INFORMATION SYSTEM FOR MODELING THE GRAIN SIZE DISTRIBUTION

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ABSTRACT

Grain size distribution is very important characteristic of primary and secondary materials, but also for the material in pharmacy, agriculture, chemical industry and in many other branches of science. Usually is presented with graphical methods. In the middle of last century, several authors have proposed several different models of analytical presentation of grain size distribution, which are based on the principle of graphical determination of these models. Using computer science, statistical analysis and information technology, we can improve the development of these models and this paper will show the method for development of information system for modeling the grain size distribution.

Keywords: *Information System, Modeling, Grain Size*

1. INTRODUCTION

Grain size is a representation of a mass distribution of pieces (grains) for the corresponding fractions in raw materials or products of preparation for raw materials [1,2,3]. The results of grain size analysis are usually presented in graphical methods of interpretation. The practical value of these diagrams is on the graphical methods for determining the characteristics of grain size distribution necessary for theoretical considerations and design (eg cross section curve and the coordinate axes, tangent, tanges corners etc). In the quest to find a satisfactory analytical model for grain size, several authors have proposed several different mathematical models where is the best known model Rosin and Rammler (1933) and equations Gates-Gaudin-Schuhmann (Gates 1915, Schuhmann 1940) and many variations of these models [2]. These equations are defined in the middle of last century and based on the graphical principle for determining the mathematical model of this analysis (usually logarithmic or exponential functions). Graphical method is performed manually because the complex mathematical operations modeling and regression analysis with iterations could not be done with the help of the former information technology. With the current development of computer science and information technology, it is possible to improve the calculation of these models with regression analysis [4,5,6,7,8] and we can do this using advance information systems for modeling of grain size distribution.

2. DEVELOPMENT OF INFORMATION SYSTEM

For development of information systems for modeling the grain size distribution, we can use the standard procedures and activities in developing information systems [9,10,32,33]:

1. analysis of the real system and define a model
   - the structured decomposition of the system into smaller parts and defining what tasks should be done,
2. creating a database
   - tables definition,
   - defining the primary key and relationship between tables,
3. design and development of algorithms for solving problems,
   - specification and description of the problem for software solution,
   - the form and nature of input data,

- the form of output results - the solution,
- statistical analysis and modeling (Rosin and Rammler, Gates-Gaudin-Schuhmann)

4. program design and implementation of defined parts of the system,
   - the integration of independently developed systems into a software system
5. testing the validity with the input datas which the results we already know

2.1. ANALYSIS OF THE REAL SYSTEM AND DEFINE A MODEL

With the analysis of the real system and planing of information system for processing and modeling of graind size of sample, we can make the structured decomposition of this complex system into smaller parts [11,12,13] which will be independently developed and then integrated into a unique information system (Figure 1):

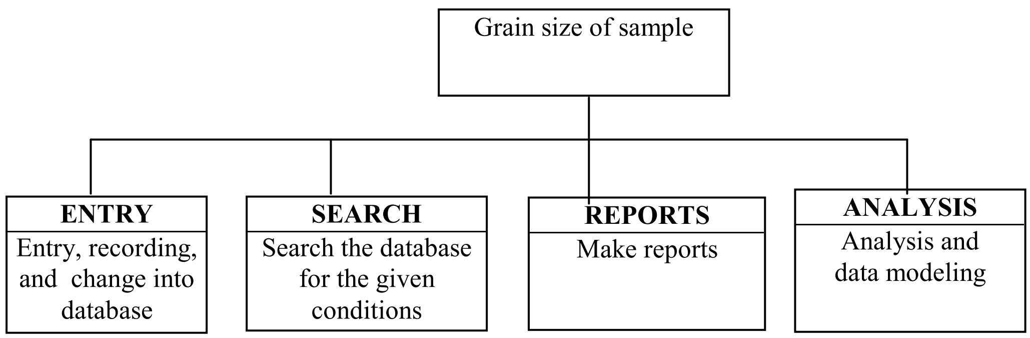

Figure 1 - The structured decomposition of system "grain size of sample "

After a structured decomposition, the next step is definitions of desired models (objects) of real systems [14]. From many properties that the object has, we can choose only the important and necessary properties for storage in a database information system. In this reason, we will not define a base model that includes all the variables and relationships between them, because such a model is an idealization and it is impossible to implement in the practice. That is why our model is simplified [15] and determine an experimental framework to include only the properties of the system necessary for solving a specific task for modeling of grain size distribution [6,8]. In accordance with the theoretical principles of grain size distribution and the practical experience, we proposed and defined the model of grain size of sample (Figure 2).

