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Aims and Scope

Journal of Electrical Engineering and Advanced Technology is a journal that publishes original research papers in the fields of Electrical Engineering and Advanced Technology and in related disciplines. Areas included (but not limited to) are electronics and communications engineering, electric energy, automation, control and instrumentation, computer and information technology, and the electrical engineering aspects of building services and aerospace engineering, Journal publishes research articles and reviews within the whole field of electrical and electronic engineering, new teaching methods, curriculum design, assessment, validation and the impact of new technologies and it will continue to provide information on the latest trends and developments in this ever-expanding subject.

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Contents

Comparative Study Of Vector Control Of Induction Motor By Using PI Controller And Fuzzy Controller

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A B S T R A C T

Induction Motors have wide variety of applications because of their advantages like rugged development, low cost and powerful performance. In latest years, more than a few facets are investigated concerning controlling induction motor. In previous year's scalar control is use for controlling purpose it is also called V/F control. It is very simple method but the main disadvantages of this method are poor dynamic performance and also it takes more time to come in stable position. After this method vector control is used. Vector control method is more complex as compare to scalar control. The VCIM drive includes decoupling of the stator current component this produces torque and flux of induction motor. It has servable advantages like good transient and dynamic performance .But it has some disadvantages like large ripple in torque in the time of starting of IM. In this paper, speed control of an induction motor (IM) using vector control with fuzzy logic and PI controller procedure has been developed and simulated. The comparative study of VCIM with PI and VCIM with fuzzy logic is done on MATLAB/SIMULINK software. Results show the effectiveness of vector control with fuzzy logic controller over traditional PI based vector control method.

Keywords: Induction motor, vector control, mathematic modeling, Fuzzy logic controller.

1. INTRODUCTION:

Induction motors are used in many industrial applications due less maintenance, robustness and simple construction. Maximum torque and efficiency can be obtained by accurate controlling of induction machine. In latest years, the control of the induction motor power is an active study discipline for engineers. Generally, the control and estimation of ac machines is difficult in the compression of dc drives, and this difficulty increase if high performance is demanded. In V/F control required feedback signal but due to presence of harmonic difficulty comes in the processing of feedback signal. The most common method for controlling of induction motor use in industries is vector control or field oriented control. There are nearly two common approaches of vector control. One called the direct or feedback system, and the other, the indirect or feed forward system. indirect vector controlled (IVC) induction motor (IM) drives used in high efficiency programs is very trendy in industrial applications as a result of their relative easy configuration, as in comparison with the direct method which requires flux and torque estimator. The most important advantages of indirect vector control are the decoupling of torque and flux easily. Vector control is also known as decoupling, orthogonal or Trans vector control. Vector control give more accurate result as compare to scalar control due to this advantages it become standard control of ac machines [1]. Conventionally PI controller used for controlling purpose and it gives good results. But in some application like ac drives it's not give desirable result. So we required an advance technique such as fuzzy logic for achieving desirable result. In this paper comparative study between the conventional vector control and fuzzy based vector control is done.

2. VECTOR CONTROL OR FIELD ORIENTED CONTROL:

The other name of Vector control is field-oriented control (FOC), is a frequency control method where the stator currents of a three-phase AC machine are divided as two orthogonal components that can be visualized with a vector. One component defines the magnetic flux of the machine, the other the torque. The control method of the drive calculates from the flux and torque references given by using the drive's speed control the corresponding present aspect references. Conventionally used proportional-integral (PI) controllers for comparing measured current with their reference values. According to PI controller output transistor switch and the stator voltage of motor produce according transistor switching. Vector control induction motor can be control like separately excited DC motor. Vector control is suitable for both induction and synchronous machine drives. In DC machine the field flux is 90 degree to the armature flux. These two fluxes produce no interaction with each other. By adjusting the field current can control the DC machine flux, and the torque may also be control independently of flux by using adjusting the armature current. the construction of AC machine is not simple like DC machine ,in AC machine both stator and rotor flux intersect each other and flux linking of stator and rotor change according to running condition We are able to obtain DC machine like efficiency in protecting a constant and orthogonal orientation between the field and armature fields. In an AC devices by way of orienting the stator current with admire to the rotor flux to be able to obtain independently managed flux and torque [3]. Vector control is suitable to each induction and synchronous motor drives. The cage induction motor drive with vector control presents a high stage of dynamics efficiency and the closed-loop control provide fast and accurate response of system. Induction Motor drives are used in a numbers of commercial and procedure control functions requiring excessive performances [4]. In high performance pressure methods, the motor speed will have to intently follow a distinct reference trajectory prevailing any load disturbances, parameter variants, and view to achieve excessive performance, field-oriented control of induction motor (IM) drive is employed. Nonetheless, the controller design of this type of procedure performs a critical role in approach efficiency. Due to parameter change decoupling characteristics of vector controlled IM are an affected. So the vector control is also known as an unbiased or decoupled control.

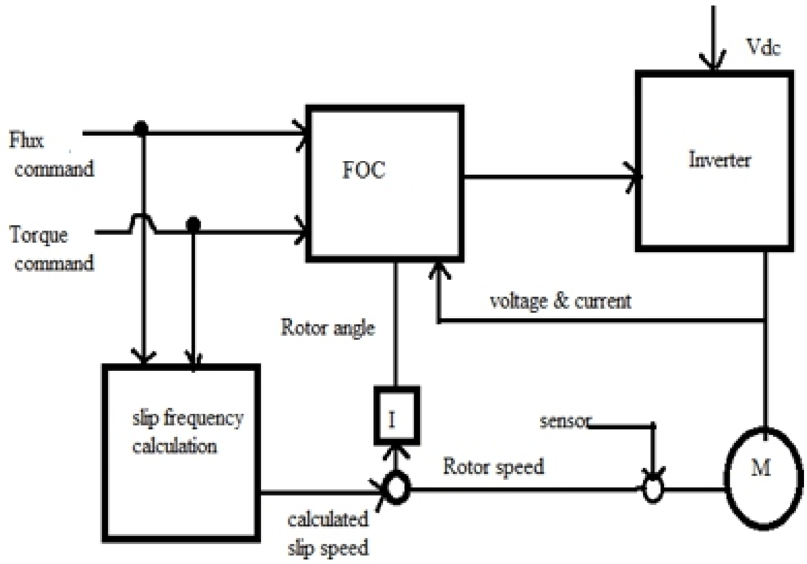


Fig 1: Field oriented control

3. INDUCTION MOTOR MODELLING:

So to reduce the complexity of the modeling the three phase quantities converted to two phase system. The modified voltage equations (1) for the rotor and stator on the synchronously rotating reference frame are as follows:-

$$Vds = RsIds + D\Psi ds - we\Psi qs \quad (1)$$

$$Vqs = RsIqs + D\Psi ds + we\Psi ds \quad (2)$$

$$Vdr = RrIdr + D\Psi dr - (we - wr)\Psi qr \quad (3)$$

$$Vqr = RrIqr + D\Psi qr + (we - wr)\Psi dr \quad (4)$$

= stator d axis voltage, = stator q axis voltage, = rotor d axis voltage, = stator d axis flux, = stator q axis flux, = rotor d axis flux, = rotor q axis flux

The above flux linkage in a synchronous rotating frame can be expressed as

$$\Psi ds = LsIds + LmIdr \quad (5)$$

$$\Psi qs = LsIqs + LmIqr \quad (6)$$

$$\Psi dr = LrIdr + LmIds \quad (7)$$

$$\Psi qr = LrIqr + LmIqs \quad (8)$$

$$Te = \frac{3}{2} p\, \Psi dsIqs - \Psi qs\, Ids \quad (9)$$

Te = Electromagnetic torque

4. PI CONTROLLER DESIGN:

The output of a traditional PI controller is given with the aid of the following equation:

$$U = Kp * e + Ki * \int edt \quad (10)$$

Where, e = error (difference between reference speed and actual speed),

Kp = proportional gain, Ki = Integral gain.

5. FUZZY LOGIC CONTROLLER:

Fuzzy logic controller consist three parts.

- Fuzzification
- Inference
- Defuzzification
- In fuzzification covert crisp value in fuzzy set which is lie between (0, 1). Within the fuzzification step the error and change in error alerts are normalized to values which lie in between -1 to 1. The triangular and trapezoidal membership function makes the calculations less difficult and controller to be simple [2].
- In inference engine all rule are applied to the system and control output according to requirement.
- In defuzzification fuzzy set convert into crisp value.

Fuzzy logic control (FLC) is a control calculation taking into account an etymological control methodology which tries to account the human's learning about how to control a system without requiring a numerical model [9]. Basic block diagram of FLC shown in fig 2.

