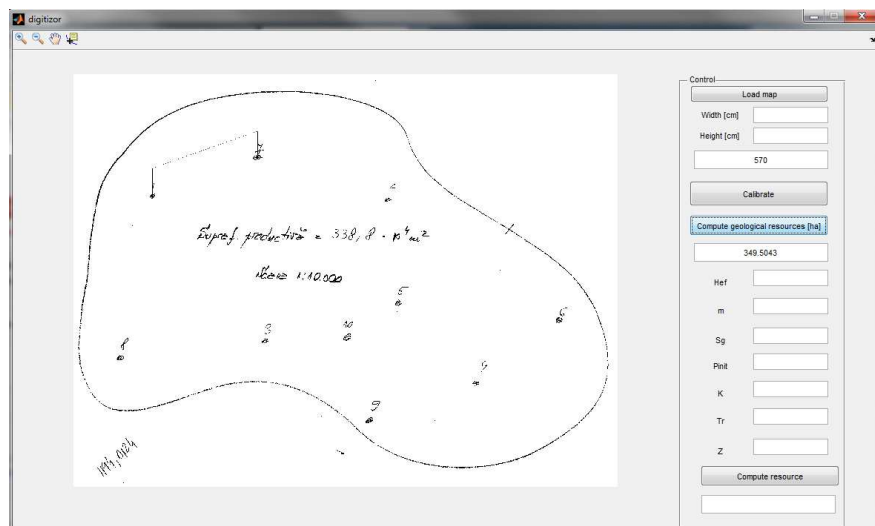


Fig. 8 – The algorithm error example – 4 %

4. CONCLUSIONS AND PROPOSALS

In this paper a new method for geological resources identification was developed based on sampling algorithm. The main purpose of the algorithm was to replace an expensive instrument named digitizer with a low – cost software tool without special PC performance requirements. The user measurement was replaced by user click on the SAP GUI of the application. Multiple examples were computed with the developed application and the results were compared with the digitizer measurement. The results show good agreement with the classical process. The differences were inserted by the user for both types of measurements. To exclude the error and to make the process automatically, an auto - selective algorithm will

be studied and developed as future work.

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Măsurarea ariilor zăcămintelor cu ajutorul digitizorului

Rezumat *Planimetrul digital (Figura 1) este utilizat pentru măsurarea suprafețelor productive ale zăcămintelor de hidrocarburi în industria de petrol. Până la începutul anilor 2000 pentru măsurarea acestor suprafețe la scara dorită, era utilizat planimetrul analogic (Figura 2).*

În prezent propunem o metodă de ultimă generație privind măsurarea acestor suprafețe productive (ce intră în calculul resurselor geologice de țiței/gaze), prin scanarea acestora și scalarea lor automat cu ajutorul unui soft specializat denumit digitizor.

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