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THE AIM AND SCOPE

The aim and scope of the Journal of Information Technology and Applications (JITA) is:

- to provide international dissemination of contributions in field of Information Technology,
- to promote exchange of information and knowledge in research work and
- to explore the new developments and inventions related to the use of Information Technology towards the structuring of an Information Society.

JITA provides a medium for exchanging research results and achievements accomplished by the scientific community from academia and industry.

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Dear Readers,
Welcome to the fourth issue of the JITA Journal!

The content of this issue of JITA consists of five papers covering different areas of information technologies. The first of the presented papers, entitled “Application of Voice Biometrics in System Protection and Crime Fighting”, by Saša Paunović, Lazar Nešić, and Jovan Kovačević, analyzes the possibility of using the voice biometrics in modern living, from simple examples, such as starting the motor of a vehicle, through opening security gates, to proving fraud and embezzlement. Special emphasis has been put on the systems of automatic speaker identification and forensic speaker recognition.

The next paper “Management of induction (asynchronous) motors using PLC”, by Mahir Zajmović, Hadžib Salkić, and Saša Stanić, tackles the problem of practical engineering management of an induction motor using PLC and VSD. Managing controls were given for HP mobile working stations, where Windows XP operative system with SCADA software from DAQFactory was installed. The link used between the working stations and the PLC was Ethernet (Modbus TCP/IP).

The article “Data Mining & Cloud Computing” by Robert Vrbić describes cloud computing as a powerful, scalable and flexible infrastructure into which techniques and methods of data mining can be easily integrated. The result of such integration should be powerful platform that will be able to handle huge amounts of data from various data warehouses.

In “Data Visualization on Information Tables - Dashboards”, Nedim Smajlović presents a specific way of data visualization for the business purpose. The information tables - dashboards have been created for the purpose of data processing as an analogy to the car dashboard, which, by means of several indicators, provides for the driver an instant insight into various data related to driving and the engine running. Display of the data in the form of charts and diagrams undoubtedly helps in obtaining new knowledge however, an individual visual displaying is seldom sufficient thus they should be combined in different variants. The work presents concrete examples of the dashboards creation both locally and globally.

Finally, the article “Integration Contemporary Java Web Technologies as a Service for The University Employees” by Uroš Romić, Igor Manić, and Ivan Pantelić, describes the web application used by employees of the School of Electrical Engineering in Belgrade. The application is based on contemporary open source Java web technologies combined together into an advanced system that provides an environment for the rapid application development, high modularity and configurability. Paper outlines application functionalities related to teaching process and financial operations, as well as additional functionalities.

On behalf of the Editorial Board we would like to thank the authors for their contributions, and also the reviewers for the effort and time invested into the preparation of this issue of Journal of Information Technology and Applications.

APPLICATION OF VOICE BIOMETRICS IN PROTECTION SYSTEMS AND CRIME FIGHTING

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Abstract: Modern communication relies increasingly more on the verbal communication between a machine and a human, aiming to govern certain resources and robots, increase the security of certain means, initiate certain processing protocols, faster financial transactions... This paper illustrates the possibility of using the voice biometrics in modern living, from simple examples, such as starting the motor of a vehicle, through opening security gates, to proving fraud and embezzlement. Special emphasis has been put on the systems of automatic speaker identification and forensic speaker recognition.

Key words: Biometry, Biometry systems, Speech, Speaker, Voice recognition, Identification, Security.

INTRODUCTION

The best method of human communication is speech as the process of articulating sounds with certain meaning [5]. In order for people to be able to execute “distant” communication (over great physical distances), it is necessary to develop devices which will enable the transfer of sound from one location to another. That is how telephone and radio devices emerged. However, after some time it did not suffice anymore. Right after the Second World War the need was felt to analyze particular speech features and depict speech in a visual form. It has set the foundation for the development of new machines and devices for voice processing.

The analysis of specific characteristics of voice has begun before the computer invention. Melville Bell, father of Alexander Graham Belle has started the research on translation of the speech into a visual form in 1867. The idea was to monitor the movement of enemy troops over the radio. However, the technology was not developed enough to support this idea. Later on, the police continued to develop Melville

Bell's idea until it reached its peak through today's software use.

Voice biometrics represents the biometric model of physical characteristics of the human voice, numerical sound carrier and the way of speech of each individual [7].

When we are talking about the speech identification through voice recognition, it is necessary to distinguish the difference between speech identification and the identification of the speaker. Speech identification represents the recognition of the spoken words while the biometrical method of identification represents the speaker identification, or the person who is speaking.

The purpose of voice recognition is the authentication of a certain person based on the unique voice characteristics, given that the voice represents the unique and constant identifier [1]. The voice uniqueness is represented on one hand in its pitch, and tone, and on the other in the difference in verbaliza-

tion, which is the difference in use of the muscles of mouth, jaw and tongue. Nobody can change one's voice to the point of unrecognizing. It is interesting to say that the voice-print of twins is not identical due to automatised speech patterns. Moreover, speech uniqueness is represented in a way people articulate sounds, make pauses while speaking, their beginning of the speech - its speed, rhythm and intonation - all these characteristics can contribute to speech identification.

Voice biometrics is applied more often in private and public sector, given that it is simple to use, acceptable by the public, and is cost effective compared to other biometric technologies. However, biometrics is not that reliable due to the fact that it is used for verification and not for identification purposes. For that reason, it is used as an additional tool in biometrics; in combination with other biometric methods.

APPLICATIONS OF VOICE BIOMETRICS IN PROTECTION SYSTEMS AND CRIME FIGHTING

How does this biometric function?

The technology of voice biometrics is the least invasive, but at the same time the least reliable one. This technology is based on voice recognition, by making the speaker say a phrase into a microphone, which is followed by software analysis that compares the voice with the speech database [2].

The process of identification is divided into two phases (steps). The first phase is the encryption and the second one is verification or identification.

First step in acquiring the biometric sample is the voice-print. Sample can be identified as a phrase, text or a serial numbers that are implemented into a database which serve to identify a certain person. Step one consists of a speaker speaking into a microphone. Microphone is the one that transforms an acoustic wave into an electric signal, which is more modified with the use of sound cards in computers. Moreover, this electric signal is adapted into various applications and infiltrated in a certain amplification range (value

interval -1 to 1) quantified by the corresponding levels etc. Finally, the signal is represented in such a way that it is possible to apply a vast number of sophisticated processes which will acquire all the significant information from the signal.

The separation is performed when an algorithm in given sample is searched for unique voice characteristics such as tone, pitch, time frame etc, which is then followed by the formation of biometrical sample which is stored into the database. This process lasts between 2 and 8 seconds. So, in this phase, the spoken phrase is transformed into a digital format (from an analogue) and is stored for future comparison reference.

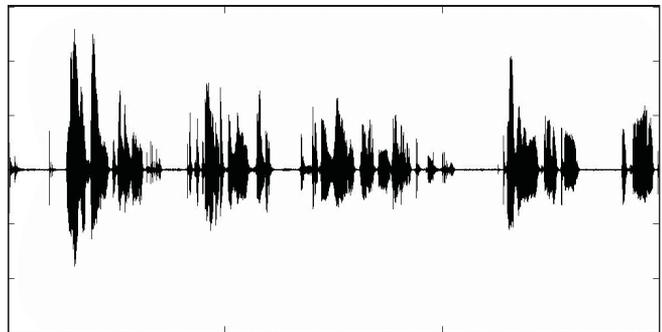


FIGURE 1. RECORDING OF 15 SECOND SPEECH WITH THE SAMPLING RATE OF 8 kHz

The next phase is the verification/identification which is performed in a way that an individual produces speech. An individual reads a text or a series of numbers into a microphone. Voice samples are then converted into digital characteristics which are then compared to algorithm characteristics in the database. This process lasts for 0.5 seconds.

Systems that are applied in speech and individual recognition can be divided into dependent, independent and integrated systems.

Speaker articulates a certain phrase that represents name, place of birth, favorite color or various numbers. This method is very simple to use because identification is verified by comparing a phrase with a database.

Compared to the dependent system, in the **independent system** quality analyses of the voice and the spoken words do not affect identification pro-

cess. In other words, this does not require the pronunciation of a certain word; the identification can be performed with the pronunciation of any word. More specifically, the authentication is done when a person speaks out a specific text, for example a series of numbers from 0-9. It is worth mentioning that specifics in pronunciation of these series of numbers should be followed for the voice identification to be safer and faster.

Speaker verification in the integrated system consists of two steps:

1. System identifies the speech by recognizing a certain text (password, personal information or a number).
2. Spoken words are compared to a database for identification. This type of system is used in bank transactions.

For example Via Voice software (developed by IBM) enables user identification via phone by combining two sources of information: voice print and user's password and personal information. The process looks like this: during a conversation, Via Voice poses a series of random questions to a user; this is followed by verification of given responses via voice print. When a sample is matched with the one in the database, Via Voice concludes that the user in question is the right one. Also, voice authentication depends on the user's right or wrong answer and the voice-print assessment. If it is the right user, this process will be short since it is composed of one question. In case of the false identification, the authentication process lasts longer since Via Voice poses more questions until the person gives the wrong answer or until it concludes that the voice-prints do not match.

TECHNOLOGY DEVELOPMENT

Technology of voice-prints is getting more advanced in the past couple of years. Before its modernization, every word had to be spoken out separately and slowly so the system could recognize it. With today's technology, this is not necessary since the system is capable of recognizing fluent speech and the computer can recognize 160 per minute. It is also im-

portant to emphasize that the system integrates neural nets, in other words it memorizes the way how every person sounds. Still, errors are unavoidable since the biometry represents a mathematical model of every person's physical trait in everyday life. However, this happens in a very small number of cases.

APPLICATIONS

Given the biometry characteristics, it is not surprising that its use is widespread. It is used to access locations and buildings, personal belongings, money transactions, etc. It is also used in security forces, usually by police in executing court orders.

Physical access to certain locations and objects

The application of biometry in this area of use is represented by a sample of voice-print with a combination of other authentication models such as codes, fingerprints and iris prints. All of these methods contribute to a maximum security. Institutions that use these kinds of methods are banks, security buildings, apartment buildings, etc.

Safe and faster access to personal devices

The application of this biometry is very significant concerning the use of cell phones, laptops and other personal devices since it offers a maximum protection from the unauthorized use. This can be overcome by denying access to anyone whose voice print does not match the owners.

Smart phones are more and more present in today's society. They usually recognize speech commands and allow hand-free use. For example, a person speaks out the name of a person that he/she wishes to call and the phone will automatically recognize that person from the memory and dial the number automatically.

Money transactions

Application of this type of biometry can be noted in ATM machines which lead to less unauthorized use.

In other words, ATM machines (cash dispensers) require the authentications with a PIN number. How-

ever, what if someone is standing behind us when we are typing the PIN number, or what if the camera that is set above the ATM machine records our PIN number? All of this can lead to illegal use of a PIN number. This can be avoided by the combination of biometry and a PIN number. Moreover, system would have to identify the person that is using an ATM machine (either with a spoken word or an answer to a certain question) and a PIN number. Once all the necessary information is verified, he/she is able to withdraw the money. This type of ATM machine use does not require a lot of time and is safe at the same time.

This type of biometry is also used in call centers within a bank when customers use telephone banking. The majority of banks have call centers that base their authentication systems on voice-print biometry. To sum up, clients are using call centers to do their money transactions and they are usually speaking with a bank official which then starts up the operations on a computer of a local or central bank.

Security forces

This type of technology is very much applied in security forces either public or secret. One of the applications is seen in the surveillance of telephone lines. This is very significant today since the classic ways of monitoring are not applied as much. How does this work? For example, in an effort to make operator's job easier, the computer would monitor large number of lines simultaneously until the key word appears on any line. When those words come up, the recorded conversation is forwarded to a human operator so he/she would verify the content. It is important to say that if the right person is expected, then those systems would be combined with an automatic recognition of the speaker so that the security of the search for the right person would be maximized.

Suspect identification, investigation and the execution of court orders

The use of this type of biometry is important in police investigations, since it provides the possibility of identifying the suspect through a voice recording. For example, when a kidnapper calls and asks for a money ransom, a voice-print can identify his/

her voice through a specialized investigation. Apart from its use in identifying the kidnappers, it is used in telephone frauds, voice recordings and transcripts.

The dependent system is mostly applied here, and it is important to develop mechanism for filtering the information due to existence of a large number of data.

In order for a voice print to be used as evidence in court, it is necessary to spot and represent the voice characteristics of the recording in question and compare them to voice characteristics of another recording. This can be done by executing appropriate analysis such as audio-linguistic phonetic or instrumental (computer).

Audio-linguistic phonetic analysis can be performed by a phonetic (phonetically). It consists of defining speech characteristics with a goal of pointing out their regularities such as: pathological patterns, speech irregularities, the use of buzzwords and maxims, various accents, etc. The result of this analysis depends on the knowledge and experience of the expert and is not objective.

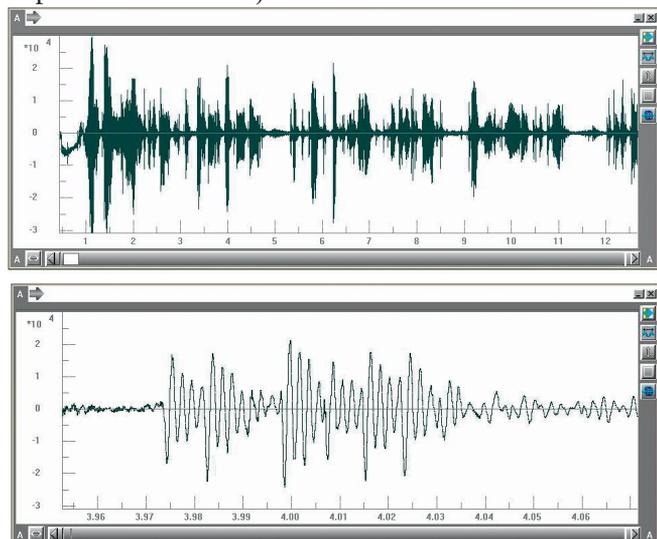


FIGURE 2. PRESENTATION OF THE SPEECH SIGNAL IN A 12 SECOND PERIOD AND ITS ONE SECOND FIGURE

Instrumental analysis is done by an engineer using modern computer technologies. Voice recording that is to be processed is usually already digitalized and depending on the way it was digitalized it is necessary for both recordings (the controversial and non-controversial one) to be compared and adjusted to similar characteristics, (Figure2.). That, as well as

other operations that are performed during instrumental analysis, are done by the use of special software adapted for forensic speech identification. After the recording adjustment, frequency of the speaker's voice is specified and compared to each other. Furthermore, signal spectrogram [7] (or digital voice print) is observed and compared to format and shape values of similar or identical voices on the controversial and non voice recording (Figure 4).

The whole instrumental analysis is based on the application of Furriers transformations which form the base of signal transformation from a time frame into a spectral field. Similar voice identification is performed in automatic systems for the speaker identification, with a difference that forensic identification requires an expert, compared to an automated identification which is done by a computer.

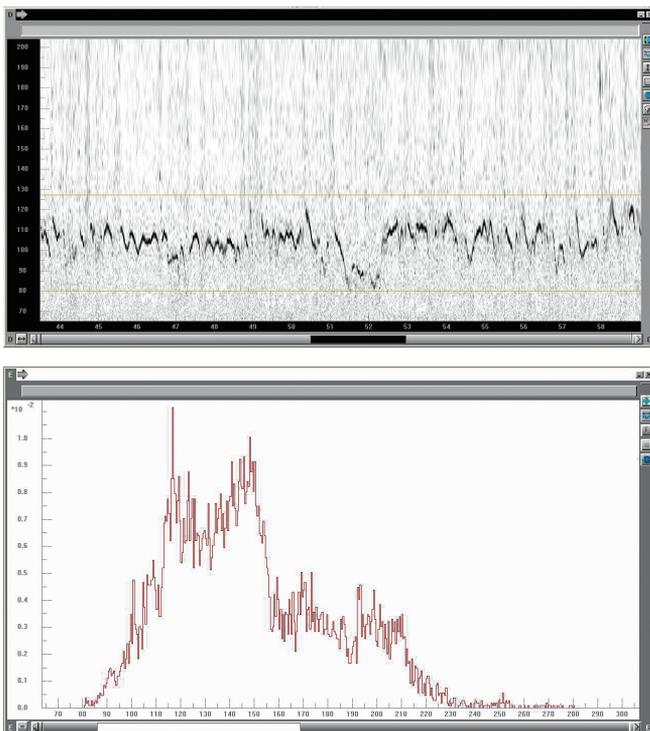


FIGURE 3. CEPSTROGRAM AND HISTOGRAM OVERVIEW OF THE BASIS FREQUENCY OF SPEECH SIGNAL

It is important to say that it is necessary to get consent from the suspect in order for this analysis to be performed.