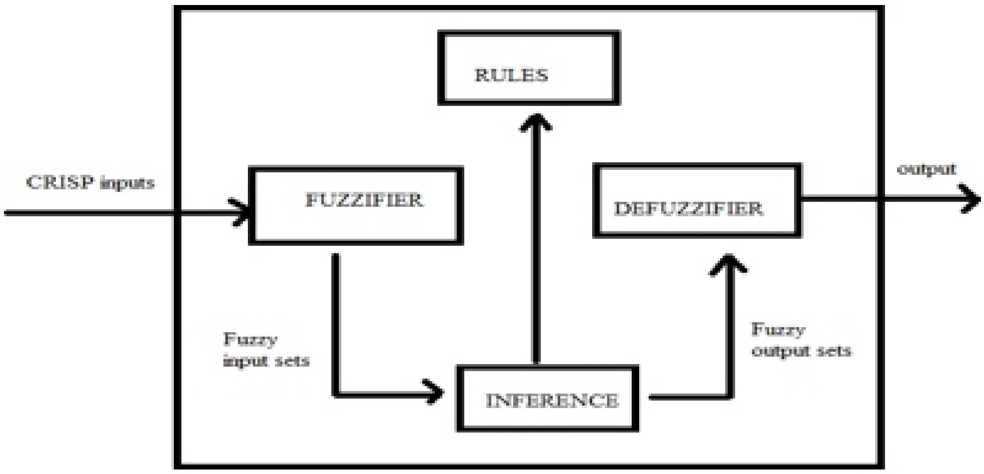
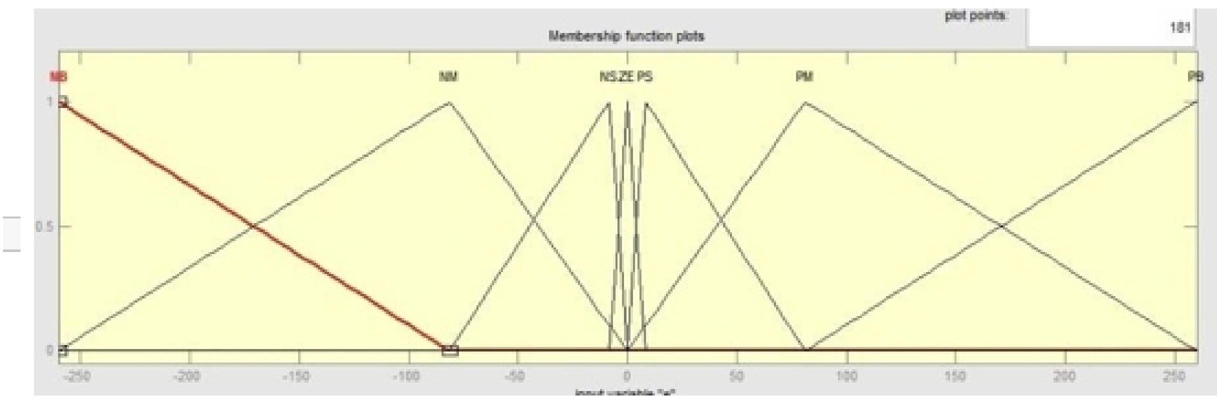


Fig 2: block diagram of fuzzy logic controller

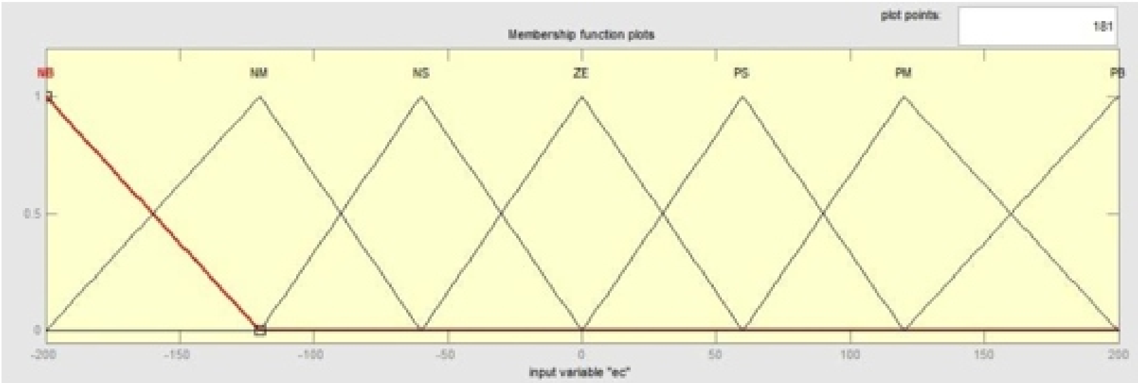
6. FLC DESIGN:

Membership Functions required for designing of a fuzzy logic controller. The membership functions should be picked such that they cover the whole universe of talk. Membership functions should be overlapping each other. This is done in order to avoid any kind of brokenness concerning the minor changes in the inputs. For better control, the membership function near the zero regions should be made tight. Broader member function works a long way from the zero regions gives speedier response to the system. Thus, the membership function should be adjusted as requirements are. After choosing suitable membership functions, a rule base should be made. It contains different Fuzzy If-Then chooses that thoroughly portray the behavior of the structure. These rules all that much take after the human perspective, in this way giving electronic thinking to the system [5, 6, 7, 8].

PLOT OF MEMBERSHIP FUNCTION



INPUT VARIABLE ERROR & CHANGE IN ERROR



OUTPUT VARIABLE

FLC RULE BASE TABLE

e / d_e	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NM	NM	NS	NS	ZE
NM	NL	NM	NM	NS	NS	ZE	PS
NS	NM	NM	NS	NS	ZE	PS	PS
ZE	NM	NS	NS	ZE	PS	PS	PM
PS	NS	NS	ZE	PS	PS	PM	PM
PM	NS	ZE	PS	PS	PM	PLM	PL
PB	ZE	PS	PS	PM	PM	PB	PB

SIMULATION RESULTS:

Circuit Description:

The induction motor is connected through a current-controlled PWM inverter which consist block of Universal Bridge. The motor drives a mechanical load characterized by inertia J, friction coefficient B, and load torque TL. For speed control loop uses a PI and Fuzzy logic controller. q Axis current (iq*) control motor torque and motor flux is control by d axis current (id*). id* and iq* convert into current references ia*, ib*, and ic*by using block dq- abc for the regulating of current. Current and Voltage Measurement blocks are used to for signal visualization purpose. Motor current, speed, and torque signals are available at the output of the 'Asynchronous Machine' block give signal of motor torque, current and speed.

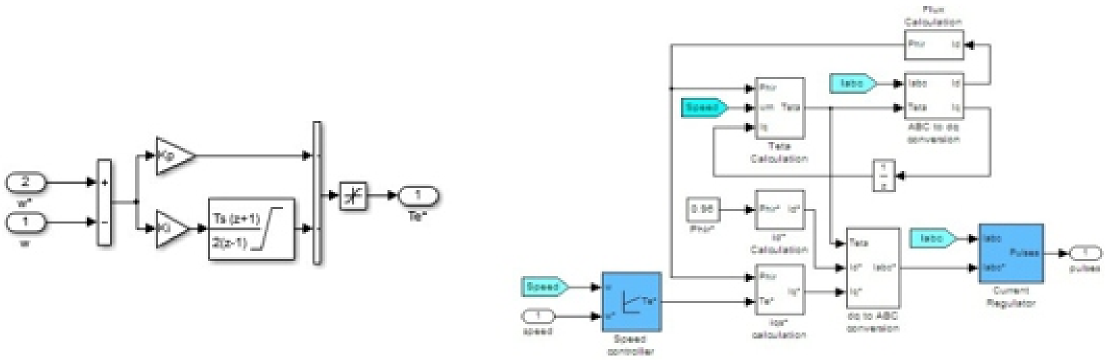


Fig 3 PI based vector control

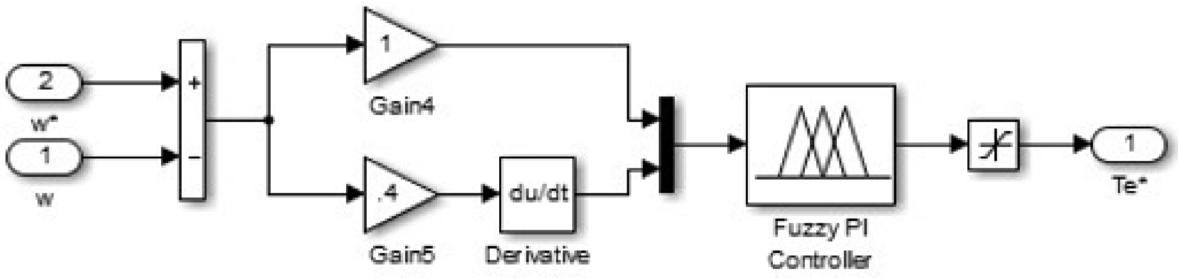


Fig 4 Fuzzy based vector control

At no load

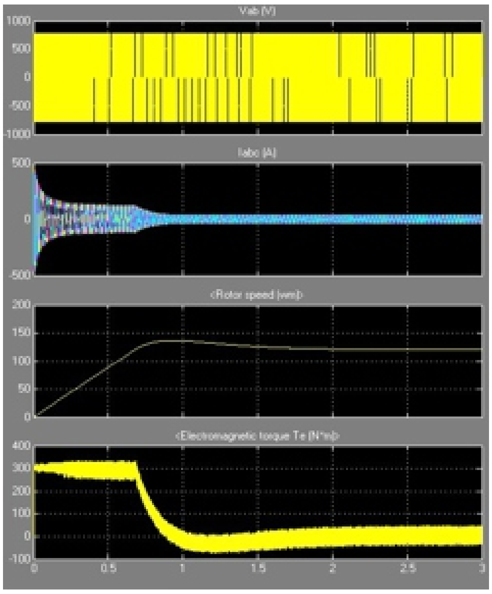


Fig 5: PI base vector control

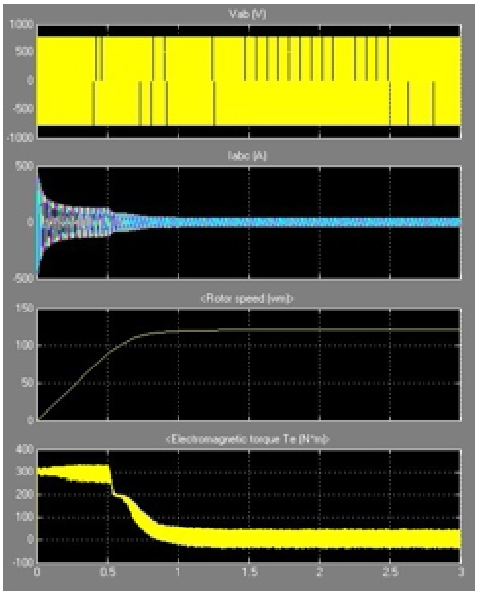
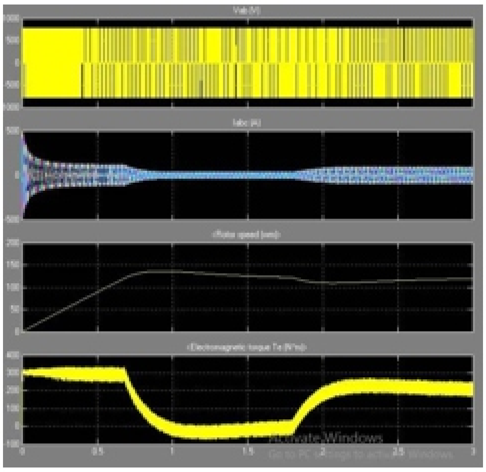


