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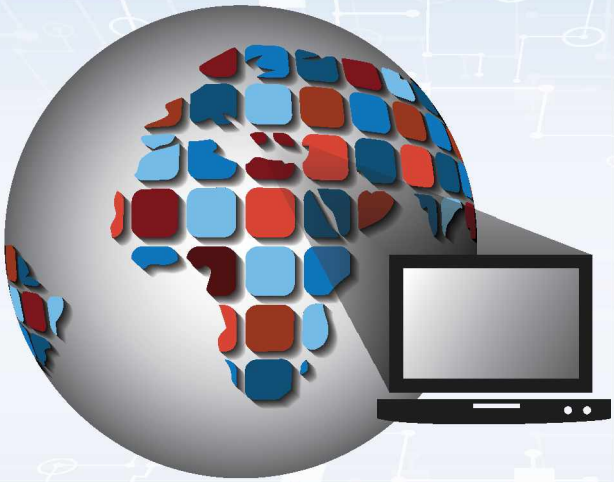

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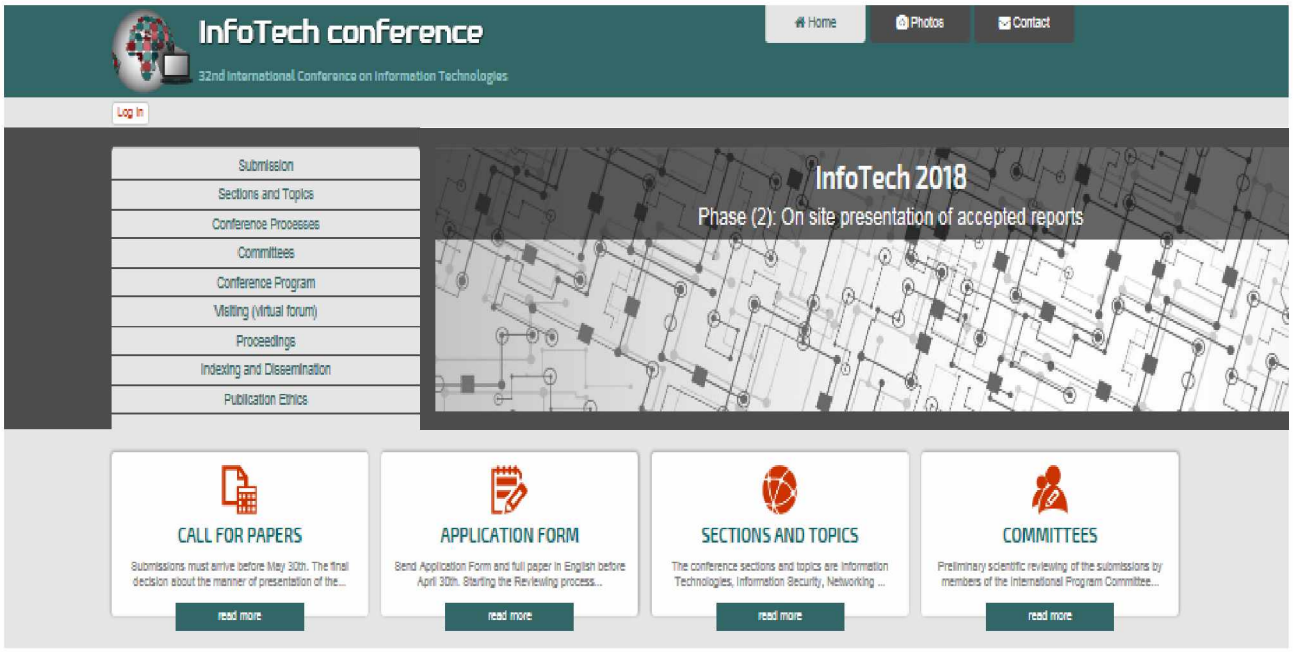

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Proceedings of the International Conference on
Information Technologies (InfoTech-2018)
20-21 September 2018, Bulgaria

BIG DATA AND INTERNET OF THINGS FOR CRITICAL DOMAINS: CHALLENGES AND SOLUTIONS

PLENARY REPORT SUMMARY [1]

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INTRODUCTION

Information, communication and electronic technologies (IT) are, on the one hand, mean of dependability (reliability, availability, safety, security) assurance for sophisticated systems for critical and commercial domains, and, on the other hand, they are source of threats, vulnerabilities, faults and failures causing new security and safety deficits and fatal effects for critical infrastructures and business applications.

Influence of modern ITs and IT related paradigms becomes more and more challengeable, first of all, for safety critical systems such as nuclear power plants (Instrumentation and Control systems of NPPs), piloted aerospace complexes, aviation and railway systems (on-board control and navigation systems, vehicle to vehicle, vehicle to infrastructure and so on), health monitoring and control systems and so on. Failures and emergencies of safety critical systems as a rule are caused by several reasons, combination of physical, design and interaction faults and human errors [1]. Physical faults are characteristic for hardware, design faults are

[1] Full version of this plenary report is published in the Special section of the **International Journal on IT and Security, No 4, vol. 10** (http://ijits-bg.com/ijitsarchive)

Vycheslav Kharchenko. Big Data and Internet of Things for Safety Critical Applications: Challenges, Methodology and Industry Cases. International *Journal on Information Technologies and Security*, No. 4 (vol. 10), 2018, pp. 3-16

characteristic for software (and programmable logics), interactive faults are consequences of physical and information intrusions on hardware and software respectively.

To ensure dependability we have to analyze related possibilities and risks at the all levels of a hierarchy "element-component-system-infrastructure" taking into account interaction and interdependency in the vertical and horizontal dimensions.

Von Neumann's paradigm (VNP) "reliable systems out of unreliable elements" should be transformed considering challenges caused by application of modern ITs. Paradigm "dependable and safe infrastructure/system/component out of undependable and unsafe (or not enough dependable and safe) systems/components/elements" is becoming more and more important. Besides, concept "IT for safety and security" should be added by "safe and secure IT".

GOALS

The paper discusses some challenges caused by application of Internet of Things (IoT) technologies and Big Data analysis (BDA) in critical domains such as Nuclear Power Plants (NPPs) and energy grids, health systems and systems for prediction of software dependability. The methodological and practical issues of implementing BDA and IoT systems and tools are analysed in context of cyber security and safety assessment and assurance.

EXTENDING OF IOT

Several problems related to IoT and IoT based systems are analysed. First question is: what does IoT mean? There are a lot of definitions. In simplified view they are formulated by the following ways:

IoT is a new technology…

IoT is a mix/joining of existed technologies…

IoT is a new idea joining of known and modern technologies…

In our opinion IoT is a paradigm of joining and parametrization of a few technologies (embedded decisions/ sensors and programmable devices, communications and cloud services).

IoT paradigm can be presented in general as

(X)Io(Y)Z ,

where *(X)* is an adjective determining main required attribute such as

X = {Dependable, Safe, Secure,…; Industrial,…},

I = *Internet* (BTW: Web of Things is known as well → WoT)

(Y) is an adjective determining actual attribute of things *(Z)*

X = {Dependable, Safe, Secure,…; Important, Intelligent,…},

Z = {Alphabet: A (Authors,...), B (Business,...), C (Cars,...), D (Drones,...), ...}

The following "formulas" are discussed:

IoT = IoT (Internet of Things = Internet of Threats),
IoE = IoE (Internet of Everything = Internet of Emergencies).

CASE STUDIES

Three industrial cases are described and discussed.

Case 1. Internet of drones based post NPP accidence monitoring system. A general structure and underlying principles for creating an Internet of Drone-based multi-version post-severe NPP accident monitoring system is described. The proposed design consists of an IoT subsystem, a single wired subsystem and three drone-based wireless subsystems. Reliability block diagrams (RBD) for the system and its subsystems are built based on considerations of different variants of sensor, communication and decision making systems. On the basis of RBDs, reliability models of the system and their subsystems are analysed. The probability of failure-free operation that depends upon various system configurations and on the use of multiple redundant Wi-Fi communicating drones is obtained and discussed.

Case 2. Internet of mobile devices based health systems. A healthcare IoT infrastructure with a brief description of each component is presented. These components are a device with a reader, cloud, healthcare provider and a communication channel. Networked healthcare devices sense electrical, thermal, chemical, and other signals from the patient's body. They directly sense and collect biomedical signals, that is, information about the physical and mental state of health. Such devices are safety critical because a human's life depends on its performance. The application of failure / attack trees to identify security problems of the IoT infrastructure is considered. An example of a fault tree for the IoT system is given. This case presents a few models of healthcare IoT system based on the queueing theory and multi-fragmental Markovian chains. The models describe streams of the requests, hardware and software faults, attacks on vulnerabilities and procedure of recovery by restart and eliminating of one and / or two vulnerabilities.

Case 3. BDA based prediction of software (SW) reliability and security. Implementation of the methodology of SW reliability and security prediction is based on processing information about software with similar attributes and metrics, which is extracted from Big Data storages. The technique to search of similar programs is discussed. The similarity principle is based on complexity and structure SWS metrics and metrics of program language similarity. The formulas for metrics calculation of group and average deviation rates describing the SWS similarity. Software Agent for Search of Similar programs and data processing (ASS) is analysed. Case study related to search programs with the same complexity metrics in data storage is described.

CONCLUSIONS

For Internet of Things (IoT) systems Von Neumann's paradigm should be specified as "a secure IoT out of unsecure nodes, communications and clouds". BDA can be used as a powerful tool for trustworthy assessment of safety and security. Industrial cases which have been analysed illustrate possibilities how IoT and BDA can be used to assure safety and security for critical systems and infrastructures. Besides, they show how can be tolerated challenges of inaccurate assessment of high availability assessment.

Proceedings of the International Conference on Information Technologies (InfoTech-2018) 20-21 September 2018, Bulgaria

INFORMATION TECHNOLOGY FOR GREEN SOFTWARE ENGINEERING FOR THE INTERNET OF THINGS [1]

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Abstract: This article describes an information technology for green software engineering for IoT devices. For the using of proposed information technology, we should know only source assembler code of the program and the types of CPU and RAM. This technology consists of three steps: scanning of assembler code and determination types of each assembler instruction and their volume in bits; applying of the method for computer's estimating power consumption based on assembler source code and finally estimating of RAM energy consumption. Proposed information technology especially useful for development of software for the devices of Internet of Things.
Key words: Green Software, Energy Consumption, Software engineering, RAM power consumption, IoT programming.

1. INTRODUCTION

There are many software engineering technologies used in software development practice. All these technologies are aimed at the rapid and effective development of the structure of software and its code. In general, software development technology is a system of engineering principles for creating cost-effective software with specified quality characteristics [1]. Software engineering technologies include a same kind of steps [2] and differs only of its sequence. The sequences of steps depend from chosen model, such as Waterfall model [3, 4], Spiral model [5, 6], Chaos model [7] and many

[1] Renewed version of this report is published in the WoS-indexed journal **International Journal on IT and Security, No. 3, vol. 10** (http://ijits-bg.com/ijitsarchive)

Elena Stetsuyk, Dmitry Maevsky, Elena Maevskaya. Methodology of Green Software Development for the Internet of Things Devices. *International Journal on Information Technologies and Security*, No. 3 (vol. 10), 2018, pp. 3-12.

others. The main aim of listed above technologies is increasing of software quality by which is meant usability and dependability.

This quality requirements are very important for the all kinds of software. But there is another class of software by which meet this requirement is not enough. Software for Internet of Things (IoT) devices was meant. Apart from the usability and dependability this software should have another requirement – energy efficiency.

Security and privacy are the biggest issues for IoT. All devices and collecting systems hold a lot of personal data about people - a smart meter knows when you are at home and who uses electronics when you are there - and this is shared with other devices and is contained in the databases of companies. With billions of devices connected together, people need to be sure that their information remains secure. Will someone be able to break the toaster and thus gain access to your entire network. IoT also opens up even more security threats to companies around the world. Safety experts say that doing is not enough to enhance the security and privacy of the IoT at the current early stages and, to prove its point, has broken a lot of means from a connected video player to automated lighting and intelligent refrigerators, as well as citywide systems such as traffic lights.

Another words, software for IoT should be green. Why it is so important? Let us look at the statistics.

All IoT devices work on computers (most popular - Raspberry Pi). The latest Raspberry Pi3 model consumes 3.6 watts [8]. IoT is gaining in popularity every year, and by 2020, about 38.73 billion devices are forecast.

A smartphone can be considered the most popular device in our time. The easiest smartphone consumes about 7 watts [9]. By 2020, the number of smartphones is forecast to increase, namely 2.87 billion.

A large number of laptop users are being tracked around the world. The average power consumption of laptops per hour is 60 watts [10]. By 2020, projected growth of laptops - up to 1545 million.

The number of desktop computers is growing every day and by 2020 their number will be about 200 million devices. On average, a personal computer consumes 200 watts [11].

It is important to note the growth in the number of tablets in the coming years. It is projected that by 2020, tablets will be larger than laptops, namely 185 million. On average, tablets consume 20 watts [12]. According to preliminary estimates [11] in 2020, the total power consumption of all computing devices will exceed 240000 MW. For comparison, installed capacity of the largest power plant in the world, called Tu Tuoketuo, located in China, is only 6600 MW. Thus, to provide electricity to all computing devices will require more than 36 power plants of similar capacity.

2. HOW THE SOFTWARE CAN BECAME GREEN?

The IoT software can be considered green if it helps save resources. The program is information, that is, an immaterial object that does not directly affect the objects of our material world. All such hardware can be conventionally divided into two groups:

devices that directly provide software operation, and devices controlled by this software [13]. The first group includes the hardware of the computer, and the second - the various peripheral devices connected to it. Therefore, green software should help save resources that are consumed both directly by the computer and its peripheral devices.

The software does not always function as intended by the developers. One of the reasons for such a malfunction is the defects made in the program at the stage of its creation, modification, or correction of other defects. The process of detection of these defects in time is the subject of study of a separate scientific direction - the reliability of software. In the case of software critical systems, the correct functioning of them is a major factor. Software defects lead to errors in its functioning, which in turn can lead to man-made accidents, environmental disasters, and human casualties. Thus, if we are talking about preserving resources, then reliability becomes a necessary requirement, which must necessarily be presented to green software.

We can conclude that the software, to become green, must meet the following requirements:

1. The requirement to minimize the resources required for functioning of software. These resources include the volume of operational computer memory, clock speed and CPU performance.
2. The requirement to save resources consumed by peripherals, which software controls.
3. The requirement for reliability of functioning and stability in relation to external target actions aimed at either termination or control of the IoT software.

This article is devoted to creation of information technology, focused on creation of green IoT software, which satisfies the first two requirements. The main feature of the models and methods implemented in this technology is the ability to perform power consumption estimation of computing devices based on the source code. This approach especially reasonable at the stage of software development, when from several algorithms, which identical in the performed functions, it is required to choose the most optimal algorithm from the point of view of power consumption.

The energy consumption is estimated only for RAM. There are several reasons for this.

First, RAM, along with the CPU, is an integral part of all computing devices, and in particular - devices of the IoT.

Secondly, RAM in modern computing devices is in second place in terms of power consumption after the CPU. So, according to [8], for a computer with a Xeon 5310 processor, RAM consumes 20% of all energy (the Xeon processor 5310 consumes 40%). Therefore, optimizing the program code from the point of view of the power consumption of RAM will significantly reduce the power consumption of the entire device.

And thirdly. Currently, the CPU has built-in tools for monitoring power consumption. RAM does not have such tools, so the task of developing information

technology, which allows to include optimal algorithms at the stage of software development, is topical.

The next section describes the structure of information technology, which allows you to compare several versions of the program code by the criterion of the amount of energy consumed by the RAM when they are executed.

3. STRUCTURE OF INFORMATION TECHNOLOGY

The term "information technology" refers to "a set of techniques, manufacturing processes and software and hardware integrated with the aim of collecting, processing, storage, distribution, display and use of information for the benefit of its users". In fact, the definition is not on the one and the many processes that are based on certain scientific positions, models and methods. The initial material and the final product of these processes is information. Thus, we can say that the purpose of information technology is to create an information product. The basis of any information technology is its theoretical basis. On the created theoretical basis, the imaging models are based refer to the process of creating the information product of the real world. It is these processes and their interconnection that make up the domain of the information system that implements the technology. The set of models, as well as rules and methods of their application forms the methodological basis of information technology. To create an information product, you need the appropriate means (means of production). Today, special information systems, such as Java Eclipse, Microsoft Visual Studio, Delphi, and many others, serve as such means of production.

For the operation of any device, resources are required - information (input), energy, material, time and so on. The minimization of consumption of these resources is the goal of green technologies. Thus, we can conclude that speaking about green information technologies, we must understand not only the top of the pyramid - information systems, but also other components - the theory, models and methods. And the information technology itself can be considered green, only if all its components are green.

Below is a description of all the components of the information technology comparing several versions of the program code by the criterion of the amount of energy consumed by the RAM when they are executed.

3.1. Theoretical basis and models

Theoretical basis of information technology of comparing software code versions is formed by two mathematical models. The first mathematical model serves to determine the total power that is spent on transferring one bit of RAM from the logical zero state to the logical one state. This model is based on the calculation of the transient in the RAM cell and is described in detail in [14].

$$S = E \cdot \sqrt{\frac{1}{T} \cdot \left[\frac{A_1^2}{2p_1} \cdot \left(e^{2\alpha_1 T} - 1 \right) + \frac{2A_1 A_2}{p_1 + p_2} \cdot \left(e^{(\alpha_1 + \alpha_2)T} - 1 \right) + \frac{A_2^2}{2p_2} \cdot \left(e^{2\alpha_2 T} - 1 \right) \right]}, \quad (1)$$

where:

$$\alpha_1 = \frac{-(R_1C_1 + R_2C_2 + R_2C_1) + \sqrt{(R_1C_1 + R_2C_2 + R_2C_1)^2 - 4 \cdot R_1R_2C_1C_2}}{2 \cdot R_1R_2C_1C_2},$$

$$\alpha_2 = \frac{-(R_1C_1 + R_2C_2 + R_2C_1) - \sqrt{(R_1C_1 + R_2C_2 + R_2C_1)^2 - 4 \cdot R_1R_2C_1C_2}}{2 \cdot R_1R_2C_1C_2},$$

$$A_1 = -\frac{(p_2 \cdot R_1R_2C_1C_2 + R_1C_1) \cdot (V_{1H} - V_{REF}) + R_2C_1(V_{REF} - V_{1L})}{R_2 \cdot \sqrt{(R_1C_1 + R_2C_2 + R_2C_1)^2 - 4 \cdot R_1R_2C_1C_2}},$$

$$A_2 = \frac{(p_1 \cdot R_1R_2C_1C_2 + R_1C_1) \cdot (V_{1H} - V_{REF}) + R_2C_1(V_{REF} - V_{1L})}{R_2 \cdot \sqrt{(R_1C_1 + R_2C_2 + R_2C_1)^2 - 4 \cdot R_1R_2C_1C_2}},$$

In these formulas: V_{IH} – logical "1" voltage; V_{REF} – voltage in the information bus; V_{IL} – logical "0" voltage; R_1 – information bus resistance; R_2 – Source-Drain resistance of field-effect transistor when it turns on; C_1 – information bus capacitance; C_2 – capacitance of the capacitor in Basic DRAM Cell. These parameters can be found in the technical documentation for RAM, for example, in [15].

This mathematical model allows you to determine the power consumed by changing the state from "0" to "1" of only one bit of RAM. However, when executing program code, not one bit is changed, but much more. The exact number depends not only on the bit depth of the operation, but also on the information that is being processed at the moment. It is impossible to predict this exact number. We can calculate only the mathematical expectation of this quantity. The second mathematical model serves to calculate the mathematical expectation of the number of bits that pass from the logical "0" state to the logical "1" state. All stages of its construction are considered in detail in [9]. In this paper we give only a finite formula:

$$M(r) = -0.00011791 \cdot r^3 + 0.00444567 \cdot r^2 + 0.19515112 \cdot r + 0.22247721. \quad (2)$$

Here: M(r) – desired mathematical expectation, and r – capacity of operation.

3.2. Methodology

Based on the mathematical models described in 3.1, a method has been developed for determining the energy consumed by the operating memory when executing the program code. This method consists of the following steps:

1. To get Assembler code of the researched program.
2. To carry out the analysis of each of the instructions of Assembler code and determine the number of clock signals, which are necessary for the instruction execution and RAM area length, which is changed by this instruction. The number of clock signals can be learnt in CPU specifications, but the RAM area length corresponds to instruction operands length.
3. To calculate the total number of CPU clock signals necessary for a single program execution on the basis of analysis described in previous paragraph. We use Nt to denote the calculated number of clock signals.

4. To calculate the expected value of the bit amount changed by this instruction on the basis of RAM area length changed by each of the instructions and with the help of mathematical model developed in paragraph 5.
5. To calculate the complex power spent in order to change the RAM state by the instruction with number k according to the formula:

$$S_{rk} = M(r_k) \cdot S_1,$$

where: r – RAM area length changed by the instruction (bit capacity of the operation); M(r) – expected value of the number of changed from "0" to "1" bits depending on the RAM area length calculated according to the formula (2); S_1 – the complex power used in order to change 1 RAM bit state according to model (1).

6. To calculate the complex power used in order to change all RAM area states during a single program execution as a sum of complex powers S_k for every separate instruction. We use S_Σ to denote this complex power:

$$S_\Sigma = \sum_{k=1}^{N} S_{rk}.$$

7. To calculate a specific power W by the computer for a one second of program execution according to the formula:

$$W = \frac{N_t}{f_t} \cdot S_\Sigma,$$

where: W – consumed energy, Nt – the number of CPU clock signals necessary for a single program execution, ft – frequency of CPU clock signal.

Value W is a final result of the energy consumption evaluation method in executing the programs on the basis of their source code.

3.3. Program Tool

Based on the models described above, information technology was developed that will help determine the program's energy consumption based on its source code. It is easier to present an information system in the form of a JDEF0 diagram. controls and mechanisms that are detailed (decomposed) to the required level by inputs and outputs. Using IDEF0-diagrams it is possible to easily define and describe the important processes of any technology to show their correct sequence. IDEF0-diagram is very convenient to use, it is an intuitive methodology of functional modeling.