In order for a suspect's voice sample to be adequate for the analysis, it is necessary for a sample to

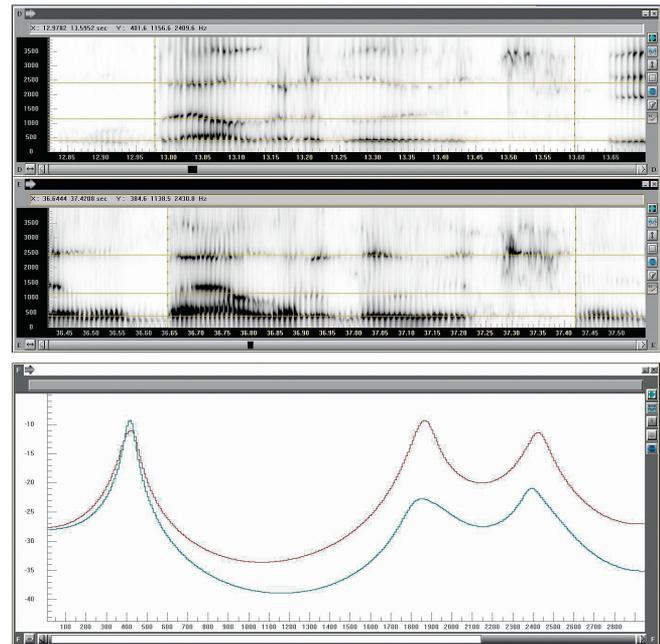


FIGURE 4. SPECTROGRAM OF THE SPOKEN SENTENCE OF CONTROVERSIAL AND NON-CONTROVERSIAL RECORDING OF THE FIRST THREE VOICE FORMATS

contain all of speech characteristics such as accent and different speech patterns under various emotional states. This is why investigations require three different ways of recordings. Suspect is first required to read a certain text, which is followed by a sentence repetition which is dictated to him. These sentences are specifically suitable for the analysis since they instigate suspect's voice to be tested in natural circumstances.

During the analysis different markers are used, but the voice pitch cannot be used as a basis for a conclusion that a person in question is the same one since the voice changes depend on the circumstances. Here is an example: Video surveillance camera recorded a thief during a night time robbery by which, the high tone of his voice was recorded. After his arrest, his voice was low since he was scared and tired. This leads us to a conclusion that the tone of the voice is not an element by which we can claim that it is the same person that we are trying to identify. Even if the tone of the voice is confirmed, it cannot automatically serve as evidence, given those two completely different circumstances.

It is also important to determine the content of spoken words especially if the sound recording is of poor

quality or if the person speaking has a foreign accent. During the identification it is important to remove the presence of other sounds such as crying, breathing, barking, etc. Moreover, it is interesting to say that during the analysis forensics compare and process voices by describing voices in the context of phonetic units-vowels and consonants. For example, forensic phonetic expert can conclude that a vowel “I” is different in two samples or that a consonant “T” can be pronounced in a specific way in both samples. Forensics analyzes taken material from the language point of view as well as non language characteristics such as voice quality, tone, pitch, intensity frequency, strength and quality of speech. The quality of speech determination is based on pronunciation, accent, consonant and vowel pronunciation, as well as sounds such as p,t,k,b,d,g which require pronounced intonation etc.

It is also important to say that this biometry is applied in the field of executing court decisions on parole prisoners. Parole prisoners are required to “call-in” to a machine at a certain time to confirm their presence in a specific place. State of Louisiana requires parole prisoners to call an official and speak a certain phrase in order to confirm that they are at a specific place [8].

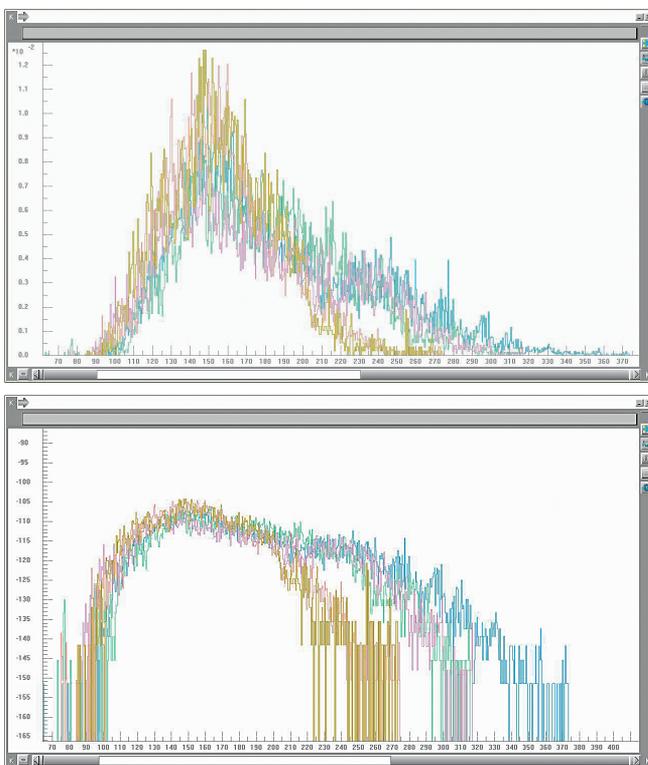


FIGURE 5. HISTOGRAMS FOR THE VOICE FREQUENCY OF THE SAME PERSON IN LINEAR AND DECIBEL SCALE

E-transactions

E-transactions are becoming more frequent ways of payment in a contemporary world in comparison to credit cards. This enables payments to be processed quicker; however, it also increases a chance of fraud, which can be decreased by applying this type of biometry. This topic will be covered later on.

On-line shopping

This type of biometry enables additional safety measure during on-line shopping. In other words, in today’s world, on line shopping is becoming more frequent since it does not require a lot of time and it can be done “from the chair“. However, this type of shopping is followed by various risks such as unauthorized credit card use, which means that somebody other than us can get a hold of our credit card and purchase items instead of us. This problem is solved by a Visa credit card company by applying voice biometrics prior to online purchases to identify and confirm a credit card user. Besides voice biometrics, the company is offering to its customers changing of their passwords via telephone which is time and cost efficient [8].

E-bay shopping

During online e-bay shopping, customer has to follow certain rules so that his/her site entry is not forbidden in the future [8]. However, this problem is not solved, since the same person can open another account and have access to the same web site. By applying this biometry, problem of this kind can be easily solved by making a user to say a certain word into a microphone during a registration process. This means that the access will be granted to a user, only if the system recognizes and confirms user’s identity.

Other applications “Smart” cars

Besides smart cell phones, other type of mass use is a smart car where communication is enabled through build-in electronic equipment via voice commands. This equipment includes FM radio, CD, air conditioning, ventilation as well as power windows, seats, lights, etc. Modern technology is enabling built in satellite navigation which gives a driver the opportunity

to be navigated to a specific place, telephone and internet lines as well as other entertainment systems such as TV, DVD, video games. However, it is important to say that these contemporary technologies should not be used while driving since they can distract a driver.

This type of biometry can be applied instead of card while entering or exiting the building or a garage. In other words, saying a certain word is safer and faster way than a card swiping which can be damaged or lost.

Applications in school system

Voice biometry is applied in schools in the United States since 2007. It was used in distributing school lunches or snacks to students. They would speak out their name and ID number which would be matched to their snack or lunch.

Voice biometrics in a contemporary business world

Voice biometrics is contributing to the employee productivity as well, which leads to a higher company profit. When we are writing or processing a certain report we do it by typing in the text into a computer. That is the way we send an e-mail which requires a certain amount of time. By applying this biometric method, much greater efficiency is accomplished in the particular case, because the time needed for some of the above mentioned actions is decreased, considering that it is much faster and easier to dictate the text than type it in. Research has shown that by using this method we can decrease the amount of time needed to finish the text of 900 words by 6, 5 minutes [2].

Some companies, such as Bell Canada, are enabling access to certain data to their employees by authenticating their identity through a phone call. This means that, by applying this biometry employees are not required to use a laptop so that they can access the desired data. Moreover, this represents more secure and faster way of accessing information.

One of the advantages can be illustrated in the following example: employees in various companies forget passwords and the procedure that requires their change is expensive. Per Say Company has pointed out that other companies spend millions of dollars on

the password maintenance that their employees use to access company's database. This kind of biometry enables employees to change their passwords by themselves without calling technical support. Password change can be executed in the following way: password change is processed when a system poses a question to a user who wants to change his/her password by authenticating it. So, if the voice is recognized by the system, the employee will be allowed to change his/her password.

The Gartner Group research has shown that 20-50% of the calls to a technical support are about password change. From the economic point of view, the average cost of password change amounts up to 32 USD per call, and the application of automated voice recording would decrease this average price to only 0.50 per call [3].

The application of voice biometry also enables auditors to access company's data by comparing their voices to a specific sample in the database [6].

In the field of social insurance, in the US, employers pay benefits for their employees online with the use of PIN number and voice sample which increases safety and security.

ADVANTAGES

Each method has its advantages and disadvantages. As far as voice biometry is concerned, research has shown that the voice is more reliable than codes. Also, it is less likely that the voice sample will fall into the wrong hands and be used for fraud.

Furthermore, voice biometry is simple and inexpensive to use since it does not require special hardware; all you need is a computer and a microphone, and most importantly it is accepted by society.

It is important to emphasize that this is the only biometrical method which gives a user an option to use the system from far away. Furthermore, the inscription process into a system is short and the authentication is quick. Moreover, biometric sample requires very small space in a computer database, as well as SIM cards in cell phones.

Today's software packages enable users to convert their voice into a text, which is directly incorporated into a word processing software or e-mail. Also, all menu functions can be voice accessed.

Physically challenged persons who are not able to use their hands to type or have vision problems can benefit from Automatic Voice Recognition.

DISADVANTAGES

Besides the above mentioned advantages there are some disadvantages to this method. The one such is a possibility that somebody records someone's voice and commits a fraud. However, the percentage of unauthorized use is very small which is supported by IBM research center. Their research shows that users, who use this method while registering online, namely hackers, would be falsely identified as real users in 0.00001% of cases [11]. In order to prevent this type of an "attack", system can ask the user to repeat a random choice of words or phrases in a certain order.

Furthermore, the disadvantage of the voice biometry is that the voice is susceptible to changes which can lead to an error. Basic factors that can lead to voice modification are [4]:

- Age (voice changes over the years);
- Disease (voice changes due to a flu, sore throat, etc)
- Acoustics (voice determined by an environment where authentication is performed)
- Person's emotional state (voice changes due to stress)
- Incorrect pronunciation of previously determined words or phrases
- Distance from the microphone or use of various types of microphones

CONCLUSION

Over time, the technology has been developing, so along with the need for transfer of spoken information, wide scope of possibilities of voice utilization has been developed, such as the "means" of personal identification, issuing orders at robotic

machines, security measures, parameters in poly-graphic research, etc.

Nowadays, the voice as the sound that carries certain information is not the only thing that matters, but voice biometrics is equally important – the numeric model of sound and pronunciation characteristic of each individual. It enables us to use voice as a unique and unchanging identifier in the world of modern machines and computers.

Like any other biometric model, this one is not perfect either, it has certain advantages and disadvantages. The advantages are its reliability, easy to use, price – inexpensive for implementation, social acceptance, etc. The shortcomings are very few and found in the fact that voice is susceptible to changes, while software and algorithms based on the voice biometrics are still not robust enough.

As there is striving for the improvement of both hardware and software, we can expect that besides the methods relating to the voice verification, we will also see the use of programs for personal identification on the basis of voice, i.e. along with the identification based on papillary lines there will be equally important identification by voice available. This possibility will significantly contribute to the curbing of crimes related to threats, ransom and extortion demands.

With the advent of technologies and computer capacities, voice biometrics is gaining in importance. New possibilities of use are appearing, advantages are being discovered and shortcomings removed. The popularity of this biometric model is growing, so in the future, voice biometrics will hold a significant position in all areas of social functioning.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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DATA VISUALIZATION ON INFORMATION TABLES - DASHBOARDS

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DOI: 10.7251/JIT1202068S

General survey
UDC: 007:005]:004

Summary: Today's level of the information technology development allows gathering of large amount of data relevant for a company. The issue of way and method of data gathering has been solved, however, at the same time the need also arises for extraction of the most important ones, since the quantity of the input data itself is not enough. In the contemporary business activities, being pursued in the circumstances of high competition, changes, speed and risk, management of the company may be compared to driving a fast car. Therefore, the information tables - dashboards have been created for the purpose of data processing as an analogy to the car dashboard, which, by means of several indicators, provides for the driver an instant insight into various data related to driving and the engine running. Display of the data in the form of charts and diagrams undoubtedly helps in obtaining new knowledge however, an individual visual displaying is seldom sufficient thus they should be combined in different variants. The work presents concrete examples of the dashboards creation both locally and globally.

Key words: Dashboard, information tables, business intelligence (BI), visual language, charts and diagrams.

INTRODUCTION

Along with high increase in the number of inhabitants on our planet, the quantity of information, processed every day, increases as well. The degree of improvement is shown in certain research fields, almost unknown until recently, since there were neither knowledge nor technological preconditions for such research. Nowadays, resources and efforts are put into new discoveries such as: human genes, virtual reality, quant computers, internet, digital communications, laser and optic fiber, cloning, cosmic technology... This is not just a curiosity of human mind seeking new knowledge, but more and more the precondition for survival. The planet earth is not boundless and human population shows the fast growing trend. The relevant institutions' forecasts show that, in 2050, there will be over 9 billion people living on Earth [1].

Such reality leaves trace in all the pores of everyday's life. Business operations are not exception as well. Digital era changes the world from its core. The year two thousand seemed to be a psychological border of a new age, and since then, almost a decade has passed. We are the witnesses of constant changes around us and, in such a context, ten years is a very long period. At the beginning of the book „Business @ the Speed of Thought“, the autor, Bill Gates, writes that since the nineteen-eighties were about quality and the nineteen-nineties were about re-engineering of business, than the two thousand would surely be about speed, the speed of business transactions, the speed by which the access to information would change the lives of the people and their idea of business. Improvement of quality and business processes will go much faster. According to him, when the speed of business becomes high enough, the very nature of the business operations changes as well... and all these changes will happen due to one very simple idea: digital information flow. [3]

In order to make this flow much smoother, it is necessary to create awareness on significance of correct and timely information required for business operations. For too long, we have lived in business information darkness and, even nowadays, we sometimes accept this as reality not realizing how much we need correct and timely information. Some companies try to change it solely by purchasing contemporary informatics equipment. The offices are crowded with computers, printers, scanners... but this is only a part of the solution.

In the business world, a digital infrastructure similar to human nervous system has been developed, which offer necessary information for thinking about certain facts or for passing timely and appropriate decisions.

VISUAL PRESENTATION OF DATA

Visual language is defined as functional and harmonized connection of words and visual elements and it represents a special way of communication which has both similarities and differences in terms of a natural communication by speech. Sometimes it is called visual-verbal language. Recently, at the presentations, on the Internet and other multimedia contents, visual language is more and more used as a dynamic link of words, pictures and forms. Visual language has significantly changed man-to-computer and man-to-man communication, having made it more efficient, more complex and more meaningful. By using it, we may express much of what was not possible to convey with just words. Given that communication is in the core of every form of business, the application of visual language creates real preconditions for creating a new quality of communication in many spheres of activities. An important question is: How to visualize the data? One of the tasks of a well conceived visualization is to "speak" clearly and directly. Computer program cannot do it by itself – a creative man is needed. A good picture is the communication by which a clear message is sent and, in order to make it the quality transfer, some esthetic principles must also be satisfied. This means that the elements of design (line, form, color, texture, ...)

must be carefully combined. This combination must also satisfy the principles of design such as: balance, contrast, emphasis, rhythm, uniformity... Information table is one of the examples of a very efficient use of visual language.

Complexly structured data is the reality of contemporary business operations but, in the informatics-wise underdeveloped business environments, written textual reports are still the dominant ones. They may include many necessary data, but the reader needs much time to see the most important contents in the abundant textual context. The higher quality reports contain important data placed in the tables. It is easier to recognize the required information in a table. The table itself may be considered a basic form of visual presentation of data. However modest, the table and the data therein may be (conditionally) formatted thus the important ones are sufficiently clearly presented. The next phase in data visualization contains graphs and diagrams while the highest degree is the level where the interactivity is added as well. Interactive graphs are unique and powerful solution for an organization which seeks the solution however, in practice, this potential is still not used enough.

INFORMATION TABLES

The Dashboard (information table) is a new name for the Executive Information Systems (EIS) developed in the eighties of the last century. Its intention was the presentation of key financial indicators to the executive managers on a simple interface. Final key information was not clearly visible on one place but was approached indirectly from several separate sources.

In the nineties, as the consequence of a fast development of information technologies, there have emerged: Data Warehousing, Online Analytical Processing (OLAP) and Business Intelligence (BI). Everything was directed towards gathering, unifying and saving the data thus having made possible the creation of timely, accurate and useful information.