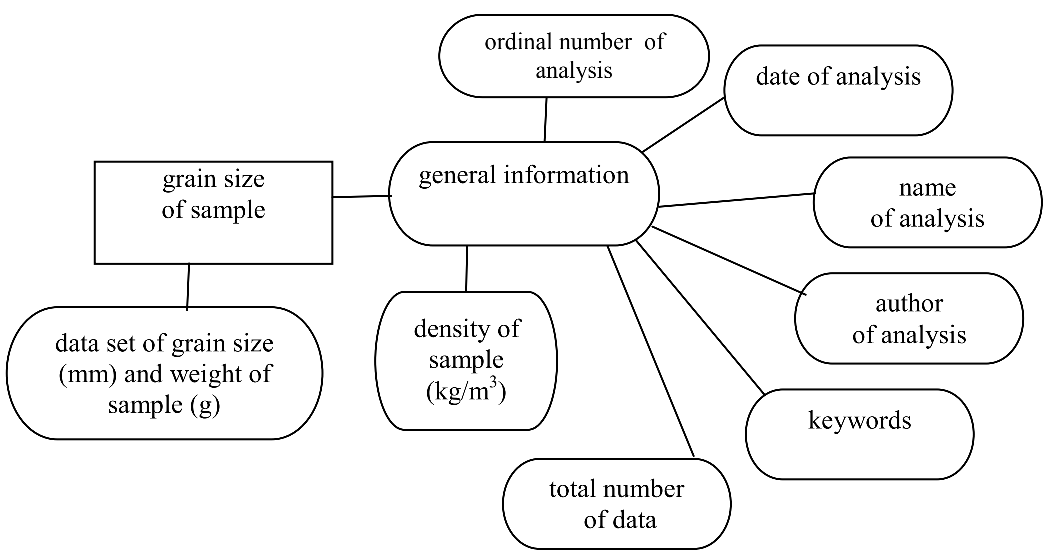

Figure 2 - The simplified object model of the real system "grain size of sample"

2.2. CREATING A DATABASE

When the real system model is defined, next step is define the tables that are part of a database for storing, searching and extraction of data in our information system [16].

2.2.1. TABLE DEFINITION

Based on the defined model, we proposed the two tables: GS_DESCR, GS_DATA whose structures are shown in Tables 1 and 2.

Table 1 - Definition of the columns, type and description of tables GS_DESCR

Name of column	Type	Description
ID_A	INTEGER(15)	Ordinal number of analysis
DATE_A	DATE(10)	Date of analysis
NAME_A	STRING(255)	Name of analysis
AUTHOR_A	STRING(255)	Author of analysis
KEYW_A	STRING(255)	Keywords
TOTAL_A	INTEGER(3)	Total number of data
DENSITY_A	NUMBER(12,3)	Density of sample (kg/m^3)

Table 2 - Definition of the columns, type and description of tables GS_DATA

Naziv kolone	Type	Description
ID_DATA	INTEGER(15)	Ordinal number of analysis
NO_DATA	INTEGER(15)	Ordinal number of data
PSIZE_A	NUMBER(12,3)	Grain size (mm)
MSIZE_A	NUMBER(12,3)	Weight of sample (g)

2.2.2. DEFINING THE PRIMARY KEY AND THE RELATIONSHIP BETWEEN TABLES

To be realized a relationship between tables, first step is to define the primary key of each table in a database information system (Table 3). After defining the primary key of table, we must define the relationships between tables in a database information system [17,18,19] using the relational columns in tables that allow the linking of data in tables through the relationship 1: M (Table 4, Figure 3).