The IDEF0 designation consists of blocks, each of which is a "black box" with controls and mechanisms that are detailed (decomposed) to the required level by inputs and outputs. Based on IDEF0-diagrams, you can quickly identify and describe the key processes of any technology to show their correct sequence. IDEF0 is a very simple and at the same time intuitive methodology of functional modeling.

With this methodology, information can be transferred between developers, consultants and users. The methodology was very carefully developed, it is universal and convenient for designing.

The program tool "ESTimation Energy Tool" (ESTET) includes an interface part that allows the user to select the required file with the code of the program that is being explored. The program includes a logical part in which all mathematical calculations are performed to determine the energy consumption. You can also select the type of processor and RAM of the computer on which the program is running and see the result of the calculations.

4. CONCLUSION

This short thesis describes the methodological foundations of information technology, which allows you to compare different versions of the program code of the different IoT devices by the criterion of power, which is consumed by the operating memory of the device. The proposed technology has merits and demerits, like everything that is created by human. Let's start with the merits.

The first advantage is that to evaluate the power you do not need to know anything except the source code and the electrical parameters of the RAM. These data are generally known.

The second advantage is the possibility of using the technology in the early stages of creating software products. At these stages, a choice is made of one or another algorithm that must implement one of the requirements for the functioning of the program. The proposed technology allows choosing among the several algorithms the best by the criterion of energy consumption. Thus, applying this technology, we get the opportunity to create software that is really green.

Now let's talk about the shortcomings of the proposed approach.

The first drawback is its approximate nature. The method of calculating the power consumption, which is applied in the proposed technology, is based on the calculation of the transient in the replacement circuit of the memory cell. However, this substitution scheme is not accurate and only approximately describes the electrical processes occurring in the operative memory. However, there is no other scheme for today.

The second drawback is the impossibility of taking into account the number of repetitions of individual cyclic sections of the program code. This defect is unavoidable and is a fundamental limitation. After all, the number of repetitions of loop operators depends on the source data. It is usually unknown at the stage of software development. To eliminate this limitation, the authors use a static code analysis while calculating the execution time of each program instruction. And then it is assumed that all the program code, as a single unit, is executed within one second. The number of repetitions of the code is determined by the total time that is necessary for a single execution of all instructions.

The third disadvantage relates to the developed software and consists in the fact that only the program code in the assembler language is analysed.

The approach described in the article is only the first step towards creating methods for developing green software. Therefore, the elimination of the noted shortcomings is also the direction of its development.

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ECONOMIC CONSIDERATIONS IN THE USE OF CLOUD COMPUTING IN THE TECHNICAL WHOLESALE

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Abstract: Cloud computing is becoming increasingly important as it is recognizable in the growing market of services in the IT infrastructure, development platforms and software sectors. For companies in the technical wholesale sector, this results in new opportunities to reorient their IT needs. The central assessment criterion here is the economic benefits that arise from the use of cloud offerings in comparison to the acquisition and operation of company-owned it. A comprehensive assessment by the company includes both quantitative and qualitative factors, which suggests an enhanced cost-benefit analysis for cloud computing. For this reason, these contributions formulate approaches that enable a cost-effectiveness view of cloud computing in enterprise use and support the comparison to the acquisition and operation of company-owned systems.
Key words: Selection processes, system evaluation, IT solutions, SaaS, PaaS

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EXPLORE MODERN RESPONSIVE WEB DESIGN TECHNIQUES

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Abstract: In the short history of web design development have long been used table web design and fluid web design. Responsive Web Design corresponds to the needs of modern devices. The modern web design uses Flexible Box Layout and Grid Layout. Grid Layout is considered to be the most appropriate technique for full page layouts. Flexbox is ideal for styling components on a page, controlling how groups of elements relate to each other.
Key words: responsive web design, frameworks, flexbox, grid layout, networking.

1. INTRODUCTION

In the early days of World Wide Web (WWW), most websites were built and managed by IT departments. The first websites have belonged to large companies, scientific and government organizations. Today, anyone with basic computer skills can build their own web site. With the help of an online platform, each user quickly gets a web space. Step by step using CMS, it's easy to create a blog and even an online store.

Nowadays, website design has become an industry that is growing. Great web designs have lead some businesses to grow and prosper. The opposite side of a badly built web sites lead to failure. There are some recommended tips for designing a web site: good content layout, simple site navigation, appropriate colour scheme, user-friendly design compatible with any devices and visible to any screen resolution.

2. EVOLUTION OF WEB DESIGN

2.1. In the beginning

The beginning of web site creation is related to Tim Berners-Lee. On August 6, 1991 — 27 years ago — he published the world's first website [2]. It started as a global hypertext project, which later became known as the World Wide Web. The first website is a simple text-based page with plain left-aligned block text and blue links on white background (fig.1).

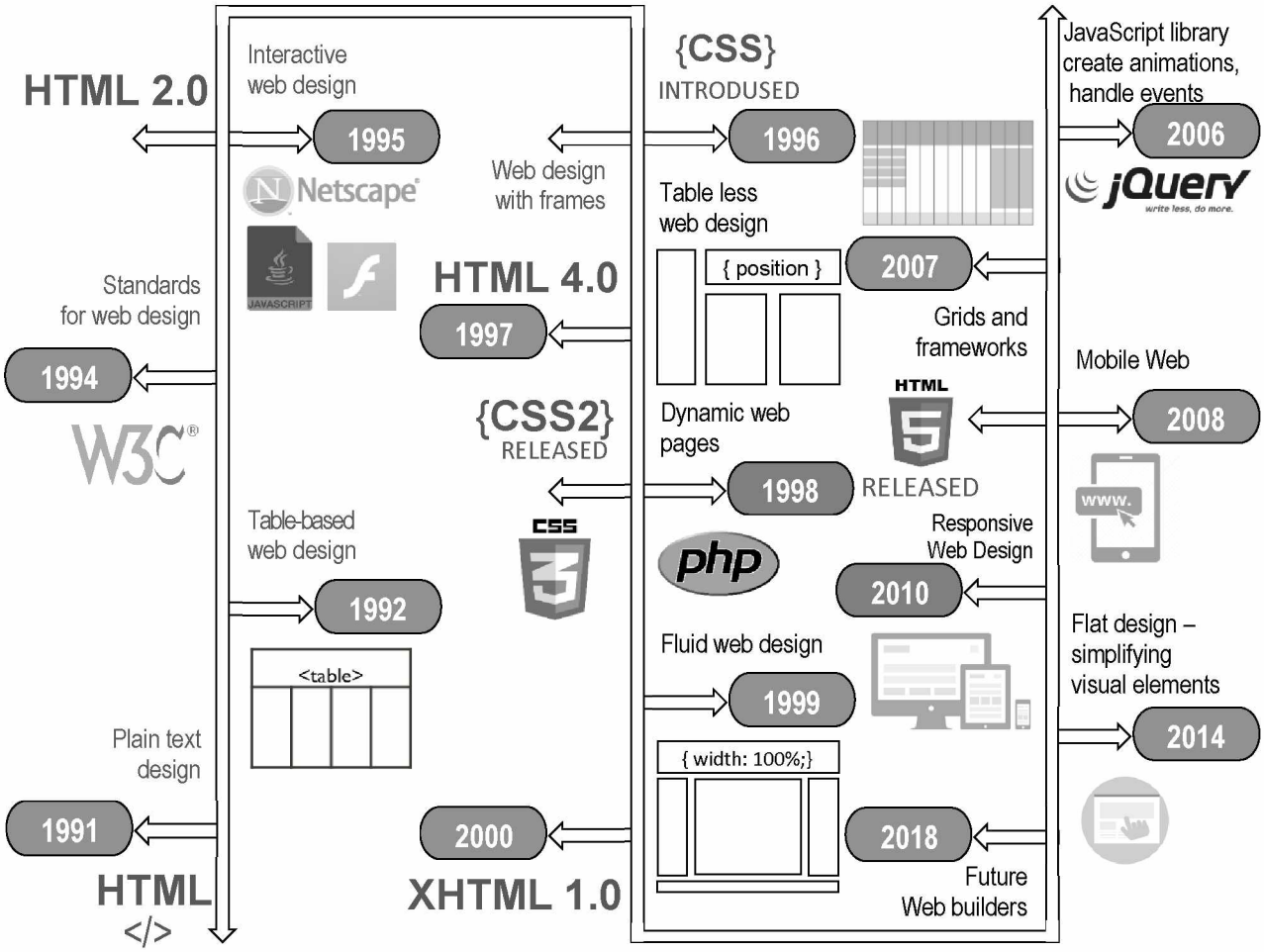

Fig. 1. The Evolution of Web Design Infographic

2.2. Developing web design

The web design as we know it was born in 1993 when early browsers began to display images with text. In the coming years is used table-based web design. Table-based layouts created additional design options by providing structure and multi-column layouts. The World Wide Web Consortium, formed in 1994, established Hyper

Text Markup Languages (HTML) as the standard. HTML has some limitations and the answer came in 1995 – JavaScript appeared.

The next year was the beginning of flash-based design. It presented more layout and design options beyond HTML. The designer could design any shapes, layouts, animations, interactive effects and use any font. Unfortunately, it wasn't search-friendly and used flash plugin to display web pages. Today, flash interactions are replaced by JavaScript handle events and instead of flash animations are used JavaScript library – jQuery. Around the same time as Flash was introduced Cascading Style Sheets (CSS).

CSS created better web page structure. CSS provides markup that determinates the structure of multiple pages instead of creating new markup for each page. CSS gave designers more creative controls, allowing them to design around the purpose of the site and fine-tune details. The appearance of CSS enabled the construction of websites with table less design. The web page layout could be fixed or limited in percentage. The design that used the percentages is called fluid web design. The liquid page layout does not depend on a screen resolution and is displayed in the same manner on different devices.

2.3. Column grids

With the growing number of mobile devices and the growing use of mobile access to the web, web design is no longer limited to desktop or browser compatibility. There are mobile devices with different sizes and resolutions. It is not possible to have different layouts for devices. Also the design be the same on the tiny screen and computer. The web page layout needs to be changed corresponding to the resolutions of different devices. The first step to improvement began in 2007 with idea of column grids. There were different variants - 8-column, 12-column, 18-column and 24-column grid. The 960 grid system won, and the 12-column division became something designers were using every day. The 960 Grid System is simple and lays out nicely in a 960px-wide window and is achieved a good view in only one browser window size. The 12-column grid is divided into portions that are 60 pixels wide. Each column has 10 pixels of margin on the left and right, which create 20 pixel wide gutters between columns. Fluid 960 grid layout it is based on 960 Grid System [1]. It replaced the fixed-width grid elements with percentage width.

Instead of creating a separate mobile layout, in 2010 Ethan Marcotte proposed that the same content could be used, but in different layouts and designed depending on screen size. This was the birth of Responsive Web Design (RWD).

2.4. Responsive web design and frameworks

A site designed with RWD adapts the layout to the viewing environment by using:

- ***viewport meta tag*** – it was introduced by HTML5 and controls user's visible area of a web page;

- ***grid system*** - it uses specific CSS classes to divide web page into columns. Each web content element fits into a certain number of columns in the grid ;
- ***media queries*** - it is a CSS3 module which allows frontend developer/designers to target specific CSS styles depending upon the display capabilities of a device.

The appearance of RWD led to the creation of responsive frameworks. The framework offers fluid grid with adaptive layout in which every element is resized proportional to container within the CSS without further structure. It standardizes the commonly used elements like forms, navigation, buttons, and to pack them in an easy, reusable way. Today, popular frameworks are Bootstrap and Foundation.

Foundation is an open source project which claims to be the most advanced responsive design framework [4]. Foundation provides a responsive grid and HTML and CSS UI components, templates, and code snippets, including typography, forms, buttons, navigation and other interface components, as well as optional JavaScript extensions. Foundation comes standard with a 940 pixel wide, flexible grid layout. It provides powerful multi-device layouts quickly and easily with the default 12-column. A series of Sass stylesheets implement the various components in the Foundation framework. In two of these components the developer determines the width of the column and the spacing between them. The toolkit is fully responsive to be made for use of different resolutions and types of devices. This adjusts the width of the columns automatically.

The Bootstrap's structure it is similar to Foundation. Bootstrap is an open-source front-end web framework. It contains HTML- and CSS-based design templates for typography, forms, buttons, navigation and other interface components, as well as optional JavaScript extensions [3]. It is modular and consists essentially of a series of *Less stylesheets* that implement the various components of the toolkit. A stylesheet called bootstrap less includes the components stylesheets. Developers can adapt the Bootstrap file itself, selecting the components they wish to use in their project. Bootstrap includes a responsive, mobile first fluid grid system that appropriately scales up to 12 columns with a gutter width 15px on each side of a column. It includes predefined classes for easy layout options, as well as powerful mixings for generating more semantic layouts.

In the 2010s, the intensive use of popular layout frameworks, inspired *CSS Flexbox* and *Grid layout* specifications.

3. MODERN WEB DESIGN

The modern web design is focused on a simple organization of building elements, an elegant positioning of construction blocks and an easy order of content. New trends are not to be used a grid system but instead of it to apply an alignment with media

queries. This web layout is possible with *Flexible Box Layout* and *Grid Layout*, standardized in the latest version of CSS.

3.1 CSS Flexible Box Layout

Flexible Box Layout or *Flexbox* is a module of CSS that defines a CSS box model optimized for user interface design, and the layout of items in horizontal and vertical positon. The concept is based on parent element that holds all child elements [5]. The parent element is called flex container and wraps any flex items. It uses the CSS display property, as the container can be defined as either flex or inline-flex. In the Flexbox model, flex items can be laid out in any direction, and can "flex" their sizes, either growing to fill unused space or shrinking to avoid overflowing the parent.

Each flex container contains two axes: the main and cross axes. The main axis is the axis on which the items align with each other. The cross axis is perpendicular to the main axis (fig.2). The axles help both horizontal and vertical alignment of the children can be easily manipulated. One of the reasons that flexbox quickly caught the interest of web developers is that it brought proper alignment capabilities to the web for the first time. Flexbox model enables proper vertical alignment, so web designers at last easily centre a box. It is easy to build items with equal height. Flexbox works well with responsive web design. The most used technique is to combine media queries with changing the width of flex items.

The reason Flexbox is not intended for layout out whole pages, is that it has a companion CSS module, the Grid Layout Module which is intended for layout.

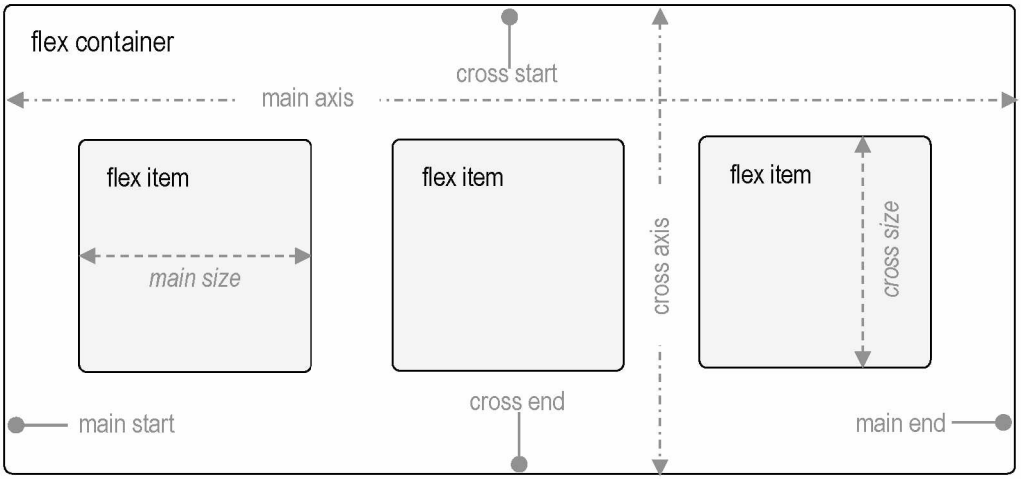

Fig. 2. Flexible Box Layout for Responsive Design

3.2 CSS Grid Layout

CSS grid layout or *CSS grid* is a technique in CSS that allows web developers to create complex responsive web design layouts more easily and consistently across browsers. Grid Layout is a CSS layout model that has powerful abilities to control the sizing and positioning of boxes and their contents. Unlike Flexible Box Layout, which

is one-dimensional layout model, Grid Layout is optimized for two-dimensional layouts [6]. By combining media queries with the CSS properties that control layout of the grid container and its children, web designers can adapt their layout to different devices. Grid enforces two-dimensional alignment, uses a top-down approach to layout, allows explicit overlapping of items, and has more powerful spanning capabilities. Flexbox focuses on space distribution within an axis, uses a simpler bottom-up approach to layout, can use a content-size–based line-wrapping system to control its secondary axis, and relies on the underlying markup hierarchy to build more complex layouts. The main difference between Flexbox and Grid Layout is browser compatibility. There is very limited support for grid at the present time. The browser support for Flexbox is much more comprehensive.

4. CONCLUSION

The modern web design uses Flexible Box Layout and Grid Layout. Grid Layout is considered to be the most appropriate technique for full page layouts. Flexbox is ideal for styling components on a page, controlling how groups of elements relate to each other. Flexible Box Layout has has better browser compatibility than Grid Layout. Today, web developers combine Flexbox with responsive grid and media queries. Preferred Flexbox techniques are effect centring and equal height of elements. These properties, are embedded in grid system and are adapted through media queries, give desired results for varying resolutions.

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NEW APPROACHES IN THE EXAMINATION OF THE CYBER THREATS[1];

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Abstract: The present paper describes some of the results obtained in the Faculty of Computer Systems and Technology at Technical University of Sofia in the implementation of project related to the application of intelligent methods for increasing the security in computer networks. In order to build a rational and consistent approach to the choice of artificial intelligence methods best suited to counteract certain classes of threats, it is necessary to achieve systematization, unification and classification of the cyber-security threats and the sources of these threats. This can be realized using the new concepts and classifications in the field of cyber threats examination.
Key words: cyber threats, taxonomy, threat agents, threat vector, threat matrix, kill chain

1. INTRODUCTION

This report aims to outline the main points of a study "Analysis of the latest trends in threats in various cyber-attacks" carried out within the framework of the project "Increasing the level of the Network and Information Security using Artificial Intelligence methods", funded by the Science Fund of the Ministry of Science and Education. The above mentioned study is a part of the work package 1 of the project

[1] This research is conducted and funded by a scientific-research project № H07/56 "Increasing the level of network and information security using intelligent methods" under the contract D07-4 with National Science Fund in Bulgaria.

named "Analysis of the application of Artificial Intelligence methods in the Network and Information Security".

The main purpose of the study is to analyze, above all, the existing practices in the worldwide investigations for a unified description and comprehensive classification of Cyber-Security threats and the sources of these threats so as to build a rational and consistent approach to the choice of methods of Artificial Intelligence, best suited to counteract certain classes of threats. Moreover, having into account not only the use of these methods for predicting certain types of attack, for repulsion of attacks, but also for automation of the process of incident handling (i.e. dealing with the consequences of the attacks).

The motivation of the research is based on the belief that the new approaches to identification, classification and analysis of the threats will be useful in choosing the appropriate application method for counteraction. Such comprehensive research into new approaches has not been found in the reference sources, which shows its novelty. The research at this stage has been completed and their outcome has served as a basis for selecting Artificial Intelligence methods for various cyber-protection cases.

2. A NEW STAGE IN THE EVOLUTION OF CYBER-SECURITY THREATS

Among the leading experts, there is a consensus that the last five or six years have been celebrated by the fifth generation of cyber-crime, where threats are becoming more complex and automated. The major cyber-crime schemes realize integration within a few sets of tools that perform different functions. One of the peculiarities of the fifth generation is so called "Advanced Persistent Threats" (APT), as a definition for targeted attacks against concrete organizations by certain well-coordinated cybercriminals [1].

In recent years, like popular cloud computing services as SaaS (Software as a Service), IaaS (Infrastructure as a Service), PaaS (Platform as a Service), and so on in the cyber-crime world has been developed so called Crimeware as a Service (CaaS) - a modern model that provides easy access to the tools and services needed to commit cyber attacks [2]. This allows even novice cyber-criminals to perform attacks on a scale that is disproportionate to their technical capacity. The next picture (Fig. 1) shows organization of Ransomware attack using the CaaS.

The radical changes in the field of Cyber-Security during the last two or three years have been formulated and adequately described in the remarkable ENISA report "Threat Landscape Report 2016" [3]. ENISA and other leading Cyber-Security players have identified a transition from the phase of Cyber-Criminality to the phase of Cyber-Ware, where the most serious destructive effects are those of a hybrid nature - a combination of cyber-attack and physical attack, the cyber-attack focused

to critical kinetic process, cyber-attack in the time of natural disaster, or critical system failure.

The expert community has very quickly adopted military approaches, technologies and tools. The "Kill chain" is a military concept related to the structure of the attack and aimed to create an effective counter-attack against the opponent in the various phases of the attack or preventive action. The IT specialists of the Lockheed-Martin Corporation have adapted this concept to information security [4], and it is already accepted in the security information community as cyber-defense instrument defining the stages of cyber attacks and corresponding countermeasures at each stage.