Fig 6: Fuzzy base vector control

The results shows that, When a speed reference step from zero to one hundred twenty rpm is applied at t = 0 sec, the speed set point doesn't go instantly at one hundred twenty rpm however follows the acceleration ramp as proven in fig 3 and fig 4. Motor reached at stablestate at 2.5 sec in conventional PI base vector control but in fuzzy based vector control motor reached stable state in 1.5 sec.

AT Load

At 1.8 sec, a load torque 200 N-M is applied at the shaft of motor due to this speed of induction motor decrease and electromagnetic torque increase. When Electromagnetic torque is equal to load torque the speed of motor stop decreasing and flow reference speed. In fuzzy based vector control take less time for reaching stable condition and approx follow reference speed (fig 6) and pi based vector control far away from reference speed (fig 5).



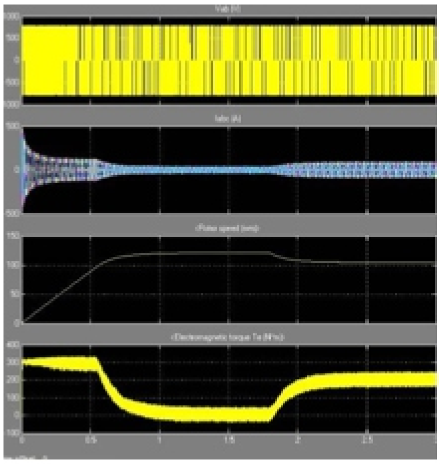


Fig 7: PI base vector control **Fig 8: Fuzzy base vector control**

CONCLUSION

On this paper we determined that conventional PI has more settling time than fuzzy controller, so fuzzy controller makes the process faster. The maximum overshoot additionally within the conventional PI controller is observed greater than fuzzy controller. Once more the variant within the approach parameters as a result of load disturbances is also less with fuzzy controller, which proves that the fuzzy controller is stronger than the conventional PI controller. So it may be concluded that the fuzzy controller improves the system performance and is better suited to excessive performance drives.

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Review Of Microprocessor Based Protective Relays

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ABSTRACT

An electrical power system consists of generators, transformers, transmission and distribution lines. Short circuit and other abnormal conditions often occur on a power system. The heavy current associated with short circuits is likely to cause damage to the equipment if suitable protective relays and circuit breakers are not provided for the protection of each section of the power system. A protective system includes circuit breakers, transducers (CTs and VTs), and protective relays to isolate the faulty section of the power system from the healthy sections. The function of a protective relay is to detect and locate a fault and issue a command to the circuit breaker to disconnect the faulty element. The conventional protective relays are either of electromechanical or static type. The electromechanical relays suffer from several drawbacks such as high burden on instrument transformer, high operating time, contact problem etc. The static relays also suffer from a number of disadvantages such as inflexibility, inadaptability to changing system conditions and complexity. The functions of electromechanical protection systems are now being replaced by microprocessor-based digital protective relays, sometimes called "numeric relays". The increased growth of power system both in size and complexity has brought about the need for fast and reliable relays to protect major equipment and to maintain system stability. The concept of digital protection employing computers which shows much promise in providing improved performance has evolved during the past two decades. Digital computer can easily fulfil the protection requirements of modern power system without difficulties. With the development of economical, powerful and sophisticated microprocessor, there is a growing interest in developing microprocessor-based protective relays which are more flexible because of being programmable and are superior to conventional relays. The objective of this paper is to give a comparative review of microprocessor-based protective relays.

Keywords: Short circuit, abnormal conditions, conventional, inflexibility, inadaptability, complexity, numeric relays, digital, sophisticated.

1. INTRODUCTION:

Numerical relays or Digital relays are the latest development in the area of protective relays. The distinction between digital and numerical relay rests on points of fine technical detail, and is rarely found in areas other than protection. They can be viewed as natural developments of digital relays as a result of advances in technology. Typically, they use a specialized digital signal processor (DSP) as the computational hardware, together with the associated software tools. These relays acquire the sequential samples of the ac quantities in numeric (digital) data form through the data acquisition system and process the data numerically using an algorithm to calculate the fault discriminates and make trip decisions. The digital protective relay, or numeric relay, is a protective relay that uses a microprocessor to analyze power system voltages, currents or other process quantities for the purpose of detection of faults in an industrial process system. These convert voltage and currents to digital form and process the resulting measurements using a microprocessor. The digital relay can emulate functions of many discrete electromechanical relays in one device, simplifying protection design and maintenance. Each digital relay can run self-test routines to confirm its readiness and alarm if a fault is detected. Numeric relays can also provide functions such as communications (SCADA) interface, monitoring of contact inputs, metering, waveform analysis, and other useful features. Digital relays can, for example, store two sets of protection parameters, which allow the behaviour of the relay to be changed during maintenance of attached equipment. Digital relays also can provide protection strategies impossible to synthesize with electromechanical relays, and offer benefits in self-testing and communication to supervisory control systems. A microprocessor by itself cannot perform a given task, but must be programmed and connected to a set of additional system devices such as microprocessor which acts as CPU, memory and input/output devices interconnected for the purpose of performing some well-defined task called microcomputer or microprocessor-based system as shown in figure no.1[1]. The single chip microcomputer is called “microcontroller”. The interconnection of different components, which is a primary concern in the design of a microprocessor- based system, must take into account the nature and timing of the signals that appear at the interfaces between components. The overall task of connecting I/O devices and microprocessor is termed as “interfacing”.

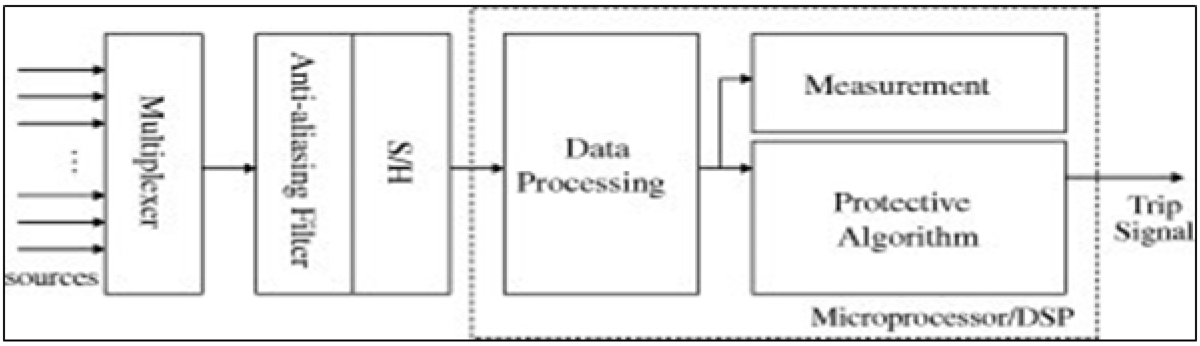

Fig.1 Block Diagram of Microprocessor Based relay

II. Related Work

Osorno, Bruno[2] provided a review of microprocessor based protective relay (MBPR) systems with emphasis on differential equation algorithms. The application of protection relaying in power systems, using MBPR systems, based on the differential equation algorithm are valued more than the protection relaying based on any other algorithms, because the algorithm has the advantages of accuracy and easy implementation. MBPR differential equation approach can tolerate some errors caused by power system abnormality such as DC offset. It is widely implemented in the protections for lines, transformers, buses, motor, and other equipment in power systems. However, the parameters for system description algorithms are obtained from power system current i(t) or voltage v(t), which are abnormal values under fault or distortion situations. So the error study for the algorithm is considered necessary.

M. Amin Zamani, Tarlochan S. Sidhu, Amirnaser Yazdani [3] explained that one of the major challenges associated with microgrid protection is to devise an appropriate protection strategy that is effective in the grid-connected as well as islanded mode of operation. They proposed a protection strategy based on microprocessor- based relays for low-voltage microgrids. Further, the structure of a new relay enabling the proposed protection strategy was presented. One of the salient feature of the developed protection scheme is that it does not require communications or adaptive protective devices. Moreover, it is to a large extent independent of the fault current magnitude and the mode of operation. Transient time-domain simulation studies are conducted to demonstrate the effectiveness of the proposed protection strategy and its enabling relay, using the PSCAD/EMTDC software package.