At that time, the author of „Dynamics of Presentation Graphics“, Dona Z. Meilach, wrote at the begin-

ning of the book:

„It's hard to imagine what most people mentally conjure when the term computer graphics is mentioned. Something futuristic? Games? Film and television production? However you picture it now, if you're in business – any kind of business – computer graphics will have an impact on your future: not the arcade game graphics variety, or the superslick television and movie displays, but business graphics in a broad brushstroke of applications. Computers will be used to produce visuals quickly for use in and out of the office, for every conceivable type of presentation.“ [7]

The word *dashboard* has been in use only since June 2003. It was mentioned above that the dashboard has been applied in one half of the 135 observed companies. However, it was not given a clear definition what exactly is understood under this word [2].

Powerful contemporary technology is not solely a passive “creator – observer” any more, it has become an active assistant. Hardware and software, in a developed business system, provide speed, accuracy and abundance of information which is made available to the “workers of knowledge”.

The word dashboard in English denotes the control (instrument) board that a car driver sees in front of him/her, which indicates the important main parameters of the car and driving. On the basis of the status of various instruments and indicator lamps, the driver receives the information on the engine status and all other things, which enables him/her to drive properly and safely. In the contemporary business operations, performed in the environment of high competitiveness, changes, speed and risk, a company management may be compared to driving a fast car. Therefore, a company management needs clear, accurate and firm indicators of the status in the company and in its environment. Thus it needs dashboards, similar to those a car driver has. Today's level of the information technology development allows gathering of large amount of data relevant for a company. The issue of way and method of data gathering has been solved, however, at the same time, the need also arises for extraction of the most important ones, since the quantity of the very input data is not enough. It is like looking directly in

the Sun – the light, being the precondition for seeing anything, there is plenty, even too much, thus nothing can be seen. Another comparison is also known – the squirt from the firefighting hose cannot fill a glass with water. It can be concluded that more does not necessarily mean better. In terms of informatics, this means that the data gathering must be followed by its quality analysis. One of the solutions is the application of the information tables.

Quality information tables are obligatorily preceded by a good knowledge of the information graphics principles. Although the computer graphics has significantly advanced recently, the book *Information Graphics* by Robert L. Harris, from 2000, can still be considered to be one of the most important books in this field. The author writes as follows: „To many people, information graphics are the images frequently used in presentations at formal meetings or the stylized charts and graphs used in newspapers and magazines. Many are used for these purposes; however, for every chart, graph, map, diagram, or table used in a presentation or publication, there are thousands that are utilized for what are called operational purposes. Informational graphics for operational purposes are used by millions of people on a daily basis for such things as improving their efficiency and effectiveness, improving quality, solving problems, planning, teaching, training, monitoring processes, studying geographic distribution of data, looking for trends and relationships, reviewing the status of projects, developing ideas, writing reports, analyzing census data, studying sales results, and tracking home finances... Fortunately, as a result of developments in computer equipment and software, most of the popular charts and graphs used on a daily basis can be generated rapidly, easily, and with little or no special training.“ [4]

At the time of making this extraordinarily written work, the expression information tables were not in use. As it has been said, this term did not appear in the dictionaries until 2003.

Big companies create information tables by means of the expensive programs made particularly for such purpose. There is no doubt that this produces good results, but there are many others who are not ready to pay such a high price for this purpose.

The Fig. 1 and Fig. 2 give two examples of information tables created by the purposed program.

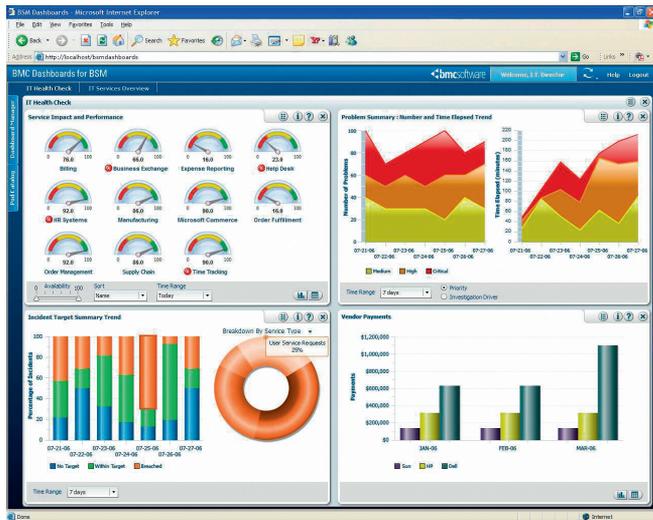


FIG. 1 INFORMATION TABLE - EXAMPLE 1 [5]

Information tables may be used for various purposes. Depending on the purpose, they have different design, each being specific, in order to be as efficient as possible. However, the information tables almost always represent some quantitative relations and show the direction of their movement. Recently, a special accent is put on an interactive visualization.

A dashboard is a visual interface that provides at-a-glance views into key measures relevant to a particular objective or business process. A dashboard consists of three key attributes.

- Displays data graphically (such as in charts). Provides visualizations that help focus attention on key trends, comparisons, and exceptions.



FIG. 2 INFORMATION TABLE— EXAMPLE 2 [6]

- Displays only data that is relevant to the goal of the dashboard.
- Contains predefined conclusions relevant to the goal of the dashboard and relieves the reader from performing his own analysis. [8]

A typical company may, for example, have the following data on its information tables:

Information tables often show some comparable parameters.

The comparisons may be various, e.g.:

Category	Contents shown
Finances	Profit, Prices, Budget, Earnings, Taxes ...
Sales	Sales points, Purchase orders, Realization, Goods pricelist ...
HR	HR statistics, Organizational structure, (Non)filled positions...
Production	Number of manufactured units, Faulty products, Supplies...
Marketing	Customers/clients statistics, Customer satisfaction, Marketing activities, Competition data ...
IT	Hardware support, Software support, Network data, Statistics of the official site visiting, IT personnel data ...
Vehicle fleet	Statistics of number, type and use of the Company vehicles ...

Comparison	Example
Same data, same measuring unit, different time	Status on the same day of the previous year or at the beginning of the current year
Actual status related to the plan	Budget Plan Realization in the given period
Relation towards the future	Percentage of achievement of the planned annual production
Spatial comparison	Shows the same event at the same time on various locations

While making the information tables, it is recommended the adherence to certain general principles such are:

- Forget about the fancy formatting
- Skip the unnecessary chart junk
- Remove gridlines
- Remove borders:
- Skip the trend lines:
- Avoid unnecessary data labels
- Do not show a legend if you do not have to
- Remove any axis that does not add value...

Due to a large variety of the information tables application, they may be divided into several categories. One of the possible divisions is shown on the figure below:

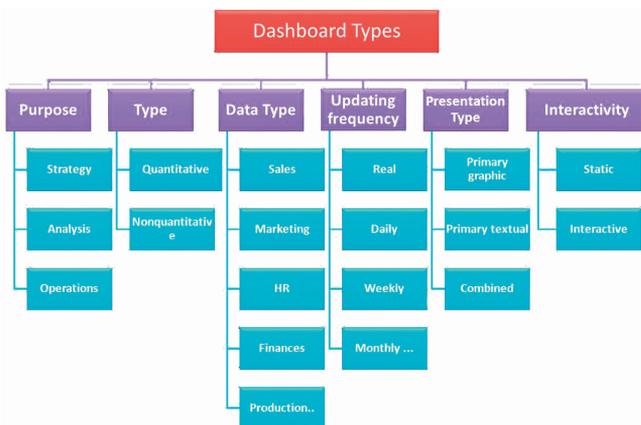


FIG. 3 DASHBOARD TYPES

Application of dashboard increases business intelligence (BI) of a company. The business intelligence is also described as a wide synergetic connection of applications and technology for gathering, analyzing and saving the data for the purpose of issuing a better business-related decision. BI is also the capability of an organization to mobilize its entire capacities and transform them into knowledge in order to release the right information to the right people at the right time. The final aim is achieving the competitive advantage on the market and lasting stability.

INFORMATION TABLES IN NATIONAL PRACTICE

It is possible to make a quality information table by means of less expensive programs, e.g. very

popular MS excel. This program’s version 2010 has been enriched with many new tools for this purpose. Once made a quality template, provides the making of new reports without constant repetition of sorting, calculation, formatting, aggregating and dividing... on new data. This offers more time for analysis of the obtained results rather than spending time on the very preparation to turn data into useful information.

In the national practice, even on the Internet, there cannot be found almost anything related to this subject, especially about concrete application of the information tables. This, certainly, gives more importance to the practical solutions developed by the Author of this paper, originated in the telecommunication company “Telekomunikacije RS“. One of the dashboard types may also be considered to be the application of the Digital Embroidery Method [9] Digital embroidery is a sophisticated visualization of the data, made by means of application of the possibilities offered by the most popular program for tabular calculation, Microsoft Office Excel 2007 or 2010. In the Digital Embroidery method, the basic principle is that worksheet cells, size of only few pixels, form a shape that will be colored depending on the numeric data joined to them. Prior to this, the criteria is defined for linking the number from the table and the color of the cell. Thus the Digital Embroidery Method links the position, number and color respectively. Change of the data in the table, automatically changes the color of the chart areas. The Digital Embroidery Method was developed for the purpose of automatic coloring of particular areas on the chart of Bosnia and Herzegovina and Europe according to the defined criteria. However, this method may be used for coloring other pictures e.g. city map, parts of various objects and everything else which contains the observed data expressed in numbers, e.g. number of inhabitants in certain area, number of students, number of registered cases or events, etc.

The picture below shows a colored map and the criteria on the basis of which certain municipal areas of Bosnia and Herzegovina were colored.

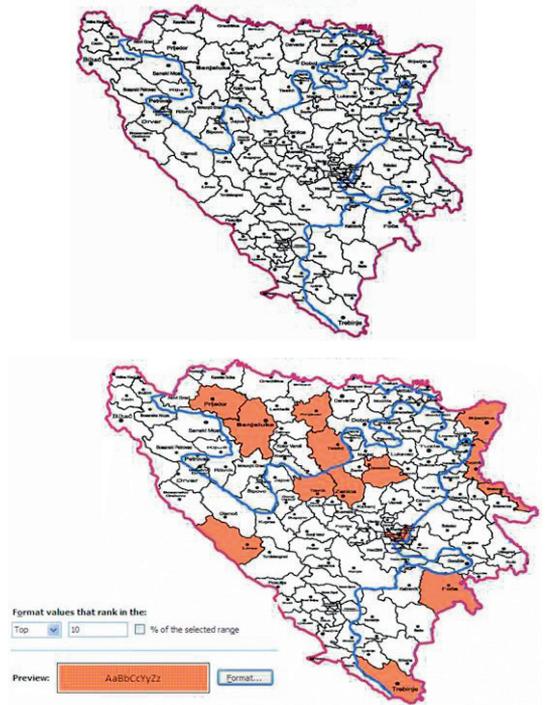


FIG. 4 APPLICATION OF THE DIGITAL EMBROIDERY METHOD

Below are the examples of the business reports the Author of the paper has created for the Telekomunikacije RS, for the purpose of making regular business analyses and reports, which may be considered to be the information tables.

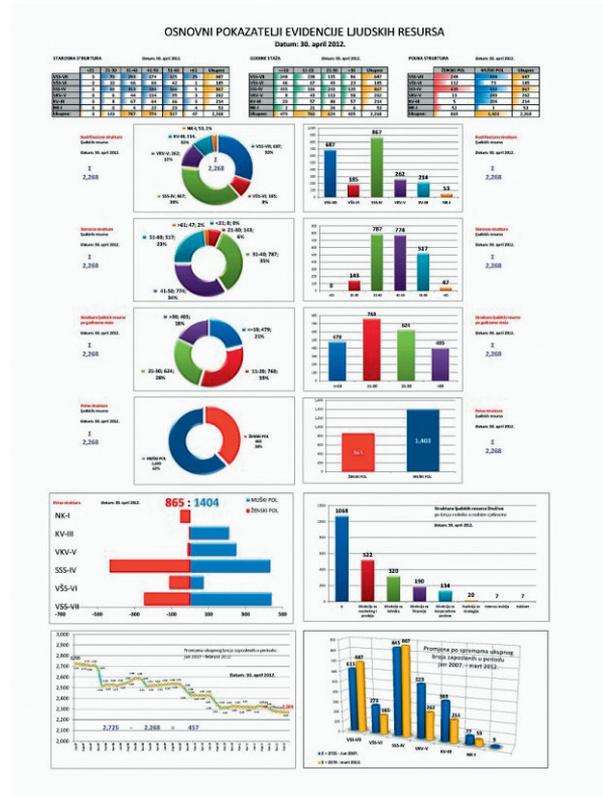
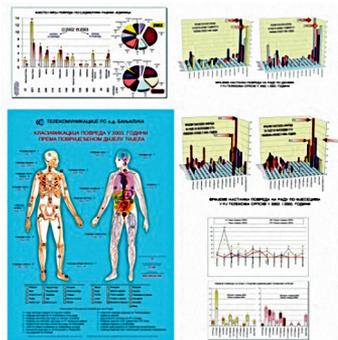
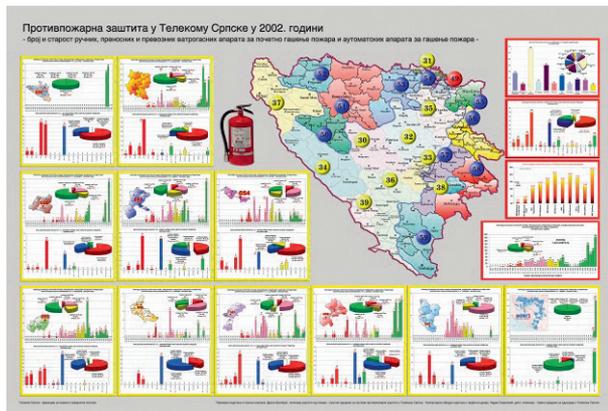


FIG. 5 INFORMATION TABLES IN USE IN THE TELEKOMUNIKACIJE RS



CONCLUSION

With application of purposely created information tables, important information in various spheres of contemporary business operations may be monitored. The information tables have been, for quite a long time, reality in the developed business world and their functional and design-wise improvement has been underway to a high extent. Therefore, the fact that they are scarcely applied in our practice is surprising. There are no technological impediments for that. It is true that there are no ready-made solutions, since every information table is separately created for particular purpose. However, this may not represent an impediment for national companies to accept and apply in practice this very powerful tool of contemporary business operations.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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DATA MINING AND CLOUD COMPUTING

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Critical review

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Summary: Cloud computing provides a powerful, scalable and flexible infrastructure into which one can integrate, previously known, techniques and methods of Data Mining. The result of such integration should be strong and capacitive platform that will be able to deal with the increasing production of data, or that will create the conditions for the efficient mining of massive amounts of data from various data warehouses with the aim of creating (useful) information or the production of new knowledge. This paper discusses such technology - the technology of big data mining, known as Cloud Data Mining (CDM).

Key words: data mining, cloud computing, cloud data mining, NoSQL

INTRODUCTION

Every day, as a consequence of business activities and, especially in recent years as a consequence of using on-line services, enormous amounts of data are being created. All this accumulated data is potentially hiding in (useful) information, such as the buying preferences, financial situation, interests, political views etc. of users or clients, which can significantly improve the decision-making. But, how to get to this hidden and potentially useful information, which is hidden in the "sea of data" when processing and storing large amounts of data, which is daily multiplying, represents a significant problem and reveals certain limitations of the traditional information and communication technologies and tools? The answer is, of course, the application of modern technology. Cloud infrastructure can be effectively used for intensive and demanding operations with data that is typical for processes of data mining. It is necessary to have available scalable data warehouses and scalable computing resources that are capable to accept, efficiently store and deeply analyze such large amounts of data, and Cloud offers that, without huge investments that are necessary if one wants to build a DM system within the IS company or organization.

GENERALLY ABOUT DATA MINING

For years, companies and other organizations "accumulate" large amounts of data and in the past few years the volume increased manifold. The question is: is some useful, some hitherto undiscovered information hidden in this data? The answer to this question can provide the application of Data Mining process (DM).

In essence, data mining is the process of discovering or finding some new, valid, understandable and potentially useful forms of data. The form of data refers to a discovered regularity among the data variables. If the detected regularity applies to all data, then it is about discovered model, if, however, the regularity can be correlated with the extent of data – it is a pattern or template.

Data mining is carried out over large volumes of data in order to „pull“ new information out of them that will be the basis for making (better) business decisions.

DM is highly multidisciplinary field, which has its roots in statistics, mathematics, information theory, artificial intelligence, machine learning theory, data-

bases and in the whole series of other related fields. It can be said that Data Mining is the natural evolution of technology, which uses the concepts, methods and techniques of the disciplines above. That evolution has began at the same time when the data was stored for the first time in the computer system and it continues with the advancement of technology access to data, and in the last few years, with the development of modern technologies which enable customers navigation through the data in real time, this new field of in-depth analysis of data and discovering new information is reaching its peak.

DM field is closely associated with the technologies of data warehousing and systems for database management, whose development directly affects the progress in the field of data mining. DM involves activities of searching large databases and data warehouses with the aim to find the hidden, so far unknown facts, regularities or patterns. With mining, it is possible to identify the following types of infor-

mation: classes, clusters (categories), conditional association events (e.g. customers who buy product A, in 70% of cases they buy the product A1), sequences, which are establishing events that in a certain probability follow one after the other and forecasts, which predict the future from the existing data.