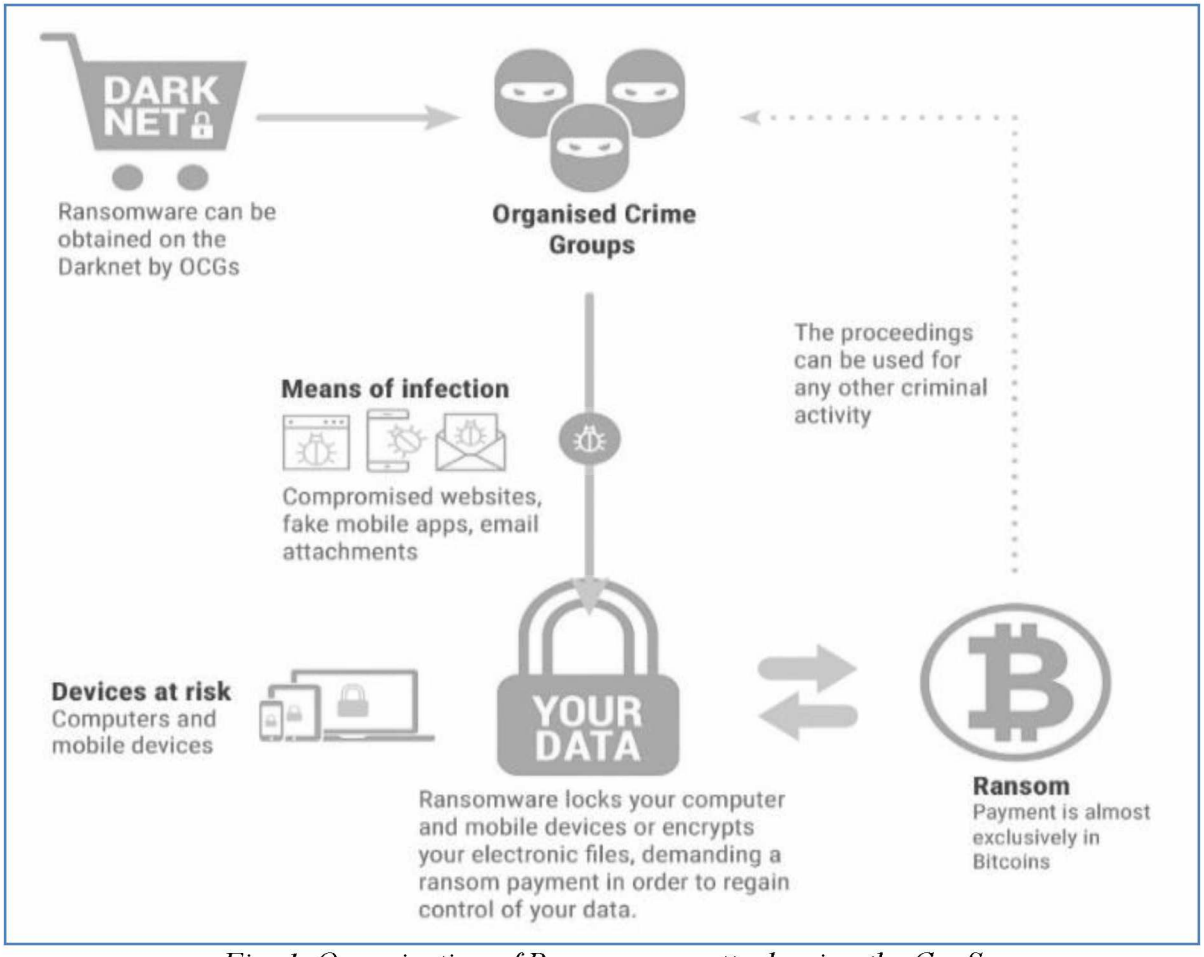

Fig. 1. Organization of Ransomware attack using the CaaS

The "Lockheed-Martin" model includes the following seven steps: a) Intelligence: the attacker selects a target, examines it, and tries to identify vulnerabilities in the target network; b) Creation of the weapon: the attacker creates weapons for remote access, such as a virus or worm, adapted to one or more vulnerabilities; (c) Delivery: the attacker sends the weapon to the victim (for example, via e-mail attachments, websites or USB devices); (d) Exploitation: the activation of the malicious weapon program code that takes action on the target network to exploit the vulnerability; (e) Installation: the malicious software installs

an access point (eg, a "back door") usable by the offender; f) Command and control: the malicious software allows the intruder to get so called "keyboard hands" - constant access to the target network; g) Action on the target: the attacker takes action to achieve his goals, such as data mining, data destruction, or ransom encryption.

3. NEW CLASSIFICATIONS AND CONCEPTS IN THREAT ANALYSIS

To enable systematization, unification and classification of cyber-security threats and the sources of these threats so that will be possible to build a rational and consistent approach to the choice of artificial intelligence methods best suited to counteract certain classes of threats, it is necessary to identify and analyze the new concepts and classifications in the field of Cyber Threats.

Above all, this is so called "Cyber Threats Taxonomy" [5] published by ENISA on the basis of an analysis of about 40 taxonomies developed by world-leading organizations (including NIST and the US Department of Defense (USA), BSI (BRD), TERENA (Netherlands), etc.).

The Threat Taxonomy is structured in three fields:

• the threat category primarily used to differentiate families of threats;

• different threats in a given category;

• details of threats - based on a specific type / method of attack or direction to a specific IT asset.

The aAdditional fields include help information such as: affected assets, threat agents, related sources / URLs, etc.

An important element of the systematic analysis of cyber threats is the systematization of the sources of threats. This is achieved through the formation of groups of sources with similar characteristics (motivations, level of capabilities, focus, level of preparedness, striking power, etc.) and called "threat agents". In [3] has been defined the following threat agents:

- cyber-criminals are the most active threat agent group in cyber-space, being responsible for at least two third of the registered incidents. This group has undergone some further maturity and progress, merely regarding its capabilities and used techniques to maximize monetization;
- insiders have been one of the main actors to threaten their organisations, both intentionally and unintentionally. Intention, negligence and error are the three sources of threats attributed to this group, intention is source of the fewer incidents. Most typical are violations of existing security policies through negligence and user errors;
- hacktivists usually protest against themes such as environmental policy, discrimination, corruption, pacifism, public health issues, support of minorities, media (incl. large events, commercial developments and international conflicts).

Experience shows that hacktivists cooperate on a group basis without any leadership schemes;

- state (or large corporation)-sponsored actors, the cyber-spies have been approximately the fourth most active threat agent group. Formally speaking, this threat group would include intelligence agencies and military organisations. Due to the early maturity of military cyber-capabilities it is not perfectly clear where the differentiation between cyber-spying and cyber-combating might be. This raises important questions in the cyber-security community, namely if the loss of high-end state-sponsored cyber-tools are equivalent to loss of heavy weapons;
- others - less important as their role in the landscape – are: cyber-fighters, cyber-terrorists and script-kiddies.

The involvement of the above mentioned threat agents in the deployment of the identified top cyber-threats is presented in the Table 1. Its purpose is to visualize which threat agent groups are involved in which threats. This information is targeted towards stakeholders who are interested in assessing possible threat agent involvement in the deployment of threats. This information might be useful in identifying the capability level can be assumed behind the top threats and thus support in decisions concerning the strength of the security controls that are implemented to protect valuable assets.

Table 1.

	Treat agents							
	Cyber criminals	Insiders	Nation states	Corpo-rations	Hacktivists	Cyber-fighters	Cyber-terrorists	Script kiddies
Malware	•	♦	•	•	♦	♦	♦	♦
Web-based attacks	•		•	•	•	•	•	•
Web application attacks	•		•	•	•	•	♦	♦
Denial of service	•		♦	♦	•	•	•	•
Botnets	•		•	•	♦	•	•	•
Phishing	♦	•	•	•	•	•	♦	
Spam	♦	•	♦	♦				
Ransomware	•	♦	•	•		♦		♦
Insider treats	•					♦	♦	
Physical manipulation/damage/ theft/loss	•	•	•	•	♦		♦	♦
Exploit kits	•		•	•		•		
Data breaches	•	•	•	•	•	•	•	♦
Identity theft	•	•	•	•	•	•	♦	♦
Information leakage	•		•	•	♦	♦	•	♦
Cyber espionage		♦	•	•		♦		

Attack methods and tools applied by the concrete threat agent form the so-called “attack vector”. This is a means by which a threat agent can abuse of weaknesses or vulnerabilities on assets (including human) to achieve a specific outcome. In the correct context, the study of the different steps performed on an

attack vectors can provide valuable information about how cyber threats can be materialized.

The description of the workflow of the attacks are important pieces of information in order to have a better understanding of cyber threats and the tactics, techniques and procedures (TTP) followed by threat agent, and gives to defenders the opportunity to implement appropriate defences to eliminate vulnerabilities.

Since kill-chains provide a generic classification scheme which is helpful for a better understanding of the method of an attack, references to the kill chain nomenclature may be found during the descriptions of the attack vector and the behavior of involved threat agents.

The identification of the adversary's abilities, the current situation, patterns of past and current behavior, and specific tasks, techniques and procedures are supported by the historical review of past campaigns, reflected in the so-called "threat matrix" [6]. This matrix (Fig. 2) gives priority to the potential scope of the threat sources by focusing on those who have already shown intent and ability to attack. It is used for priority allocation of resources to most likely opponents and contains qualitative and quantitative evaluation criteria.

THREAT PROFILE							
THREAT LEVEL	COMMITMENT			RESOURCES			
					Knowledge		
	Intensity	Stealth	Time	Technical Personnel	Cyber	Kinetic	Access
1	H	H	Years to Decades	Hundreds	H	H	H
2	H	H	Years to Decades	Tens of Tens	M	H	M
3	H	H	Months to Years	Tens of Tens	H	M	M
4	M	H	Weeks to Months	Tens	H	M	M
5	H	M	Weeks to Months	Tens	M	M	M
6	M	M	Weeks to Months	Ones	M	M	L
7	M	M	Months to Years	Tens	L	L	L
8	L	L	Days to Weeks	Ones	L	L	L

Fig. 2. Threat matrix

The threat modelling [7] is another useful tool for the systematic analysis of threats. This is an iterative process consisting of five major steps (Fig. 3):

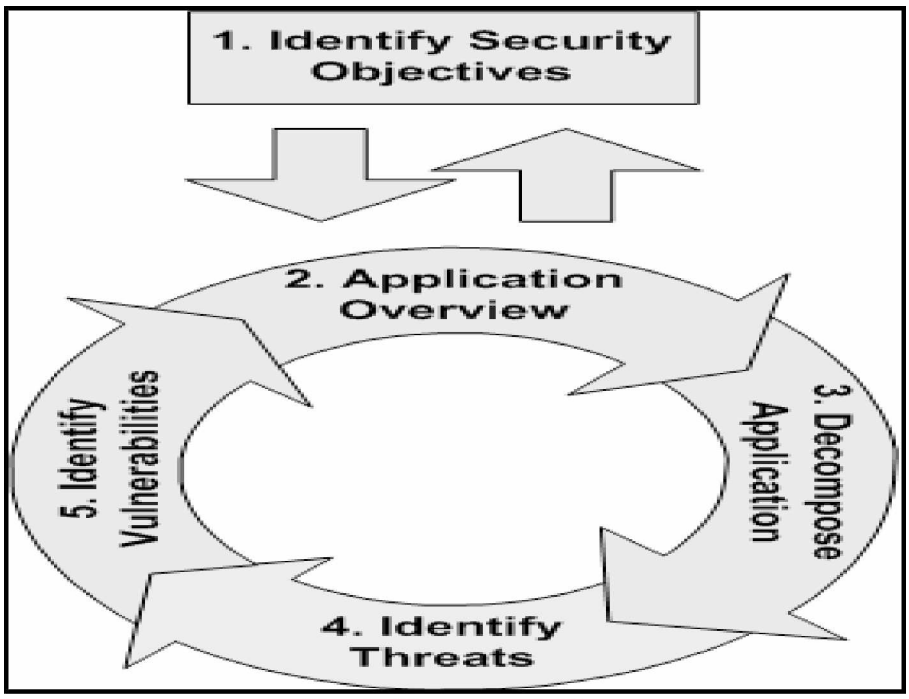

Fig. 3. Threat modelling

a) identification / verification of security objectives – it helps to focus the threat modelling activity and to determine how much effort to spend on subsequent steps;

b) creation of application overview - itemizing application's important characteristics and actors it helps to identify relevant threats during next steps;

c) decomposition of application - a detailed understanding of the mechanics of application makes it easier to uncover more relevant and more detailed threats;

d) threats identification - using threat analysis such as so called "STRIDE" [7], attack trees and a generic risk model;

e) vulnerabilities identification – reviewing the layers of application for searching weaknesses related to these threats and using vulnerability categories to focus on those areas where mistakes are most often made.

Because the key resources identified in threat modelling are also likely to be key resources from a performance and functionality perspective, the model can be adjusted for the concrete needs.

4. CONCLUSIONS

Using part of the above-mentioned new classification and concepts for threat analysis, over 40 types of threats (some with several subspecies) were examined in

the Work package 1 of the project - in terms of their evolution, level of impact and complexity, sophistication, availability, attribution, etc.

The analysis of the most important of these threats gives opportunity to evaluate possibility for potential attack pattern recognition and to develop models for active cyber defence.

Ultimately, this predetermined the choice of Artificial Intelligence methods for experiment in the subsequent phases of the project (Multi-agent system - for the case of Tactical Cyber Intelligence and Recurrent Neural Networks - for the case of Operational Cyber Intelligence.

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OPERATIONAL CYBER-THREAT INTELLIGENCE SUPPORTED BY ARTIFICIAL INTELLIGENCE METHODS [1]

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Abstract: The present paper describes some of the results obtained at Technical University of Sofia in the implementation of project related to the application of intelligent methods for increasing the security in computer networks. The analysis of the feasibility of various Artificial Intelligence methods has shown that a method that is equally effective for all stages of the Cyber Intelligence cannot be identified. While for Tactical Cyber Threats Intelligence has been selected and experimented a Multi-Agent System, the Recurrent Neural Networks are offered for the needs of Operational Cyber Threats Intelligence.

Key words: Cyber Threats Intelligence, Artificial Intelligence, Behavior Assessment, Neural Networks, Sequential Feature Selection, Remote Network Monitoring.

1. INTRODUCTION

Over the last few years, the trends of transition of the Cyber Threats from the Cyber-Crime phase to the Cyber-War phase has also prompted an adequate transition of Cyber Defense techniques to military technology [1]. First of all, this concerns the perception in the analysis of the threats of the so-called "Kill Chain" model, as well as the application of traditional Military Intelligence Technology.

Furthermore, in the conditions where well-resourced and trained adversaries conduct multi-year intrusion campaigns targeting highly sensitive economic, proprietary, or national security information, the network defense techniques which

[1] This research is conducted and funded by a scientific-research project № H07/56"Increasing the level of network and information security using intelligent methods" under the contract D07-4 with National Science Fund in Bulgaria.

leverage knowledge about these adversaries can create an intelligence feedback loop, enabling defenders to establish a state of information superiority which decreases the adversary's likelihood of success with each subsequent intrusion attempt. That's why according to the vast majority of experts, the qualitative transition to new Cyber Defense tools must involve the widespread use of Artificial Intelligence methods to analyze information exchanged, network flows, sources of threats, and to plan effective impact measures, including proactive ones.

Following these trends, the Faculty of Computer Systems and Technology at Technical University of Sofia began research on the application of intelligent methods for increasing the security in computer networks. An essential section of this investigation is dedicated to the Cyber Threat Intelligence. The present article summarizes some results of a research done by the project team.

2. BASIC FEATURES OF THE CYBER THREATS INTELLIGENCE PROBLEM FORMULATION

The Cyber Intelligence or, more precisely, Cyber Threats Intelligence (CTI) has the following definition in the draft Bulgarian National Cyber Security Strategy [2]:

• establishment of mechanisms and technical means to maintain an up-to-date picture of possible threats of different scale, sources and character, trends in geopolitical context development and relevant national cyber picture analysis and;

• development of capabilities to help identify attribution sources and take appropriate forms of protection and counteraction.

According to the documents of INSA (Intelligence and National Security Alliance) [3, 4, 5] the preparation of the intelligence in cyber operational environment is a systematic and continuous process of analyzing potential threats to detect a suspicious set of activities that may endanger systems, networks, information, employees, or customers by providing means to visualize and evaluate a number of specific penetration sensor inputs to bring up a particular threat. This process supports the organization's risk management strategy and decision-making in the area of information security. Its application identifies potential threats and assists security and risk managers selectively implement and maximize deep defense strategies by better understanding the critical points in time and space in the operating environment.

The Cyber Threats Intelligence Cycle [6] is a systematic, continuous process of analyzing potential threats to detect a suspicious set of activities that might threaten the organization's systems, networks, information, employees, or customers by providing a means of visualizing and assessing a number of specific intrusion sensor inputs and open source information to infer specific threat courses of action. The model supports the organization's risk management strategy and the information security group's decision-making. The application of the model identifies potential threat courses of action and helps the security and risk management leaders selectively apply and maximize a defence in depth strategy via a greater

understanding of the organization's cyber threats at critical points in time and space in the operational environment by:

(a) defining the operational environment;

(b) describing the operational environment effects on network defence;

(c) evaluating the cyber threats;

(d) developing cyber threat courses of action.

Figure 1 is a graphical representation of the Cyber Threat Intelligence Cycle.

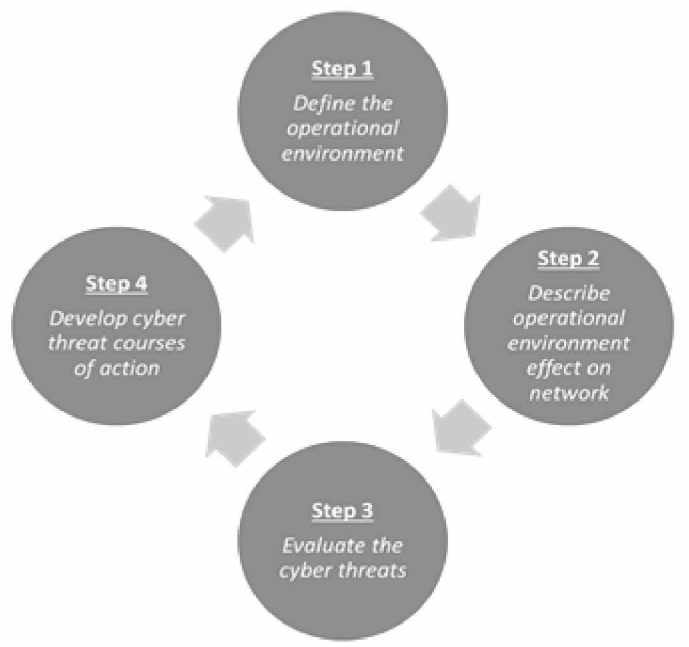

Fig. 1 Cyber Threat Intelligence Cycle

Like its military analogue, the Cyber Threats Intelligence is developed at three levels: strategic, operational, and tactical. For the purposes of this study, the second one is considered: INSA defines [5] the operational level as: "The level at which campaigns and major operations are planned, conducted, and sustained to achieve strategic objectives within theaters or other operational areas. At this level, actors build the capabilities needed to support the tactical operations. They maneuver in cyberspace to position capability where they need to in order to be effective in their tactical missions. At the operational level, an organization's operating environment can be described in terms of physical, logical, information and social layers".

3. METHODS OF ARTIFICIAL INTELLIGENCE IN NETWORK AND INFORMATION SECURITY

The essence of Artificial Intelligence (AI) is based on the statement that people's intelligence (the potential (inborn) ability of a conscious individual to conclude on a given information) can be described so precisely that it is machine-simulated. After several decades of research, AI is not only the subject of research or planning of some movement, but also of more complex and interdependent solutions. Artificial Intelligence is defined as the intelligence displayed by machines and / or software. This is an academic field of study exploring the goal of creating intelligence. The main issues explored by AI include reasoning, knowledge presentation, automated planning and scheduling, machine learning, natural language processing, computer vision, robotics and common intelligence.

AI enables us to develop autonomous computer solutions that adapt to their context of use, using self-management, self-tuning and self-configuration, self-

diagnosis and self-healing. When it comes to the future of information security, AI looks like a very promising field of research that focuses on improving cyberspace security measures.

With rapid pace of development and the desire for more effective countermeasures, Artificial Intelligence comes as a natural solution to the problem of coping with the ever-growing number of network attacks. Applications in the field of AI are widely accepted by the modern information society. This interdisciplinary endeavor has created a joint link between computer specialists and network engineers in designing, simulating and developing network penetration patterns and their characteristics.

As mentioned in the introduction to this article, world practice has already noted a significant number of various Artificial Intelligence applications in computer security. Without trying for a comprehensive classification, we could divide these methods into two main directions:

A. Conditionally named "distributed" or "network" methods:

A1. Multi-Agent Systems of Intelligent Agents;

A2. Neural Networks;

A3. Artificial Immune Systems and Genetic Algorithms, etc;

B. Conveniently named "compact" methods:

B1. Machine Learning Systems, including: associative methods, inductive logic programming, Bayes classification, etc.

B2. Pattern recognition algorithms;

B3. Expert Systems;

B4. Fuzzy logic, etc.

Having into account this variety of methods, it is of particular importance that adequate criteria are selected for the assessment and selection of a specific application for each specific solution. In the above mentioned project, the specification was carried out for two of the main sections of CTI. It should be noted here that within the project the application of Multi-Agent systems was chosen and experimented as the most appropriate method for the needs of the Tactical Cyber Intelligence.

4. METHODS OF ARTIFICIAL INTELLIGENCE SUITABLE FOR OPERATIONAL CYBER THREATS INTELLIGENCE

The ultimate goal of Operational Cyber Intelligence is to reduce risk to an organization's critical mission and assets by: defining the operating environment; describing the impact of the operating environment; evaluating the adversary; and determining potential adversarial courses of action (COA). The Operational Cyber Intelligence provides a thread that links the probability and impact of a cyber attack with its strategic level implications by ensuring a coherent framework for analysis and prioritization of potential threats and vulnerabilities given the organization's threat environment. Operational Intelligence is based on the Doctrine of Active Defense.

Instead of searching for information regarding a specific attack against the organization, it focuses on analyzing the opponents' combat doctrines, weapon systems and attack and operational scenarios. This approach shifts the center of gravity to the ability to respond and block the outcome of the attack within the organizational environment or in its immediate vicinity.

Our main idea was that the basis for the automation of the Operational CTI can be the behavioral model of the likely adversary. It should be emphasized that the problem of using artificial intelligence methods in the Operational CTI is a completely new matter, and systematized literary sources have not yet been found. Only, there are reports concerning the use of behavioral analysis based on machine learning by the companies: Exabeam (USA), Darktrace (UK), CyberX (USA), Interset (Canada).

The TU-Sofia team concluded that the activity and the outgoing traffic in the network of the supposed adversary were to be the main source of information for building his behavioural model. This evokes analogies with the Non-Invasive Brain - Computer Interface whereby the physiological signals of the human brain (for example, through Electroencephalograms (EEGs)) can be used for human emotions evaluation [7].

Indeed, the streams of measured parameters received by n-number different IP addresses of the monitored object using RFC 1757 Remote Network Monitoring methods [8] can be compared to EEG with n-number of channels.

If this analogy is applied in practice, first of all, on the order of the classification model of emotions [9], a basic classification of the behavior of the possible adversary, based on the needs of our research, must be constructed,. Currently, in the absence of references for such studies, it is assumed that this behavior can be divided for the present into two basic types: hostile and non-hostile.

