

## Use of Artificial Intelligence in Improvement of Power Quality

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### ABSTRACT:-

Expanding interest in power quality has advanced over the previous decade. This paper studies the writing for current utilizations of advanced artificial intelligence techniques in power quality (PQ). An extensive collection of literature covering applications of fuzzy logic, expert systems, neural networks, and genetic algorithms in power quality is included.

**Key words**—Artificial intelligence, expert systems, fuzzy logic, genetic algorithms, neural networks, power quality.

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### I. INTRODUCTION

Power quality (PQ) plays an important role and has been an exploration region of dramatically expanding interest especially in the previous decade [1,2]. The appropriate determination of PQ issues requires a significant level of designing ability. Worsening PQ finding is that the necessary master information isn't in any one region but instead in numerous territories of electric force, e.g., electric drives, sensors, rotating machines, transformers, power electronics, and power supplies. New and useful assets for the examination and activity of power frameworks, just as for PQ finding are presently accessible. The new apparatuses of interest are those of man-made reasoning (AI). The utilization of AI methods in electric force has gotten broad consideration from analysts in the electric power zone and the literature on these applications has become rather huge in volume [3]–[6]. Regions of electric force where the utilization of AI has been investigated include: alarm processing, systems diagnosis, protection, system security, system restoration, system control, power system planning, power system stability, power system analysis, load forecasting, and fault diagnosis and location. In this field there is various application of artificial intelligence. [7]. Power electronics and motion control are another territory where master frameworks, fuzzy logic, and neural networks have been applied [8]. Artificial Intelligence has been acknowledged as an appropriate device for the investigation and determination of PQ issues. Numerous AI applications in the power quality region have developed in the previous few years. Coming up next is an overview of work archived in the writing including the use of AI procedures to PQ

related issues. The main focus of the review has been on the use of expert systems, fuzzy logic, neural networks, and genetic algorithms in PQ applications.[1]

### II. POWER QUALITY

Despite survey papers, articles, and books distributed in the territory of electric force quality, its definition has not been generally settled on. Notwithstanding, everyone acknowledges that it is a significant part of force frameworks and electric hardware with direct outcomes on effectiveness, security, and unwavering quality. Different sources utilize the expression "power quality" with various angles. It is utilized usually with "supply dependability", "administration quality", "voltage quality", "current quality", "quality of supply" and "quality of utilization". Perusing all the various definitions, power quality is for the most part intended to introduce the nature of voltage as well as the nature of current and can be characterized as: the measure, examination, and improvement of the bus voltage to keep a sinusoidal waveform at appraised voltage and frequency [9] Producers, then again, think about PQ just like that level taking into account appropriate activity of their hardware, while clients consider great PQ that guarantees the persistent running of cycles, tasks, and organizations. [1]

### III. WHY WE NEED POWER QUALITY?

The Main explanation that we are keen on force quality is economic value. There are economic effects, for utilities, their clients, and providers of and suppliers of load equipment. The nature of force can have a direct financial impact on numerous customers. This normally implies electronically

controlled, energy effective gear that is frequently significantly more delicate to variety in the supply voltage. Private clients normally don't endure direct financial misfortune or the weakness to acquire pay because of most influence quality issues, yet they can be an intense power when they comprehend that the utility is offering helpless assistance. Numerous makers are additionally unconscious of the sorts of aggravations that can occur on force frameworks. The essential obligation regarding amending lack in load equipment eventually lies with the end client who should buy and work it. Particulars should incorporate force execution rules. Since many end users are also unaware of the danger, one useful service that utilities can provide is especially information on power quality and the requirements of load equipment to properly operate in the real world. [9]

#### IV. EVALUATION PROCEDURE OF POWER QUALITY

Basic evaluation procedure for the power quality audit.

- First step is to identify the problem what is the exact problem for ex. Voltage sag, voltage swell, flickering etc.
- Second step is to list out the problems and arrange into particular list so that we can characterizes what is the root cause of the problem in sense where the problem is being observed.
- Third step is that only we can list out the solutions regarding to the corresponding problems.
- Now our task is to choose the solution into the range of the solution which is the best suitable for the problem it considers such aspects such as money, area etc.
- After selecting suitable solution then and then only we can solve the problem. Power quality has wide range of problems in different phenomena. For development of force quality and gear execution every wonder has scope of various causes and individual arrangements. Anticipating the overall advances which are related with examining a considerable lot of these issues, particularly if the means can include association between the utility supply framework and the client office.