Data mining is a complex and challenging activity, or set of activities, whose implementation requires experts from different fields. It is usual that in the DM project are participating:

- Computer scientists - their role is data preparation,
- Analysts - their task is the choice of method and methodological interpretation of the results of mining,
- Experts - they are familiar with the problem domain, define a business problem, choose relevant data and suggest activities on the basis of the obtained results.

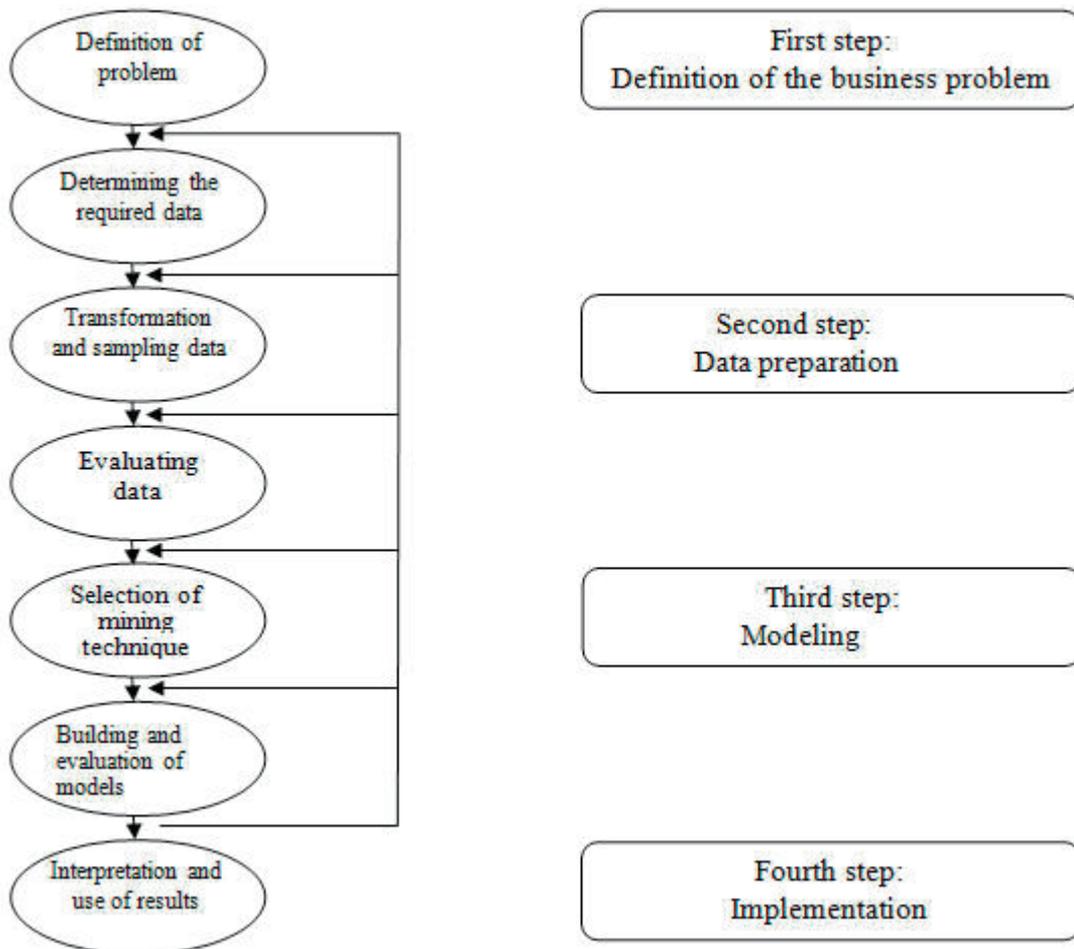


FIGURE 1: PHASES OF THE DATA MINING PROCESS [2]

It is recommended that in the project team there is one more person- the project manager, whose role is to coordinate and lead organizational DM project.

There is no prescribed procedure for data mining, which will surely and always result in finding valuable information. However, it is possible with the planning approach, following the standard steps (phases) of data mining process, significantly increase the probability of success.

Building a model is particularly important step in the process of data mining. It is a complex process that involves several activities: selections of data mining technique, identifying the case, the choice of entities that need to anticipate, identify data for analysis, optional creating dimension and virtual cube from the resulting model and processing of model and collecting the results. When creating the DM model, the biggest problem is how to apply different techniques (and different algorithms) to different sets of data, with the aim to find interesting, important and useful patterns.

A huge amount of complex and disparate information does not permit the application of the same algorithms, or technique of mining, so the role of the analyst – an expert in the field of data mining is particularly important because it is in his competence the decision on the choice of tools, techniques and methods that will be used in specific cases. In one data mining project it is possible to choose by using multiple methods, where the procedure itself is carried out in the same way as in the case of choosing one method. If it is decided that the chosen method, or methods, is (or are) inappropriate, parameters of chosen method can be changed or the selection of the new method can be made. Some of the most used methods and techniques of DM are: classification,

associations, sequential analysis, clustering, prediction, neural networks, fuzzy logic, decision tree, market basket analysis and memory based reasoning.

In the context of this work, the application of data warehouses is very important. Specifically, for the purposes of modern companies that operate in the global market, and whose IS does not end at the front door of the company, it is required such form of organizing (and management) data which is based on the concept of data warehousing. Data warehouses merge, or integrate the data from different sources, historical data on the management of company and the data (of interest) from the environment. Data warehouses, according to the technical requirements and content, are significantly different from the "standard" transaction-based systems and designed to provide one with an easier data search, their analytical processing and reporting. Data warehousing is an important concept of effective decision support system which is extensively developing in the last few years. It brings the idea of active finding and offering the information needed in the decision (business) making process. It uses the procedures of analytical processing, data mining and knowledge discovery from data. By mentioning concepts and methods based on information technology, the aim is to achieve intelligent management of the company in today's complex market conditions.

As already noted, the data enters into DW from various sources, including the company's transactional systems. The most important and most comprehensive work in the process of data storing is the integration of such data and organizing the content. These activities are part of ETL (Extract, Transform, Load) process, whose task is to capture or collect data from heterogeneous sources, transform it in the appropriate format and fill the warehouse with such prepared and filtered data. Although data mining can

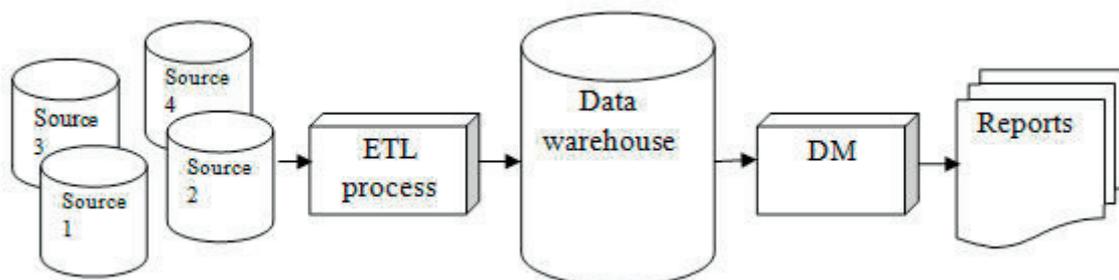


FIGURE 2: A SIMPLIFIED REPRESENTATION OF DW AS A SOURCE OF DATA FOR THE DM PROCESS

be conducted without the data warehouse, it is clear that its establishment and application significantly increases the chances of success of the DM process.

CLOUD COMPUTING

In recent years, one of the most important and interesting topics of the ICT world is certainly - Cloud Computing, therefore here will be presented only basic information and features of this technology or business model.

NIST (National Institute of Standards and Technology) defines Cloud Computing as a model that provides a ubiquitous, simple and on-demand network access to a shared set of resources (e.g. network resources, servers, data storage, applications and services) that can be readily available for use, or, if necessary, shut down, and all with minimal intervention of service providers [1]. Influential Gartner & Forrester provides the following definition: "CC is the area of computing in which scalable and highly resilient IT facilities provide in the form of services delivered via the Internet to numerous external customers." A large number of experts believe that this is about a new business model and technology platform for accommodation, launching and usage of various IT services and products. Seen from the users' point of view, Cloud Computing can be defined as a new, cheaper and safer (?) way of using software solutions which will be leased as needed. On the other hand, from the aspect of the service provider, Cloud Computing can be defined as a new way, new technology and different distribution channel primarily of IT products and provision of IT services.

Despite the large number of definitions, which have as a focus different aspects of this, and which are still regarded as controversial, business and technology model is possible, on the basis of everything previously said about them, to know the basic idea, and the possibilities offered by the concept of Cloud Computing which will surely mark, to a lesser or greater extent, the world of information and communication technologies. CC has already become a phenomenon that engages, in one way or another, the whole world of ICT. The fact that the largest (and richest) IT companies like Microsoft, Google,

Oracle and Cisco are now standing behind this concept represents a clear sign of the direction in which the world of information technology is moving, at least in the next few years. CC concept, according to NIST, has five key characteristics:

- On-demand self-service,
- Broad network access,
- Resource pooling,
- Rapid elasticity,
- Measured service [1].

Cloud service delivery models and models of its implementation

Providing CC services is divided into three elementary architectural models and different derivative combinations of the basic models. These three basic classifications are known as SPI (Software, Platform, and Infrastructure) model.

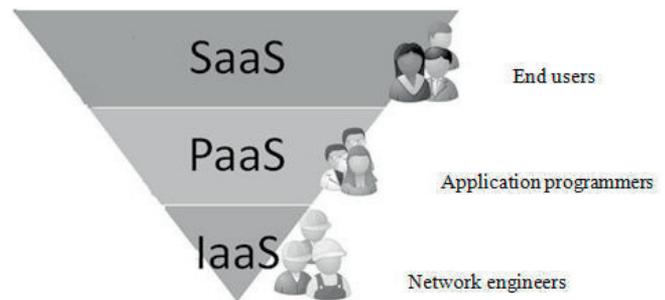


FIGURE 3: SPI MODEL [9]

Thus, the basic models of providing CC services are:

- SaaS (software as a service) - a technology platform that allows access to applications via the Internet in the form of services that are hired as needed, instead of buying a separate software programs that must be installed on the user (office and /or home) computers;
- PaaS (Platform as a Service) - model is a variation of SaaS structure that, as a service delivers environment development. Allows the user to build his own applications that run on the provider's infrastructure. Applications are delivered to users through the servers' interface accessible via the Internet.
- IaaS (Infrastructure as a Service) - provides the ability to use computer infrastructure (mainly virtual platforms). Users do not buy servers,

software, data storage or network equipment, but they buy these resources as an external service.

Regardless of the type of service delivery models (SaaS, PaaS, or IaaS), there are four basic models of implementing Cloud Computing services, including:

- Public Cloud - platform available and open to the public, regardless of whether they are individuals or organizations;
- Private Cloud - CC infrastructure accessible to only one organization. It can be managed by the organization itself or someone else who is doing that for the organization (outsourcing);
- Community Cloud - model of implementation that provides the ability for more organizations to share the same CC structure. Infrastructure supports special communities that have common interests, needs and security requirements;
- Hybrid Cloud - Model, which consists of two or more previously, discussed types of the establishment of CC structure which remain unique and independent entities, but with a certain kind of reciprocal link, in order to achieve mobility of data between them.

Advantages and disadvantages of Cloud Computing

Like any other technology, and CC, in spite of many advantages, has some (significant?) disadvantages. The table below gives an overview of them.

TABLE 1: ADVANTAGES AND DISADVANTAGES OF CC

Advantages	Disadvantages
possibility for significant cost reduction	problem of availability (lack of availability)
reducing the need for maintenance software support	safety problem
reduction of IT departments in companies	management problem
Scalability	the possibility of sudden termination of the provider
focusing on the primary business	
availability and independence of the unit	
saving energy and contribution to the conservation of the environment	

Cloud Data Mining - CDM

CDM (Cloud Data Mining) offers tremendous potential for analyzing and extracting the (useful) information in various fields of human activities: finance, banking, medicine, genetics, biology, pharmacy, marketing, etc. The application of this technology should enable that with just a few clicks of the mouse one can reach the desired information about customers, their habits, interests, purchasing power, frequency of purchases of certain items, location and so on. Cloud should enable everyone to use this potential, providing, in the form of service, what was recently reserved only for the big (and rich) companies. Small and medium-sized companies that do not have sufficient funds to invest in (too) expensive systems, now have the opportunity to rent a Cloud service for efficient analysis of all the data in the organization, as well as the data out of it, and which is of interest to the organization.

Cloud provides technology that can "handle" huge amounts of data, which cannot be processed efficiently and at reasonable cost using standard technologies and techniques. Analyzing data which coursesq to social networks, pattern recognition, processing of large-scale images, encryption and description and, of course, data mining is just one of the examples of the tasks that are ideal for implementation in the Cloud.

Data mining in Cloud (CDM) is, from a technical point of view, a very tedious process that requires a special infrastructure based on application of new storage technologies, handling and processing. Big Data/Hadoop is the latest hype in the field of data processing. Based on the algorithms and technologies developed by large Internet companies, there is a

quite widespread ecosystem of solutions for processing and analysis of huge amounts of data.

Big Data and NoSQL bases (storages)

Huge data production, in the last few years as a result of business activities, the activities within the social network etc., implies the need for efficient storage and analysis of this data. Big Data is (relatively) new term for large and complex data sets that cannot be processed and maintained by using traditional tools for managing databases. Big Data involves the use of so-called NoSQL database that proved ideal for storing very large amounts of data in distributed systems. Relational databases are based on strict principles, that means that the stability, reliability and failure resistance is insured. However, in the Cloud, where it is necessary to provide a base that has to be fast, scalable and easily extensible, relational databases deal with the problem. Of course, this does not mean that the relational model is inferior to non-relational models, but the complexity that brings relational model cannot provide the required efficiency and speed in terms of processing very large volumes of data, and the lack of scalability of RDBMS is the major cause of new (and different) mechanisms or ways of managing data - NoSQL (Not Only SQL) database. Large Internet companies such as Google, Twitter, Facebook, and Amazon, which work with very large amounts of data, have created a technology for their storage and processing in the Cloud in order to maintain distributed systems and scalability of database. Such databases, non-relational, of course, do not support the ACID (Atomicity, Consistency, Isolation, and Durability) properties in full; actually they represent pure data warehouses with simple mechanisms of data control and transactions.

NoSQL concept relies on the following grounds:

1. Scalability - ability to automatically respond (giving the required major resources) in accordance with the increase in the application;
2. Replication - data in the case of distributed databases is stored in multiple nodes;
3. Partitioning Data – means data sharing in a way that the different parts of the database are in different nodes. The goal of the partitioning

data is to improve performance when reading and writing data.

Possible occasional inconsistencies of the NoSQL base data "compensate" by providing much greater flexibility and ensuring scalability, that in the Cloud environment represents a fundamental requirement. Compromises in terms of ACID properties are necessary in CC environment because they can overcome certain limitations of relational databases and provide better performance in the following areas of application:

- Storage and processing of very large amounts of data,
- Storage and processing semi-structured and unstructured data, all with low latency reading operations and automatic scalability.

There are several key factors that influenced the appearance and development of NoSQL databases, including:

- Continued growth of data production,
- Growing demands for processing semi-structured and non-structured data,
- Avoiding complex and costly object-relational mapping,
- Cloud Computing requests,
- Effective work, efficiently storing large amounts of data and its processing,
- Scalability,
- Indispensable compromise in relation to the ACID properties.

In the last few years NoSQL solutions are developing quickly, so that today there is a significant number of them. Although there is no single definition which defines what is included in the term NoSQL, in practice there are the following classes of NoSQL databases: Key-Value, Document oriented, Graph, Column oriented.

Apache Hadoop

Apache Hadoop, an open source project, is seen as a framework for the development of distributed and scalable applications that work with very large amounts of data (measured in petabytes). It is based on Google's MapReduce algorithm and a special

data management system HDFS (Hadoop Distributed File System), which also derived from Google's File System. Hadoop was developed in Java, so it is about a cross-platform product [3].

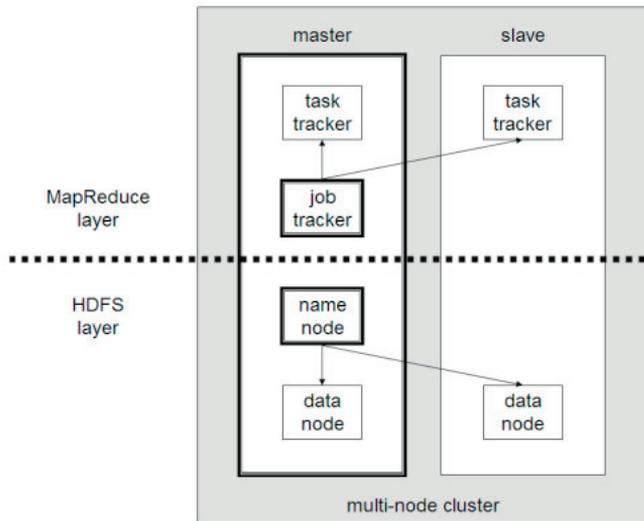


FIGURE 4: HADOOP CLUSTER [3]

It works in a manner that the tasks, needed to be done, are allocated per cluster computer and then manage those computers in order to perform tasks as quickly and reliably as possible. Hadoop framework supports the ability to perform a huge number of calculations and performs processing of "naked" unstructured data. Hadoop, among others, use Google, Facebook, IBM, Yahoo, Twitter, Amazon, Adobe and, more recently Microsoft as a part of its Azure Cloud platform. For implementation of data warehouse and in-depth analysis and data mining, additional modules Hive and Pig are used.