In order to obtain the best possible performances, it is necessary to work with a smaller number of values which describe some relevant properties of the data retrieved from the network. These values are known as “features”. Features can be aggregated into a vector known as “feature vector”. Thus, feature extraction can be defined as an operation which transforms one or several signals into a feature vector. Identifying and extracting good features from signals is a crucial step, because otherwise the classification algorithm will have trouble identifying the class of these features, i.e., the behavioral state of the possible adversary. According to some researchers [10], it seems that the choice of a proper pre-processing and feature extraction method have more impact on the final performances than the selection of a good classification algorithm.

Therefore, following the analogy of the Brain-Computer Interface, two basic tasks have to be solved:

• to find a suitable approach to selecting characteristics from which to derive features suitable for behavioral interpretation and validation. In doing so, the necessary inter-subject discrimination of the features for the subsequent classification must be ensured;

• to build and optimize an ensemble of classifiers based on trained models to be used to assess behavior.

According to the researcher's scenario, design of the system of assessing the behaviour of the supposed adversary can consist of two main phases: 1) offline training phase to calibrate the system and 2) online phase which uses the system to recognize the type of behavior states and translate them into the computer commands. Both offline and online phases follow a closed-loop process, generally composed of six steps:

a) network activity measurement- this step consists in network surveillance of broadband Internet traffic (e-Mails, Web traffic, instant messengers, etc.) using methods, such Packet Capture Appliances (Fig. 2) in order to obtain signals reflecting the opponent's intentions [11];
b) preprocessing - this step consists in cleaning and denoising input data to enhance the relevant information embedded in the signals;
c) feature extraction – this extraction aims at describing the signals by a few relevant values called "features";
d) classification - this step assigns a class to a set of features extracted from the signals, which corresponds to the kind of behavioral state identified. This step can also be denoted as "feature translation". Classification algorithms are known as "classifiers";
e) translation into a command/application - once the behavioral state is identified, a command is associated with this state in order to control a given application.

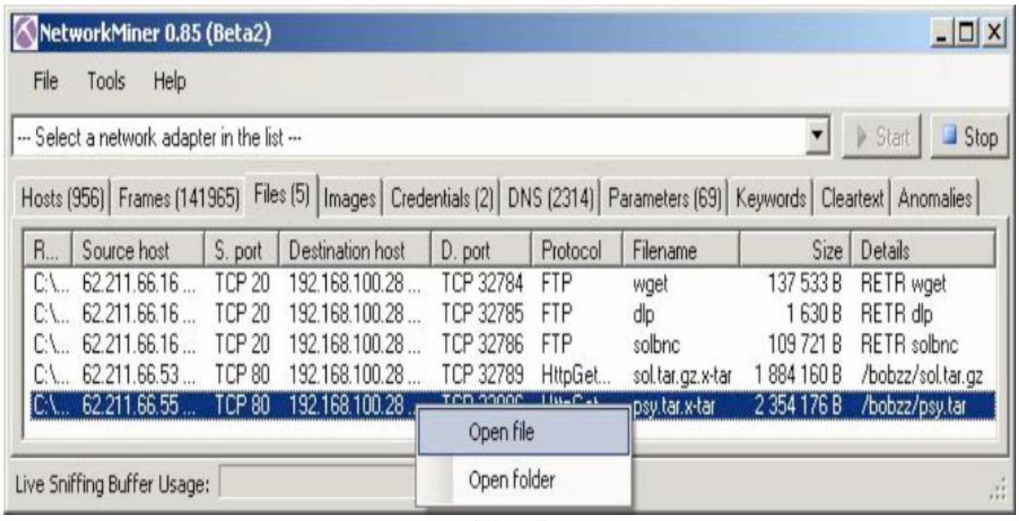

Fig. 2

Once the data have been acquired, they are pre-processed to clean (de-noise) the signals and to enhance relevant information embedded in these signals. The pre-processing step aims at increasing the signal-to-noise ratio of the input signals.

To perform this pre-processing, various spatial-spectro-temporal filters [10] can be used. Naturally, numerous other pre-processing methods, which are more complex and more advanced, can be proposed and used. But in our initial experiments we

were based on two of the most popular methods, namely, Independent Component Analysis (ICA) and Common Spatial Patterns (CSP) method.

Based on a study of literary sources, the Echo State Network (ESN) method was proposed as a mechanism for feature selection – this is a class of Recurrent Neural Networks where the so-called "Reservoir Computing" approach for training is formulated [12].

The basic structure of an ESN, presented in Fig. 3, consists of a reservoir of random connected dynamic neurons with sigmoid nonlinearities (usually hyperbolic tangent):

$r(k) = f\,res(W\,inin(k) + W\,resr(k-1))$

and a linear readout $f\,out$ (usually identity function) at the output:

$out\,(k) = f\,out\,(W\,out\,[in\,(k)\,r\,(k)])$

Here k denotes discrete time instant; $in(k)$ is a vector of network inputs, $r(k)$ - a vector of the reservoir neurons states and $out(k)$ – a vector of network outputs; nin, $nout$ and nr are the dimensions of the corresponding vectors in, out and r respectively; $W\,out$ is a trainable $nout$ (nin+nr) matrix; $W\,in$ and $W\,res$ are $nr\,nin$ and $nr\,nr$ matrices that are randomly generated and are not trainable. In some applications, direct connection from the input to the readout is omitted.

The main advantage of the ESN is the simplified training algorithm since only weights of the connections from the reservoir to the readout neurons are subject to training [13]. Thus instead of gradient descent learning much faster least squares method can be used.

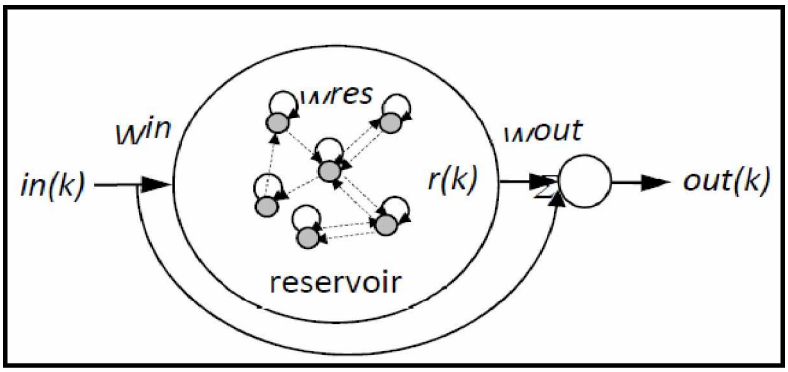

Fig. 3

We started on the presumption that using reservoir computing pre-training is beneficial for selecting the most relevant discriminative features and reaching state-of-the-art performance for subject independent recognition. The Reservoir Computing approach could be used not only for time series processing but also for high dimensional static data representation. Finally, the existing practice shows that IP-trained ESNs outperform pre-trained deep auto-encoders and can actually achieve almost 100% testing accuracy.

Exploring the feasibility of training cross-subject classifiers, we have settled on the Sequential Feature Selection (SFS) procedure [14] that reduces the inherent data

variability and can lead to a high inter-subject behaviour status recognition accuracy. Starting from an empty set, SFS increments sequentially a new feature that best predicts the class at the current iteration. The process stops when there is no more improvement in the prediction. SFS is a very effective way to identify the dominant behavioral signatures across subjects. However, it is a computational heavy and time-consuming procedure, which was the main motivation to look for a computationally less intensive alternative.

The state of the art of the works described in this article can be defined as a transition from the development of a theoretical model to an experimental setting.

As the experiments are in their early stage, it is necessary to point out that the results are encouraging, but it is still too early to declare any definitive conclusions.

5. CONCLUSION

As can be seen from the above, the process of introducing Artificial Intelligence methods at the different levels of Cyber Threat Intelligence is at very different stages: while in Tactical Intelligence, it has long gone out of the phase of research and experiments and is used for building real effective systems, In the field of Operational Intelligence, these studies are in a very initial phase and require the commitment of substantial resources. Furthermore, the question arises as to the application of possible outcomes of Operational Iintelligence in the activity of Tactical Intelligence systems, which are intended to neutralize the immediate threats to computer systems and networks.

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MODELLING AND IMPLEMENTATION OF MACHINE LEARNING TECHNIQUES FOR HATE SPEECH DETECTION IN MOBILE APPLICATIONS

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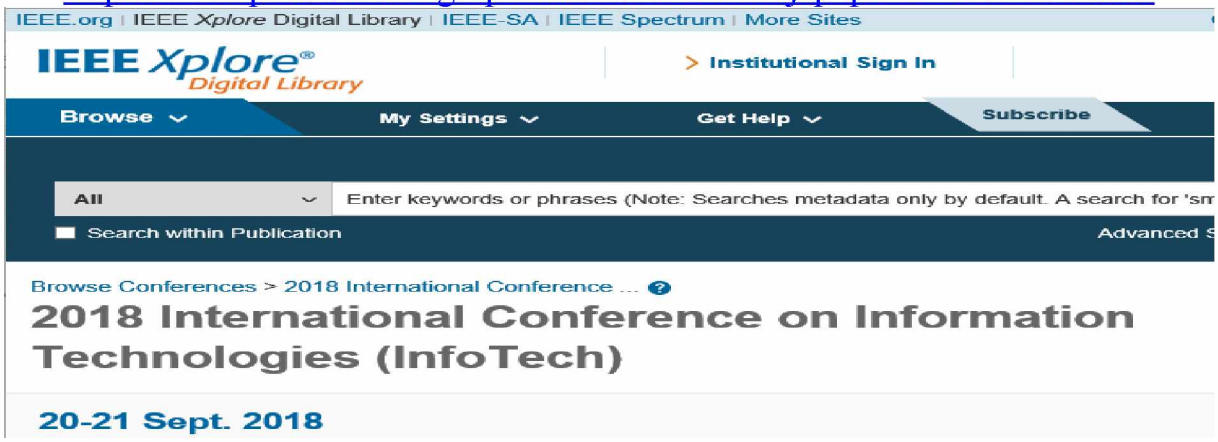
Abstract: The proliferation of data through various platforms and applications is in constant increase. The versatility of data and its omnipresence makes it very hard to detect the trustworthiness and intention of the source. This is very evident in dynamic environments such as mobile applications. As a result, designing mobile applications that will monitor, control and block any type of malintents is important. This paper makes an attempt in this direction by implementing a lightweight machine learning classification scheme for hate speech detection in Albanian Language for mobile applications. Initial testing and evaluations indicate good classifier accuracy in mobile environments where frequent and realtime training of the algorithm is required.

Key words: automatic hate speech detection, machine learning, artificial neural networks (ANNs)



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ARTIFICIAL INTELLIGENCE IN INTERNET OF MEDICAL IMAGING THINGS: THE POWER OF THYROID CANCER DETECTION

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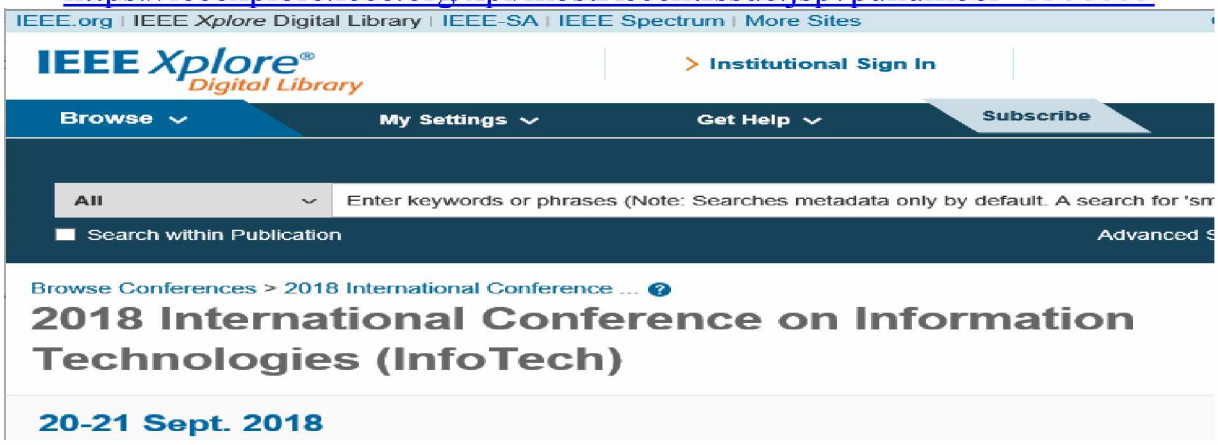
Abstract: The paper proposed an approach for thyroid cancer detection based on artificial intelligence in Internet of Medical Imaging Things (IoMIT) ecosystem. Ultrasonic imaging collected in IoMIT ecosystem is the best way for thyroid cancer diagnosis. Image segmentation and detection of benign and malignant thyroid nodules is an important part of the proposed approach. It is implemented in Apache Spark using MLlib based on Convolutional Neural Networks (CNNs). Finally, the results of medical imaging analytics are discussed.

Key words: Internet of Things (IoT), Internet of Medical Imaging Things (IoMIT), Artificial Intelligence (AI), Big Data (BD), Thyroid Cancer Detection.



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DUAL MLP PAIRS WITH HIDDEN LAYER SHARING

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Abstract: Artificial neural networks (ANN) are well known and widely used from decades. One of the most popular is the multilayer perceptron (MLP). MPL's general characteristic is that it has more than one layer. The most used topology of MLP has three layers (input, hidden and output). Layers are fully-connected, between each other (the input with the hidden layer and the hidden layer with the output). The general disadvantage of this topology is the lack of recurrent connections. The common usage of MLP is to solve only a single task. This research addresses these two common features of the MLP.

Key words: artificial neural networks, multilayer perceptron, topologies.

This article has not been presented during the conference sessions

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APPLICATION OF DEEP LEARNING APPROACH IN SEQUENTIAL GAMES

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Abstract: This article focuses on the application of deep learning techniques in sequential games. The main hypothesis is that sequence to sequence learning approach is applicable and demonstrate better performance than classic reinforcement learning. So autonomous agents trough sequence to sequence approach are capable of discovering good solutions to the problem at hand by learning in dynamic environment.
Key words: sequence to sequence, sequential games, autonomous agents

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SOLVING THE GLOBAL TRAJECTORY OPTIMIZATION PROBLEM WITH ARCHIVE-BASED DIFFERENTIAL EVOLUTION

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Abstract: The paper describes application of differential evolution with modified mutation strategy to the global trajectory optimization problems. The problems are provided by the European Space Agency and represent trajectories of several well-known spacecraft, namely, Cassini, Rosetta and Messenger. Using archive based differential evolution, global best solutions were found for these problems, and the best known solution was found for the Cassini mission.
Key words: Differential evolution, global trajectory optimization, spacecraft trajectory optimization.

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20-21 September 2018, Bulgaria

EDUCATION AND PRACTICAL KNOWLEDGE FOR PROJECT AND RISK MANAGEMENT IN ICT AREA

PLENARY REPORT SUMMARY [1]

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Abstract: The report discus and makes insight in the current efforts of the universities to deliver and perform practical knowledge to the students in the era of new economy and project environment they are working after graduation. The education should follow the changes in the business of new millennia and its' orientation towards projects with various types, sizes and categories. This challenge, especially in the ICT area, the universities and professors are faced with, needs their creative and unique approach in delivering practical knowledge and skills to the young professionals that will be needed in their workplace.

Key words: Education, ICT projects, Project management, Project Based Learning management.

1. INTRODUCTION

The acceleration we live is becoming faster and faster and the business and as the result of IC technologies working environment in general is dynamically change. Consequently, education is oriented towards meeting demands of such society's new

[1] Full version of this plenary report is published in the Special section of the **International Journal on IT and Security, No. 4, vol. 10** (http://ijits-bg.com/ijitsarchive)

Vangel Fustik. Education and Practical Knowledge for Project and Risk Management in ICT Area. *International Journal on Information Technologies and Security*, No. 4 (vol. 10), 2018, pp. 17-24

economy and new project environment in terms of: new and professional knowledge, wide range of business and project management skills and higher level of competence to deal with challenging and new technological developments. However, the nowadays students' needs for successful professional carrier is dramatically different from the end of 20-th and beginning of 21-th century. Especially engineering education is faced with challenges that need new approach in organizing the companies, running a business and creating the everyday working habits in a new project and risk management environment. A certain surveys [1] worldwide highlighted this phenomena indicated that top two skills desired from new hires are project management and business process management. In addition in Europe a survey for appointment data [2], found that while there was a modest increase in overall IT recruitment, the need for IT management positions with project management skills grew faster. This trend was attributed to increased levels of confidence, leading to the implementation of the new projects requiring management professionals, while lower-lever technical tasks were frequently outsourced.

2. INSIGHT IN THE MAIN ISSUES

2.1. Project environment and New Economy

Projects complement regular business processes and are often the main vehicle for strategy implementation in an organization. The processes are how work gets done on a daily operational basis, projects are important efforts to meet the organization's strategic objectives and to implement changes. However, as projects take a more crucial role in organizations, project management discipline has become a leadership competence. In today's workplace there could be hardly found managers who just "do their job". Especially in engineering environment managing projects alongside one's regular function is a daily reality, and project success has become an important factor in any manager's performance evaluation. The number of engineering jobs has increased and engineering positions are more varied, while greater job mobility has reduced the opportunity for engineers to take advantage of longer on-the-job training periods [3]. As a consequence, engineering educators are been challenged to look at their curricula and retool coursework to incorporate non-traditional information and subject matter. Students' need for theory understanding to enable engineering problem solving remains a top priority, but today's graduates could not enter the workforce *only with technical skills*. Engineering specialties have become varied and diverse, and therefore industry is demanding new "rounded" engineers whose initial skills stretches beyond technical competency having supporting work skills. In addition, the New Economy of 21 century is more concurrent and global, and therefore with lower money to share, so this trend and new project environment that the business is running make a totally different philosophy for education the young professionals.

2.2. Student' needs and Engineering curriculum

Engineering education in ICT and student' needs are identified in a number of studies and research [4], [5], [6]. Summarizing these needs of the interested stakeholders in educational processes are linked and identified and could be listed as follow:

Student Needs: Strong theory foundation; engaging. real-world application work; creativity/problem solving skills; critical work skills; risk analysis.

Industry Needs: Technical competency; communication skills (written, verbal, presentation); leadership and teamwork skills; enthusiasm and personal drive (a sense of a mission); intuitiveness; integrity; other supporting work skills.

Curriculum Needs: Theory; hands-on trough lab work and practical examples; more intense hands-on applications work using industry-based scenarios and problems; opportunities to develop basic yet critical supporting work skills.

Based on these considerations, the education of specialists in the field of ICT must be divided in 2 categories [7]:

- *education of ICT developers (experts)*
- *education of ICT managers*

For the students in the field of computer sciences, who is assumed to be future developers, the universities provide very comprehensive and high ranked curricula that prepare and armed the students with a well recognized and acknowledged knowledge.

For the future ICT managers: the example curriculum in the specifics of tools should be shorter, but subjects in the ICT services and ICT management must be included as: E-commerce, E-banking, marketing, business innovation, project and risk management, creativity and ethics.

Technologies
Internet Technology
Data Communication and Networks
Security Management and Technology
Industrial Automation
Software engineering
Mathematics
Services
E- Business Innovation (E-Commerce)
Entrepreneurship
Knowledge Management
IS Development
Management
Project Management
Business and ICT Strategy

Business Process Management
Business Intelligence
Financial Management of ICT
Social and Legal aspects of ICT

2.3. Project Based Learning

The young professionals and university graduates may initially be hired primarily for their technical skills while *long-term career success* is more dependent on *non-technical skills*. However, these skills should be integrated throughout the curriculum, rather than be taught later in some isolated activities of the person. That is a way the students will receive a full-picture view of real world of the business, projects and for sure the practice of engineering. The professors in engineering and especially in emerging and fast changing technology, such as ICT, should seeking ways to introduce more workplace related experience earlier in the curriculum and to incorporate "supporting work skills" such as: communication and time management skills, project planning and execution, project manager duties and responsibilities, teamwork leadership, risk management, decision making and ethics. However, to teach the undergraduate students project management theory and practice is complex, since there is a lot necessary and preparatory business things to be learnt. In that sense, curriculum has to follow the underway trends in project management and deliver the knowledge and skills that will prepare the engineers for project management profession. There are discussions and studies [5,8,9,10] that reflect this issue and that could be easy checked-out among companies and young professionals. In our case – Faculty of El. Engineering, UKIM Skopje, introducing Project management curricula was not easy task. On post graduated studies it was much more easier, and we have had a great success with enrolling students and their ambition to obtain such knowledge. The practical examples of real projects, seminars, planning tools and case studies that we are teaching students from our personal experience are very helpful to the students to understand their role in business and company itself. University and Industry should work together (that is their common interest) to provide such knowledge and training.

Therefore, the guiding equation of Project Management for Education could be:

PM (Project Management) + PBL (Project Based Learning) = Deeper Learning for Career, Community and Life

2.4. Project management trends

The University should be aware that it is now a project based world. An optimal way to prepare young people is to ensure they have access to high-quality project-based learning (PBL). In that sense, some of the issues could be listed:

• Professors and educators should communicate the practice for project-based learning (PBL), and empower possibilities offered by their management to make sure students have support and tools for high-quality PBL professional practice.

• Professors should be involved in real project activities to share that experience and to construct high quality learning methodology.

• Industry and business leaders should advocate for community connected PBL and contribute in efforts to support, mentoring and train PBL in their professional communities.

• There should be a wide range of learning opportunities for the students. They should experience success! It will enable their self-esteem and encourage them to experience innovation and new approaches and way of creative reasoning. They should learn to experience and overcome mistake that could occur in their efforts for success in competitive world.

• The students should have a good basic knowledge in Project management and to investigate and experiment in Risk management being creative in order to be helpful for organization for better ROI and good reference among clients. So, it is a trend that Risk management in international ICT project management has a growing concern these days.

The selected modern trends in project management are listed as follow:

- Agile will gain more popularity in IT projects and continue to be accepted in wide range of industry projects.
- Risk management will be an incredibly popular topic for project managers to be learnt and applied.
- PMP certification will become more popular, but changes are needed.
- The Need and project requirements – not organizational chart will create project team.
- Remote teams will become normal.
- The rise of BYOD will cause project management software to have more ticketing options. BYOD ("Bring Your Own Device").
- Emotional intelligence will be most desired skill for new project managers.