Table 3 - Proposed primary keys for tables

Name of table	Description of table	Primary key	Description of primary key
GS_DESCR	General data for analysis of grain size of sample	ID_A	Ordinal number of analysis, 0...N
GS_DATA	A series of grain size and weight of sample	ID_DATA	Ordinal number of analysis, 0...N

Table 4 - Relation columns and the relationship between tables in a database information system

Name of relation column	Name of relation column	Description of relationship
GS_DESCR -> ID_A	GS_DATA -> ID_DATA	The relationship between general information of analysis and data series of grain size

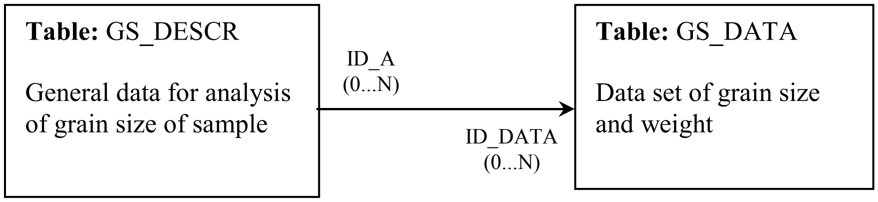

Figure 3 - Diagram of relationships between tables in a database information system

2.3. THE FORM AND NATURE OF INPUT DATA

The form and nature of input data are defined in the process of table definition for database (Table 1 and 2). Based on this tables GS_DESCR, GS_DATA, the input data is recorded in database information system. First, we must enter the general information of grain size of sample: number of analysis, date of analysis, name of analysis, the author of analysis, keywords, the density of the sample, and the total number of data which must be greater than or equal to 2 (TOTAL_N $\geq$ 2) because the mathematical modeling must have at least two data [20,21,22]. After that, we can enter the number of paired data: grain size and the weight of the sample.

2.4. THE FORM OF OUTPUT RESULTS - THE SOLUTION

There are three forms of the output results for grain size distribution [2] and this is tabular, graphical and analytical form (Figure 4, Figure 5, Figure 6).