Apache Hive

Hive is a data warehouse infrastructure built on the top of Hadoop framework and allows analyzing data and generating queries in a way similar to SQL queries in RDBMS (HiveQL). Hive was initially developed specifically for Facebook, but today it is used and developed by others, such as Netflix and Amazon (as a part of Amazon Elastic MapReduce platform) [4].

Pig

Pig is a platform designed for high levels of Hadoop, which is responsible for making MapReduce programs.

Pig makes it easy to write MapReduce code introducing a special language - Pig Latin and the environment for the execution of such code. Pig translates the code from higher-level language (Pig Latin) into MapReduce code that is then executed in a cluster computer.

```

-----
INPUT = LOAD '/tmp/my-copy-of-all-pages-on-
internet';
-- Extract words from each line and put them
into a pig bag
-- datatype, then flatten the bag to get one
word on each row
WORDS = foreach INPUT generate flatten(TOKENI
ZE((chararray)$0)) AS word;
-- filter out any words that are just white
spaces
FILTERED_WORDS = FILTER WORDS BY word
matches('\w+');
-- create a group for each word
WORD_GROUPS = GROUP FILTERED_WORDS BY word;
-- count the entries in each group
WORD_COUNT = foreach WORD_GROUPS generate
COUNT(FILTERED_WORDS) AS COUNT, GROUP AS
word;
-- order the records by count
ORDERED_WORD_COUNT = ORDER WORD_COUNT BY
COUNT DESC;
store ORDERED_WORD_COUNT INTO '/tmp/number-
of-words-on-internet';
-----
    
```

FIGURE 5: PROGRAM CODE THAT WILL GENERATE A PARALLEL EXECUTION OF TASKS IN A DISTRIBUTED ENVIRONMENT (IN THOUSANDS OF COMPUTERS) HADOOP CLUSTER FOR COUNTING THE WORDS IN THE HUGE SETS OF DATA [5].

MapReduce

MapReduce is a module that is used for highly distributed processing of large data sets using thousands of computers. Introduced in 2004 by Google, MapReduce can be seen as a framework or system for the execution of a query in the background. Regardless of the amount of data, the system processes the entire data set for each query. Processing is defined by two functions:

- Map - transparently reading "raw data" from a distributed file system, filtering and generating pairs of key - value;
- Reduce - processing of associated and sorted pairs generated Map functions and generating output in the key - value format.

MapReduce is a fundamental concept of processing in Hadoop environment. Subsystem for performing MapReduce programs in Hadoop makes a major node, which is called „job tracker“, and a set of node’s workers is called „task tracker“. MapReduce program sent to perform an action is called "job". Hadoop divides the job into a set of tasks. Entrance to the MapReduce program is a set of data stored within the distributed file system. Hadoop shares data in the partitions of the same size which are then allocated to Map functions, or to say it performs the mapping data. Map functions generate k-v pairs that the system merges and sorts by key. When all Map functions are finished with the task, Reduce functions perform tasks on sorted and allied pairs.

Performing of tasks is completely under the control of the main node. Before the performance of specific tasks, "job tracker" must choose to which job task it belongs, that will run. Anticipated job scheduler selects the first job that comes into the job queue. After selecting the job, job tracker assigns tasks that make him free worker. Task tracker periodically reports its state to head node, where the situation represents information on the number of available slots for Map/Reduce tasks. After Map / Reduce tasks are granted, significant optimization is accomplishing. Specifically, the Map tasks are assigned to nodes’ workers that contain their own data that handles just the assigned task. This is extremely important because in this way we avoid the (expensive) network communication. The job ends when a node worker that performs the last task is presented to the head node as the one that has completed the assigned task [6].

CDM solutions in application

Considering that mining in the Cloud is something new, still there is no large number of solutions that are fully completed and available to users; however, new products are coming, and soon, a significant number of solutions for data mining which will exploit the potential of Cloud Computing will appear on the market,. Here, only some of the existing solutions will be briefly presented:

- Google BigQuery Service (Dremel),
- Amazon Elastic MapReduce (EMR) and
- MS SQL Server Data Mining for the Cloud.

Google BigQuery

Google's Cloud service BigQuery is one of the "fresh-est" services of this type. Namely, after eleven months in the previous year have passed, Google announced the limited available test version of this tool, and this service is only a few months ago (from 1.5.2012) publicly available.

Basic features: speed (analyzes billions of records in one second), scalability, simplicity (communication through simple and accessible SQL-like language), the possibility of group work, security (SSL is used to access), various possibilities of use (through the web user interface - BigQuery browser tool, over the command line, BigQuery command-line tool or through REST API). Google has provided client libraries for virtually all major programming platforms, along with scripts and examples of ready applications. Google has offered the possibility of using this Cloud service completely free of charge with a limit of 100 GB of data that can be stored and analyzed on a monthly basis [7].

Here will be shown some screenshots that illustrate the operation and features of the CDM tool. For access, it is necessary to have a Gmail account and the process of logging into the service is fast and intuitive. For testing, I used two existing warehouses that Google has made available to users just for testing purposes (natality and wikipedia).

Table Details: natality

Table Info

Table ID	publicdata:samples.natality
Table Size	21.9 GB
Number of Rows	137,826,763
Creation Time	1:47am, 2 May 2012
Last Modified	1:47am, 2 May 2012

Table Details: wikipedia

Table Info

Table ID	publicdata:samples.wikipedia
Table Size	35.7 GB
Number of Rows	313,797,035
Creation Time	1:48am, 2 May 2012
Last Modified	1:48am, 2 May 2012

FIGURE 6: BASIC DETAILS OF USED "TABLES"

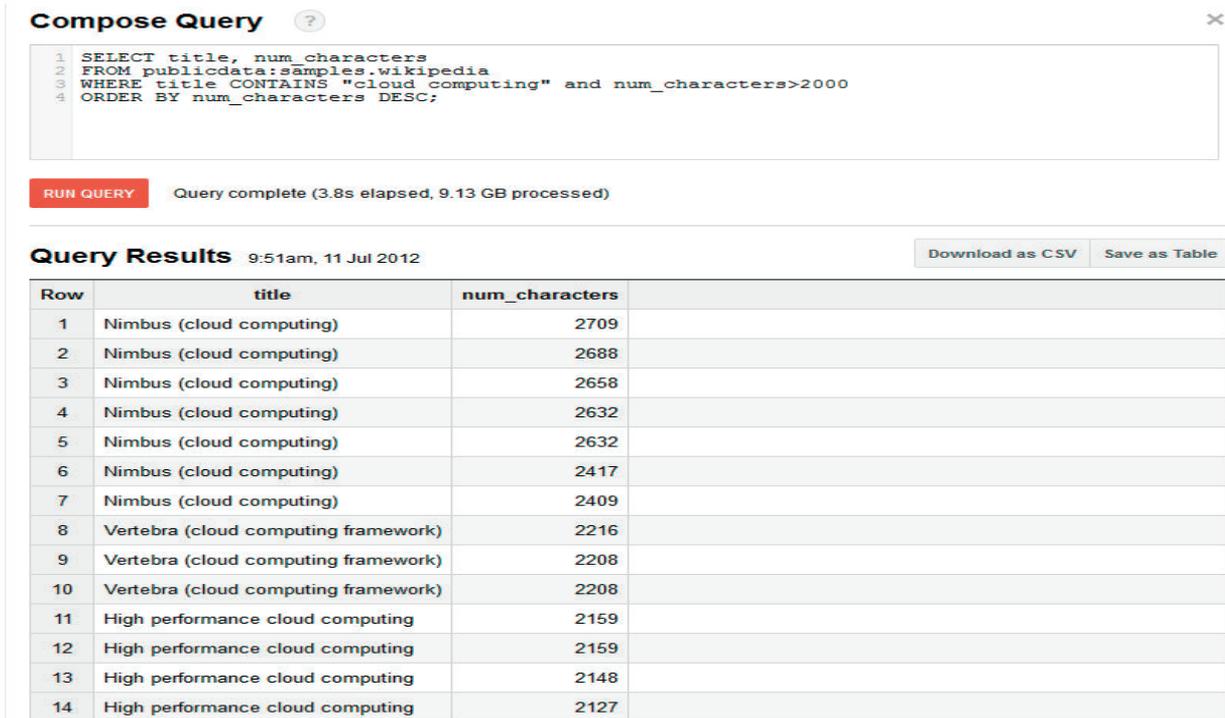
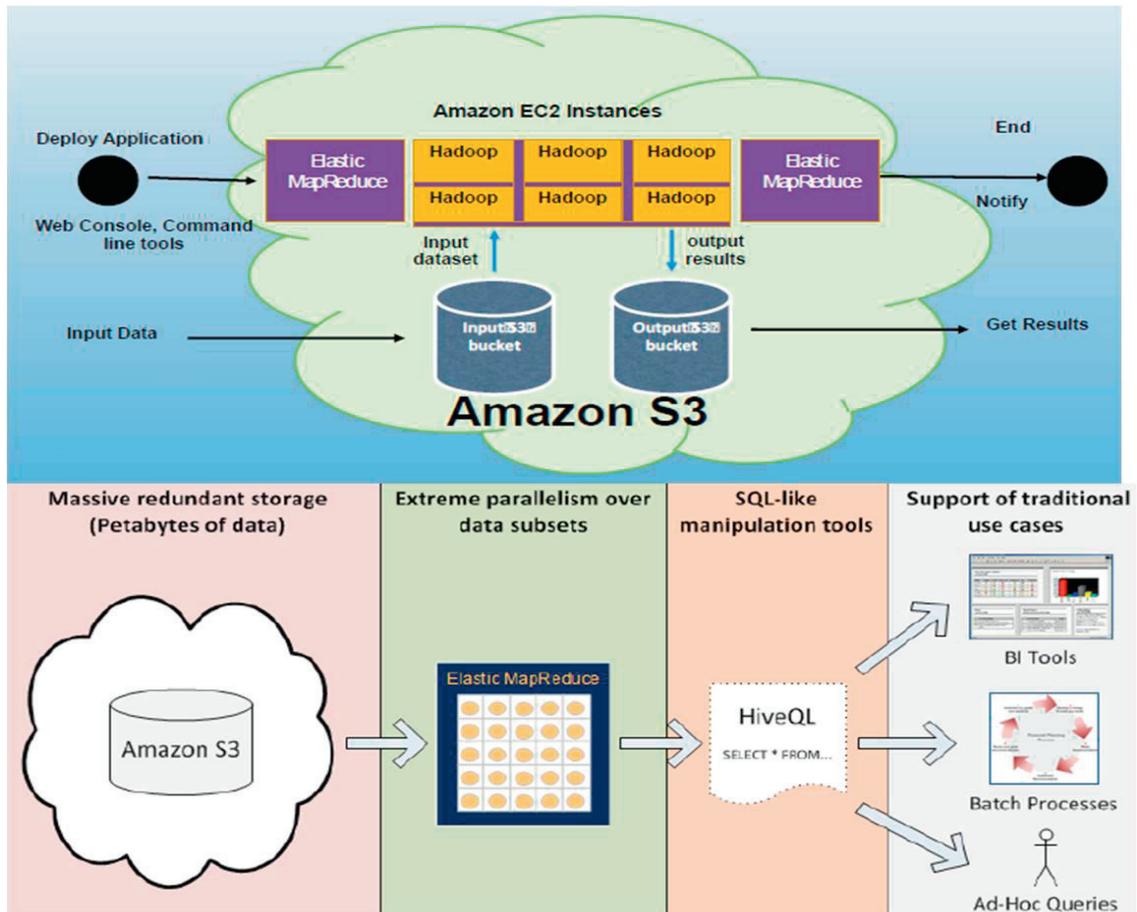


FIGURE 7: QUERY AND QUERY EXECUTION RESULTS WHICH FIND HOW MANY ARTICLES OF WIKIPEDIA IN THE TITLE HAVE THE WORDS “CLOUD COMPUTING” AND THAT THE ARTICLE CONTAINS MORE THAN 2000 CHARACTERS

FIGURE 8: AMAZON EMR ARCHITECTURE [8]



Amazon Elastic Mapreduce (EMR)

EMR is a platform for developing applications that enable analysts, developers and researchers that in a relatively simple and fast way, and without large expenses, analyze massive amounts of data from different data sets. EMR is based on Hadoop and executes on a scalable infrastructure Amazon EC2 and Amazon Simple Storage Service (Amazon S3).

Amazon EMR allows making DM applications and / or analytical scripts, which are made in the SQL-like languages like HiveQL or Pig. If, however, one wants to create sophisticated applications in Java, C++, Perl and other languages Amazon has provided quality support in the form of examples with complete source code and related tutorials. The principle of operation of the EMR can be described through the following four stages:

1. Creating scripts or applications;
2. Transfer of data and / or applications in the Amazon S3 environment;
3. Running Map / Reduce job through the management console system (AWS Management Console) where one gives the number of EC2 instances and determines the location of data

- and applications on the S3 platform;
4. Observation of the given activities till obtaining the final result of mining.

Amazon with this service provides, for many, the leading market position in the field of providing CDM services, or as some authors call it "Analytics as a Service." With EMR, Amazon targets companies that operate with huge amounts of data and companies that need elastic and flexible infrastructure for storage and in-depth analysis (mining) data.

What offers EMR?

First of all, EMR is an on-demand service, which can be classified as a category of SaaS (Software as a Service) and PaaS (Platform as a Service) solutions, depending on the implementation by the user. EMR offers flexible resources, programmability, payment according to the standard CC principle only used resources, geographically dislocated EC2 infrastructure and in most cases an increased level of security [10].

Amazon EMR integrates a wide array of tools of other, independent producers like Karmasphere An-

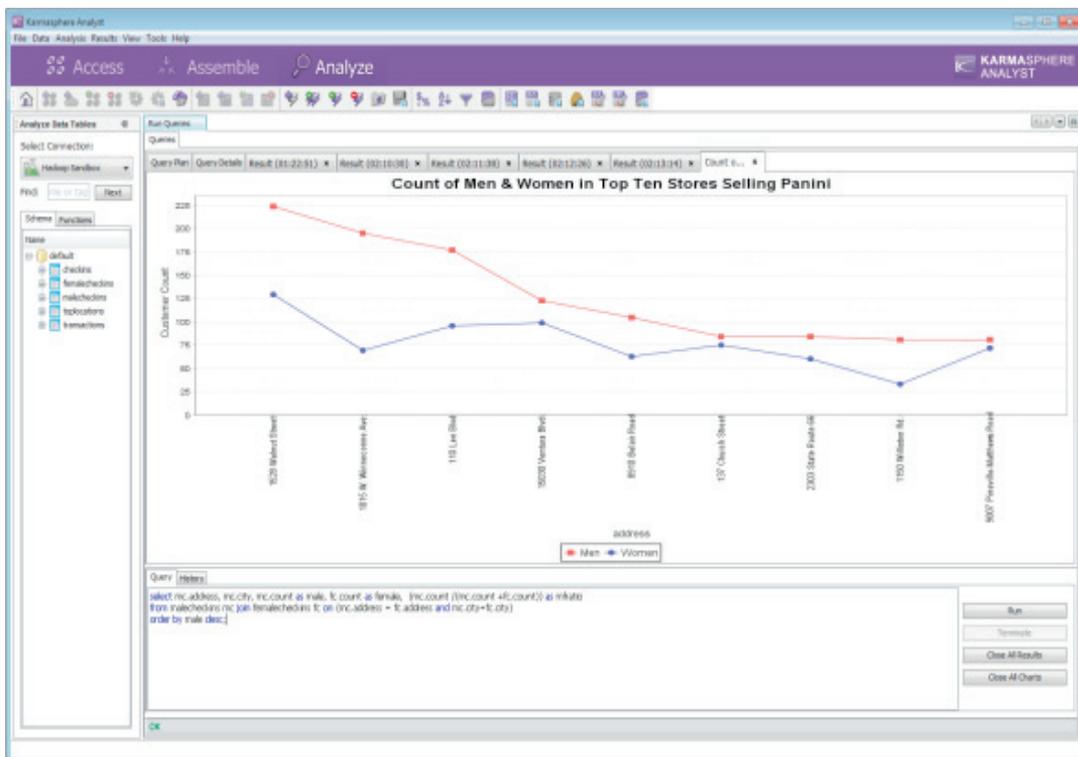
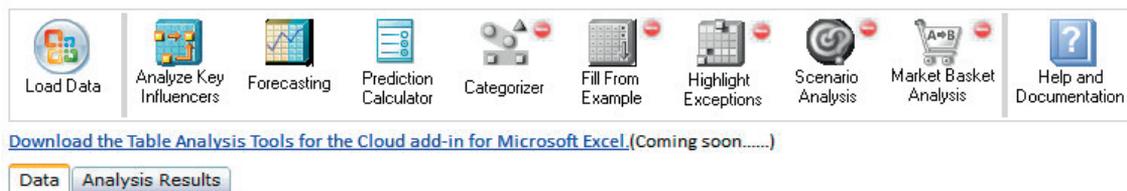


FIGURE 9: KARMASPHERE ANALYST [13]

SQL Server Data Mining for the Cloud



alyst, the intuitive integrated environment designed primarily for professional analysts.