3. CONCLUSION

Since the education is a life-long process, introducing project management to meet the needs of the students and industry (and not to forget the entrepreneurs) is a challenging mission. It is no doubt that our industry, companies and organizations will embrace, value and utilize project management and attribute their success to it. However, the efforts that are making both University and industry working together, a common engineering education in project management will find the way to ensure that our graduates and master degree students have all of the tools they need to

succeed and continue to contribute in economic and technological growth. The Engineering universities and faculties especially in ICT, in their curriculum have to be up-front in the following, understanding and applying new trends in project management. It is a very complex task the professors are faced with and their mission is challenging that ever before.

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THE USE OF SCRIPTS AND STORYBOARDS IN CRISIS SITUATIONS

PLENARY REPORT SUMMARY [1]

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Abstract: To be prepared for a flooding crisis the city counsel of Prague prepared a crisis plan. In such a plan possible crisis events and corresponding actions of rescue workers have been described. The extensive text based crisis plan cannot be used to inform and train civilians in the crisis area and first responders. Storyboards and scripts offer a possible visualization of the crisis plan. In the paper the use of storyboards in case of a flooding crisis have been described. Some experiments have been performed and the results are presented

Key words: crisis plan, scripts, storyboards, data visualisation, artificial intelligence, experiments.

1. INTRODUCTION

In 2002 there was an enormous flooding in the old city of Prague. The water of the river Vltava went beyond its borders and caused a lot of damage of buildings, infrastructure. A dozen of citizens were drown but many more were injured. A crisis management team evaluated the flooding crisis and concluded that the city was badly prepared for the flooding. Parallel with the renovation and reconstruction of the old city, the city council took some measurements to control the raising water in the river in a better way. A plan for building water reservoirs was designed and cascades in the

[1] Renewed and extended version of this plenary report is published in the Special section of the **International Journal on IT and Security, No. 4, vol. 10** (http://ijits-bg.com/ijitsarchive)

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river to buffer the water. The river bed was deepened and enlarged to enable faster drain of the water.

The crisis management team designed a flooding crisis plan with a detailed description of events to be expected during a crisis and possible action. First responders members of fire brigade, police and medical service play key roles during a flooding crisis. To be prepared for a flooding crisis training events are organized for first responders at regular times on different places. For such training events special scenarios have been designed. But it proves that all the documents are difficult to read and understand by first responders.

During the flooding in 2002 many movies and pictures were taken. Eyewitness reports were written and recorded. Newspapers, radio and TV broadcasts reported about the flooding and present the flooding events on timely basis. This multimodal material has been included in the training material of first responders. Compared to written documents it proves that scripts, storyboards, gaming and MOOCs are highly appreciated by first responders. According to a well-known saying "a picture tells more than thousands of words", it is not a big surprise that multimodal material is more informative than written documents. In this paper we will research a psychological grounding of this phenome. Next we will research how storyboards can be constructed from available multimodal recordings of a flooding disaster with and without use of augmented reality technology.

The outline of the paper is as follows. In the next section we will present a literature survey. Then we will present a model in section 3. This model has been tested in some experiments presented in section 4. In section 5 we come to a conclusion and end this paper with references.

2. RELATED WORK

In [1] the AI researcher Robert Schank introduced the concept of behavioral scripts. Behavioral scripts are a sequence of expected behaviors for a given situation. Schank reported that humans are able to store many life evens as a sequence of scripts in their memory. It proves that all people have common stories in their brain. Famous is the restaurant script. After entering a restaurant a customer may look for and empty table, order first some drinks, select food on the menu card. After finishing his nail the waiter askes for a dessert or some coffee. Before leaving the restaurant the customer pays his meal. The different roles and actors are well defined in the script. Schank developed a formal language to describe different scripts. Scripts are prototype behavior patterns. Details can easily be included by people. If a lot of contradictory information is perceived, humans are willing to give up

There is lot of psychological research to validate the script theory. In their study Bower et all [2, 3] asked participants in their experiments to read different scenarios. Next the participants were asked to remember as much of each scenario. It proves that respondents reported events that were not part of the scenario but part of the underlying

prototype script. Participants were also requested to indicate on a 7-point scale if some presented sentences were actually taken from the scenarios. It proves that respondents recognized some sentences as if they were from the scenario. In fact these sentences reported relevant issues from the scenario but were actually not from the scenario. Ultimately, Bower, Black, and Turner's study suggested that scripts serve as a guide for a person's recall and recognition for certain things that they already know.

Klein [4] studied the behavior of first responders. It proves that fireman had possible scripts of crisis scenarios in their memory. If they are confronted with the first features they select one of these scripts and stay to it until the moment they are confronted with so many conflicting features that they have to give up the chosen scripts and come up with a new script where all the features find their place. Fireman learned their scripts from past experience and training. It proves that they had problems finding a script if they were confronted with a disaster they have never seen before.

In one of his studies Rothkrantz [5, 6, 7] reported that fireman came up with possible scripts of fire in the underground or train incidents if they were confronted with wounded people and panicked people leaving the exit from the underground. Thee fireman were never confronted with the possible scenario of terroristic attack.

Rothkrantz [8, 9] showed that also human reasoning is quite different from reasoning using (probabilistic) expert systems. As Klein demonstrated human experts select from the beginning a possible script and stick to it until they are confronted with many conflicting events. In expert systems many possible scenarios are considered simultaneously. Every observed feature contributes with some weight to a possible script. Every moment the most probable script has been selected

3. PROBLEM DEFINITION

A crisis plan is usually an extensive written document. It proves that visualization of a crisis plan by storyboards is useful in application and training, exercises. The problem is how to design storyboards from multimedia recordings of past flooding events. In how far is a sequence of video frames a visualization of a prototype of a story.

4. MODEL

In [10] Lefter et al. defined 25 topics of overt aggressive behavior in railway stations and trains. Eleven stand-up comedians were requested to play the aggressive scenes and all scenes were recorded by multimodal video recorders. The video footage was analyzed and it proves that all recorded scenes had a similar underlying model as displayed in figure 1. It always started with an introduction to the context, travelers in a train or in a station. Next the topic was introduced such as someone who uses the train without paying, pickpocket, embarrassment, inappropriate behavior of drunken

traveler, loud speaking phone caller, beggar, hooligans. In all the recorded movies there was a rising action to a climax of overt aggressive behavior, followed by removal of the aggressor and returning back to the default situation.

After the different scenes were recorded we made a storyboard of all the 25 different topics. An artist made drawings of characteristic scenes and the composing scenes of the storybook form a comic. The question was how the characteristic scenes were selected. A final criteria was that the composed scenes have to tell a story. The selection by the artist was by intuition. Later we deleted and added scenes without changing the basics of every storybook. It proves that in 82% of the storybook of the artist remain unchanged. Given every drawing we were looking to a similar frame in the video recordings. It proofs that the artist was inspired by the video recordings but was able to reduce characteristic scenes to the essentials. In fact the artist used also enhanced reality technology to generate characteristic scenes.

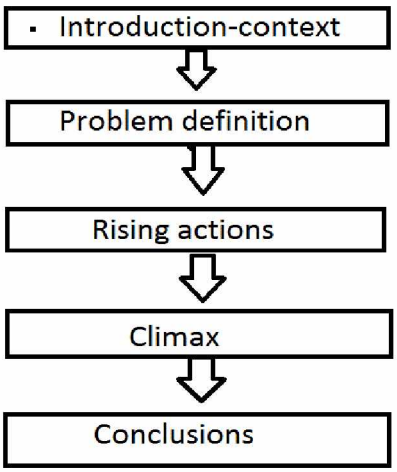

Fig. 1. Model of a storyboard

5. EXPERIMENTS

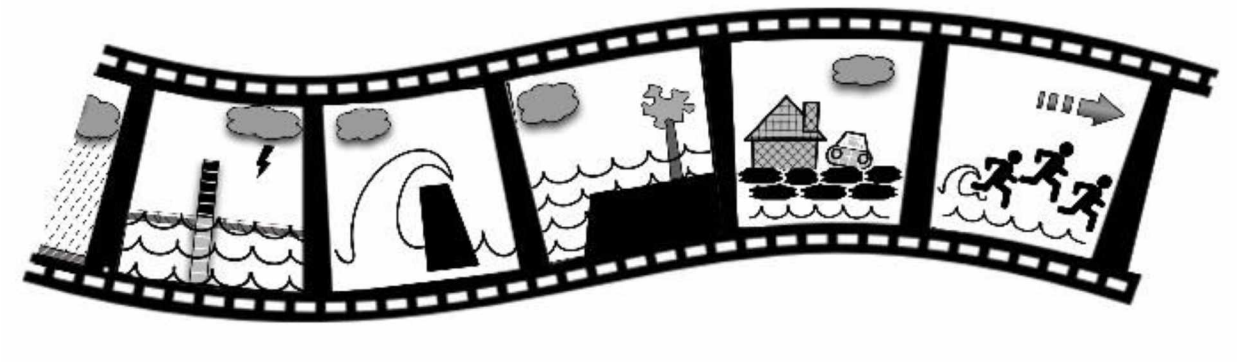

Fig. 2. Storyboard of a movie of flooding.

We performed some experiments to verify our hypothesis a defined in section 3. In this section we will describe the experiments and present the results

5.1. Stories related to storyboards

Our assumption is that some flooding events are stored as prototypes in the common memory of people. An artist made an artistic impression of the storyboards 5 flooding events such as the onset of a flooding, measurements to prevent flooding, successive flooding of the lower parts of Prague, mass evacuation, finger in the dike by soldier Schweik.

The participants in the experiments were 28 students Computer Science from Delft University of Technology. The storyboard as displayed in Figure 3 was displayed to them without text labels. Students were requested to fill in the text labels and a summarising story. It proves that 19 students were able to fill in the text labels correctly and summarised similar stories.

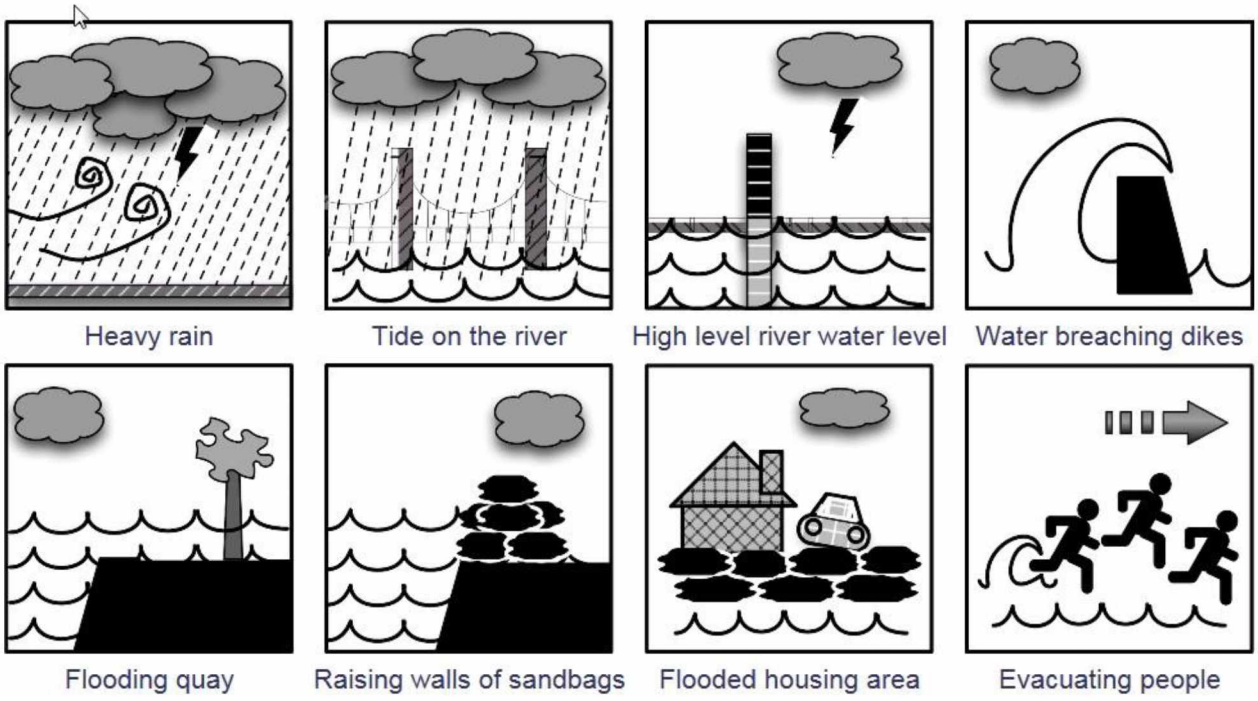

Fig. 3. Storyboard of flooding.

A possible flooding crisis can be described by a sequence of events. Maybe it starts with heavy rainfall, causing raising of the water level in the river, followed by breaching dikes, flooding quays, building walls of sandbags and evacuating people. These events can be visualized by pictures. These pictures tell a story. But not every sequence of pictures tells a meaningful, unique story. An interesting question is which flooding stories are in the mind of people and if these stories are similar?

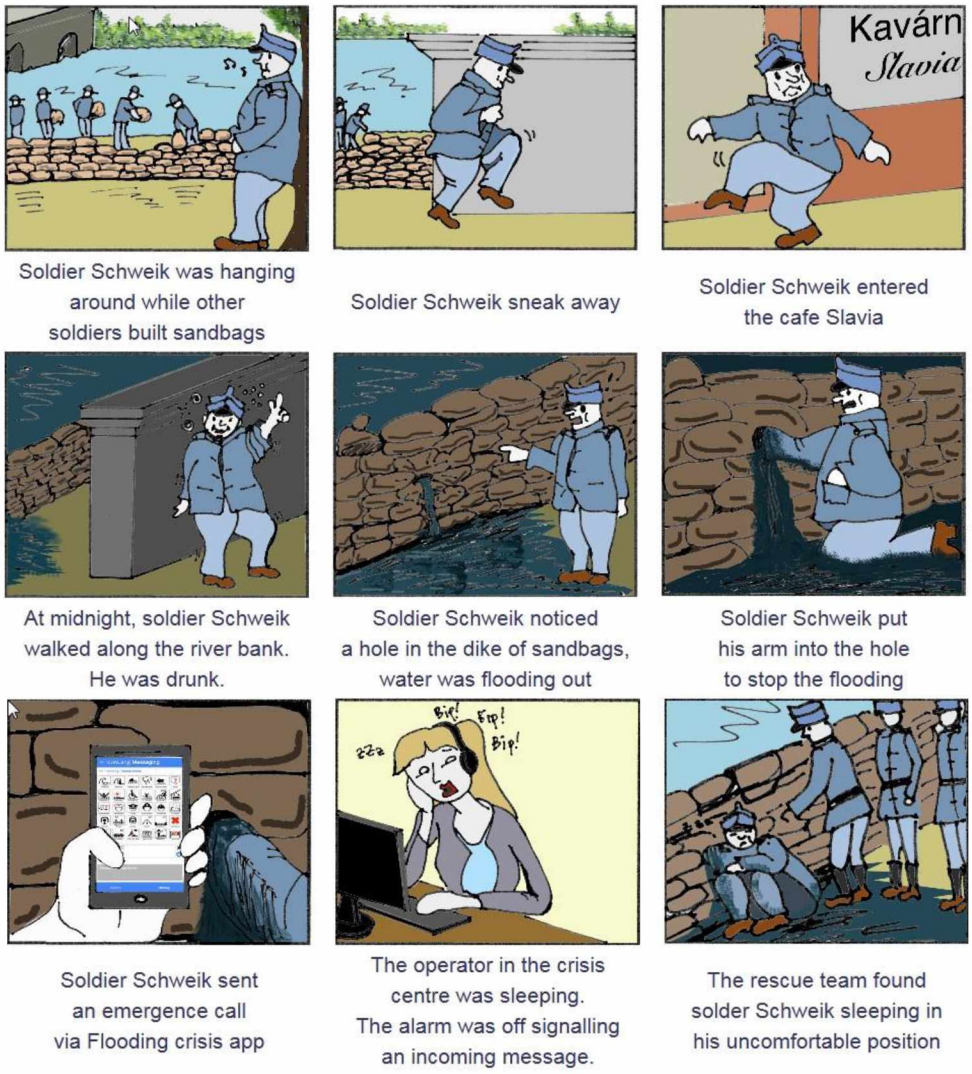

Fig. 4. Storyboard of soldier Schweik saving the city of Prague.

It is not necessary that, a storyboard is composed of pictures of realistic events. Augmented reality or even imaginary pictures can be used to accentuate the focus of the pictures and to enable the expected interpretation. Fantasy and imagination is also used in fairy tales and comics. Let's read the story (below) about how soldier Schweik saved Prague from flooding.

In a second experiment our 28 respondents were confronted with the storyboard as displayed in Figure but without text labels. Again the respondents were requested to generate appropriate text labels and 21 of them were able to do this. Some student never heard about the Dutch children story of the boy Hans Brinkers putting his finger in the dike and saved Holland.

5.2. Storyboards generated from movie frames

There are many movies, pictures, scripts available from the real life flooding disaster in 2002. In Figure 5 we display some examples. A sequence of random choice

of pictures will not tell a story. A special selection is needed and even some pictures processed with augmented reality technology.

In a third experiment our 28 students from DUT were confronted with a set of 25 pictures and were requested to generate a flooding script/storyboard composed of 10 of them. The generated storyboards were checked by 3 other students in a discussion. It proves that 22 relevant storyboards were generated, recognized by the other students.

Fig. 5. Samples of pictures from the flooding disaster in 2002.

6. CONCLUSION

In this paper we studied the generation and recognition of storyboards around a flooding disaster in Prague. It is assumed that humans use scripts to store information about real life events.

In a first experiment we tested if a storyboard of pictures of scenes from a flooding disaster were recognized by a panel of students.

In a second experiment we tested if a storyboard was recognized based on a well-known children story of Hans Brinkers putting his finger in a hole in the dike saving Holland from flooding. Respondents familiar with the children story recognized also the flooding storyboard.

Finally in a third experiment respondents were confronted with set of real life pictures of the flooding at Prague in 2002. The assignment was to generate a storyboard

from the pictures. It proves that most respondents were able to select appropriate pictures and put them in a logical order. Apparently most students had a flooding script in their mind and were able to generate a similar script using the pictures.

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SERVICE-ORIENTED ARCHITECTURE AND PROCESS MODELING

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Abstract: Nowadays, uncertainties in business environment enforced enterprises to utilize innovative patterns for the interpretability and integration of the processes and services. Therefore, enterprises have, throughout time, shifted to IT-based business processes based on Service-oriented Architecture (SOA) to augment the agility, integration, and flexibility of IT-based applications in enterprise networks. Thus enterprises have embarked on the implementation of integrated information systems to support their business processes. To this effect, SOA, as a highly capable paradigm in IT, has been increasingly used in Business Process Management (BPM) and enterprise information systems using the Web service technologies. This has helped the attainment of required agility and flexibility for inter-organizational networks. The aim of this paper is to review the underlying concepts of SOA and to identify how SOA business process.
Key words: Service-oriented Architecture, Service-oriented modelling, Process modelling

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ANALYSIS AND COMPARISON OF DOCUMENT-BASED DATABASES WITH SQL RELATIONAL DATABASES: MONGODB VS MYSQL

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Abstract: In this paper, we aim to make a comprehensive analysis and comparison between document-based and relational databases. We review and evaluate data storage and data management principles of each type of concerned databases. In addition, we evaluate the performance of CRUD operations using different scenarios on MongoDB and MySQL as two representatives of respected data models. The results give insights to advantages and disadvantages of each database model.
Key words: NoSQL, SQL, MongoDB, MySQL, evaluation, analysis, comparison.

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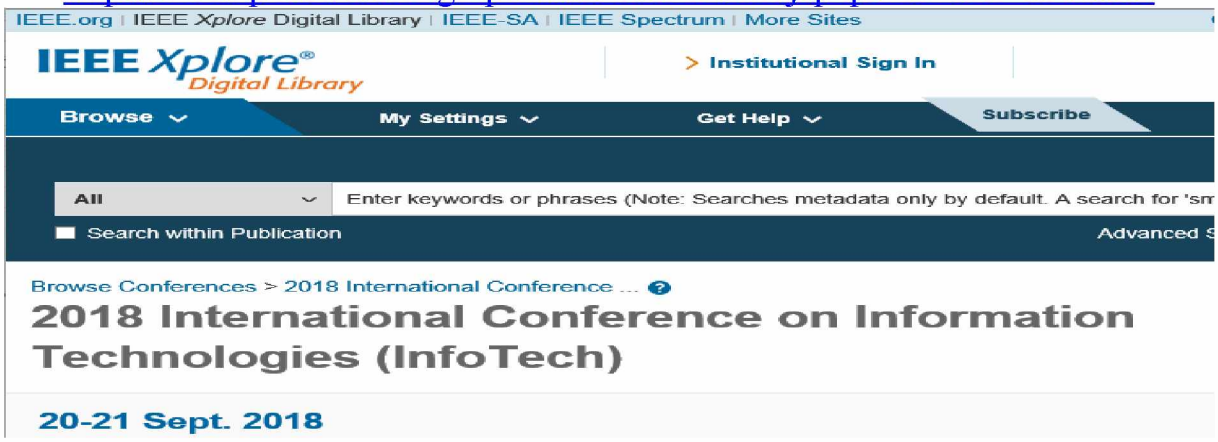

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SIMULATED COMPARISON OF PUSH/PULL PRODUCTION WITH COMMITTED AND NON-COMMITTED AUTOMATED GUIDED VEHICLES.

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Abstract: The purpose of this paper is to show the value of modelling and simulating a production line. This will allow for better configuration of production lines in the real world and produce improved output. In order to cover a realistic number of configurations, the simulation is applied to push and pull production setups of the same line. Additionally it covers the scenarios of committed and non-committed automated guided vehicles (AGVs).
Key words: SCM, push/pull production, simulation.