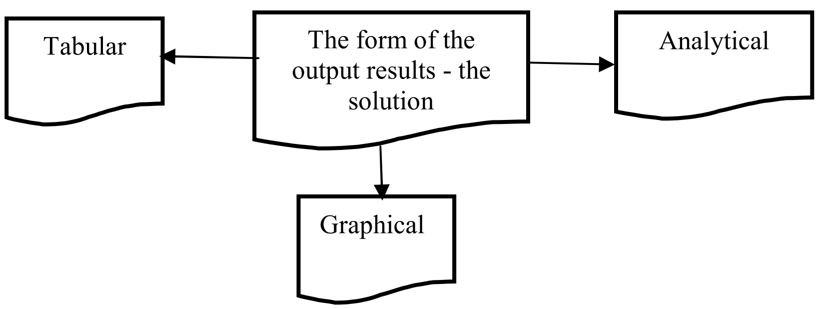

Figure 4 - The forms of the output results of grain size distribution

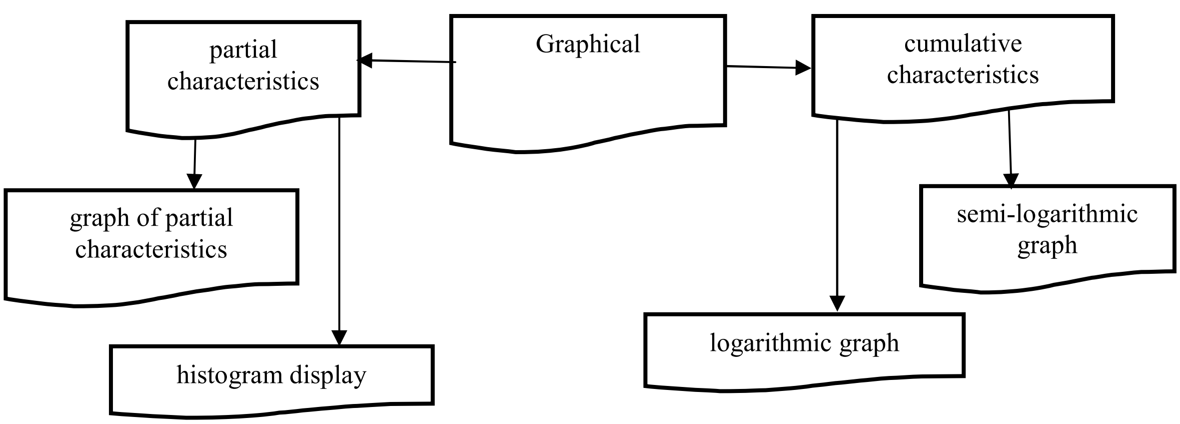

Figure 5 - Graphical forms of the output results of grain size distribution

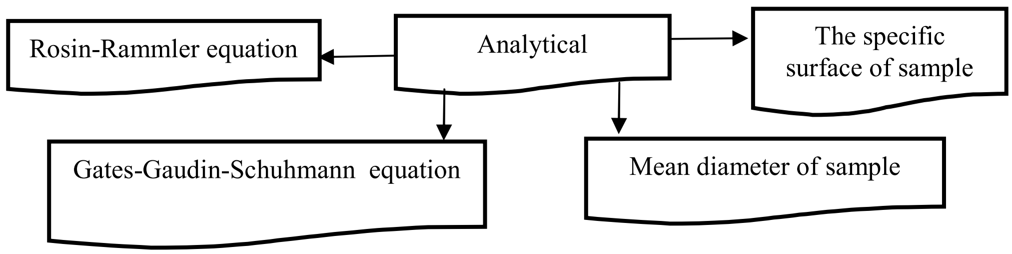

Figure 6 - Analitical forms of the output results of grain size distribution

2.5. STATISTICAL ANALYSIS AND MODELING

Statistical analysis is used for sorting and grouping of statistical data, calculation and determination of statistical indicators [23,24,25,27]: arithmetic mean (average value of the sample), median, range, variance, standard deviation, coefficient of variation (Figure 7). The modeling of data is performed with regression analysis and linear regression for determine the correlation coefficient and coefficient of determination [26,28,29,30,31] which determines the representativeness of these models - equation of Rosin-Rammler, Gates-Gaudin-Schuhmann (Figure 8).