John J. Novak, Richard D. Kirby [4] explained that improvements in protection and control via communications methods used to exchange digital bits (DBs) among devices are common in progressive utilities in high-voltage substations. These improvements are now being incorporated into the process-sensitive electric power distribution systems of large industrial plants. Until now, new equipment purchases for new projects in industrial facilities using microprocessor (μP) multifunction protective relaying technology were typically done as a direct replacement of older technologies or as an updated equivalent. They described a recently commissioned electrical substation design philosophy, including implementation, construction, maintenance, and performance with μP-based protective relaying, metering, and control schemes. These schemes extensively utilize the interdevice DB exchange and programmable logic capabilities of time- synchronized μP technology.

Gary H. Fox[5] discussed the issues that can exist when applying multifunction microprocessor-based protective relays in switchgear that has alternating current (ac) control voltage rather than a direct current (dc)-battery-based control bus. He recommended several techniques for overcoming these issues.

Montignies, Patrick, Jover, Bernard [6] explained that digital microprocessor based protective relays, installed in low voltage compartments of medium voltage switchgear and/or in control panels, become more and more exposed to EMC disturbances due to interferences that may affect the power quality of electrical networks. End- users sometimes report unexpected circuit breaker tripping and significant financial consequences due to process discontinuity. After analysis, it is quite easy to demonstrate that these incidents are caused either by a relay failure that went to a fall back position, incorrect operation or improper installation/cabling rules. Due to higher market requirements and more demanding applications, mainly in the Oil & Gas sector, digital protective relays have to integrate more powerful protection, control, monitoring and communication functionalities. Although these relays comply with the latest IEC 60255 and IEC 61000 standards and associated subsets, they have to be installed by switchboard manufacturers, whoever they are, in airinsulated or Gas Insulated switchgear. Improper installation rules can sometimes result in unexpected tripping.

Tingfang, Yang ; Xin, Yang[7] proposed a generalizing modern microprocessor- based relay protection at the power transmission line and a design of relays based on ARM processor was put forward. This device used DSP made by TI to be the protective CPU, which mainly answered for controlling data acquisition, the sampled data processing, the protective function implementation, the human interface and peripheral serial interface and Ethernet communication, and used other devices to be assistant to control sampling/holding, multi-path option switch and the I/O switching value. The system is mainly composed of several modules such as A/D samples circuit, Fourier algorithm, fault analysis system. The test results show the design of the microprocessor-based protection has good performance.

III. PROBLEM FORMULATION

Electrical Power System protection is required for protection of both user and the system equipment itself from fault, hence electrical power system is not allowed to operate without any protection devices installed. Power system fault is defined as undesirable condition that occurs in the power system. These undesirable conditions such as short circuit, current leakage, ground short, over current and over voltage. The functional security of the power grid depends upon the successful operation of thousands of relays that may be used in protective scheme for preventing the power system from cascading failures. The failure of one relay of the protective scheme to operate as intended may imbalance the stability of the entire power grid and hence it may lead the whole system to blackout. In fact, major power system failures during a transient disturbance are more likely to be caused by unnecessary protective relay tripping rather than by the failure of a relay to take action. In other words, the performance of protective relay or system is very important to be known especially in smart power grid. In other words, the performance of protection system is measured by several criteria including reliability, selectivity, speed of operation, etc. Reliability has two aspects: dependability and security. Dependability is known as the degree of certainty that a relay system will operate correctly when there is a fault on the system. Security is the degree of certainty that a relay will operate unnecessary even when there is no fault on the system.

Originally, electromechanical relays were used to protect power system. Most relays used either electromechanical attraction or electromechanical induction principle for their operation. These relays were classified as amplitude comparators or as phase comparators. When solid state technology was introduced, amplitude and phase comparison were implemented using discrete components including vaccum tubes. Solid state relays appeared as the technology poised to replace electromechanical relays. Devices using electron tubes were studied but never applied as commercial products, because of the limitatons of vacuum tube amplifiers. The advances in the in the Very Large Scale Integrated technology(VLSI) and software techniques led to the development of microprocessor based relays. Computer hardware technology has tremendously advanced since early 1970s and new generations of computers tend to make digital computer relaying a viable and better alternative to the traditional relaying systems. The additional features offered by microprocessor technologies encouraged the evolution of relays that introduced many changes to the industry. These multifunction relays reduced the product and installation cost drastically. This trend has continued until now and has converted microprocessor relays to powerful tools in modern substations.

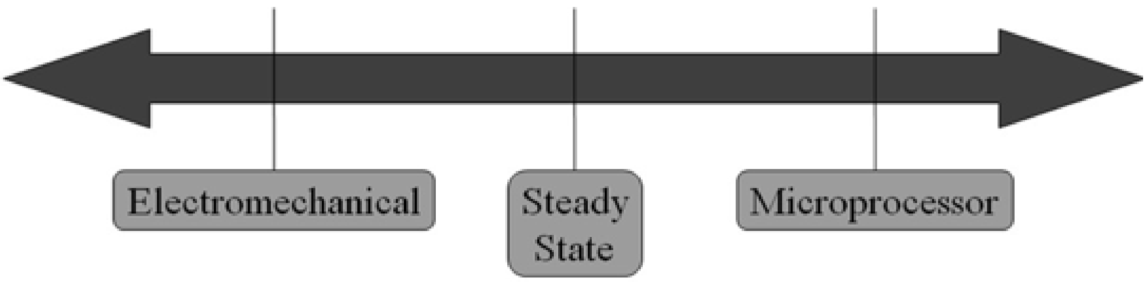

Fig 2. Evolution of Protection Devices

A. OBJECTIVES OF THE WORK

The objective of this paper is:

- To discuss the disadvantages of electromechanical and static type relays.
- To highlight the benefits of microprocessor based relays.
- To give an overview of basic principle of digital relays.
- To explain the construction/working of a simple microprocessor based overcurrent relay.

B. BASIC PRINCIPLE OF DIGITAL RELAYS OR METHODOLOGY USED IN DIGITAL RELAYS

In digital relays digital signals are used for data processing instead of analog signals. Analog signals are continuous signals and cannot be processed easily because of their several limitations as compared to digital signals. Digital signals are in form of coded square pulses which represents discrete elements of information (data). In digital system, the signals are in binary form i.e. only two discrete values referred to as binary coefficients 0 and 1 or logical values true and false. The number of binary digits needed to encode the various discrete elements of information (data) has a significant influence on the design of a digital system. The digital system generally operates on groups of 8 or 16 or 32 bits of information at once. The range of the digital system of encoding the information by a n bit group is 2n. Hence digital systems with larger bit operating group can process a wider range of encoded information. The information to be processed may be textual, numerical and logical.

IV. MICROPROCESSOR BASED OVERCURRENT RELAY

A. COMPONENTS OF A SIMPLE MICROPROCESSOR BASED RELAY

An overcurrent relay is the simplest form of protective relay which operates when the current in any circuit exceeds a certain predetermined value, i.e. the pick-up value. It is extensively used for the protection of distribution lines, industrial motors and equipment. Using a multiplexer, the microprocessor can sense the fault currents of a number of circuits. If the fault current in any circuit exceeds the pick-up value, the microprocessor sends a tripping signal to the circuit breaker of the faulty circuit. As the microprocessor accepts signals in voltage form, the current signal derived from the current transformer is converted into a proportional voltage signal using a current to voltage converter. The ac voltage proportional to the load current is converted into dc using a precision rectifier. Thus, the microprocessor accepts dc voltage proportional to load current. The schematic block diagram of the relay is shown in figure 2 [8]. The microprocessor accepts signal in digital form. Therefore analog signals must be converted into digital form before feeding them to the microprocessor for processing. Both voltage and current are analog quantities. As the microprocessor accepts only voltage signal in digital form, the current signal isfirst converted into proportional voltage signal and then the voltage signal is converted into digital form for applying to the microprocessor. An A/D converter is used to convert analog signals into digital forms. If more than one analog quantity is to be converted into digital form by using only one A/D converter, analog multiplexers are used to select any one analog quantity at a time for A/D conversion. The output of the rectifier is fed to the multiplexer. The microcomputer sends a command to switch on the desired channel of the multiplexer to obtain the rectified voltage proportional to the current in a particular circuit. The output of the multiplexer is fed to A/D converter to obtain the signal in digital form. The A/D converter ADC0800 has been used for this purpose. The microcomputer sends a signal to the ADC for starting the conversion. The microcomputer reads the end of conversion signal to examine whether the conversion is over or not. As soon as the conversion is over, the microcomputer reads the current signal in digital form and then compares it with the pick-up value. For time-varying voltages such as ac voltage, a sample and hold circuit is used to keep the desired instantaneous voltage constant during conversion period.