Some broad advances that are regularly needed for the examination of force quality shows and the significant contemplations that should be tended to at each progression. [9]

#### V. POWER QUALITY PROBLEMS

A PQ issue could be characterized as being "any force issue showed in voltage, current, or frequency deviations that bring about

disappointment or maloperation of client hardware" [20]–[29]. PQ includes research in a few regions that are identified with the primary parts of the nature of electric force. These territories might be summed up as essential ideas and definitions, demonstrating and examination, estimation and instrumentation, include extraction strategies, sources of PQ problems, effects of PQ deterioration, problem analysis and diagnosis, solutions to and mitigation of PQ problems, and educational issues related to power quality.

There are numerous purposes behind the developing concern with PQ:

- The broad utilization of sensitive microprocessor-based controls and power electronics devices
- The intricacy of industrial process, which brings about immense financial loss if gear comes up short;
- The expansion of huge PC frameworks into numerous organizations and business offices;
- The development of much sophisticated power electronics equipment gear utilized for improving framework solidness, activity, and effectiveness.
- Liberation of force industry, which gives clients the option to request higher caliber of force;
- Development in use of such gadgets as high-productivity customizable speed drives and force factor improvement shunt capacitors.
- The intricate interconnection of frameworks, bringing about more serious results if any one part comes up short;
- Equipment producers making progress toward better-execution hardware.

Various problems are as follows:-

##### 5.1 Voltage Sag (or dip)

Voltage sag is characterized as the decrease of evaluated voltage for brief timeframe because of some flaw or unexpected change in burden basically because of the over-burden condition.

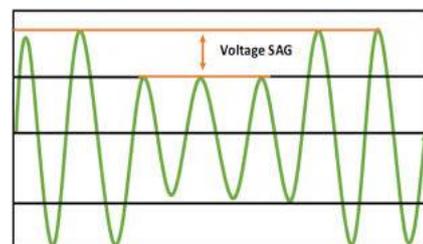


Fig -1: Voltage Sag

##### 5.2 Very Short Interruptions

Exceptionally short interference is characterized as the nonappearance of electrical force for some millisecond because of the launch of electrical switch of diesel generator or when the flawed part is disconnected to the healthy part.

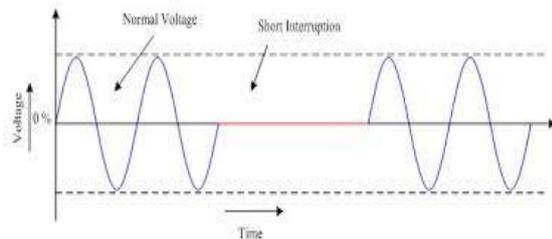


Fig -2: Very Short Interruptions

### 5.3 Long Interruptions

Long Interruption is characterized as the nonappearance of electrical power supply for long time because of the equipment disappointment or because of the protection disappointment or because of the flaw.

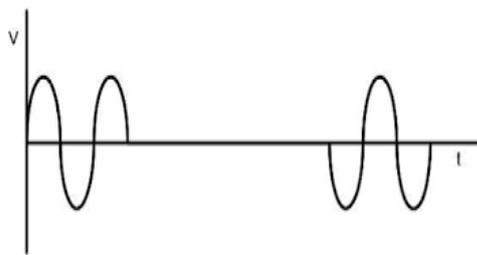


Fig. 3. Long Interruption  
 Fig -3: Long Interruption

### 4.4 Voltage Spike

Voltage Spike is characterized as the abrupt expansion in the evaluated voltage for brief timeframe period because of the lightning stork or due to the impulse.

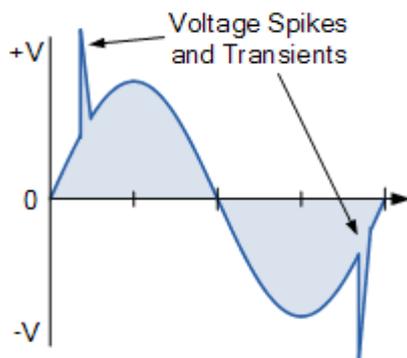


Fig -4: Voltage spike

### 5.5 Voltage Swell

Voltage swell is characterize as the expansion in the evaluated voltage because of abrupt separating of the heap or because of the highly capacitive load.