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PHASE-PLANE MODELS IN KORELIA SOFTWARE

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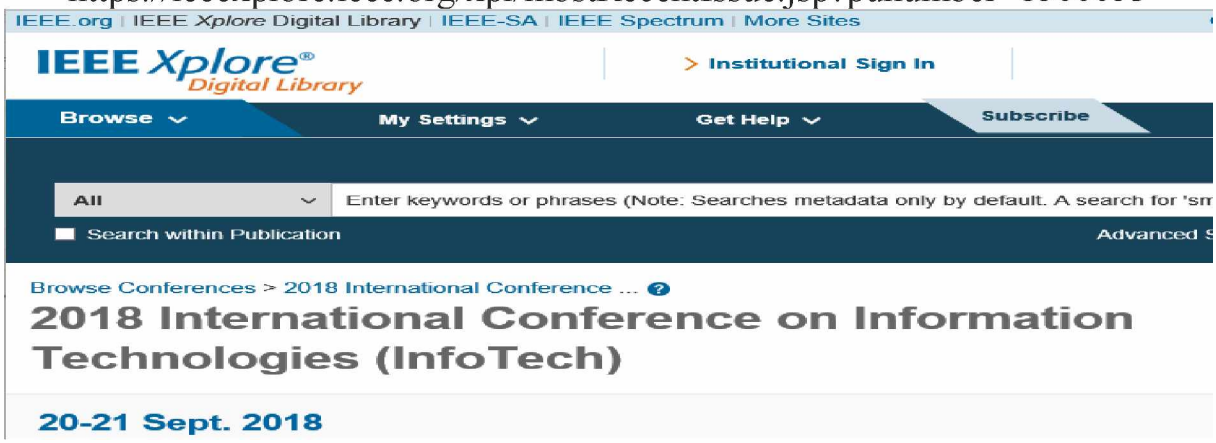
Abstract: In this work, the possibilities of the Korelia program for analysis of dynamic processes by the phase plane method are explored. The dynamics model is described using a specialized programming language. An algorithm for constructing nullclines of the process and for calculating equilibrium points is presented. The type of points is determined by the state matrix eigenvalues. All derived dependencies and parameters are displayed in graphical form. The approach is illustrated by a model of plasma renin activity after treatment of experimental animals with nicardipine. The special point is initial condition and it is of the stable focus type.
Key words: dynamics, modeling, stability, simulation, phase portrait, Korelia.



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UI DESIGN OPTIMIZATION AND ANALYSIS ON COUPON PLATFORMS FOR IMPROVING SERVICE QUALITY

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Abstract: As popularity of social couponing websites increases constantly, so does the competition. The good and usable design of the websites interface makes a huge difference between success and failure in the group buying market. In this paper usability evaluation is conducted on a relevant case study. The usability of an group buying platform was tested using two different methods: heuristic evaluation by experts and scenario testing by users. Results show that each method uncovers different types of problems that contribute to the improvement of the overall performance on the website.
Key words: usability evaluation, group buying, user interface, user satisfaction

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INVESTIGATING BINAURAL LOCALISATION ABILITIES FOR PROPOSING A STANDARDISED TESTING ENVIRONMENT FOR BINAURAL SYSTEMS

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Abstract: Binaural sound systems are a growing industry in the upcoming age of three-dimensional (3-D) technology. While many commercial and home systems are entering the market, there is no clear method of determining their suitability for different applications, such as gaming, movies and so on. Thus, a standardised methodology for testing such systems is proposed which evaluates and compares new and existing binaural microphone array systems. The implicating factors which determine the location of a sound, and methods of capturing such sounds, have been identified. A testing and comparison methodology is proposed based on data collected. The proposed methodology provides quantitative and qualitative comparisons to determine the function and suggested application of any given binaural sound system.

Key words: Audio technology, microphone arrays, psychoacoustics, binaural, sound localisation.

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INRUSH CURRENT INTERFERENCE BETWEEN POWER TRANSFORMERS

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Abstract: In this paper the transient analysis of the inrush current of parallel connected power transformer is investigated. The MATLAB-Simulink simulation model is developed for the purpose of mathematical validation.
Key words: sympathetic interaction, simulation model, power transformers, inrush current, MATLAB/Simulink

1. INTRODUCTION

When calculating the transient switch-on current, it is usually assumed that the transformer is switched on in a power system in which there are no other transformers. In practice, this situation is almost impossible, i.e. at least one transformer is already connected to the moment when the next transformer is connected.

In the systems with significant serial resistances, such as long transmission lines, the above situation can lead to transient interaction between transformer that is switched on at the moment and those already connected.

The connection of large power transformers can lead to incorrect operation of the differential protection of the other transformers in the system. This is due to the saturation of the already connected transformers as a result of the unexpected voltage drop in the system [3]. The saturation of the remaining transformers is also observed in systems where the transformers are directly connected to synchronous machines, as a result of the overvoltage induced by the response of the automatic voltage regulator to the synchronous generator.

Inrush current impact

It is known that the switching on transient magnetizing current of one transformer is a consequence of the saturation of the transformer core. This dc current, grows sharply to its peak value in the first half-period after the transformer has been switched on, and then decreases to its normal stationary value in subsequent periods.

In general, the amplitude and duration of the transient current depends on:

- The moment of switching on, i.e. the instantaneous value of the supply voltage at the moment of switching on the transformer
- The magnetizing flux maximum value in the transformer core (remanent magnetizing flux) and its direction
- The saturation of the magnetic core
- The total impedance of the inrush current circuit

All this applies if only one transformer participates in a transient phenomenon, ie, for the case when the first transformer is switched on in the system [2]. In cases where there are transformers in the system that are previously connected, the amplitude and duration of the initial current of the transformer which at this moment turns on can significantly deviate from the expected ones. The reason for this is the saturation of the already connected transformers as a consequence of the inrush current of switching on the newly connected transformer. This phenomenon in the literature is known as sympathetic interaction between transformers. Therefore, in addition to the above factors that influence to the inrush current, the next, not so insignificant condition should be added:

- The level of saturation reached by the already connected transformers in the system

This indicates the fact that the established transient influence between the transformer that is switched on in the system and those previously connected can extend the duration of the transient regime of switching on the transformer.

Sympathetic interaction between transformers

Complicated phenomenon, such as the sympathetic inrush current (transmitted saturation), is the topic of recent research in this field.

Transient magnetizing currents of high intensity do not have to flow exclusively in the transformer that switched on but also through the transformers that are already connected to the system. It has also been established that the transient period of these currents is very long and they are decreasing much slower than the transformer's inrush current that would be the only or first in the system.

The simulation model in MATLAB / Simulink is based on the electrical scheme shown in Figure 1. It is assumed that the power system short-circuit impedance Zs in the connection point-bus bar B1 is of high value (weak network).

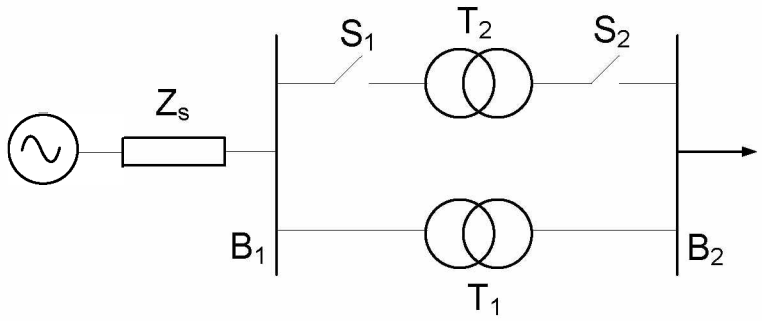

Fig. 1. Power system scheme for inrush current analysis

The Transformer T1 is previously connected and is in a stationary operating regime. At a given time in parallel whit them, the transformer T2 is switched on. As a consequence of the transient current of the T2 switching, a voltage drop of the impedance Zs occurs decreasing the voltage of the bus bar B1. In this case, the transformer T1 begins to be demagnetized. After several damping periods, of the current flowing through power transformer T2, the B1 voltage begins to increase, making the power transformer T1 magnetizing again. It is clear that a inrush current occurs in the transformer T1. This current can lead to a incorrect activation of the differential protection, while turning off the power supply to the consumer.

2. RESEARCH OBJECT

Research object is a three-phase distribution transformer, type ETN 50-10 / 0,4, in oil performance. The nominal data of the analyzed transformer are S_n=50 kVA; U_1/U_2=10/0,4 kV; I_1/I_2=2,89/72,2 A; u_{kn}=4 %; f_n=50 Hz; p=±2x2,5 %; Yz_n5. The analyzed transformer is shown in Fig. 2, and the magnetization characteristic of the transformer core is given in Fig. 3.

Fig. 2. Distribution transformer, type ETN 50-10/0.4

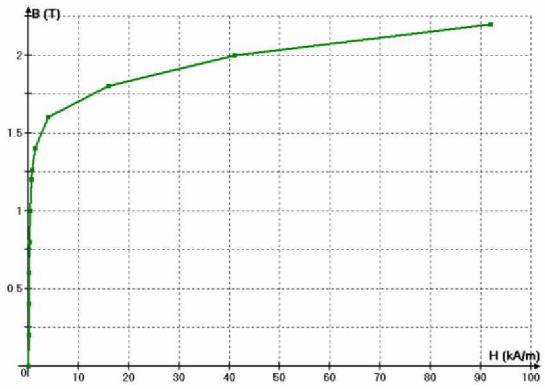

Fig. 3. Magnetizing characteristic of the transformer core

3. MODEL IN MATLAB / SIMULINK FOR ANALYSIS OF SIMPATIC INTERACTION BETWEEN TRANSFORMERS

The single-pole scheme for the analysis of the phenomenon of sympathetic interaction between two transformers is shown in Fig. 4, and the MATLAB / Simulink model is shown in Fig. 5.

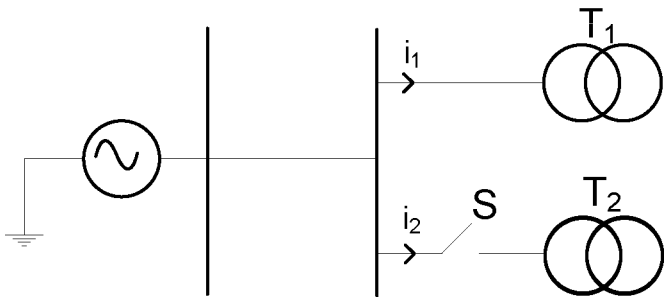

Fig. 4. Connection of T2 transformer in parallel with T1 (single-pole scheme)

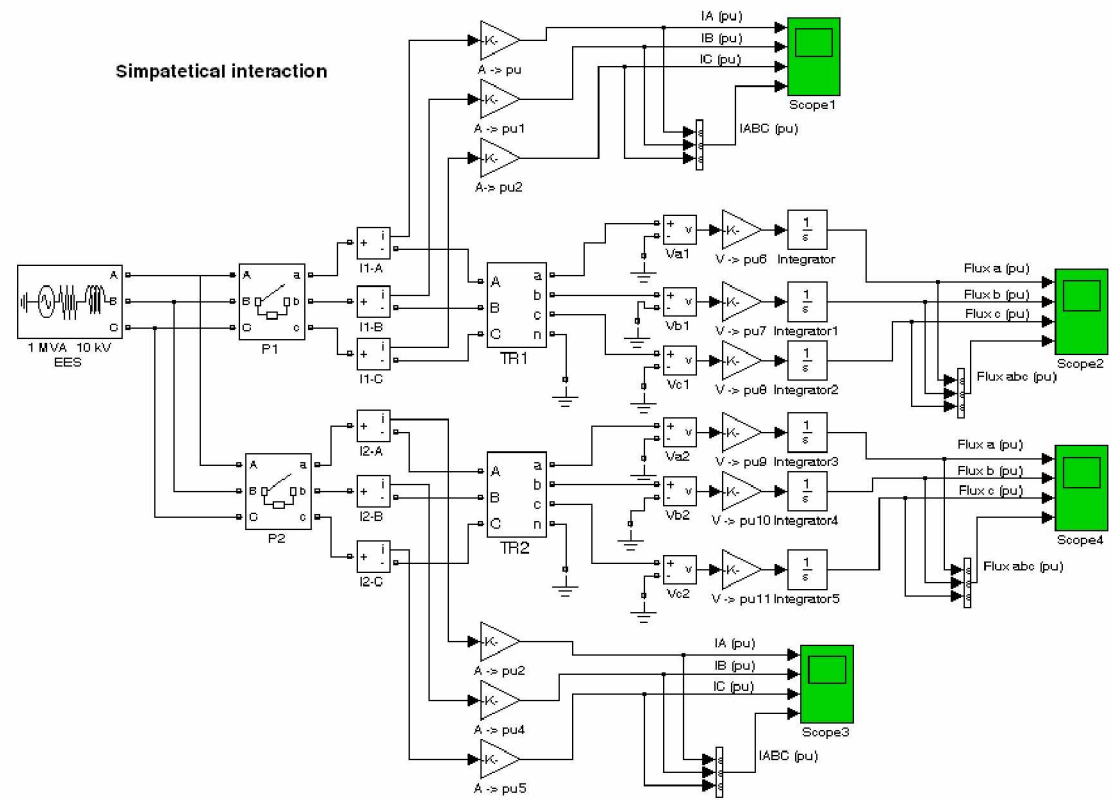

Fig. 5. Simulation model in MATLAB / Simulink for sympathetic interaction analysis between two three-phase transformers

The power supply of the two transformers is realized by a three-phase electric source with its own internal impedance, which is equivalent to the power system [5]. Its internal resistance represents the short-circuit impedance at the point of connection of the transformers (this is the busbar B1 from Fig. 1). The electrical source generates a three-phase voltage system in the model and is tuned so that the voltage in phase A has an initial angle of 0 degrees. The output line voltage at the

source is with an effective value of 10 kV, as much as the value of the primary winding voltage of the transformers.

Through two switches suitable for both transformers, the voltage is carried on the primary windings. The switch-on time of the first switch is t_1=0,06 (s), and of the second is t_2=3 (s). The time of the whole simulation is set to t=10 (s). The times are tuned in this manner: first the transformer T1 must be switched on, its transient regime passes. The time when the second transformer is switched on in parallel with the first should be long enough for the first to be entered into stationary regime. After 3 (s) from the beginning of the simulation, the second transformer is switched on and the currents are monitored in both transformers. Also, the total time of the simulation should be long enough for both transformers to enter the stationary regimes and since they are identical, can compare the duration of the transient process when switching the network transformer on its own and in parallel with an already connected transformer. In other words, the time of the transient regime of switching on of the first transformer, which was independent at startup, and the time of the transient switching regime of the second transformer, which is connected in parallel with the first one, will be compared. Calculated switching times of both transformers are taken in the moment when current has the greatest value, and when the voltage drop to zero. The residual magnetism at the core of the transformer is neglected.

Phase A is taken for the reference phase to which the times are set.

To measure the primary currents for each phase individually both current transformers are set current meters. The current signals are monitoring via oscilloscope. Also, the three signals for the individual phase currents with multiplexer are unified in a three-phase signal, which represents the three-phase system of primary currents.

In the transformer blocks, all values for its data and parameters are given, such as: nominal power, nominal primary and secondary voltage, nominal frequency, active and reactive resistance of primary and secondary windings in per units, magnetization characteristic, delta-, or way-connection, and winding vector group [1].

On the secondary terminals of the transformers, voltage sensors are placed, recording the voltage measured signals. Then the multiplier signals turn into single sizes and ultimately led into integrators that exit the flux for each phase individually as an integral of the corresponding phase voltage [4]. Fluxes are further implemented on oscilloscopes, which monitor their change over time.

4. SIMULATION RESULTS

Fig. 6 shows the switching on currents of the transformer T1, and in Fig. 7 the phase fluxes, respectively for each of the phases. For the transformer T2, the

switching currents are shown in Fig. 8 and the fluxes in Fig. 9. The figures show that transient phenomena are most dominant in phase A, since that phase is taken as a reference, respectively, and both transformers are switched on at the moment when the phase voltage U_A passes through zero, and then the flux has a maximum value. In the other two phases, the amplitude of the transient inrush current is less than in phase A. If the current in phase A is considered, it can be noticed that when the transformer T1 is switched on in no-load regime, due to the process of magnetizing the transformer core, its amplitude reaches a value of about 70% of the nominal. In the simulation, the two transformers are tuned at the time of switching on to have no residual magnetism in their magnetic circuits. If there is a residual magnetism, other transient phenomena would occur, and the greatest amplitudes of the transient currents occur in the remanent magnetism with the opposite polarity from the magnetic flux that is established at the moment of connection. When the transformer T1 is connected to a network, another transformer is not connected to the terminals and its transient process lasts about 1.5 (s). Then the transformer enters stationary mode and the effective current value is I_0. At the moment t=3 (s), it switches on of the network at the same transformer T2, but now one transformer has already been connected to the network. At that moment in T2 begins the magnetization process and because it is identical to T1, the amplitudes of the inrush currents are the same. Then there is a sharp drop in the terminal voltage, because the short-circuit impedance at that point has a great value ("weak network"). Transformer T1 has a reversible process from that of T2. The T1, which is entered into the stationary regime and its core is magnetized, in case of a sudden drop in voltage, its core begins to be demagnetized and a transient process is called sympathetic interaction between the transformers. The current that occurs in this process is called the sympathetic current of the transformer T1. From Fig. 8, it is noted that the inrush current in phase A of the transformer T2 is more difficult to dampen than in the case when T1 was turned on, as the first transformer in the network. The transient period is much longer and lasts about 8 (s). This is due to the transient interaction of the two transformers, which are already connected in parallel. The duration and influence of the sympathetic current on the power systems i.e. the other transformers depends on various factors. The phenomenon is more evident in transformers with higher power, in high-impedance networks at a short circuit at the point of switching on the transformer. Also, the appearance is more noticeable in transformers with a aged magnetic material. An important role for the amplitude of the inrush current is the combination of the moment of connection and the magnitude of the remnant magnetic flux.

The sympathetic saturation of the transformers is intensive at the first electrification of the transformer substation, especially on no-load mode of operation or at very low loads.