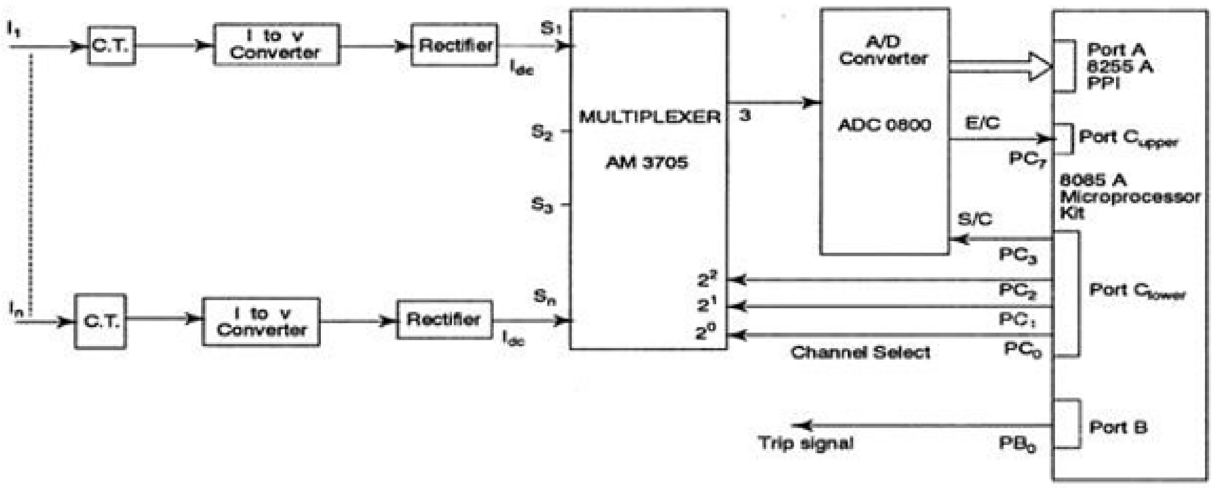

Fig .3 Block diagram of Overcurrent relay.

B. FLOWCHART FOR OVERCURRENT RELAY

The program flowchart is shown in figure 3 [8].The microcomputer first determines the magnitude of the fault current and then selects the corresponding time of operation. A delay subroutine is started and the trip signal is sent after the desired delay. Using the same program, any characteristic such as IDMT, very inverse or extremely inverse can be realised by simply changing the data according to the desired characteristic to be realised. The microcomputer continuously measures the current and moves in a loop and if the measured current exceeds the pick-up value, it compares the measured value of the current with the digital values of the current in order to select the corresponding count for a time delay. Then it goes in delay subroutine and sends a trip signal to the circuit breaker after the predetermined time delay.

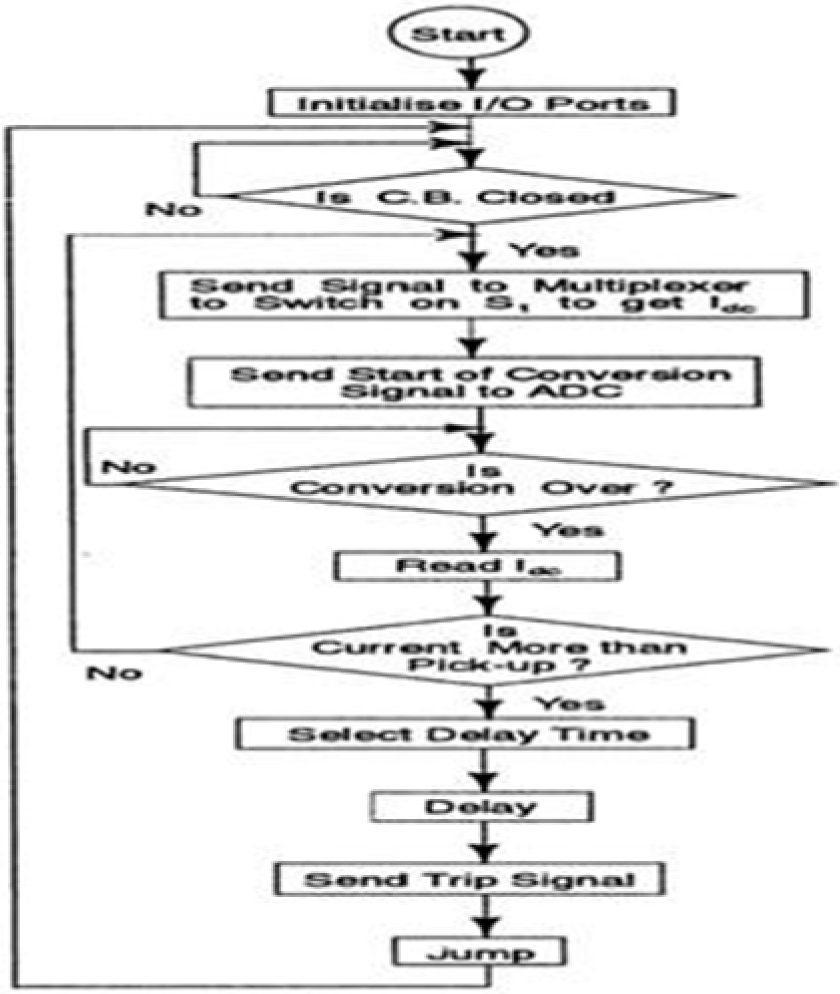

Fig .4 Flow Chart for Overcurrent Relay

V. Results and Discussions

The programmable microprocessor based relays have superior features which include the following:

1. Ability to combine a large number of protective and monitoring functions in a single relay unit.

2. Measured values of variables are processed digitally by microprocessor. The digital processing by microprocessor gives several abilities to the protective system such as combinational logic, use of on-line processing of variables, programmable features etc.

3. Digital relays are widely used because of their economy, compactness, flexibility, reliability, self-monitoring and self checking capability, multiple functions, low burden on instruments transformers and improved performance, high speed of operation over conventional relays of electromechanical and static types.

4. Microprocessor based digital relays can have interface with other relays, protected equipment and control and protection devices in the substation.

5. Microprocessor based relays are easy to apply, operate and use, yet highly capable. These relays are more accurate and can store large number of signals.

VI. CONCLUSIONS

The present downward trend in the cost of Very Large Scale Integrated (VLSI) circuits has encouraged wide application of numerical or digital relays for the protection of modern complex power system. Economical, powerful and sophisticated numerical devices (e.g., microprocessors, microcontrollers, digital signal processors (DSP), etc) are available today because of tremendous advancement in computer hardware technology. Various efficient and fast relaying algorithms which form a part of the software and are used to process the acquired information are also available today. Hence, there is a growing trend to develop and use numerical relays for the protection of various components of the modern complex power system. Numerical relaying has become a viable alternative to the traditional relaying systems employing electromechanical and static relays. Intelligent numerical relays using artificial Intelligence techniques such as Artificial Neural Networks (ANNs) and Fuzzy logic Systems are now available in the market and are still.

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Effect Of Cold Chamber Temperature, Hot Chamber Temperature And Supply Voltage Of Stirling Cryocooler On Refrigeration Effect

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A B S T R A C T

Now a day cryocoolers of miniature and micro miniature capacity are very famous in defence as used for missile infrared night vision equipment and heat seeking infrared missile guidance systems. These infrared devices are developed with optical characteristics with very low temperature. Very low temperature as 120 K can be produced by cryocoolers. A cryocooler generally consist of a compression unit, an expansion unit and heat exchanger.In this paper analysis is made for effect of cold temperature of chamber, hot temperature chamber and supply voltage on cooling capacity of stirling cryocooler.

Keywords: Stirling cycle; Cryocoolers; Regenerator; Inertia force; Magnetic force; Electromagnetic force; Piston; Cooling capacity.

1. INTRODUCTION:

Stirling cryoccoler is getting a great attention all over the world. In stirling cryocooler gas such as helium or hydrogen is used. In stirling cycle gas performs a closed cycle, during which it is, alternately compressed at ambient temperature in an expansion space. An ideal Stirling cycle consisting of two isotherms and two isochors produces refrigeration at the Carnot coefficient of performance.

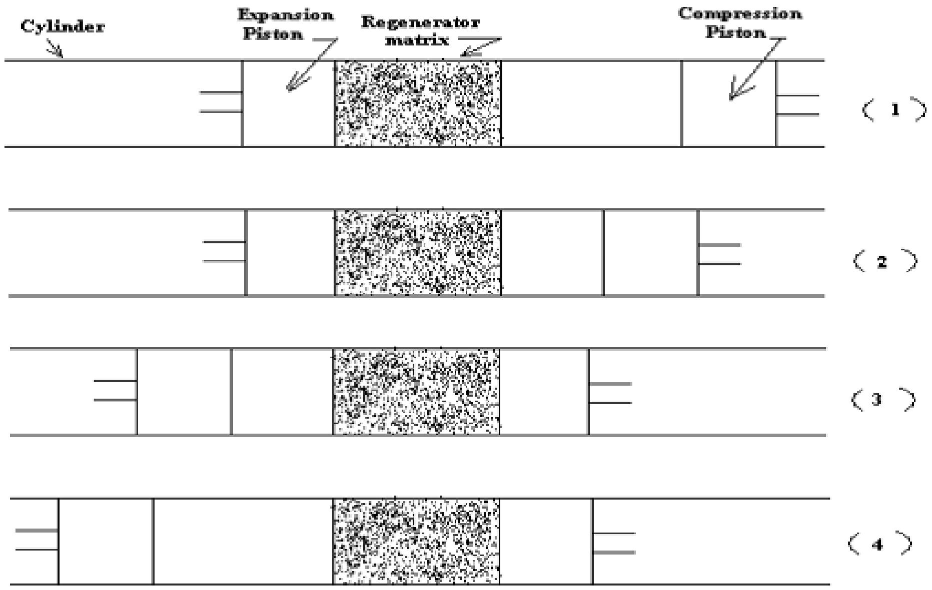

Figure 1- concept of stirling cryocooler

To understand stirling cryocoolers consider a cylinder containing two opposed pistons, with a refrigerator between them. The regenerator may be thought of as a thermodynamic sponge, alternatively absorbing heat and releasing heat. This is accomplished with a matrix of finely divided metal in the form of wires or strips. One of the two spaces between the regenerator and the pistons is called the expansion space, and is maintained at low temperature TE. The other space is called the compression space, and is maintained at ambient temperature TC. It is assumed that there is no thermal conduction in the longitudinal direction, then temperature gradient (TC-TE) across the transverse faces of the regenerator exist. The pistons are assumed to move without friction or leakage of the working fluid enclosed between them. Consider the fig: 1. [1]. In small free piston stirling cryocoolers Helium is the typical working fluid and the pressure waves that are generated by the dual- opposed pistons of the linear compressor are the driving force of the displacer inthe expander. The dynamic characteristics of the linear compressor are determined not only by the forces caused by the pressure differences between the compression space and the buffer space, but also by forces of the mechanical springs and masses of the moving parts of the compressor like piston etc.[2]