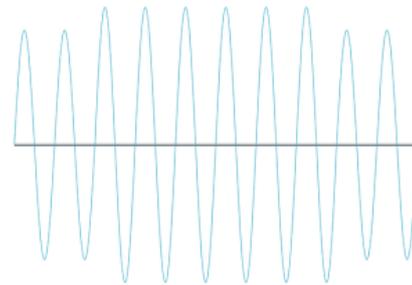


Fig-5 voltage swells

### 5.6 Harmonic Distortion

Harmonic distortion is the distorted wave waveform of the ordinary waveform because of the load. Essentially sounds is the waveform which has the frequency of integral multiple of the fundamental waveform.[9]

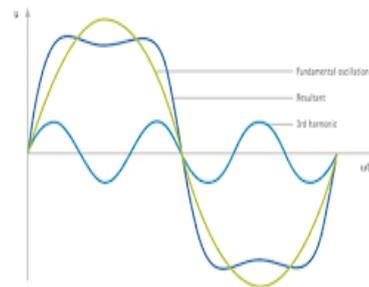


Fig 6- harmonic distortion

## VI. ARTIFICIAL INTELLIGENCE

### 6.1 History of Artificial Intelligence:

Artificial Intelligence consciousness was first proposed by John McCarthy in 1956 in his first scholastic meeting regarding the matter. Machines working like people started to be the focal point of researcher's psyche and whether on the off chance that it is conceivable to cause machines to have a similar capacity to think and learn without anyone else was presented by the mathematician Alan Turing. Alan Turing had the option to place his theories and inquiries into activities by testing whether "machines can think"? After arrangement of testing (later was called as Turing Test) incidentally, it is conceivable to empower machines to think and learn much the same as people.

### 6.2 Introduction and techniques of Artificial Intelligence

Artificial Intelligence is the field of study that portray the capacity of AI simply like people and the capacity to react to specific practices otherwise called (A.I.).[19] An expansive meaning of AI can be the robotization of exercises that are related with human thinking, for example, dynamic, critical thinking, learning, perception, and reasoning. The AI instruments important to the

electric force local area incorporate fuzzy logic (FL), adaptive fuzzy logic (AFL), expert systems (ESs), artificial neural networks (ANNs), and genetic algorithms (GAs). Master frameworks are an endeavor to copy the human perspective through information portrayal and derivation instruments. Inside a bound space of information, ESs is equipped for dynamic on a level equivalent in quality to human specialists.

### 6.3 Fuzzy logic

FL is an all the more remarkable variety of crisp logic, where information portrayal is all the more firmly identified with the manner in which people think. FL has the solid induction capacities of master frameworks just as the force of regular (linguistic) information portrayal. FL has been effectively executed in charge applications where framework models don't exist or where the models are numerically intricate and computationally serious.[1]

Characteristics and application of Fuzzy Logic

Fuzzification provides oversimplification, superior expressive power, and an improved capability to model a complex problem at low cost and at the same time minimizes problem complexity Fuzzy logic has suitable applications in power system, like reactive power and voltage control, system stability analysis and control, fault analysis, security assessment, load forecasting, power system protection, etc. It can be used to increase the efficiency and for designing physical components of power systems from small circuits to large mainframes.[20]

### 6.4 Artificial neural network

ANNs emulate the neural cerebrum structure of people. This structure comprises of straightforward number juggling units associated in profoundly complex layer design. ANNs are equipped for speaking to complex (nonlinear) capacities, and they gain proficiency with these capacities through model. [1]

Characteristics and applications of ANNs

ANNs are quick and vigorous and needn't bother with any fitting information on the framework model. Since they are issue lenient, they can deal with circumstances of deficient or degenerate information and data. They have learning and information variation capacity. Then again, ANNs can't play out an undertaking other than the one for which they are prepared. For some other undertaking, they must be retrained. ANNs consistently create the outcome despite the fact that the sources of info information are preposterous. ANNs can be especially valuable for issues which require snappy outcomes, similar to those

progressively activity. ANN methods can be applied to control framework security.[20]

### 6.5 Adaptive fuzzy logic

AFL is a fuzzy-logic based paradigm that gets a handle on the learning capacities of ANN or the streamlining abilities of GAs to upgrade the intelligent system's presentation utilizing from the earlier information.