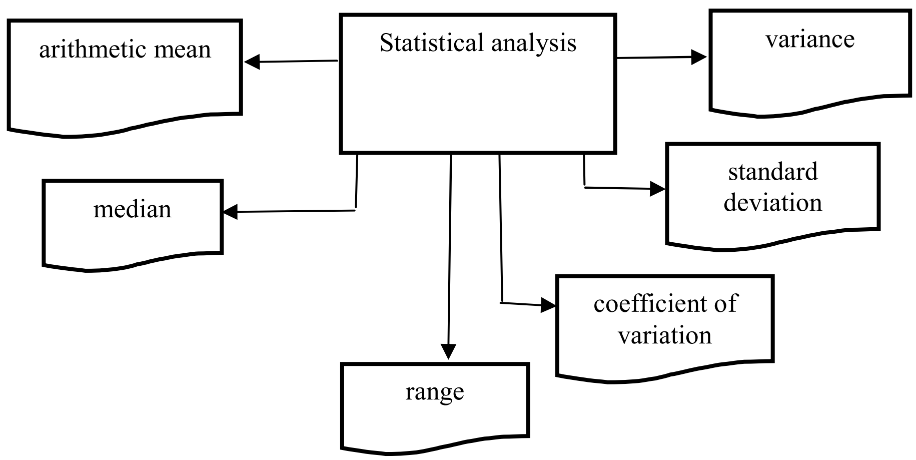

Figure 7 - Statistical data analysis

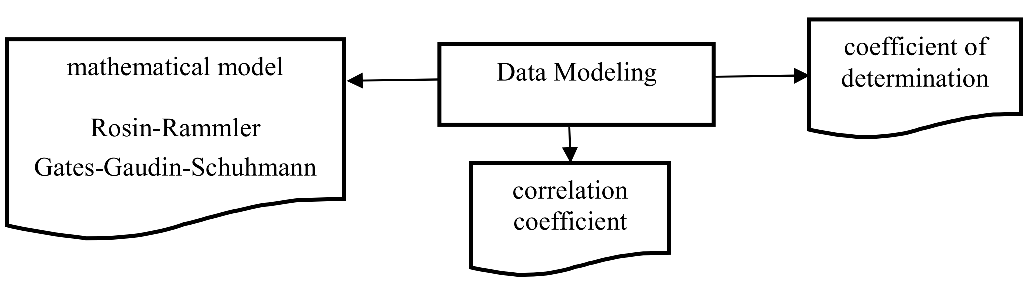

Figure 8 - Data Modeling

2.6. SEARCHING THE DATABASE

Searching the database is a basic function of any information system [32.33] and in our information system this solved with SEARCH subsystem (Figure 9). When the data of analysis of grain size distribution recorded in the database, it is possible to be searched in different ways: search by date of data analysis, the authors, key words, dates and authors, etc.

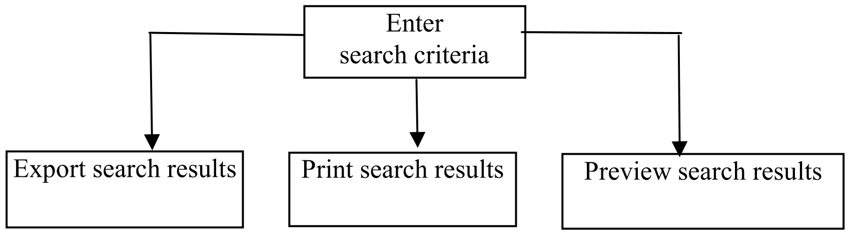

Figure 9 - Subsystem SEARCH

3. APPLICATIONS AND IMPLEMENTATION DEFINED PARTS OF THE SYSTEM

When we defined the subsystem for our information system, we must write a program in some programming language [34.35]. There are numerous and various of programming languages, and selection of some of them is depend on the experience of developers, his knowledge and capabilities of a programming in this language to create a program that will give the solution of the problem [36, 37].

For our information system for modeling of grain size distribution, we proposed XBASE syntax of programming languages, because this language allows the creation of information system with relational databases using Windows Form with visual objects [38] and controls such as: Button, Menu, ListBox, CheckBox, RadioGroup, TextBox etc.

4. CONCLUSION

Based on the theoretical principle of information systems and statistical analysis, this paper show the method for creating the information systems for modeling of grain size distribution of sample, and this is one way of applying computer-information technology in solving and improvement the logical-cognitive approach to the problem and acquiring new knowledge and information necessary to resolve certain practical problems.

This information system improving the determination of the characteristics of grain size distribution necessary for theoretical considerations and design who have been using a graphical presentation and methods such as the section curve and the coordinate axes, tangent, graphics, tanges corners etc. With this information system, calculate this characteristcs is based on using mathematical modeling and regression analysis which gives the precision to avoid subjective errors in the determination of the model and the parameters on the graphics. Databases and this information system can be easily upgraded and expanded in accordance with the requirements in practice. Example, use of this information system in the industrial flotation of copper should be expand for storage in a database more details of sample like content of copper in feed and concentrate, pulp density etc.

Using the showed principles for creating information system, for his doctoral thesis author of this paper created Windows® information system "UniModBase" in XBASE syntax of programming languages. With stored data of grain size of sample into this information system, preparation of all required reports is automatic, fast and always available for a future analysis, tests, change etc. The process of statistical analysis and modeling of results has been simplified with "UniModBase" because the mathematical operations and procedures is "hidden" from the users and automatically is calculated with a selection of some of the options in this information system. The entry of input data in "UniModBase" is user friendly, visual object-oriented and give the user easily moves through the information system. This is possible by proper choice Windows® environments which allows to users quick and intuitive work with this information system.

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