2. ANALYSIS AND EQUATION

With the help of Fourier hv/hg can be written as:

$$hv/hg = [\, a_0 + a_1 \text{Cos}\, \beta + a_2 \text{Cos}\, 2\beta + \_\_\_\_\_ a_n \text{Cos}\, n\beta \,] + [\, b_0 + b_1 \text{Sin}\, \beta + b_2 \text{Cos}\, 2\beta + \_\_\_\_ + b_n \text{Cos}\, n\beta \,]$$

Normalized active height, $\frac{hv}{hg} = a_0 + a_2 \text{Cos } 2\beta + a_4 \text{Cos } 4\beta + \_\_\_\_\_ a_{2n} \text{Cos } 2n\beta$ (1)

$i = [A_1 \cos\beta + A_3 \cos 3\beta + \ldots + A_{2n-1} \cos(2n-1)\beta] + [B_1 \text{Sin }\beta + B_3 \text{Sin } 3\beta + \ldots + B_{2n-1} \text{ Sin}(2n-1)\beta]$

(2)

so, $Pi = \frac{E_0}{2R_T(1+R_L^2)}\left[E_0 - \frac{E_S(2a_0 - a_2)}{2(hs/hg)}(\sin\phi + R_L \cos\phi)\right]$ (3)

$Po = \frac{1}{2\pi}\int_0^{2\pi} E_M \, id\beta$ (4)

$Po = -\frac{1}{2\pi}\int_0^{2\pi} Es\frac{(hv/hg)}{(hs/hg)} \, i \text{ Sin}\beta \, d\beta$ *(from eq 4)*

$= -\frac{1}{2\pi}\int_0^{2\pi} \text{Es}\frac{(hv/hg)}{(hs/hg)} \, i \text{ Sin}\beta \, d\beta$ (5)

We get, $Po = -\frac{E_S}{2\pi(hs/hg)}\left[a_0 B_1 + \sum_{n=1}^{\infty}\frac{a_{2n}}{2}(B_{2n+1} - B_{2n-1})\right]$ (6)

Refrigeration effect Q_{co} is given by $Q_{co} = n\int_0^{2\pi} P_e \, dV_d$

$Qco = -n\pi A_d . X_d [Z_p X_p \text{ Sin}\theta - F_{pe} X_p \omega \cos\theta - F_{de} X_d \omega]$ (7)

The expression for work done or power input to cryocooler is given by:

$Pci = n\int P_c dV_p = n\int(\overline{P} + Z_p x_p + Z_d x_d + F_{pc} x'_p + F_{dc} x'_d) dV_p$

$Pci = n\pi Ap X_p [Z_d X_d \text{ Sin }\theta + F_{pc} X_p \omega + F_{dc} X_d \omega \cos\theta]$ (8)

$COP = -\frac{A_d X_d [Z_p X_p \sin\theta - F_{pc} X_p \omega\cos\theta - F_{dc} X_d \omega]}{A_p X_p [Z_d X_d \sin\theta + F_{pc} X_p \omega + F_{dc} X_d \omega\cos\theta]}$ (9)

Various force acting on the piston are.

Pressure force $= (Pc - \overline{P}) Ap = Z_p X_p A_p \text{ Cos}(\beta) + Z_d X_d A_p (\text{Cos}(\beta)\text{Cos}(\theta) - Z_d X_d A_p \text{ Sin}(\beta)\text{Sin}(\theta)) - \omega F_{pc} X_p A_p \sin\beta - \omega F_{dc} X_d A_p [\text{Sin}\beta Cos\theta + Cos\beta Sin\theta]$ (10)

Spring force $= K_p x_p = K_p X_p \text{ Cos}\beta$ (11)

Electromagnetic force, $Emf = B_u E_0(\text{Cos}\phi + R_L \text{Sin}\phi)\text{Cos}\beta - B_C R_L X_p \omega \text{Cos}\beta + B_C X_p \omega \text{Sin}\beta + B_u E_0(R_L \text{Cos}\phi - \text{Sin}\phi)\text{Sin}\beta + B_S X_p \omega(\frac{S_A}{E_S}\text{Cos}\beta + \frac{S_B}{E_S}\text{ Sin }\beta)$ (12)

now substituting these values in the balance force

$-M_p\omega^2 X_p \text{ Cos }\beta + A_P[Z_p X_p \text{ Cos }\beta + Z_d X_d \text{Cos }\beta\text{Cos }\theta - Z_d X_d \text{Sin }\beta\text{Sin}\theta - \omega F_{pc} X_p \sin\beta - \omega F_{dc} X_d \text{ Sin}\beta Cos\theta - \omega F_{dc} X_d Cos\beta Sin\theta] + K_P X_p \text{Cos }\beta = B_U E_0(\text{Cos }\phi + R_L \text{ Sin }\phi)\text{Cos}\beta - B_C R_L X_p \omega \text{Cos }\beta + B_S X_p \omega(\frac{S_A}{E_S}\text{ Cos }\beta + \frac{S_B}{E_S}\text{ Sin}\beta) + B_C X_p \omega \sin\beta + B_u E_o(-\text{Sin}\phi + R_L \text{ Cos }\phi)\sin\beta$

$X_p = \frac{B_U E_0(\sin\phi - R_L\cos\phi)}{A_p Z_d \frac{X_d}{X_p}\sin\theta + \frac{S_B}{E_S} B_S\omega + B_C\omega + F_{pc}\omega A_p + F_{dc}\omega\frac{X_d}{X_p}A_p Cos\theta}$ (13)

3. RESULT AND DISCUSSION

To study the effect of temperature of hot chamber, temperature of cold chamber and supply voltage on cooling capacity of a stirling cryocoolers a computer programme is develop. From this computer program results are taken in form of tables and then by using these tables graphs are plotted for refrigeration capacity.

Table 1 Supply voltage to linear motor

S.No.	e0	qe0
1	18	0.93771
2	19	1.03712
3	20	1.14055
4	21	1.24785
5	22	1.35887
6	23	1.47342
7	24	1.59139
8	25	1.71261
9	26	1.83692
10	27	1.96417
11	28	2.0942
12	29	2.22687
13	30	2.36203

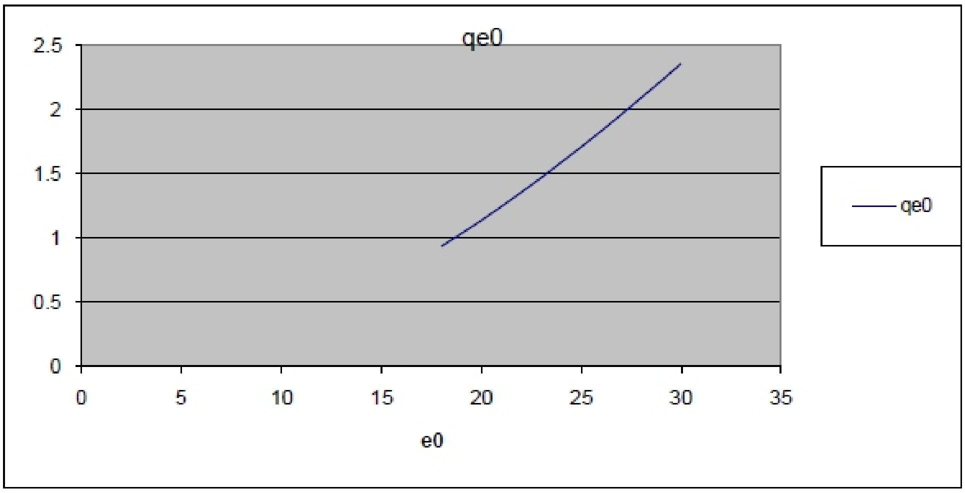

Figure 2- Refrigeration vs Supply Voltage

As clear in the plot between refrigeration (qe0) and supply voltage.(e0), if one want to increase the refrigeration effect of stirling cryocoolers the supply voltage must increases.