### 6.6 Genetic algorithm

GAs utilizes the methods of human hereditary development to produce ideal arrangements. GAs might be considered as a multidimensional improvement strategy dependent on a hereditarily irregular web index [1]

### 6.7 Pros and Cons of Artificial Intelligence

Advantages

- Reduction in Human Error
- Takes risks instead of Humans
- Available 24x7
- Helping in Repetitive Jobs
- Digital Assistance
- Faster Decisions
- Daily Applications
- New Inventions

Disadvantages

- High Costs of Creation
- Making Humans Lazy
- Unemployment
- No Emotions
- Lacking Out of Box Thinking[21]

## VII. APPLICATIONS IN POWER QUALITY

### 7.1 FUZZY LOGIC

FL and AFL are arising as incredible AI procedures. A few uses of fuzzy logics in PQ have been created they are

- diagnosing PQ issues;
- giving pragmatic help to PQ work force;
- managing data and information mining;
- instructing utility staff and clients;
- characterizing PQ aggravations;
- versatile metering of force, rms voltage, and rms current;
- allocating capacitor banks while maintaining harmonic distortion levels within acceptable limits;
- estimating power quality indices using fuzzy constraints
- finding wellsprings of unsettling influences in power frameworks;
- building up a general PQ director with a FL-based control plot;

- computerizing the ID of irregular framework activity utilizing versatile fuzzy methods;
- anticipating framework strange activity;
- Robotizing framework VAR control for improved voltage security and better voltage profiles.

#### 7.2 EXPERT SYSTEMS APPLICATIONS

Albeit expert system is costly and tedious in their turn of events, some examination including the utilization of master frameworks in PQ has been reported. Such applications incorporate

- Characterizing contorted voltage and current waveforms into classifications
- investigating sounds utilizing master framework innovation;
- creating methods for PQ critical thinking in a specialist framework structure;
- estimating and dissecting electromagnetic similarity;
- mechanizing deficiency examination and issue area;
- distinguishing PQ occasions through an adaptable framework;
- overseeing PQ information;
- Instructing staff associated with power quality.

#### 7.3 NEURAL NETWORKS APPLICATIONS

ANNs are among the most seasoned AI procedures; they have been around the power research field for a long while. Neural organizations have been applied broadly in PQ. Primary applications incorporate

- distinguishing PQ occasions from non power quality ones;
- modeling the patterns of harmonic creation from singular fluorescent lighting frameworks;
- estimating harmonic distortions and PQ in force organizations;
- recognizing constantly PQ occasions utilizing the wavelet change related to neural organizations;
- recognizing high-impedance issue, fault like burden, and typical burden current examples;
- breaking down consonant twisting while at the same time dodging the impacts of commotion and sub harmonics;
- Building up a screening apparatus for the force framework designer to use in tending to PQ issues.

#### 7.4 GAS AND PQ

GAs are viewed as an excellent intelligent paradigm for enhancement utilizing a multipoint, probabilistic, irregular, guided search instrument. A few uses of GA in force quality are reported. Ideal choice of lighting innovations with a target of reducing

harmonic distortion is one; ideal position of capacitor banks is another. Versatile metering utilizing GA to advance examining rates is likewise detailed

#### 7.5 GENERAL APPLICATIONS OF AI IN PQ

The writing contains a lot of work including some broad applications and conversations with respect to both AI and PQ. The issues are different and don't fall explicitly under any of the above groupings. A portion of the applications are

- examining the capability of applying AI methods in power quality;
- building up a caution preparing framework and determination framework for a force network utilizing AI apparatuses;
- incorporating AI and progressed correspondence advances in substation intelligent electronic devices (IED);
- utilizing MATLAB/SIMULINK and several AI toolboxes for the simulation of transient phenomena and harmonic propagation;
- using a fault-tree induction algorithm for classifying power quality voltage/current waveforms.

### VIII. RESULT

The review of artificial intelligence techniques in improvement of power quality has been done. Artificial intelligence plays a very important role in power quality improvement.

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