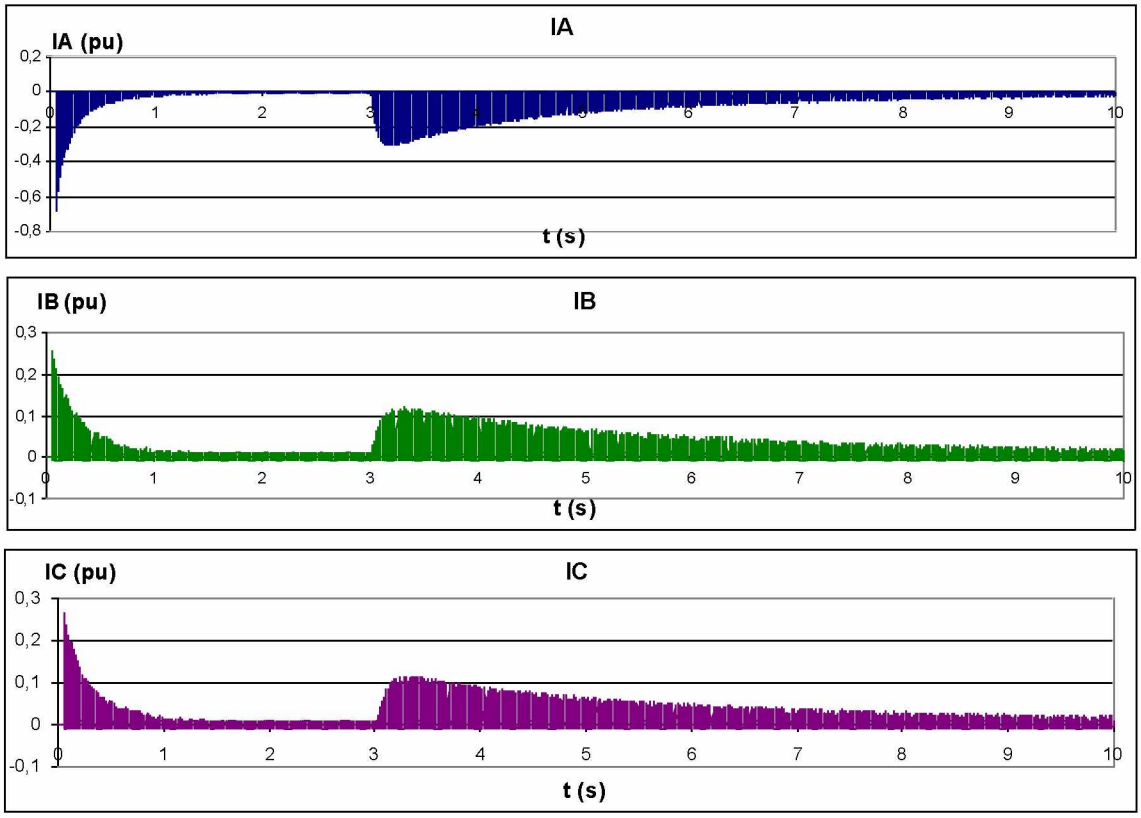

Fig. 6. Inrush current in the transformer T1

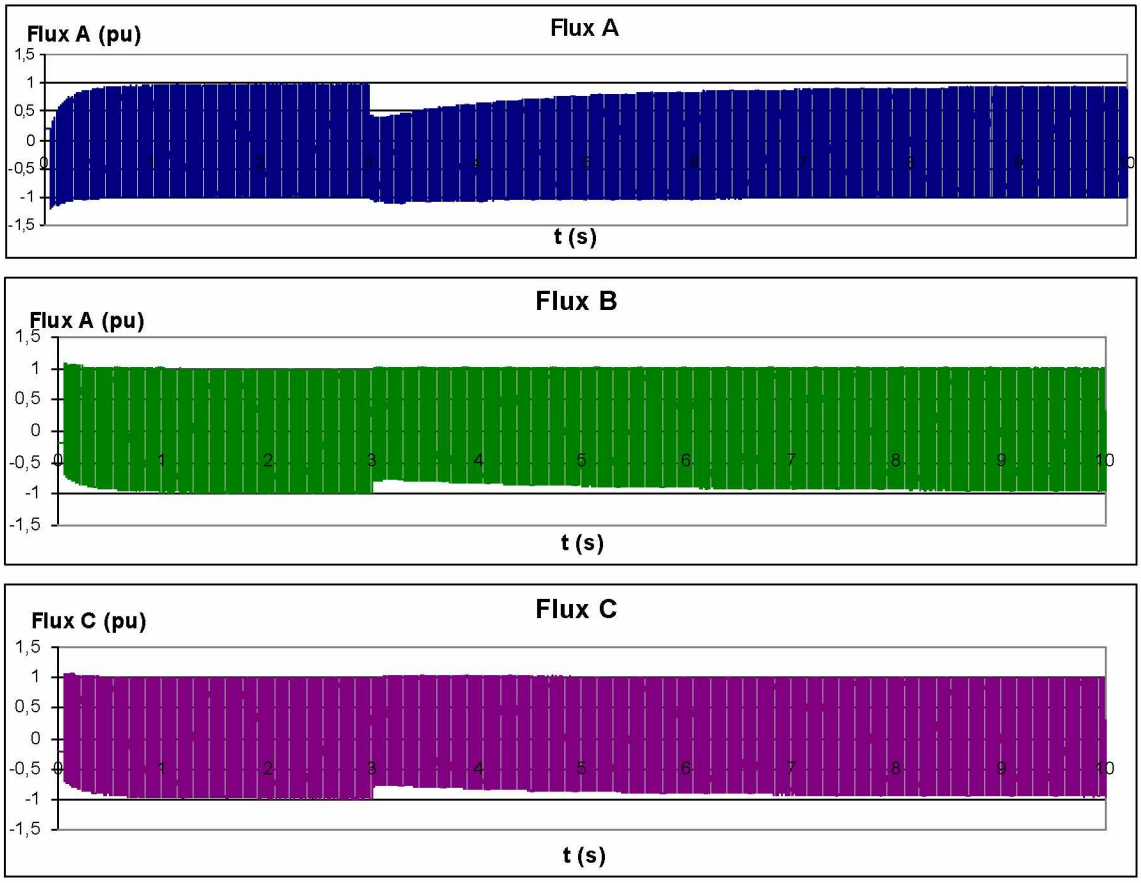

Fig. 7. Phase fluxes when the switching on the transformer T1

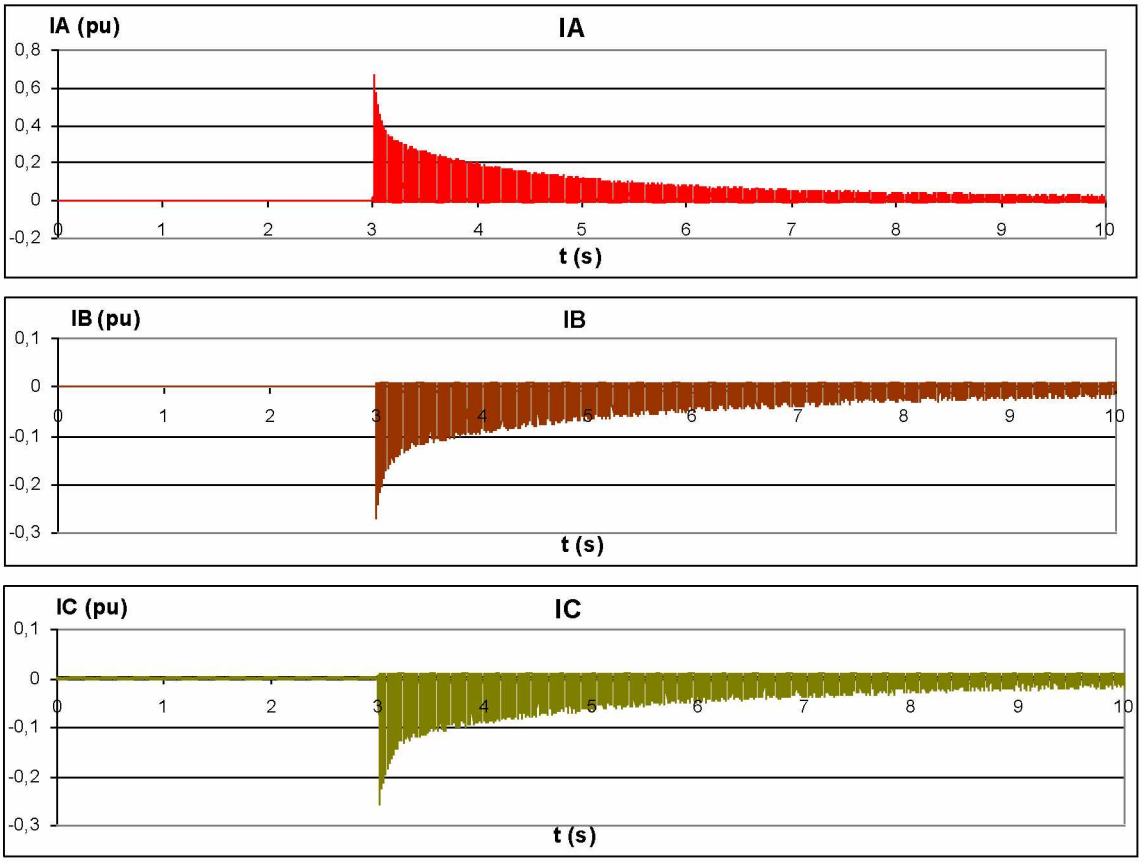

Fig. 8. Inrush current in the transformer T2

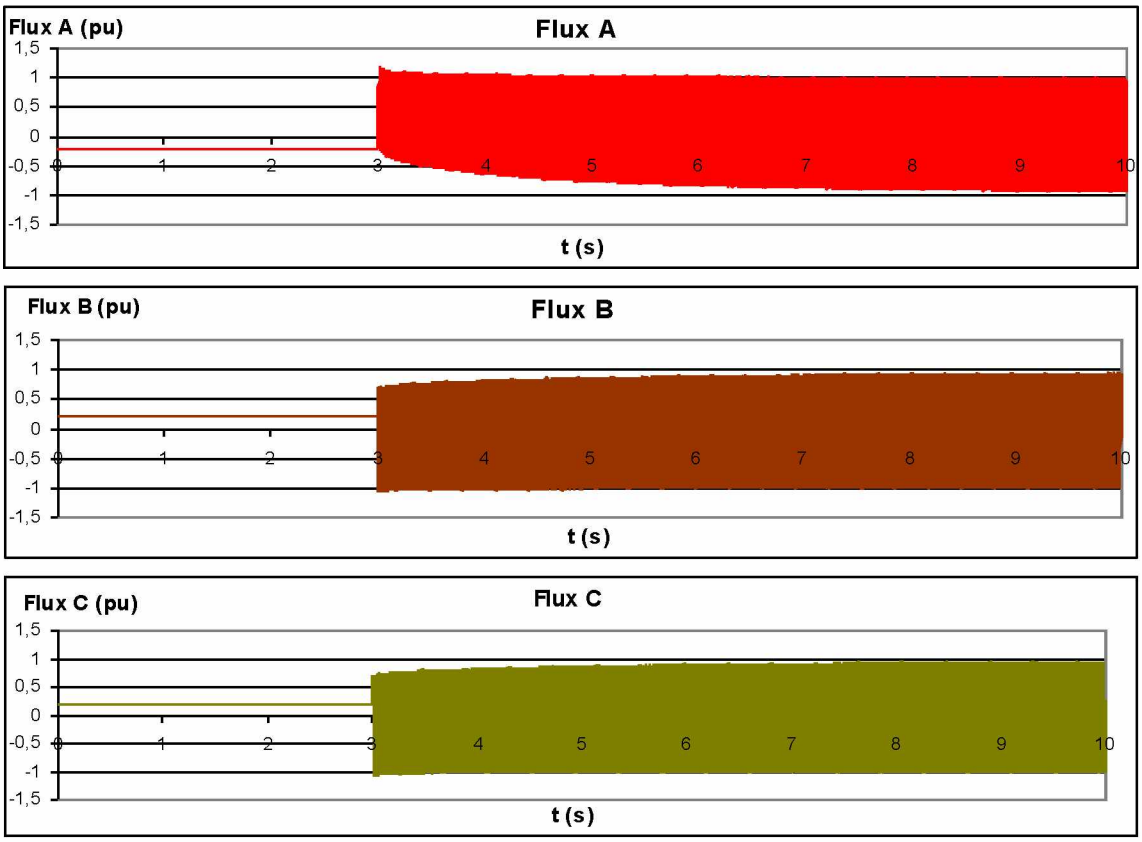

Fig. 9. Phase fluxes when the switching on the transformer T2

5. CONCLUSION

When one unloaded transformer is connected to a network, the primary current does not currently reach its nominal value, but this occurs after the transient period, which is characterized by a current that is significantly increased in the beginning then decreases. It is called an inrush current. This dc current, grows sharply to its peak value in the first half-period after the transformer has been switched on, and then decreases to its normal stationary value in subsequent periods.

The conditions on which the amplitude and duration of the inrush current are dependent were previously mentioned. In worst-case switched on/off conditions, the peak value of the in-line current can reach up to 40 times the rated current of the transformer. The whole phenomenon is generally dampened in a few seconds, but in certain extreme circumstances (for example, in the case of interference between two high-power transformers) it may take even minutes.

The inrush current is not dangerous to the transformer itself that is switched on, but it can affect the protection equipment (over current protection, differential protection, etc.) that can interrupt the electrical circuit and thus disable the switching on/off of the power transformer. Also, due to the sympathetic effect, during the power transformer switching on/off grid procedures, a significant influence may occur on the other transformers in the substation or in one part of the power system. These things indicate that certain preventive measures need to be taken to avoid these unpleasant phenomena in the power systems. Often the preventive measures are aimed for enhancing the inrush current damping and configuring and adjusting the protection schemes in order to avoid unwanted activation in the transient process of switching on the transformer.

Some of the preventive measures to mitigate the impact of these phenomena are:

- Time delay of transformer protection
- Second harmonic control of the transient inrush current, because it has a considerable value
- Identification of the inrush current using the techniques of pattern recognition, as the most modern technique
- Adding the resistance to the series with the primary transformer winding

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CONTROLLING INDUCTION MOTORS

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Abstract: This year is anniversary of 130 years induction motor (IM) invention. Today IM is the dominant motor on the market. This study attempts to give a review of the historical development of induction motor control systems, present condition as well as the future trends in the development of vector-controlled induction motors (IM) drives. The discussion focuses around various scalar systems and their characteristics, the developing stages of individual constitutive parts of the control system, as well as the domain of their application. The procedure of space vector modulation has been briefly described and its peculiarities and advantages have been discussed with regard to the classical modulation techniques. There has been given principled classification of the vector systems for controlling induction motors. By comparing the basic functional block diagrams of the direct schemes for vector control, the indirect schemes as well as the systems for direct vector control of the torque and the flux, emphasis has been put on the basic peculiarities and performances of individual systems and their application domains

Key words: induction motor, controlling scalar systems, vector systems, simulation,

1. INTRODUCTION

The induction motor (IM) compared to direct current (DC) motor, is superior in terms of largeness/power coefficient, rotor inertia, maximal possible speed, efficiency, compactness, simplicity, reliability and price [16], [26]. Up until 1972, mainly due to the non-linear highly interactive and multivariable control-dynamic structure, induction motors have been practically unfit to replace direct current motors in drives with high speed and torque control requirements. The principles of vector control were presented in 1972 in the works of Hasse [16] and Blaschke [2], [3], while the first experimental experiences have been acquired at the Darmstadt and Braunschweig Technical Universities and at the Siemens AG laboratories.

In DC motors, the reaction of the induct and excited flux has shifted by 90° el. This orthogonality between the axes of the excitation flux and the reaction of the induct does not depend on the rotor's rotation speed, whereas the developed electromagnetic torque of the motor is proportional to the product of the flux and the armature current. If a negligible small saturation is assumed, the flux is proportional to the excitation current and cannot be changed under the impact of the armature current due to the orthogonal setting of the rotor and stator field. So, in a direct current motor with independent excitation and constant excited flux, the developed electromagnetic torque is directly proportional to the armature current [2].

In induction motors, the space angle between the stator's and the rotor's flux changes with the load, causing more complex relations between the currents, the fluxes and the voltages in the machine, as well as the phenomenon of oscillatory dynamic responses. The control of this space angle could ideally be implemented by decoupling the input stator's current to d-component, responsible for the excitation flux, and q-component responsible for the developed electromagnetic torque. This can be achieved through the method of vector control enabling relatively simple solution to the problem of "coupling" between the d- and q- axes and approximating the dynamic model of the induction motor towards the model of direct current motor with independent excitation [1], [2], [3]. Furthermore, recently there have been developed more sophisticated digital dynamic models of induction motor [18], [21], [26], [29] in order to achieve certain improvements in the induction motor vector control systems.

In the last several years, a large number of studies have investigated the methods of pulse-width modulation (PWM) of the voltage invertor: sinusoidal PWM, improved sinusoidal PWM and space vector modulation [10], [11], [14], their mutual comparison and evaluation by the help of FFT, simulation and mathematical analysis etc. Some advantages of space vector modulation [26] have been emphasized, and at the same time, attempts have been made to discover uniform criteria for evaluation of space vector modulation and the classical PWM techniques. Also, intensive researches have been carried out on the influence of the so-called "blocked time" of the valves on the distortion of the space vector of the stator voltage [26], [31].

The methods for controlling the induction motor vector control systems are taking key position in many works in this area. In order to optimize the control structure, the impact of the varying parameters of the induction motor on the control quality is investigated, and new methods for adaptive control are proposed [14].. Recently, an interesting variation of the direct vector control has appeared; the so-called sliding mode control. The proposed system has a cascading structure and the controller in the sliding mode is easily adapted to various requirements of servo applications. Direct vector control [8], [10], [24], [26] shows certain advantages over the indirect vector control, above all, in simplifying the control structure. In particular, the control concepts based on the space vector of the stator flux find ever greater application in servo applications. With direct vector control of the torque and

the flux [8], [9], [10], it appears that a new chapter opens up in vector control of induction motors. Here, crucial role is played by the contributions to predictive control of the torque and the trajectory of the stator flux's space vector, using only the speed as feedback information [29].

With this survey the authors intend to give a practical overview of a different control techniques for IM and assist the engineers in praxis to understand better the application performances of different variable speed drives (VSD). With an appropriate elected drive system and control technique the energy saving and efficiency of the whole control system could be improved significantly.

2. INDUCTION MOTORS CONTROL SYSTEMS

As beginnings of the more sophisticated systems for controlling induction motors (U/f systems, vector systems) are regarded the Ward-Leonhard's EMP and the so-called Kramer's EMP. Up until 1970, the controlled electromotive drives with direct current motors are predominant and represent standard industry drives. This especially refers to drives with high performances regarding controlling more variables such as speed, torque, position, acceleration etc. Typical of such applications requiring high performances of the drive is to provide: control accuracy sustenance at high speeds better than 0.5%, speed control in an 20:1 range, fast response in transient mode (for example, faster than 50rad/s for the speed control cycle) etc. Only until recently have these applications been an exceptional part of the domain of the controlled direct current drives. However, by choosing appropriate control (U/f control, vector control), with the fast development of the power semi-conducting components, and with the development of hybrid digital signal processing systems, the application of the controlled AC electromotive drives in the last decade marks a revolutionary growth. With their mass application it's been evaluated that around 10% of the generated energy can be saved. The IM control systems could be divided globally into scalar and vector control systems. The scalar control systems still find their application in general-purpose drives (circa 90%), and can be one-engined or multi-engined. Higher-capacity power drives as well as special-purpose drives usually use vector control systems. Recently, vector control systems, especially the so-called direct torque control systems, increasingly find their application in electrical traction drives.

Regarding the implementation of control cycles in the control systems, analog technology slowly but surely gives way to digital technology or the microprocessor-based control systems. Also, inevitable is the accelerated growth of application of various adaptive methods such as the variable structure systems (VSS), the self-tuning systems (STS), models of robust control, models of reference adaptive control (MRAC), and lately, and especially in the USA, Germany and Japan, expert fuzzy logic-based systems, genetic algorithms and artificial neural networks (ANN) have been intensely developed and applied.

2.1 Scalar systems: Voltage control, U/f control, PWM

The scalar IM control systems, globally, are divided into voltage-controlled IM, voltage and frequency-controlled IMs – U/f control, and PWM-controlled induction motors.

IM speed control, although accompanied with increased losses by changing the stator voltage, is attractive due to its relatively simple elements in the automated control system and its simple application in wounded rotor IMs and squirrel-cage IMs. The increased losses constrain the application of this solution to low powers, circa 250kW. Nevertheless, in this power domain, the IM drive is cheaper than the DC drive and is applied in ventilator drives, lifts, transport drives etc. To decrease losses, the so-called sub-synchronized cascade or lossless voltage control, so-called Kramer's EMD is used (Fig 1.). In the rotor's circle is embedded a converter consisting of a rectifier, damping inductance and line side controlled converter, through which the slipping power goes back in the three-phase network. The damping inductance provides continuous current, and the transformer is used to adapt the damping inductance's voltage towards the rectified voltage of the rotor. In stationary mode, these two voltages are in balance. Although this drive does not permit reversing and braking, however, since it gives constant torque in the whole speed control range (50% to 100% of the synchronous speed is recommended), it is economically and technically the most suitable for application in drives with sub-synchronized cascade (pumps, ventilators, compressors) to approximately 20MW. The dynamic characteristics of the sub-synchronized cascade are satisfactory in drives with low requirements with regard to dynamics, especially at synchronous speeds.

For controlling IM with variable voltage and frequency of the stator winding various power converters (cycle-converters, direct and indirect frequency converters) have been developed.

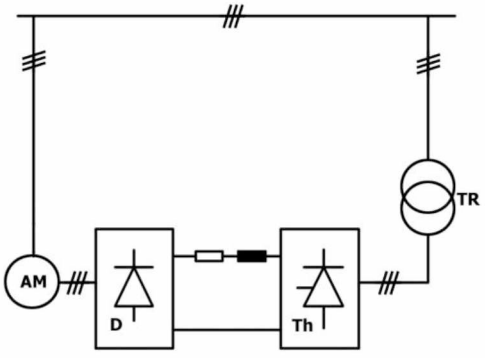
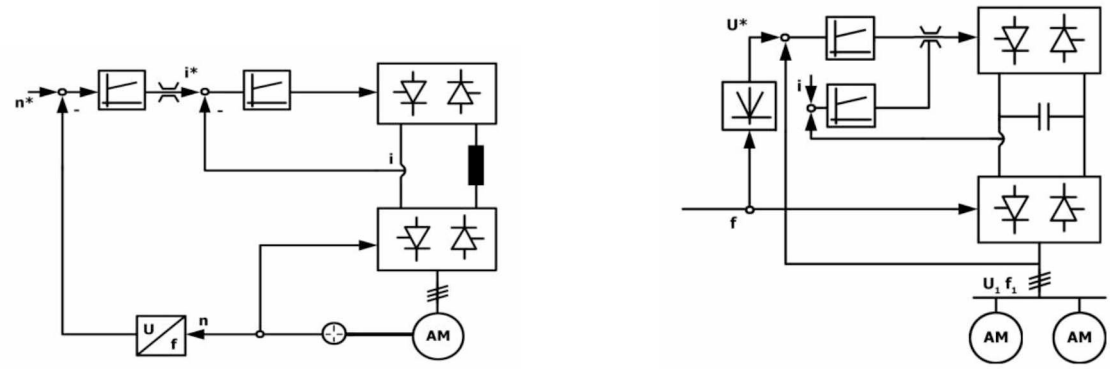


Figure 1. Principled scheme of the so-called Kramer's EMD

The cycloconverter has a simple structure composed of three line side-controlled reversible converters in anti-parallel relation without cycling currents. The controlling signals are always phase-shifted among themselves by 120 °el in order to achieve symmetric three-phase voltage at the output terminals, with 45% upper limit frequency of the powering frequency (20Hz is achieved for a network frequency of

50Hz). In particular cases, if the cycloconverter is powered by aggregates, it is possible to achieve output frequency of 400Hz. The cycloconverters are especially applicable in charging low-speed alternating high-power motors. Also, cycloconverters are applied in feeding squirrel cage IMs with multiple windings for cargo vehicles, because they ensure small pulsations in the torque (due to the approximately sinusoidal output shapes of the voltage and the current) and a wide range of speed control with minimal losses at low speed to zero.



Current source inverter *Voltage source inverter*

Figure 2. Indirect frequency converters

Indirect frequency converters on the network side have a controlled rectifier, while on the driving motor's side a controlled inverter, with its own control; while depending on the type of the DC circle they are divided into voltage source inverters and current source inverters (Figure 2).

The indirect current source frequency converters are cheaper and with dynamic performances closer to those of the direct current drives, and are applied in one-engined drives with one-square or multi-square mode, with power up to 1MW and frequencies up to 200Hz. The indirect voltage source frequency converters in practice are somewhat more expensive and are applied in charging squirrel cage IMs and synchronous motors (ventilating pumps, extruders, cranes, dredges, surface processing machines etc.) The voltage in the circulating current circuit could be constant (the output inverter has PWM and the output frequency is limited to 200Hz) or variable (the output inverter is constantly led and the output frequency goes up to 600Hz or even to 1000Hz with a reduced load).

Induction motor drives, feded with pulse-width modulated invertors (PWM invertors), are increasingly becoming a standard in the highly developed industrial countries worldwide. At the same time, various output signal modulation methods have been used as PWM inverters (sinusoidal modulation, improved sinusoidal modulation, space vector modulation).

Each of these modulations is defined by the manner of generating the switching functions of the switches S_a, S_b, S_c of the inverter (Fig. 3).The sinusoidal modulation is such technique that employs comparison between the referent sinusoidal base frequency signal and the carrying (triangle) signal with raised frequency. The

improved sinusoidal and space vector modulation could be classified under the so-called programmable PWM techniques.

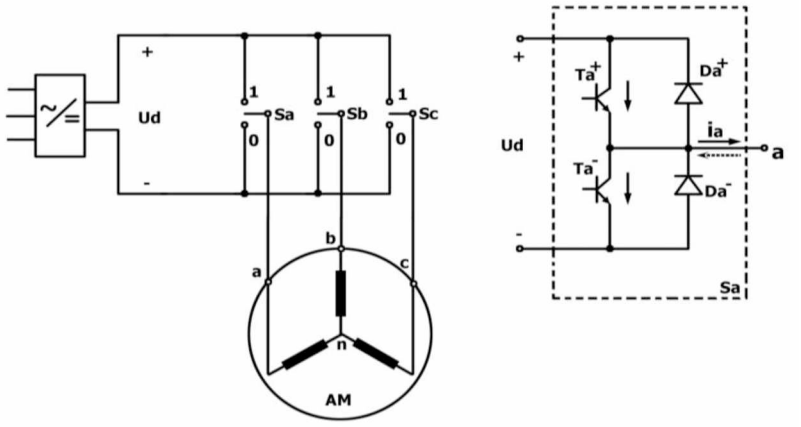


Fig. 3. Voltage inverter and the switching functions of the switches S_a, S_b, S_c

The sinusoidal modulation is considered a basic PWM technique that uses sinusoidal base frequency wave shape as referent signal, whereas triangle wave shape with increased frequency is mostly used as a signal carrier. Given that the IMs are constructed so as to work on sinusoidal voltage, it is obvious that it is necessary to use three-phase sinusoidal wave as a referent modulation signal in order to obtain PWM wave shape at the output of the inverter, in which the width of the pulses is sinusoidal modulated during in the course of one semi-period.