Table 2 cold space temperature

S.No.	tc	qe0
1	40	0.84301
2	42	0.90656
3	44	0.97141
4	46	1.03751
5	48	1.10482
6	50	1.17329
7	52	1.2429
8	54	1.3136
9	56	1.38536
10	60	1.53199
11	70	1.91557
12	80	2.32193
13	82	2.40582

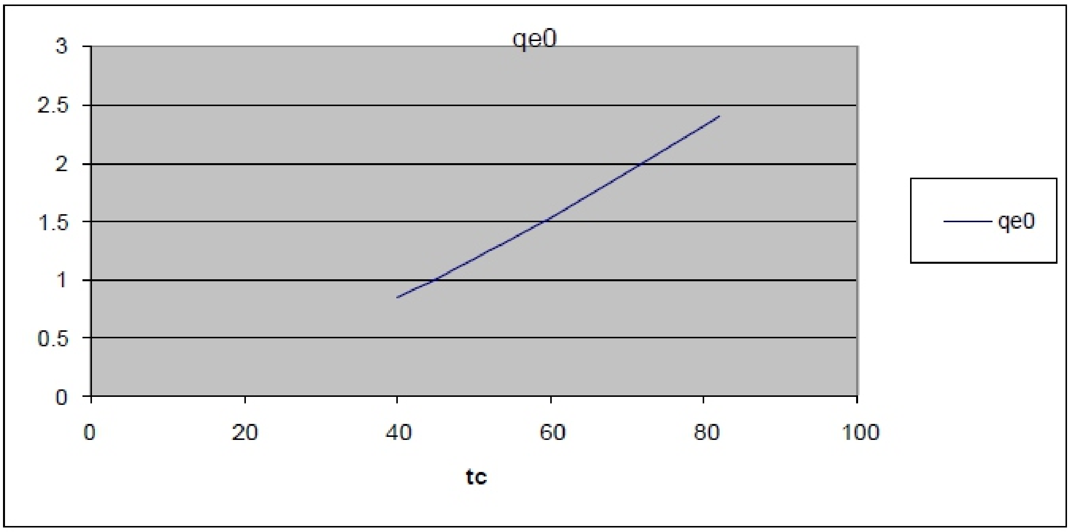

Figure 3- Refrigeration vs Cold Chamber Temperature

In plot refrigeration effect Vs cold space temperature, we can observe that with increase in temperature of cold chamber refrigeratiom effect increases and with decrese in cold chamber temperature refrigeration effect decreases.

Table 3 hot chamber temperature

S.No.	th	qe0
1	250	2.28862
2	260	2.16304
3	270	2.04857
4	280	1.94386
5	290	1.84777
6	300	1.75931
7	310	1.67766
8	315	1.63916
9	320	1.60209
10	325	1.56639
11	330	1.53199

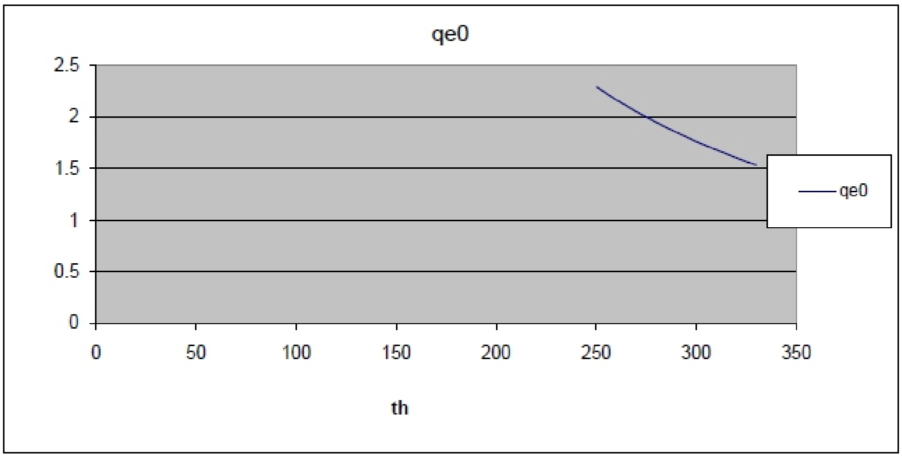

Figure 4- Refrigeration vs Hot Chamber Temperature

In plot Refrigeration effect Vs hot space temperature with increase in hot chamber temperature curves come downward. Hence we can say with increase in hot chamber temperature refrigeration effect decreses.

4. CONCLUSION

The results give a clear illustration of the effect of supply voltage, cold chamber temperature and hot chamber temperature on the refrigeration effect. It is concluded that with increase in cold space temperature refrigeration effect increases, and decreases when cold space temperature decreases. When we increase the supply voltage, the refrigeration effect of stirling cryocoolers increases, and decreses and vice versa. When one increases the hot chamber temperature the refrigeration effect decreses.They also show how much significant supply voltage, cold chamber temperature and hot chamber temperature becomes when we require cooling effect.

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Distributed Scheduling For Mesh Networks With Chain Topology

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ABSTRACT

The IEEE 802.11 DCF Protocol which is used in the Multi-hop networks based on the Bus Topology doesn't provide the sufficient through put for each node because of the exposed/hidden node problem or collision. Removing this variation from the hidden nodes and confronting the collision is a key to reach the high performance in the Mesh network.

Keywords: Wireless Mesh Network, Hyacinth, IEEE 802.11 DCF, TDMA, Token, NIC

1. INTRODUCTION:

The wireless mesh network is a technology used for reaching the broadband Internet. The mesh network is self-improved which means that the network can be run when one of the nodes is out of service or the connections are being destroyed. The result is that this model of the network is very reliable and guaranteed.

In this kind of the network each node needs just a single transmitter. Until it gets to the other node, each node operates as a repeater. This network is used for sending data, from the closest node to the parallel node in a remote and out of reach distance. As a result, this kind of network can have a wide range, and is suitable for places which are rough and there cannot be any electrical grounding and wire connections.

2- DISTRIBUTED TIME BASED ON TOKEN

In this part, we will first investigate the problems of the wireless mesh networks and in continue, will

2-1- INVESTIGATE DOMAIN COLLISION PROBLEM

For the efficient transfer timing in the bus topology we investigate the transfer behavior [1]. The main idea is making the transfers possible in the nodes which are 4 hops away from each other. In Figure 1 we suppose that all nodes are transferring some pockets in a 7-node bus network.

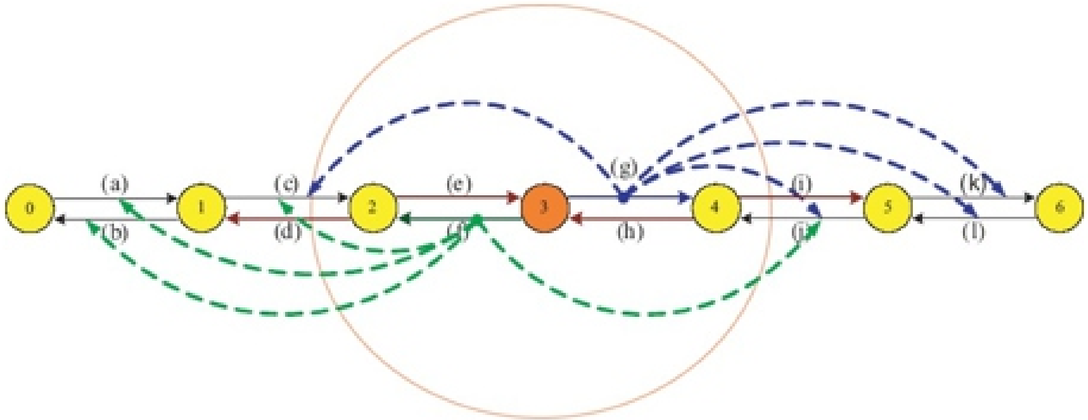

Figure 1: Domain Collision in 4 Hops

The traffic, which is specified in a one-direction connection, shows the movement of the data from one node to its adjacent node. We analyze this problem from the perspective of Node-3. For a successful traffic in the path G, from the node 3 to the node 4, nodes 2 and 5 must not send the K, J, E, and D traffics. This job is amplified by nodes 2 and 5 in "802.11" which perform the Virtual Transfer Sense. The Traffics I, H, and F are denied because nodes 3 and 4 are involved in receiving the traffic Y. Also traffics C and L may cause transfers from nodes 2 and 5. When the traffic C is generated by the node 1, these pockets intervene transfers from the node 3 so they are not differentiated in the node 2.

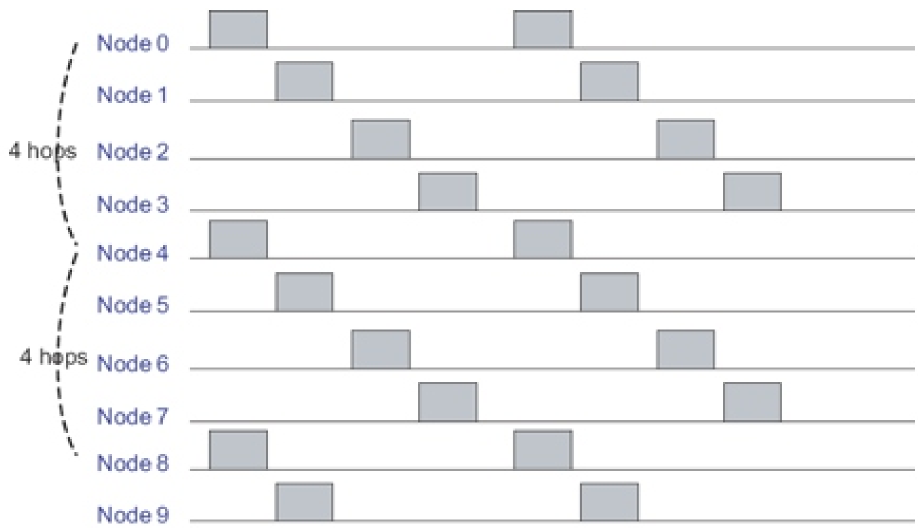

Figure 2: Bus Topology with 10 Nodes for Efficient Transfer Timing

In Figure 2, when the node 4 is trying to start a transfer, nodes 5 and 8, which are 4 hops away from the node 4, can start transfers. After the node 5, nodes 4 and node 8 send frames respectively. The next transfer time is given to nodes 1, 5 and then 9. The node 4 can transfer again after the node 7.

2-2- ASSUMPTIONS AND CONFIGURATION

Before explaining TDS we consider some assumptions:

- ✓ Network Topologies is a temporary network with Bus Topology.
- ✓ Each node knows its position in the Bus Topology
- ✓ Every node can send its pockets to the right destinations
- ✓ The size of the each pocket is fixed

RTS frames (Return-Token) must be added to “802.11MAC.” As shown in Graph 1, the Token-ID's field is one byte and its range varies from 0 to 255. The Next-Node-ID's field is 6 bytes and its value shows the physical address of the next node. Each node passes its token by filling the details of the Token and the address of the next node. The frame Return-Token is used to give the token back to the Boss [2].