Karmasphere Analyst provides support for the processes of "big data" in-depth analysis. It executes through the "4A" (Access, Assemble, Analyze, Act) activities or phases.

Access phase connects to the Hadoop cluster. One can create, configure and test the connection and save the connection settings for later use.

Assemble phase involves organizing structured, semi-structured and unstructured data in different formats and their preparation for the next page. The result of this phase is one or more tables.

Analyze activity allows one to perform iterative analysis, based on HiveQL language. It has a number of tools that help to define the query and its modification. When in the process of analysis it starts to recognize trends and patterns, it enters into new iterations with obtained results, which can additionally format, filter and sort.

Act is the final stage of "big data" analysis. It is conducted by obtaining results and includes certain activities of the results, such as saving in the form of database table, Hive table, in Excel format (.xls) or as a graph [11] [12].

SQL Server Data Mining for the Cloud

SQL Server Data Mining for the Cloud is a Microsoft service for performing data mining in the Cloud, and is developed as a WCF (Windows Communication Foundation) application. WCF is a set of APIs in .NET framework for developing service-oriented applications. It enables users' access to the service via a special tool or application that runs within a web

FIGURE 10: CURRENTLY (STILL) ARE AVAILABLE ONLY THREE DM TOOLS

browser and allows users to set up user data on the server / servers, selection of DM tools, configuration of tools and review of results. The connection with the service ends when the client application displays the results. The service is publicly available (with limited functionality, or with a limited number of DM tools) at <http://clouddm.msftlabs.com>. For its use no registration is required.

DM tools available to users are:

- Analyze Key influencers,
- Forecasting and
- Prediction Calculator

Service allows the upload of user's data using "Load Data" tool, which should be in .csv format or using existing tables to test - "BikeBuyer Sample" and "Forecasting Sample"

Case Study – Facebook

Intensive data mining on Facebook is impossible without the use of CC solution. With about 500 million users and an average of one billion page views per day, this most popular social network (and Cloud application) daily generates and accumulates huge amounts of data. One of the biggest challenges, practically from the start, was (and still is) solving the problem of efficient storage, processing and analyzing (mining) of this data. To solve this problem, engineers and analysts needed powerful tools for mining and manipulating such large (huge) data sets. None of the servers have the capacity that could satisfy these needs, and the use of relational databases and RDBMS is no longer an option. Facebook, therefore, in order to continue its growth and business, had to develop and implement technology that will allow daily processing and storage of about 15 terabytes of new data; data that is unstructured, in

different formats, in different languages, and from different platforms ... Facebook needed extremely powerful, massive framework with the possibility of parallel processing and with the ability of a reliable and secure storing of huge amounts of data. In addition, it had to ensure an efficient way (model) of mining this data. Such extreme requirements traditional ICT infrastructure cannot fulfill in a satisfactory manner. But CC can! For example, Cloud, for Facebook needs, delivers 8500 CPU cores, and gives the option of using petabytes (250B) of storage space. Such power and capacity provides (for now) the possibility of performing rich in-depth data analysis on a wide range of mining parameters.

CONCLUSION

We live in a time of information that is the most important and most expensive resource. Huge amounts of data daily produce and in themselves hide potentially useful information. The data that is processed does not originate only from multiple information system of companies, giant amount of it comes from "on-line" environment, with a variety of services that users use for both commercial and private purposes. This data contains significant potential, and out of it invaluable information about, for example, buying preferences, financial situation and clients (users) interests can be drawn.

The task of ICT is to create methods and tools for efficient data processing. Today, that is not an easy task, on the contrary; processing and storage of vast amounts of data that are multiplying daily, represents a significant problem and reveals the limitations of the traditional information and communication technologies and tools. For some time, and even presently, a significant problem represents a general lack of funds. Companies are no longer able to invest great funds in the development of their IT sectors. On the other hand, the need for treatment, demanding deep processing and analysis of data has never been greater.

Where is the solution?

One of the solutions, surely, can offer the integration of in-depth analysis of data (data mining) and Cloud Computing. Huge storage and processing potential of CC, and well-known techniques and methods of data mining, which have "moved to the Cloud," create a powerful platform for analyzing vast amounts of data that is produced daily and in itself it hides much (useful) information, which is the basis for new knowledge and better business decisions, which, in return, is ultimately the main goal. By developing cloud based data mining solutions accessing data mining services every time and everywhere and from various platforms and devices will be made possible. Ultimately, the application of CDM solutions can provide a sort of knowledge discovery eco-system built of a large numbers of decentralized data analysis services.

Also, a significant moment that should be noted is that the creation and giving the service of data mining in the Cloud, today a critical business activity, which, otherwise, requires significant financial and technical resources, becomes accessible to the less affluent, small and medium-sized companies that have not used so far the advantages of the applying this segment of business intelligence.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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CONTEMPORARY JAVA WEB TECHNOLOGIES AS A SERVICE FOR THE UNIVERSITY EMPLOYEES

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Case study

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UDC: 004.438JAVA:004.738.5

Abstract: This paper describes the web application used by employees of the School of Electrical Engineering in Belgrade. The application is based on contemporary open source Java web technologies (including frameworks such as Spring, JSF, Hibernate, etc.). They were combined together into an advanced system that provides an environment for the rapid application development, high modularity and configurability. Paper describes main groups of application functionalities related to teaching process and financial operations, as well as additional functionalities. Application three-tier architecture is described in detail, with the description of technologies used in each tier. Application development environment is presented including build process management. Also, the security solution is described, as well as distributed computing model chosen for communication with other information systems within the School of Electrical Engineering.

Keywords: Java, Spring, JSF, Distributed Computing

INTRODUCTION

Employees of the School of Electrical Engineering (ETF) in Belgrade have been using web-based services for several years to access and input various types of information [1][2]. These services are currently implemented through application eZaposleni (e-Employees), which is a part of Integrated Information System (IIS) developed in the Computer Centre of School of Electrical Engineering in Belgrade, in cooperation with the development team of the Computer Centre of University of Belgrade (RCUB). It is a web application based on Java web technologies [3][4] and relies on two independent IIS subsystems – Faculty Information System (FIS), for monitoring and organizing the teaching process at the Faculty and FIMES, for personnel records, financial and material operations of the Faculty.

Separate instances of eZaposleni application, with Faculty-specific customizations, are used within IIS instances at about twenty faculties in Serbia and Bos-

nia and Herzegovina, including faculties at University of Belgrade, as well as Universities Singidunum and Sinergija. Since 2010, over 1000 user accounts were created, and about one million user requests were served.

BUSINESS ENVIRONMENT AND FEATURES OVERVIEW OF EZAPOSLANI (E-EMPLOYEES) APPLICATION

A significant part of the application functionalities depends on the interaction, within IIS, with previously mentioned FIS and FIMES systems. Therefore, two groups of functionalities which deal with the processes supported by each of these two systems should be pointed out and the most significant ones will be described below. Also, for certain functionalities, communication with information systems outside IIS is implemented based on different platforms, such as the faculty library information system and information system for technical support. The appli-

cation also includes a group of functionalities that are implemented as separate modules, independent of the surrounding systems, such as records of scientific papers and books, or the possibility of uploading and downloading documents.

Within eZaposleni application, functionalities related to the records of the teaching process at the faculty include: grades input, defining and entry of students' pre-examination and examination activities, input of data on the activities of teachers in the teaching process, search and review of students' data, overview of class schedules, examination and free hall schedules, overview of student surveys and others. Special attention was paid to functionalities for input and review of students' activities and evaluations, within which, free configuration of the number and scoring of pre-exam and test activities is provided. Thereby, support is provided for recording the data sets of points and grades, regardless of the manner in which exams of a particular subject are organized. Also, import and export of data of variable structure within .csv and .xls file is made possible, which further facilitated the process of teacher input and opportunity of automation of the process. In order to better organize grades input, teachers have the possibility of temporary or permanent transfer of permissions for input of grades and confirmation of other teachers' grade inputs. Functionalities for search and review of students' data provide the ability of searching by several groups of criteria, Cyrillic-Latin conversion of entered keywords, and an overview of the basic or broader set of students' data, depending on user privileges, which can be configured at each instance of application. An especially important place within the application, from a user point of view, hold functionalities related to input and review of the entered activities of teachers within the teaching process. Information about the held classes, exercises and laboratory exercises, as well as exam duties and review of exam assignments are recorded. The teacher enters and confirms completed obligations through the application features. The calculation of benefits on the basis of held educational activities is realized through mutual cooperation of FIS and FIMES systems. Within the groups of functionalities that are applied to the records of the teaching process, the functionalities intended for a specific group

of privileged users, which are mostly Faculty authorities, have been separated. Functionalities intended for the authorities include review of engagement of employees in teaching, as well as generating reports, within which, there is a possibility of printing over 40 different reports related to the educational process (exam results and enrolment statistics, records related to classes, exams, surveys and so on).

Functionalities related to personnel records and financial and material business of faculty are partially or fully available to all users who are employed at the university, regardless of whether they are employed as teachers or administrative staff, and in accordance with their privileges. Among others, these functionalities include the review of salaries and fringe benefits to employees on various grounds, application for projects grants and overview of detailed information about them, review of worksheets, application of different email notifications by FIMES information system, possibility of sending user login to corresponding university departments of finance and personnel records, and others. Functionalities for review of salaries and benefits provide a detailed insight into the data on the payments, for the defined criteria related to the category, type of payment and time period. The data includes gross and net amounts, as well as information on tax and contributions for each payment. Records of projects are supported through the group of functionalities that allow a detailed review of project information for the managers of those projects, and the possibility of sending a request for opening projects to the Faculty authorities or the relevant department, by submitting detailed information about the project. As in the case of the educational process functionalities, in the case of personnel records and financial and material business there is a part of the functionalities intended for the Faculty authorities. Functionalities for the authorities include review of personnel information, review of the payment of salaries and compensation for employees, as well as an overview of projects and worksheets. Each of these functionalities includes review based on different criteria given by the user. Also, the Faculty authorities have the ability to review and update submitted applications for project opening, which automates the process of their approval.

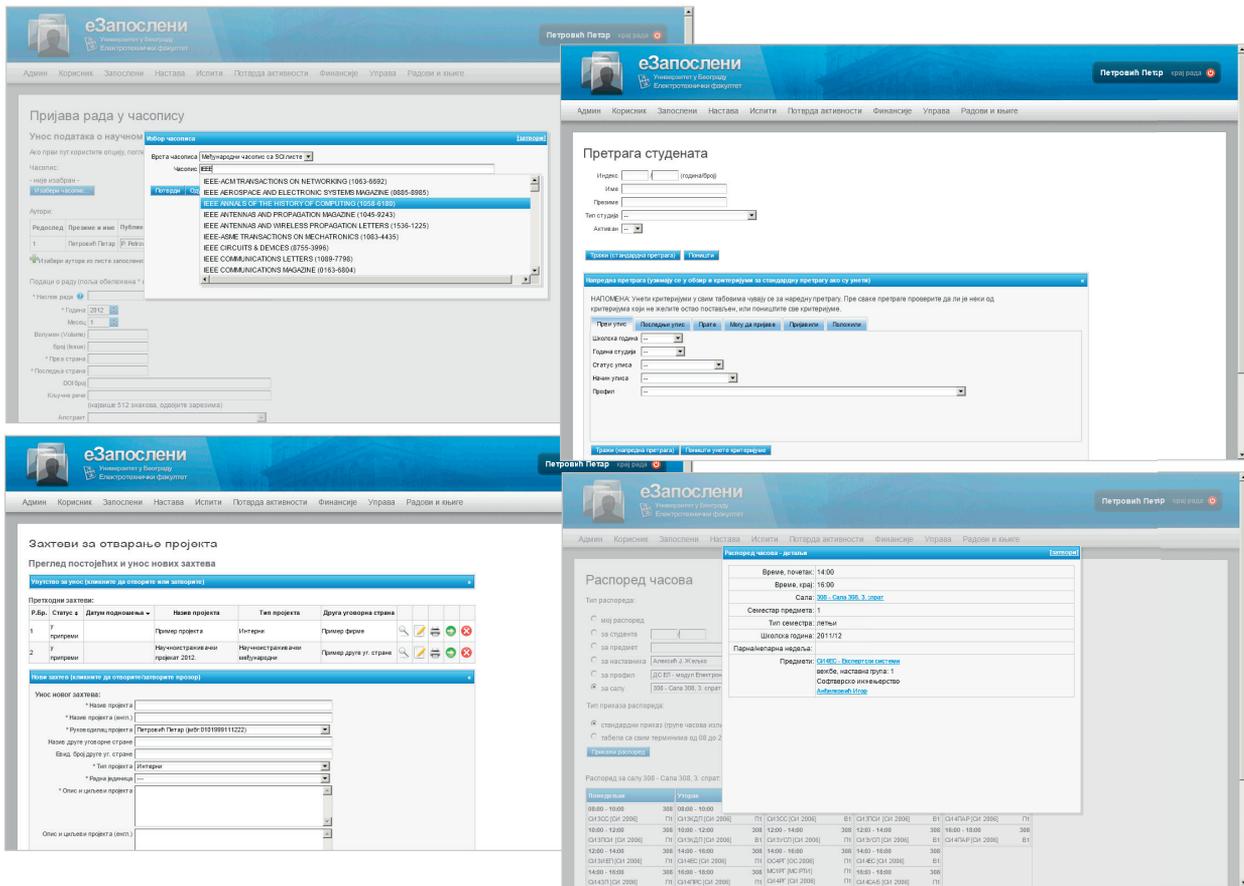


FIGURE 1 AN EXAMPLE OF eZAPOSLENI USER INTERFACE.

Within a separate module, the functionalities for the records of published books and scientific papers published in international journals have been realized, which is the basis for establishing an up to date database of scientific research within the Faculty. Users have the option of input of papers published in journals from the Science Citation Index Expanded (SciE) list, and an overview of the entered papers for which they are registered as one of the authors. Once entered, paper is attached to all users of the application who are listed as its authors, thereby avoiding the need for multiple entries for each paper. This module includes a database with currently over 11,000 journals included in SciE list that have impact factors (IF) since year 2000. Information about the journal IF can be updated within special option, and there is a possibility of insight into the evaluation of papers based on the year of publication and the journal in which they were published. A special option for the privileged user enables export of predefined set of data on published papers, in XML, for the pur-

pose of exchanging data on works with other systems. In a similar way as in the case of scientific papers, records of published books have been realized (textbooks, electronic textbooks, monographs, etc.).

In addition to these specific groups of functionalities that provide support for certain processes at the Faculty that require interaction with employees, eZaposleni application contains common functionalities, such as review of their own personal information and contacts, change of passwords, user manuals, as well as the ability to download different types of documents, forms and requests in electronic form. Setting and updating available documents is also possible for users with special privileges. System options are intended for system administrators and allow users to reset forgotten passwords and a detailed review of data on the use of application, in order to check the current load and the number of active users, and to prevent possible abuse.

OVERVIEW OF APPLICATION ARCHITECTURE AND USED TECHNOLOGIES

The application is implemented using three-tier distribution architecture [5][6], in order to achieve modularity and ease parallel development and maintenance of the individual tiers. Three main tiers are Presentation, Application and Data tier, with Application and Data tiers being multi-tiered themselves, as described below.

Spring framework is used throughout the application, to manage and connect separate tiers, as it supports the integration of different technologies that were selected for this project [7]. Java classes that form the application's business logic are defined in separate XML files, as Spring beans. To define and manage dependencies between classes, Inversion of Control (IOC) principle is applied using Spring Dependency Injection (DI) mechanism. In this way, higher level of code re-usability and easier testing is achieved. One of the main benefits achieved by using Spring DI is the so called loose coupling, i.e. defining dependencies between objects and their behavior through the interfaces and defining the appropriate interface implementations via the meta-data. The implementation of particular interface may then be easily changed without changing the code, but only by changing the configuration files. Therefore, some of eZaposleni application tiers are divided into two packages, containing interfaces and implementation classes, in order to support loose coupling principle.

Data tier is responsible for integration with the RDBMS. Currently, PostgreSQL version 9 is used as the most advanced open source RDBMS solution. This tier is separated into Domain and DAO tiers, first one containing the Domain objects and latter containing DAO (Data Access Object) interfaces and implementations. Data is managed using Hibernate implementation of JPA specification. Domain objects are Java classes that map tables from relational databases using JPA annotations for object-relational mapping. DAO interfaces and implementations provide methods for manipulating data and include mostly simple CRUD operations. Hibernate uses entity manager object to maintain the integrity of the Domain objects.

Application tier provides business logic and it is divided into Service tier and Controller tier. Service

tier methods provide implementation of application use cases, by communicating with one or more DAO tier interfaces. This layer is also responsible for the transaction management that is defined in a separate XML descriptor using Spring AOP, and is executed on the selected service methods. Spring AOP additionally simplifies the transaction management by defining aspects at meta-data level, and applying them transparently to the defined methods, at their execution time. In this way, a very important part of application business logic is clearly separated and can easily be maintained or changed. Controller tier consists of Java bean classes that are called controllers within application and are used as JSF managed bean, i.e. the communication between presentation tier and the controllers is implemented using JSF technology. Each controller supports user actions within one or more views using action methods that interact with one or more Service tier interfaces.

The third layer is the presentation layer that allows display of data to users. Graphical user interface is implemented using JSF 1.2 with RichFaces 3.3 component library to provide better interaction and more convenient use. Web pages conform to XHTML syntax, as a standard recommended by W3C (World Wide Web Consortium) [7]. RichFaces components have a built-in support for AJAX asynchronous calls to the server and allow partial loading of parts of web pages, which speeds up the GUI. Facelets technology is used for view rendering, and it also provides advanced page template mechanism in order to reduce development time and minimize the maintenance of GUI [8].

Spring Web Flow technology is used to navigate users between pages because it enables easy definition of complex scenarios of usage where it is necessary to guide users through the exact defined steps.

The modularity of the applications is further enhanced by the division into independent modules - packages that include groups of similar functionalities. It should be noted that presentation tier components, that is, JSF views, are also stored in these packages, as well as Spring XML declarations, making it easier to add or remove individual modules and export them into JAR libraries.

SPRING SOLUTIONS IMPLEMENTED IN EZAPOSLENI APPLICATION

The “core” of eZaposleni application, as already said in previous chapter, is Spring framework (currently, version 3.0) and its DI mechanism [9]. DI represents pattern in which values of attributes of an object, during its creation, are placed from outside, by another object. In the case of Spring technology, the facility which implements DI is called Spring IoC Container, and is realized using two interfaces – BeanFactory and ApplicationContext, latter being the complete superset of the first and more frequently used. Information about classes that need to be instantiated, the extent of their mutual dependence is stored in the form of metadata, into XML configuration files. Instantiation of the IoC Container in the case of Java web application is done by adding the appropriate configuration (two context listeners) into web application descriptor (web.xml file).

In eZaposleni application, ApplicationContext interface was used to connect the dependent objects that are located in adjacent layers of the application. In addition of using the DI for connecting classes within the application, Spring framework's support for other tools was used and embedded, such as Hibernate or iBatis, which enables easier configuration of these tools. Again, DI templates and XML configuration was used, without additional Java code. Spring Aspect Oriented Programming (AOP) module is also used, primarily for managing transactions, as well as Spring Web Flow and partially Spring MVC (dispatcher servlet).

Important parts of the application structure are HTTP Invoker (used for implementation of distributed programming) and Spring Security (in the field of application security). The implementation of these technologies within eZaposleni application is described below.

Since it is a web application with a thin client, which should be available from anywhere on the Internet, special attention was devoted to the application security, that is, authentication and authorization of users. As a solution that meets all set requirements in terms of safety, as well as being a part of Spring technology, Spring Security project was elected. Con-

figuring Spring Security is done by defining a corresponding class in XML files within the application, which is loaded by Application Context along with the other Spring XML definitions. Additional benefit, introduced in Spring Security from version 2.0, is so called Namespace configuration that allows easy setup of security options through the usage of predefined XML components. However, it must be noted that for each advanced configuration of security elements it is necessary to use the classic way of defining beans, which gives greater freedom in choosing classes for the realization of some functionalities. In eZaposleni application Namespace, configuration elements were used as much as they were able to respond to requests, while additional adjustments were made using standard definitions beans. Setup of the security options is separated in a special XML configuration file. Namespace configuration included the parameters definition of the basic <http> element, as well as its sub items - definition of login form, templates that determine which user roles would have access to certain URLs application, limiting the number of sessions per user etc. Additional settings, implemented by standard bean definitions, refer to the definition of appropriate classes for the connection with application database and fetching of users data (username, password, roles), as well as defining passwords encryption (SHA-256 with the username as a salt). There is a possibility for further extension of configuration by using classes that will decide on the possibility of access to the application on the basis of arbitrary parameters, such as IP address of the user.

It is mentioned that one of the most important requirements that was set is the efficient implementation of communication through the remote reference service with the existing and future versions of university information systems. Given the fact that eZaposleni and other surrounding systems rely on Spring technologies, for their communication, one of the following RPC models for which Spring libraries provide adequate support: RMI, Hessian / Burlap, HTTP Invoker or JAX-RPC/SOAP was elected [3]. HTTP Invoker model was chosen, which allows remote calls via HTTP and using standard Java serialization of facilities. HTTP communication is an important requirement, given the security constraints of the ETF network which would represent a problem for stan-

standard RMI services. Furthermore, Spring provides full support for the implementation of this model through the XML configurations. HTTP Invoker model is, on the "client" side of the application, implemented by declaring bean in the application service layer, which references the Spring class `HttpInvokerProxyFactoryBean`. Within the declaration, `ServiceURL` and `ServiceInterface` attributes were initialized. `ServiceURL` represents URL to which the application that provides the service responds. `ServiceInterface` is the name of the interface with service methods signatures. Declared `HttpInvokerProxyFactoryBean` has been included as an attribute into all other service beans which need fetching of data from remote systems. Within those beans it is treated as a standard Spring bean and there is no need for additional adjustments related to HTTP Invoker. On the "server" side, in an application that provides service, HTTP Invoker model has been realized through declaration of an `HttpInvokerServiceExporter` type bean, with `service` and `serviceInterface` attributes. The first attribute references the bean with service methods, and the second one the interface implemented by service bean. In order for the HTTP Invoker to translate customer requirements into service methods, it calls the corresponding servlet in web application descriptor that provides the service, which has been defined. Servlet name must be identical to the name of an `HttpInvokerServiceExporter` bean. Servlet URL pattern determines through which URL application the service will be provided, that is, which `ServiceURL` attribute will be used by HTTP Client Invoker.

APPLICATION BUILD PROCESS AND DEVELOPMENT ENVIRONMENT

Application structure, build process, and dependencies are managed using Apache Maven 3. Multi-module application structure is defined in Maven's Project Object Model (POM) files, and further customization is realized using different parameters for each instance of application. In this way, creating application web archive (war) file for desired application instance is simplified and is performed by using single Maven command.

Eclipse IDE 3.7 (Indigo) is used as an application development environment, as well as Spring Tool Suite (STS), version 2.9.1 which is based on the Eclipse In-

digo platform and comes with integrated features and pre-configured support for the development of J2EE applications based on Spring technology. Eclipse was chosen due to extensive configuration options, and as a good support in the form of supplements for other tools used for developing applications. Version control is implemented by using Subversion and Subclipse plug-in for Eclipse. Support for review and validation of Spring XML configuration files and bean definitions is provided by Spring IDE tools for Eclipse. In order to accelerate the development of GUI, JBoss Tools Eclipse add-on was chosen, which provides content assist, visual page editor, full compatibility with RichFaces and Ajax4JSF components, and support for both standard JSF and Facelets components. Apache Tomcat 7 is used as an application container in development and production environment. In production environment, Apache HTTP Server (httpd) is used in front of Tomcat, to provide additional security and configurability.

CONCLUSION

Solutions implemented in the application *eZaposleni* were chosen not only to facilitate communication and adjustment of surrounding systems, but also to be mutually compatible and, when possible, to effectively complement one another. Thereby, further development of the system in terms of adding new functionalities such as dynamic control of user privileges with the help of a Spring Security or multilingual support should be facilitated. Also, the transition to the new versions of used development tools and frameworks, or complete replacement of technologies in certain application layers is facilitated. Current development environment allows rapid adjustment of the system for different needs, so that it can be used as a template for a series of similar web applications. Finally, it should be noted that all used technologies are free of charge, which makes this system ideal for students' research projects.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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MANAGEMENT OF INDUCTION (ASYNCHRONOUS) MOTORS USING PLC

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Case study

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Abstract: This paper describes the management of an induction (asynchronous) motor using PLC and VSD. For the realization of the practical part of this paper Schneider Electric equipment was used, which makes a complete system that is used in Natron Hayat d.o.o Maglaj, where this experiment was done. For this paper, a Schneider Zelio PLC was used, which with the aid of a 5.5 kW Schneider Altivar ATV312HU55N4 modulator (frequency transformer), managed the work of a 5.5 kW induction motor at speed of 1500 RPM. Managing controls were given for HP mobile working stations, where Windows XP operating system with SCADA software from DAQFactory was installed. The link used between the working stations and the PLC was Ethernet (Modbus TCP/IP).

Keywords: asynchronous, motor, PLC, VSD, frequency, transformer, management, SCADA, software, DAQFactory

THREE PHASE AC ELECTRICAL MOTORS

The first electrical motor was a unidirectional motor (DC motor) made in 1833. Speed regulation of this motor is simple and corresponds to the needs of a number of applications and systems. In 1889, the first alternate motor (AC motor) was made. Even though a lot more robust and simple, the three-phase motors had one huge flaw. Their rotation speed was constant, so were the torque characteristics, and that is the reason why AC motors were not used in special applications where speed regulation was requested. Three-phase motors are electro-magnetic transformers of energy, which convert electrical energy into mechanical (motor mode) or vice versa (generator mode) in accordance with the law of electro-magnetic induction. The law of electro-magnetic induction states that if a conductor is moving in a magnetic induction field B, so that it cuts the field lines, it will induce a voltage. If a conductor is part of a circuit, electricity will flow through it. When a conductor is in motion, force F which is vertical to the magnetic field lines, will act on it. Generator mode (induction

in motion). In the generator mode by moving the conductor in a magnetic field, we generate voltage on its ends, (Figure 1), Motor mode.

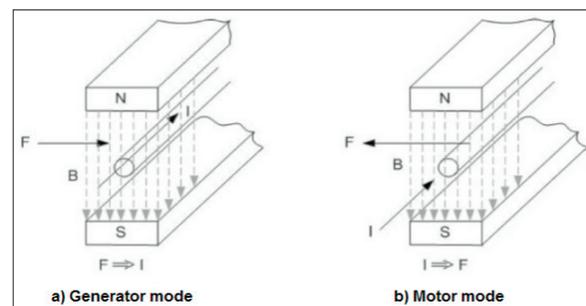


FIGURE 1. THE PRINCIPAL OF ELECTRO-MAGNETIC

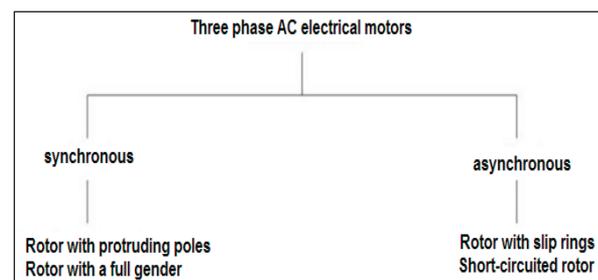


FIGURE 2. TYPES OF THREE-PHASE ELECTRIC MOTORS INDUCTION

In this case, we have a conductor in a magnetic field through which electricity is flowing. Then, there is a force on the conductor which tends to move the conductor out of the magnetic field. In the motor mode, the magnetic field and the conductor with electricity generate movement (Figure 2).

A motors magnetic field produce a static part (stator), and the electro-magnetic force that acts on the conductors is on the mobile part of the machine (rotor). Three-phase motors can be divided into two main groups: asynchronous and synchronous motors. Stators on both motors are alike, but the design and motion of the rotor in relation to with the magnetic field is different. With synchronous motors, the speed of the rotor concedes with the speed of the rotating field, while with asynchronous the speed of the rotor is different.

ASYNCHRONOUS MOTORS

Asynchronous motors are the most used motors and hardly need maintenance. In a mechanical sense, these motors are standard units, so that compatible distributors are always near. There are a few types of asynchronous motors, but the work principle on all is the same. The two main parts of the asynchronous motor are the stator (static part) and the rotor (motional part). Stator is the static part of the motor. It consists of a casing (1), bearing (2) on which the rotor lays (9), side panels, ventilator (4) which is at the end of the casing and used for cooling of the motor and protection cap (5) used as protection from the ventilator. Terminal box (6) is placed and mounted on the stator casing. The stator casing holds the magnetic core (7) made of thin (0.3 – 0.5mm) iron sheets. These sheets contain grooves in which three-phase coils are placed.

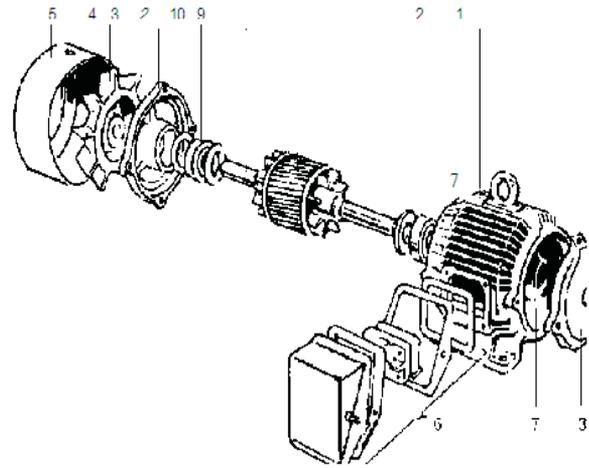


FIGURE 3. MAIN PARTS OF THE ASYNCHRONOUS ELECTRIC MOTOR

Phase coils and stator core produce magnetic flux. The numbers of paired poles determine the rotation speed of the magnetic field. When the motor is connected to a nominal frequency, it is that, that the speed of the magnetic field which is called the synchronous motor speed (n_0) and in Table 1 the connection between the pairs of poles (p) and speed (n_0) is shown.

Magnetic field. A magnetic field rotates in an air space between the stator and rotor. The magnetic field is induced after the connection of a phase coil to power. The position of this magnetic field in relation to the stator is fixed, but is changing directions. The speed in which the direction is changed is determined by the power frequency of the motor. In a network frequency of 50 Hz, the field changes direction 50 times in a second. If a two-phase coil is connected to an appropriate power, the induction of the two magnetic fields will occur immediately. In the motor with two poles, a movement of 120 degrees exists between the two poles. The maximum that is reached by the two poles is time-shifted. This causes the magnetic field not to be static any more in rela-

TABLE 1. CONNECTION BETWEEN NUMBER OF PAIRS AND POLES

Pairs of poles	1	2	3	4	6
Number of poles	2	4	6	8	12
n_0 [1/min]	3000	1500	1000	750	500

tion to the stator, but starts to rotate. However, this rotating field is highly asymmetrical, until the third phase is connected. Three phases generate three magnetic fields mutually shifted in space for 120 degrees.

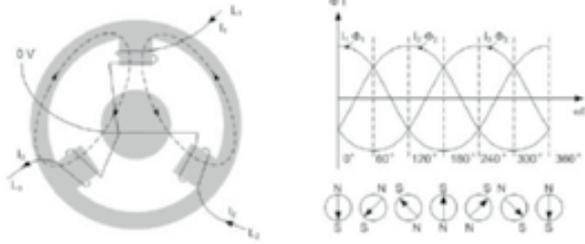


FIGURE 4. INDUCED FIELD OF ONE PHASE

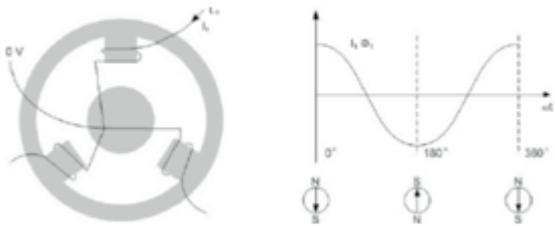


FIGURE 5. TWO-PHASE ASYMMETRICAL ROTATING FIELD

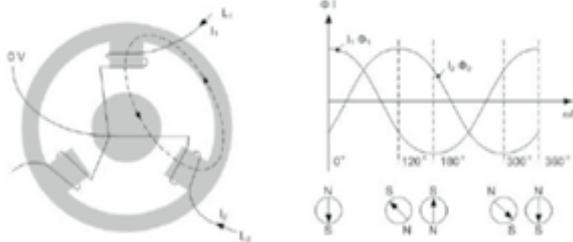


FIGURE 6. THREE-PHASE SYMMETRICAL ROTATING FIELD

The stator is now connected to a three-phase source of power, and the magnetic fields of each of the coils together make a symmetrical rotating magnetic field. Rotating field amplitude is constant and 1.5 times greater than a one-phase magnetic field amplitude.

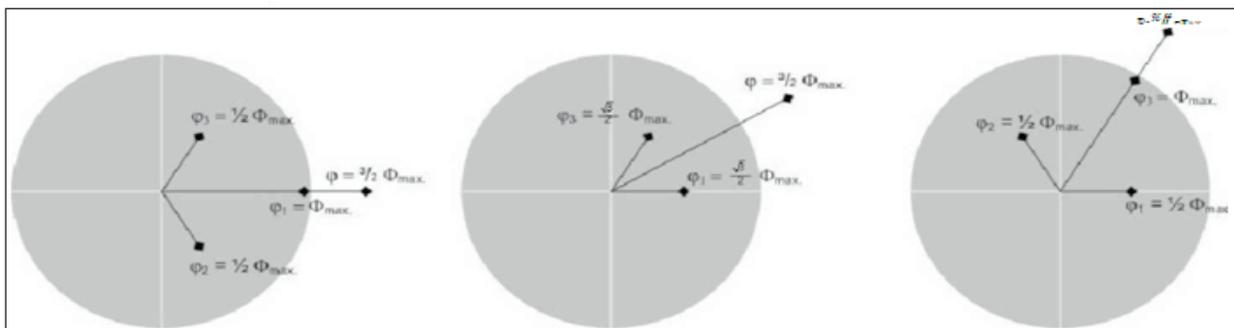
$$n_0 = \frac{f \times 60}{p} \left[\frac{1}{\text{min}} \right]$$

Where: f=frequency, n0=synchronous speed, p= number of pole pairs is.

Speed depends on the number of pole pairs (p) and frequency (f) voltage. The illustration shown below, Figure 7. shows vector scales of the magnetic field at three different moments. The diagram of a reverse field with a vector and appropriate angle speed gives a circle. As function of time, in a coordinated system, the rotating field gives a sine curve. If during pole rotation the amplitude changes, then the rotation field would look like an ellipse. The rotor is mounted on the motor shaft (10).

As well as the stator, the rotor is made of grooved thin iron sheets. There are two types of rotors: *rotor with slip rings* and *a short-circuited rotor*; the difference is in the coils placed into the grooves. The rotor with slip rings, as well as the stator, has coils of wire placed in the grooves and for each phase one slip ring onto which coils are connected. After brief joining of the slip rings, the rotor with slip rings will work in the same way as the short-circuit rotor. With short-circuit rotors, aluminium rods are poured into the grooves. Aluminium rings are placed at the ends of the rotor which briefly connect the rods. A short-circuit rotor is used more often. Having in mind that the work principal of both rotors is the same, here we will describe only the short-circuit rotor, because it is the type of electric motor we used for this paper. This flux induces electricity (Iw) in a rotor rod on which force (F) begins to act on. Force on the rod is determined by magnetic induction (6), inducted electricity (Iw), length of the rod (l) between the force vector and magnetic induction vector: $F = B \times Iw \times l \times \sin a$. If we put that $a=90^\circ$, the term for force is then: $F = B \times Iw \times l$ rotor and angle (a) between the

FIGURE 7. MAGNETIC FIELD AMPLITUDE IS CONSTANT



force vector and magnetic induction vector: $F = B \times Iw \times I \times \sin a$. If we put that $a=90$ degrees, the term for force is then: $F = B \times Iw \times I$.

The next pole, whose magnetic field runs through a rotor rod, has an opposite polarity. This magnetic field induces electricity in an opposite direction.

As the direction of the pole is also opposite, the force has the same direction as before (Figure 8). If a whole rotor is now placed in a reversed magnetic field, the force which tends to spin the rotor acts on the rotor rods.

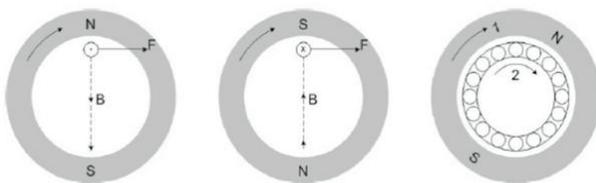


FIGURE 8. INDUCTION IN ROTOR RODS

FREQUENCY TRANSFORMERS

Static frequency transformers are electronic devices that enable the management of the speed of three-phase motors transforming network power and frequency, which are fixed values, into changeable values. While principles stayed the same, a lot has changed since the appearance of the frequency transformer, which contained thyristors, till today's transformer is managed by a microprocessor. Most of the static frequency transformers used nowadays in industry for the regulation or management of speed in three-phase motors were made on the basis of two principals:

1. Frequency transformers without an inter-circuit (known as a direct transformer).
2. Frequency transformers with changeable or constant inter-circuit.

Frequency regulator consists of four main components:

1. Adapter, which is connected by the main mono/three-phase AC power and generates pulsing DC power. There are two main types of adapters – controlled and uncontrolled.
 - a) Convert adapting power to direct electricity
 - b) Stabilize (iron) pulsating DC power and make
2. Inter-circuit. There are three types:

it available to the inverter

- c) Convert the constant DC power of the adapter into changeable AC power

3. Inverter, which generates power frequency on the motor. Alternatively, some Inverters can also convert constant DC power into changeable AC power.

4. Management circuit, which receives and sends signals from the adapter, inter-circuit inverter. Parts of the regulator which are controlled depend on the design of the regulator itself. What all frequency regulators have in common is that the control circuit uses signals to engage and disengage semiconductor elements. Frequency regulators are divided by their cut-off mode that controls the motors' power. For this paper we used a 5.5 kW Schneider Electric frequency transformer, type Altivar ATV312HU55N4, and 400 VAC of entry power, Figure No. 9.



Figure 9. Schneider Electric Altivar ATV312HU55N4 frequency transformer

The needed adjustment of parameters of the frequency transformer for the 5.5kW, synchronous speed of 1500 RPM, three-phase induction motor that was used, we did with the help of a local control panel which is mounted on the frequency transformer.

SCHNEIDER ELECTRIC ZELIO SMART RELAY/PLC

PLC (Programmable Logic Controller) is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. Zelio falls under the category of sophisticated “smart” relays which have limited abilities of programmable logic controls and are provided for managing smaller systems, electric motor propulsions and such. Advantages of these controls are a modular concept with a low price. Programming logic inside a Zelio control can be established through a function panel, in other words, interfaces on the basic module control or with the aid of a PC, with corresponding cable and software “Zelio Soft”. The starting configuration of the chosen Zelio hardware is shown in Figure 10.

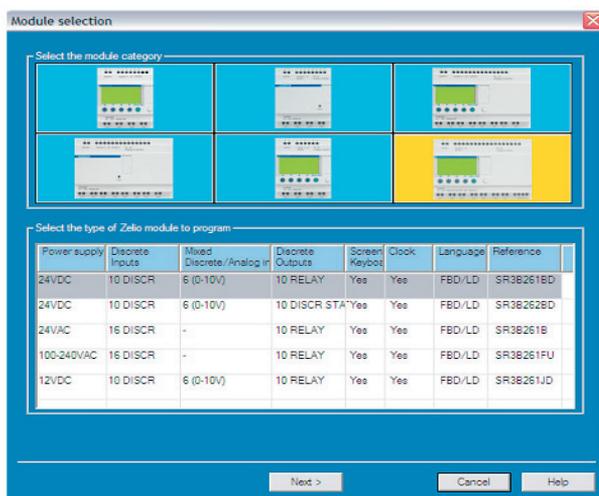


FIGURE 10. SELECTION OF THE BASIC MODULE SR3B261BD

The basic module SR3B261BD has a 24 VDC power source, 10 discrete inputs (input-i from I1 to IA). 6 inputs with the possibility of a discrete or analogue input 0 – 10 V (input-i from IB to IG) and 10 discrete relay outputs (output-i from Q1 to Q8 relays 8A, Q9 to QA relays 5A). This module has the possibility of logic programming in so called FBD mode (Functional Block Diagram) and LD mode (Ladder Diagram). For this paper we used FBD. Ethernet communication module SR3NET01 has 4 integrated 16-bit. inputs and 4 integrated 16-bit. outputs. The Ethernet extension on the network is present as a server.

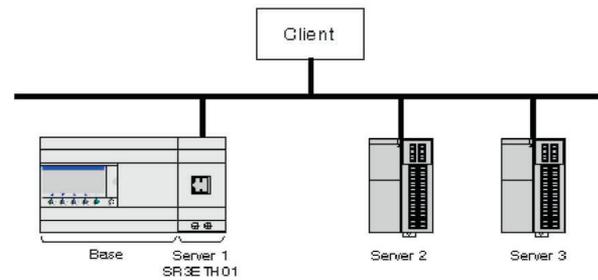


FIGURE 11. NETWORK ARCHITECTURE OF THE ETHERNET COMMUNICATION MODULE SR3NET01

The analogue module SR3XT43BD has two analogue inputs and two analogue outputs with the resolution of 10 bits. In this Zelio Soft programme configuration, a choice between current (0-20mA) or voltage (0-10V) input and output is made possible. Such complex modules are ready for wiring with other elements for the production of this MCC (Motor Control Centre). Electric scheme of the energy and management circuit of the electric motor is shown in Figure 12.

The chain of management is as follows: the Zelio controller on the basis of already made logic will send control signals to the VSD (Variable Speed Drives), from which it will receive feedback information on the state of the VSD and motor speed, so the VSD itself, with an appropriate modulation of voltage and frequency, control the electrical motor.

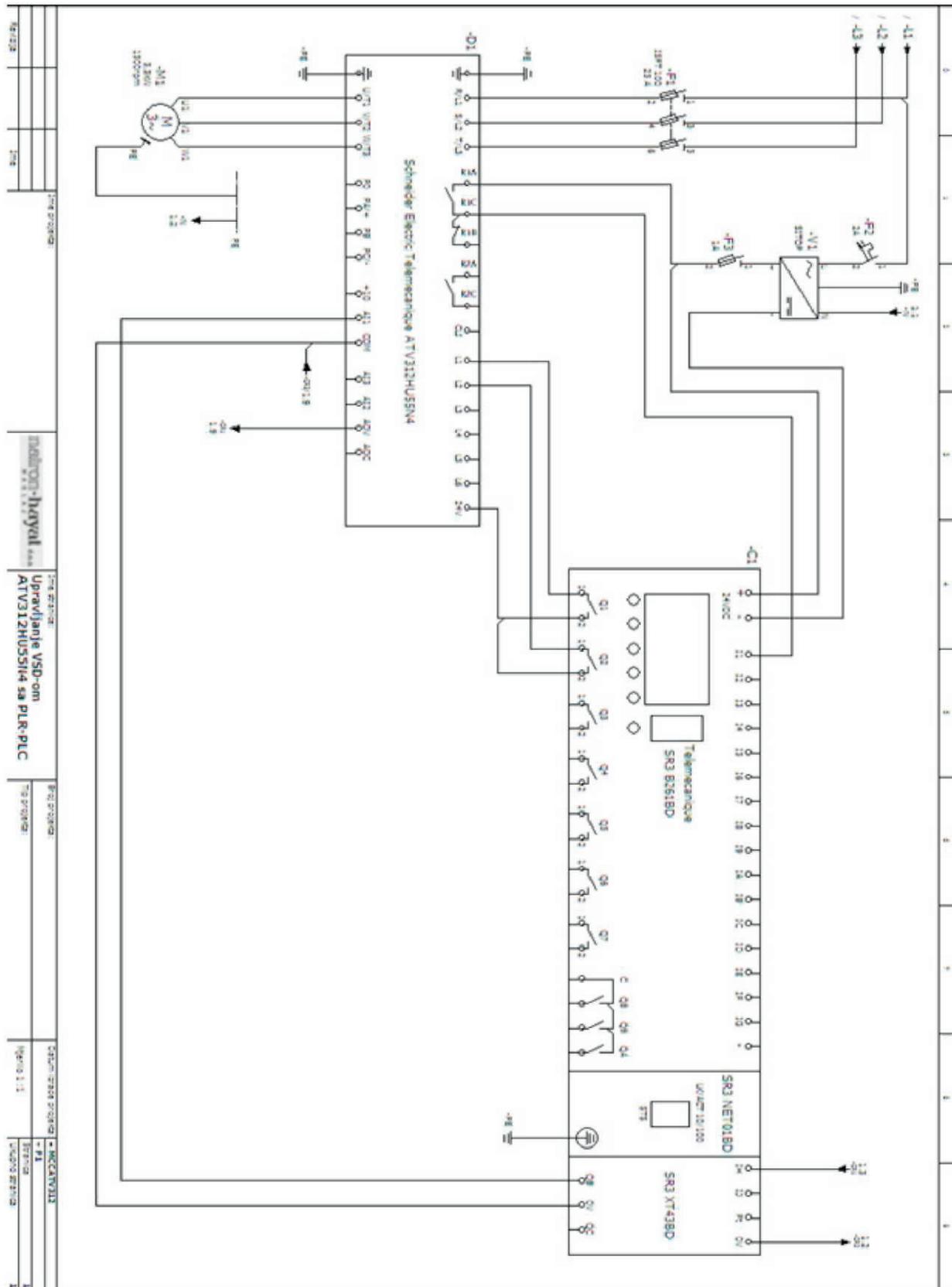


FIGURE 12. ELECTRIC SCHEME MADE IN CAE SOFTWARE ePLAN P8 ELEC

INTEGRATION OF ZELIO CONTROLS AND DAQFACTORY SOFTWARE

After we manufactured the logic of managing VSD and electric motor, we need to enable visualisation of parameters of controlling and overseeing work of the whole system inside a Zelio controller. For that, with the aid of Ethernet, we enabled communication between Zelio controls and a PC with installed DAQFactory software.

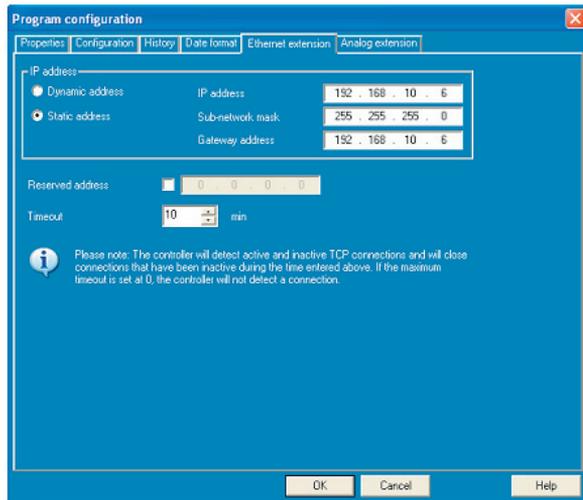


FIGURE 13. SETTING OF IP ADDRESS OF THE ePLAN P8 ELEC ZELIO ETHERNET EXTENSION

Entry words are entirely in write mode while output words are entirely in read mode; meaning, in the register of the input words it is possible to “write” values, while in the registers of the output words it is possible only to “read” values inside the register. As it can be seen from the logic control of the input words we used J1 and J2, in other words, addressed 16 and 17 respectively, while with the output words we used O1 and O2, in other words, addressed 20 and 21 respectively. With the input word J1 we control VSD (forward, back, stop) while with the input word J2 we assign a reference speed value. With the aid of output word O1 we receive information on the current measured motor speed while the output word O2 is used to receive status information of VSD (ready or fault).



FIGURE 15. IMPLEMENTATION

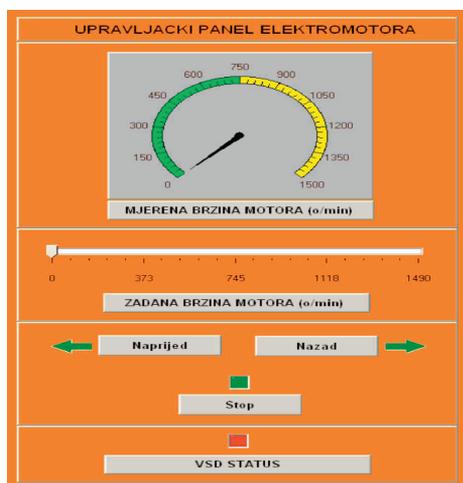


FIGURE 14. CONTROL PANEL (FACEPLATE)

TABLE 2. ZELIO ETHERNET EXTENSIONS

Zelio Ethernet input words	Zelio Ethernet output words
J1 (adress 16)	O1 (adress 20)
J2 (17)	O2 (21)
J3 (18)	O3 (22)
J4 (19)	O4 (23)

CONCLUSION

It is very easy to assume the role and importance of induction motors by monitoring the development of technological advances from their beginnings to the present date. As the time goes by, industrial development is increasing, and therefore the induction motor is gaining an advantage over the DC motor due to the transmitting it has. What we can have concluded and presented in this paper, is to successfully manage asynchronous motor with programmable logic controller (PLC) and VSD in a way that controller based control logic sends signals and receives information about the state and the speed of the motor. It also enables the visualization of the process control using electric motors and a complete software that manages processes and data in the system.

Authorship statement

Author(s) confirms that the above named article is an original work, did not previously published or is currently under consideration for any other publication.

Conflicts of interest

We declare that we have no conflicts of interest.

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