The practical implementation of this modulation technique demands that every inverter branch should have a comparator supplied by a referent sinusoidal voltage from its own phase and symmetrical triangle wave carrier common to all three phases. The ratio between the frequencies of the carrier and the referent wave $z_p = \frac{f_n}{f_r}$ (carrier ratio) gives the number of output voltage pulsations from the corresponding inverter branch and this ratio must be divisible by 3 ($z_p = 3 \cdot k, k = 1,2,3...$) in order to achieve an identical wave shape of the voltages from all three phases. The carrying triangle wave has constant amplitude and the ratio between the amplitudes of the referent sinusoidal wave and the carrying triangle wave $M = \frac{|U_r|}{|U_n|}$ is referred to as modulation index.

A disadvantage of the sinusoidal PWM is the low value of the base harmonic maximal amplitude, which for a maximal unity modulation index (M=1) amounts only to 50% of the value of the DC voltage between the converters. The simplest procedure to increase the base harmonic amplitude could be achieved by the improved sinusoidal PWM. This technique is realized by adding a third harmonic to the base referent sinusoidal signal multiplied with the so-called improvement parameter (usually amounting to 1/6) which is defined so as to obtain maximal value of the base harmonic amplitude of the output voltage.

Unlike the classical modulation techniques (sinusoidal, improved sinusoidal, etc.) space vector modulation is not oriented toward individual phase voltages but to

their resulting space vector [27]. The essence of this modulation technique is to provide the voltage system required by the IM control cycles is provided through 7 (seven) different voltage vectors standing at the inverter's disposal. The objective of the procedure is to define, in each sampling period T, the given referent vector of the stator voltage $\vec{u}_1^*$ by $\alpha - \beta$ components or by a module and a space angle.

2.2 Vector systems

The current tendency of fast development in the field of power electronics and modern highly integrated electronic devices for signal processing increasingly bring about solving industrial facility situations by applying alternating current (AC) machines.

Figure 4 shows a principled block structure of a vector control system. The control system is principally divided in three sections. One of them represents the object of control, i.e. the dynamic non-linear and multi-variable mathematical model of the induction motor. The second section is the inverter, i.e. its discrete mathematical model with a variable structure, and the third section represents the DSP (Digital Signal Processor) which is to perform the function of the entire control in the closed control system. It implements the controlling algorithms, the acquisition and estimation of valid data, transformation of the coordinates, as well as the algorithms of control circuit synthesis.

Lately, there has been an ever growing substitution of scalar U/f control with vector control in the area of IM control, which assures higher dynamic performances of the drive. Main disadvantages of the U/f or scalar control in the eyes of the majority of the world's manufacturers of this kind of equipment are the limits in dynamic response (their characteristics vary with the change of the work-mode), with their extremely small number of revolutions, as well as with the possibility of high torque control dynamics.

The main reasons for these disadvantages of U/f-control, of course, are the non-linear model of the induction machine and the accompanying effect of coupling between the machine's d and q axes.

Accordingly, vector control is a method for dynamic control of the speed and the torque of the induction motor through permanent control of the intensity and the angle of the space vectors of the electromagnetic variables. One of the most important benefits of this control is energy saving, because the vector control enables dynamic control of the factor of power. With all this in mind, it can be easy to explain the common tendency of the world's highly developed countries to accept vector control as a universal method for controlling AC drives.

Basically, there are two vector control techniques: direct and indirect method. The indirect method uses the mathematical model of the induction motor, i.e. for rotor flux-oriented control it uses the corresponding slipping relation and is very dependant on the change of the machine's parameters. The direct method is based on direct measuring or estimating the space vectors of the stator's or rotor's flux.

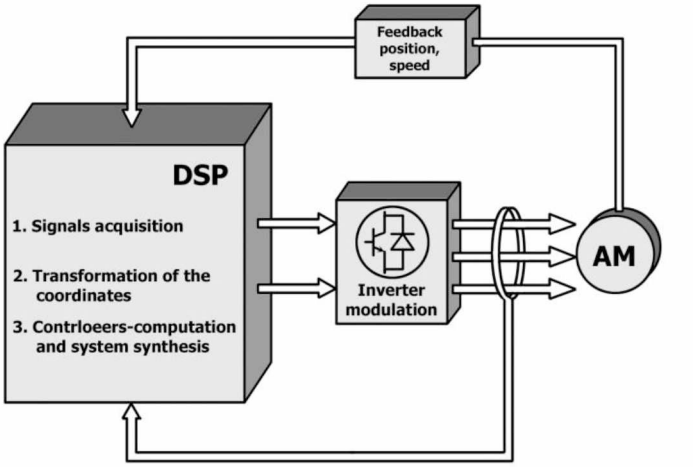


Figure 4. Principled block structure of vector control system

A basic, common characteristic to all approaches toward the different types of vector control is the dynamic equivalent scheme of the induction machine (Fig. 5) by the help of which the dynamic non-linear structure of the induction motor is transformed or approximated to the model of a DC engine with independent excitation. This results in the possibility of four-quadrant work-mode of the induction motor with full response and torque dynamics, as well as good performances of the drive down to zero-speeds. In order to provide as good overall system dynamics as possible for a broad range of speed and load, two dynamic models of induction motor so far have found practical use depending on whether the control is oriented to the vectors of the stator's current and the rotor's flux or to the vectors of the stator's and rotor's flux.

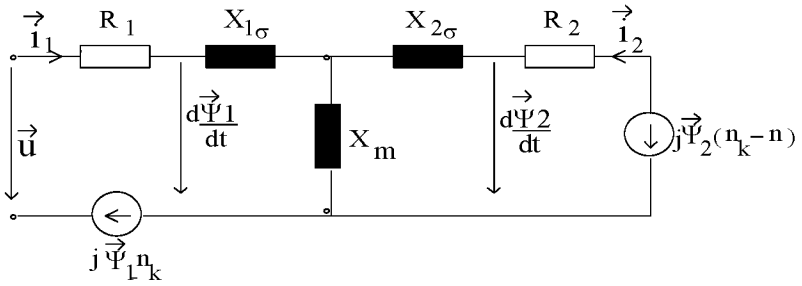


Figure 5. Dynamic equivalent scheme of the induction machine

The vector control system which is oriented to the vector of the rotor flux is intended mainly for electromotive drives in traction applications and shows relatively high sensibility with the machine's variability parameters. The vector control system of an induction motor in a stator coordinate system is oriented to the vector of the stator flux and the inverter's switching work-mode is intended almost exceptionally for servo applications. The simplicity, robustness and reliability of this relatively new control approach open up broad perspectives and new possibilities in vector-controlled servo systems with induction motors.

2.2.1 Indirect vector control systems

The indirect vector control methods with orientation on the field do not estimate or measure the space vector of the rotor flux, but use the slipping relation to calculate the output signals of the stator current's space vector (at vector control with a current inverter), or correspondingly the output signals of the stator's voltage space vector (at vector control with a voltage inverter).

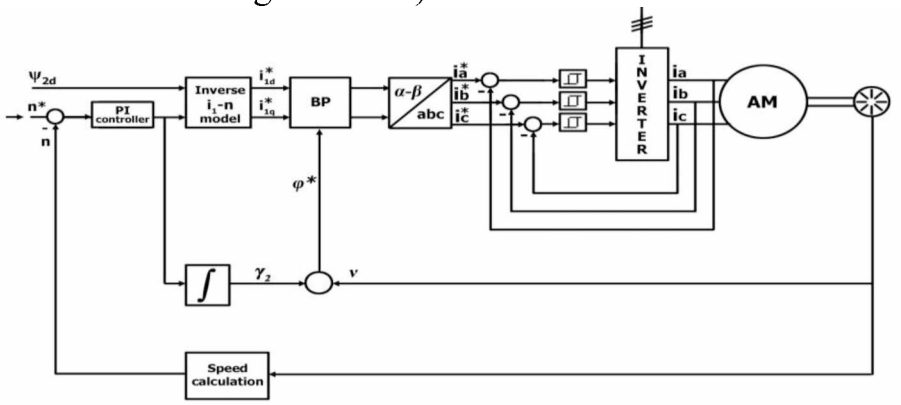


Figure 6 Principle block scheme of indirect vector control system

In order to reduce the machine parameters' dependence on heating or saturation, implementations in different coordinate systems are used. Also, there have been developed numerous numerical schemes for parameter adaptation. Well-known employed techniques are the self-tuning systems (STS), the robust control systems, model reference adaptive control systems (MRAC systems) etc. Figure 6 features a principled block scheme of an indirect vector control system. Similar variations of indirect vector control schemes have been analyzed by Flugel and Hasse [12], [16].

2.2.2 Direct vector control systems

In contrast to the indirect vector control systems, the direct system is based on measurement, acquisition and (or) estimation of the space angle of the rotor's flux. In order to avoid rotor flux acquisition problems, the recent general tendency is to leave the approach of measuring the flux through additionally embedded coils or Hall's probes, and to acquire the flux through appropriately adapted mathematical models for this purpose [26]. The measurement of the rotor flux mainly has disadvantages connected with the loss of machine's simplicity due to installing additional measurement elements in the course of constructing the machine and to extra expenses for additional signal processing equipment [12], [13], thus increasing the price and reducing the need to apply such control drives. The model-based acquisition of the rotor flux has a disadvantage related to the heating sensitivity of the parameters, which is closely related to the drive's state of the motor. In this sense, long-term researches have been implemented and many models in different coordinate systems for rotor flux acquisition have been developed, as well as qualitative-quantitative evaluation and compensation of the error which is due to the temperature and magnetic variability of the parameters.

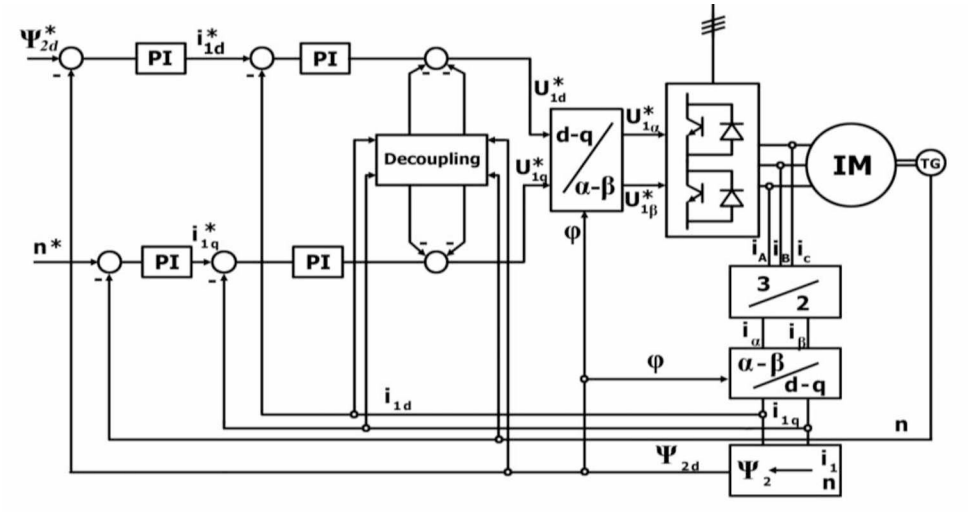


Figure 7. Principled scheme of direct vector control system

2.2.3 Direct torque control systems

According to the needs for an ever greater automation of the manufacturing processes, the servo systems most often operated by induction motors are becoming increasingly necessary for different applications, both in the field of robotics and the field of the numerically controlled machine tools. In recent years, especially in the highly developed industrial countries, a much intensified development of various concepts for IM field-oriented control can be noticed which, in a control sense, enables approximation of the induction torque to the DC motor. Unlike the control system which is oriented to the space vector of the rotor's flux $\vec{\psi}_2$, on the $\vec{i}_1 - \vec{\psi}_2$ dynamic model in a d-q coordinate system of IM and PWM of the voltage inverter, thereby using linear control technique and linear controllers, the direct torque control systems have a different concept for vector control. These systems are based on the space angle of the stator flux, on the model of the induction motor in a stationary coordinate system and on the space-vector modulation of the inverter [10], [11], [22], [27], [30], [31]. Thereby, this concept uses non-linear control techniques and non-linear controllers (Fig. 8). The orientation of the control system to the space vector $\vec{\psi}_1$, greatly reduces the control structure's dependence on the temperature variations of the parameters of the equivalent induction motor scheme.

In contrast to field-oriented IM control systems in which the precision in the estimation of the space angle of the rotor's flux $\vec{\psi}_2$ is directly dependent on the motor's parameters which determine the rotor's time-constant, in this vector control concept [27], [31], there is no need to acquire the space angle of the rotor flux $\vec{\psi}_2$. The orientation of the control structure to the $\vec{\psi}_1 - \vec{\psi}_2$ model of the induction motor in a stationary $\alpha - \beta$ coordinate system avoids the need to transform the coordinates of the machine's space angles which take part in the analysis and synthesis of the control circles [27].

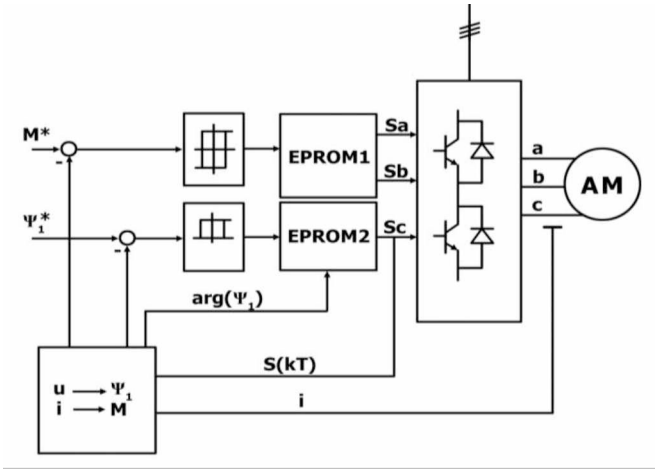


Figure 8. Direct flux and torque control

Space-vector modulation enables maximum use of the inverter's dynamics, easy and simple optimization of the on-off frequency regarding the quality of the expected response of the controlled variables (flux, speed, torque etc.), which in the same time reduces the inverter's on-off losses, losses introduced by higher harmonic voltage members and the current used to charge the machine, as well as the noise. The induction motor is a high level non-linear system and its vector control by means of linear techniques and controllers requires the use of complicated mathematical models. Consequently, due to the complexity of the non-linear differential equations which describe the dynamic model of the induction motor, signal processing in the control system becomes complicated. On the other hand, the power inverter is also a non-linear element, because it is composed of 6 (six) power switches (Fig. 8) which are also non-linear elements.

3. SOME TRENDS FOR THE FUTURE

Fuzzy logic-based control has aroused ever greater interest over the last few years. It is much closer to natural human reasoning and language rather than to traditional control techniques. Fuzzy logic enables effective processing and representation of real world's inexact nature. The fuzzy logic-based control systems enable simple, fast and efficient conversion of linguistic control strategy based on expert knowledge and science in a strategy for automatic control. Experience has shown that fuzzy control could achieve better results compared to classical control, especially when applied in control systems in which the controlled object is described by a complex and difficult mathematical apparatus or when its exact mathematical description is generally impossible. The simplified three-block structure of a fuzzy logic controller is given in Figure 9.

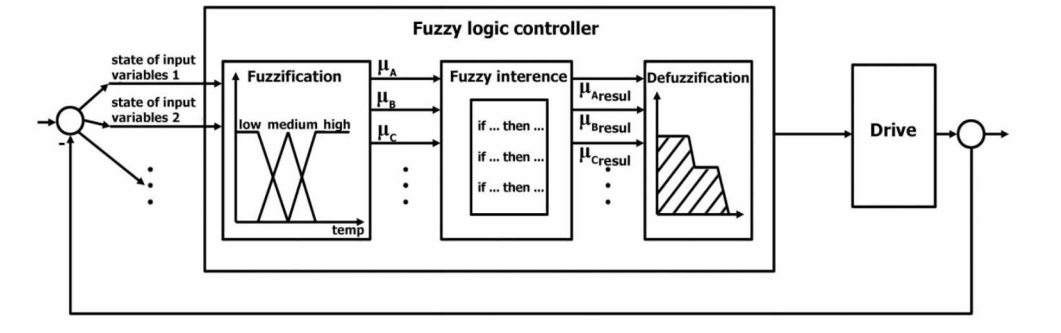


Fig. 9: Schematic block diagram of a fuzzy logic controller system

Fuzzification refers to association to a set of logic terms (variables) for describing exact states of the input variables. With this input, generalization or a logical explanation is made on the variable or the state of the input variables. For that purpose, mathematical operators based on linguistic logic are used (and a sequence of other experience rules) and mainly three asks are performed such as: Joining/associating an appropriate linguistic variable to each input variable; Determining the membership functions and Estimation of the membership coefficient

On the other hand, the Artificial neural networks-based control (ANN) finds its greatest application in non-linear systems identification and control.

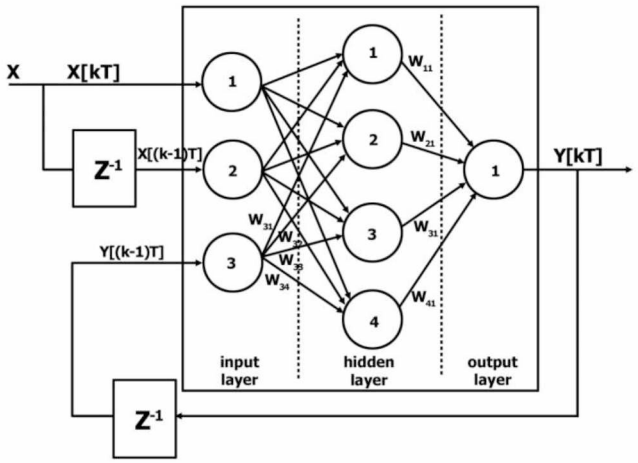


Figure 10. Principled scheme of a PI controller implemented with a three-layered ANN based on the backpropagation procedure

Artificial neural networks represent a non-linear adaptive dynamical structure containing highly interactive processing elements called neurons. Their structure is based on the neurobiological structure of the human brain. There already are many existing and developing models of neural networks, but their basic characteristic is the ability to train and adapt which makes them ideal for application in systems for automated adaptive control. The artificial neural networks-based controller (Fig.10) can be applied successfully even in cases when the parameters of the motor and the load are unknown. For that purpose, the neural networks, first, identify the unknown dynamics of the system and afterwards a thus-trained neural network can be combined with a reference model in order to reach the required control accuracy. In order to achieve more precise identification of the system, ANN is set in parallel with

the unknown controlled system (for example, engine + load). The most applied method for setting the ANN's weighting factors is the so-called backpropagation procedure. A neural network consists of neural nodes interconnected with links defined by the so-called weighting factors, organized in several layers.

4. CONCLUSION

The simulation of the vector control systems becomes an increasingly attractive CAD tool especially among young researchers and engineers working on designing vector control systems. Mass application of vector control simulation packages gets this trend closer to an ever greater number of users and engineers dealing with this professional area. Many companies developing such equipment as well as many institutes for electric machines and drives at renowned universities worldwide are developing their own simulation packages to shorten the time needed to develop new more sophisticated vector control systems, to increase the effect and to reduce design costs. In that sense, this work describes a portion of the possibilities of some of the most famous simulation packages by which IM vector control systems could be designed. Future trends in the area of power converters will take place in the field of constructing smart power modules which will include protection, built-in drivers, signalization and, eventually, their being built into a low power motor, so that a so-called electronic motor would be obtained. Dominant semi-conducting valves would be IGBT thyristors and the MCT thyristors. Also, continuity is expected in the search for new materials which will combine thermal conductivity, electrical isolation and mechanical solidity. In the area of control is expected continuation and intensification of application of various adaptive methods such as the variable structure systems (VSS), the self-tuning systems (STS), models of robust control, models of reference adaptive control (MRAC), expert fuzzy logic-based systems, genetic algorithms and artificial neural networks (ANN). In future, wider choice among the DSP software tools is expected, whereby application of the DSP vector-controlled electromotive drives will be significantly increased.

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Proceedings of the International Conference on
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CREATING AN ELECTRONIC MAGAZINE IN WORDPRESS FOR PROMOTING THE PRACTICAL TRAINING OF STUDENTS

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Abstract: The report presents ideas and experiences in creating an electronic magazine for exposing knowledge and skills acquired during the practical training of students. We present the rational on relying on a Content Management System such as WordPress to set up a dynamic site where students can create articles with topics related to their practical training that would appear in public after a review process that would include their work and college supervisors. The benefits of such an endeavour could be multifold; students will be improving their writing and reporting skills, instructors will be gaining insights on the activities students are facing when entering the marketplace and employers will be gaining visibility in college settings that could help them attract prospective employees or establish synergies with the technological institutions.
Key words: e-learning, electronic magazine, students' practical training, internship.

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A MODEL FOR IMPLEMENTATION GDPR BASED ON ISO STANDARDS

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Abstract: The implementation of GDPR within organizations should be considered in the context of achieving their business objectives. The emphasis should be on the benefits of its application and the added value to the business itself. The implementation models focus on risk-based thinking taking into account technological innovations, environmental factors, information management, supply chain management and globalization. In this article the author proposes the use of the ISO 9001:2015 standard, putting forward another idea of obtaining a methodology for GDPR implementation.
Key words: GDPR, Standards, ISO 9001:2015, implementation, model.

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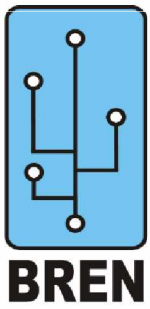

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