2-3- SIMULATION RESULTS

We modify the protocol “802.11” and for simulation scenarios, 512-byte pockets are used randomly and sent by a channel rate of 2mbps. Column 1 shows the results of a simulationfor a 3-node to 8-node Bus Topologies with the protocol “802.11.” Column 3 shows the whole capacity for 3 nodes to 9 nodes with a 512-Byte and 1000-Byte pocket. In all cases except the number 5 and the number 6 groups, TDS serves more acceptance capacity than “802.11.”

Table 1: Frame Fields are modified

Frames	Added Field	Size
RTS	*Token_ID*	*1 bytes*
	Next_Node_ID	*6 bytes*
Return_Token	*Token_ID*	*1 bytes*
	Next_Node_ID	*6 bytes*

Table 2: The permittivity of each node in the TDS algorithm (Kb/sec)

Nodes	3	4	5	6	7	8
Thruput	421.42	307.59	307.54	307.60	307.60	307.59

Table 3: The permittivity of each node in 802.11 (Kb/sec)

Nodes	3	4	5	6	7	8
Node 0	273.45	155.73	539.03	550.01	375.03	275.50
Node 1	644.22	475.38	134.51	459.33	436.39	419.59
Node 2	290.16	424.67	292.62	52.67	241.99	304.33
Node 3		133.04	149.01	51.28	53.90	125.50
Node 4			540.51	462.11	273.86	121.73
Node 5				547.14	432.21	279.35
Node 6					335.87	437.53
Node 7						294.26
Average	402.61	297.20	331.14	353.76	307.04	282.23

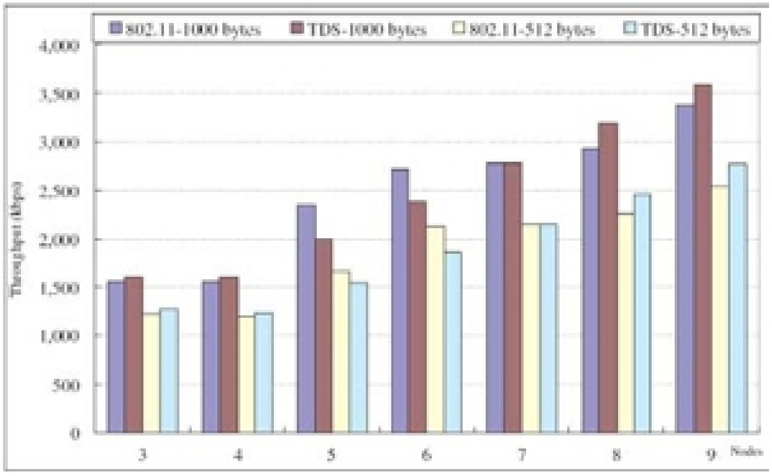

Figure 3: The comparison permittivity between TDS and 802.11

3- ARCHITECTURE OF A MESH NETWORK WITH HIGH CAPACITY

Most of the temporary Multihop networks based on “802.11” work in a channel. This matter greatly decreases the bandwidth for each node because of the interference between consecutive nodes on the same path and also adjacent paths. Shape 4 shows the intensity of this interference. So the ordinary Temporary One-Channel network architecture cannot be used for building a wireless mesh networks [3].

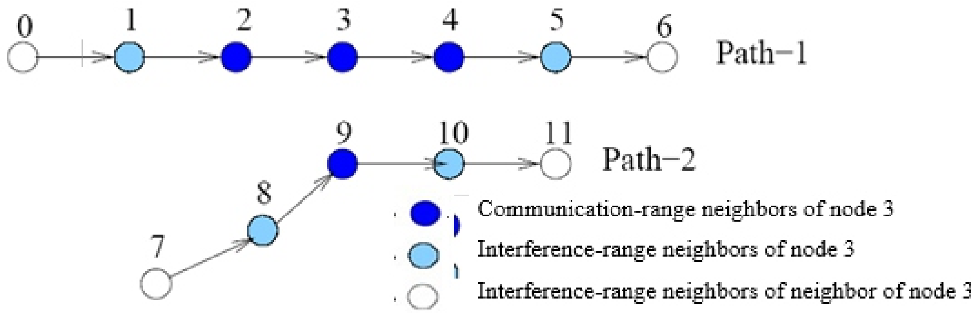

Figure 4: Interfere with the path and the path in a network of ad hoc multi-hop single-channel

nodes 1, 2, 4 and 5, the amplitude of the interference node 3, and so could not when node 3 is activated the send / receive. Nodes 8, 9 and 10, which belong to the non-connected there are other 3 nodes, are in interference range. Therefore none of the wireless link cannot form simultaneously when node 3 to node 4 will move to work

4- TOPOLOGY

We concentrate on the linear Bus Topologies. An N-Hop wireless mesh network has N+1 nodes and N links. N= {0, 1, 2,…, n} shows the Set of the nodes. The link between nodes I-1 and I is the link I. I= {1, 2,…, n} shows the set of the nodes. The node 0 is the origin of the TCP that owns unlimited data to send. The node N is the receiver of the TCP. Shape 5 shows the sample of the network topology [4].

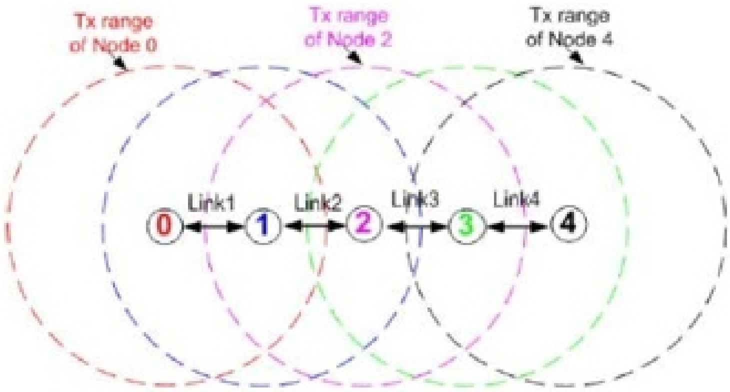

Figure 5: Colors to characterize nodes and their transfer domain-all nodes work in a same channel

5-CONCLUSION

Because of preventing from the collision by using more than a single network adaptor, the Multihop method can provide us a suitable bandwidth and release us from the problem of the adjacent nodes. However, based on the studies, a combination of the both TDS and Multichannel is recommended. For solving the problem of these methods, we will talk in the next article.

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2. Survey paper (giving an original, detailed and critical view of a research problem or an area to which the author has made a contribution visible through his self-citation);
3. Short or preliminary communication (original management paper of full format but of a smaller extent or of a preliminary character);
4. Scientific critique or forum (discussion on a particular scientific topic, based exclusively on management argumentation) and commentaries. Exceptionally, in particular areas, a scientific paper in the Journal can be in a form of a monograph or a critical edition of scientific data (historical, archival, lexicographic, bibliographic, data survey, etc.) which were unknown or hardly accessible for scientific research.

Professional articles:

1. Professional paper (contribution offering experience useful for improvement of professional practice but not necessarily based on scientific methods);
2. Informative contribution (editorial, commentary, etc.);
3. Review (of a book, software, case study, scientific event, etc.)

Language

The article should be in English. The grammar and style of the article should be of good quality. The systematized text should be without abbreviations (except standard ones). All measurements must be in SI units. The sequence of formulae is denoted in Arabic numerals in parentheses on the right-hand side.

Abstract and Summary

An abstract is a concise informative presentation of the article content for fast and accurate Evaluation of its relevance. It is both in the Editorial Office's and the author's best interest for an abstract to contain terms often used for indexing and article search. The abstract describes the purpose of the study and the methods, outlines the findings and state the conclusions. A 100- to 250- Word abstract should be placed between the title and the keywords with the body text to follow. Besides an abstract are advised to have a summary in English, at the end of the article, after the Reference list. The summary should be structured and long up to 1/10 of the article length (it is more extensive than the abstract).

Keywords

Keywords are terms or phrases showing adequately the article content for indexing and search purposes. They should be allocated heaving in mind widely accepted international sources (index, dictionary or thesaurus), such as the Web of Science keyword list for science in general. The higher their usage frequency is the better. Up to 10 keywords immediately follow the abstract and the summary, in respective languages.

Acknowledgements

The name and the number of the project or programmed within which the article was realized is given in a separate note at the bottom of the first page together with the name of the institution which financially supported the project or programmed.

Tables and Illustrations

All the captions should be in the original language as well as in English, together with the texts in illustrations if possible. Tables are typed in the same style as the text and are denoted by numerals at the top. Photographs and drawings, placed appropriately in the text, should be clear, precise and suitable for reproduction. Drawings should be created in Word or Corel.

Citation in the Text

Citation in the text must be uniform. When citing references in the text, use the reference number set in square brackets from the Reference list at the end of the article.

Footnotes

Footnotes are given at the bottom of the page with the text they refer to. They can contain less relevant details, additional explanations or used sources (e.g. scientific material, manuals). They cannot replace the cited literature.

The article should be accompanied with a cover letter with the information about the author(s): surname, middle initial, first name, and citizen personal number, rank, title, e-mail address, and affiliation address, home address including municipality, phone number in the office and at home (or a mobile phone number). The cover letter should state the type of the article and tell which illustrations are original and which are not.

Notes: