An Innovative Fuzzy Based Power Quality Assessment Considering Short Circuit Level

Sanhita Mishra, S.C.Swain, Pampa Sinha

***Abstract:** power quality evaluation is highly essential for modern power system to maintain proper accuracy for responsive equipment. There are various power quality indices which evaluates the power quality but it is highly crucial for combining all the indices into a single value which can evaluates the power quality successfully. Considering representative quality factor(RQPF), detailed pollution factor(DPF),total harmonic distortion(THD) and short circuit level(SCL)an untraditional power quality index can be evaluated. Fuzzy inference system has been implemented for doing the incorporation of different power quality indices. In this paper THD module is formed by the union of total harmonic distortion voltage(THD_V) and total harmonic distortion current(THD_I) and THDSCL module is formed by the fusion of THD and SCL. The innovative THDSCL has better significance for measuring power quality Index*

***Keywords :** About four key words or phrases in alphabetical order, separated by commas.*

I. INTRODUCTION

In the present scenario for hygienic power it is highly essential to maintain good power quality. There are various power quality disturbances such as voltage dip, swell or transient disturbances occur in power system. The author has calculated RQPF which is mainly permutation of DEPF,TEPF and OSCPF. Under various conditions such as sinusoidal, non sinusoidal, linear, non linear, stationary and non stationary[10] conditions a new PQI has been calculated which mainly draw a conclusion for the best electrical supplier in the market. Different types of power component definitions are mentioned[2] which are mainly described in IEEE standard 1459-2000 and depends on frequency domain approach. Author has used DWT to save more time and to code power component. These reformulated definition are very supportive for setting tariff. Wavelet packet transform is mainly used for calculation of Fuzzy wavelet packet power quality index has been calculated using Wavelet and it is redefined under non stationary disturbance[7]in frequency domain. With the help of actual present power quality indices fuzzy wavelet packet based power quality indices has been developed which is acting as an output of fuzzy based module. Two different cases has been studied where frequency is considered with most priority with considering different wavelet families such as Daubechies, Coiflets and symlets [8]. Fast Fourier tranform(FFT) mainly gives more appropriate result of PQI under stationary waveform condition. Various types of case studies such as three phase balanced and three phase unbalanced are being considered for PQI analysis. An unconditional difference parameter has been considered in the result in case of non stationary waveform its value is very less when WPT is used and its value is very large when FFT is used in the same condition. One important factor phase crest factor [9] helps to resolve an PQI for a 3 phase system. As there are lot of generating harmonic sources ,so it is highly important to find out location of harmonic generating sources[1] .So the author implement a new algorithm for finding out the exact location of dominant harmonic generating resources. A case study has been done considering a radial distribution system which mainly helps in finding out the exact location of harmonic source and most dominant harmonics. A new single point strategy has been discussed for detecting harmonics upstream and downstream of metering section. Reactive power compensation plays a vital role in power system as harmonic pollution is continuously increasing due to increasing use of various types of power electronics load. The author uses DSP, artificial intelligence technique and machine learning which has some uniqueness in organizing power quality distortion.

II. POWER COMPONENT BASED ON DWT [2]

Author (s) can send paper in the given email address of the journal. There are two email address. It is compulsory to send paper in both email ad when discrete wavelet transform mainly used for dividing the frequency spectrum into bands or levels. The rms values of voltage (V) and current (I) are given by

$$V = \sqrt{\frac{1}{T}\int_0^T v^2(t)dt} = \sqrt{V_{jo}^2 + \sum_{j \geq jo} V_j^2} \qquad (1)$$

$$I = \sqrt{\frac{1}{T}\int_0^T i^2(t)d} = \sqrt{I_{jo}^2 + \sum_{j \geq jo} I_j^2} \qquad (2)$$

Here $V_{jo}\, I_{jo}$ mainly represents rms value of the voltage and current of the lowest frequency band and the approximated voltage and current are represented as (V_{app}) and (I_{app}), respectively. $\{V_j\}$, $\{I_j\}$ basically show the rms values of voltage and current of individual frequency dress.
show the rms values of voltage and current of individual frequency band and the wavelet-level

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* Correspondence Author
Sanhita Mishra*, School of Electrical Engineering, KIIT DU,BBSR, India, sanhita.mishra@gmail.com
S.C.Swain, School of Electrical Engineering, KIIT DU, BBSR, India
Pampa Sinha, School of Electrical Engineering, KIIT DU, BBSR, India

which is mostly higher than or equal to the scaling level j_0 and are known as detailed voltage and detailed current and represented i n the form of(V_{det}) and (I_{det}) respectively. The voltage THD (THD_V) which is mainly defined in DWT domain

$$THD_V = \frac{V\det}{V app} \quad (3)$$

The current THD which is represented as (THD_I) in DWT domain mainly represented as

$$THD_I = \frac{I_{\det}}{I_{app}} = \frac{\sqrt{\sum_{j\geq jo} I_j^2}}{I_{jo}} \quad (4)$$

The active power with approximation known as P_{app} represented as

$$P_{app} = P_{jo}\frac{1}{T}\sum_k c'_{j0,k}\, c_{j0,k} \quad (5)$$

The detail active power is given by

$$P_{\det} = \sum_{j\geq jo} P_j = \frac{1}{T}\sum_{j\geq jo} d'_{jo,k}\, d_{jo,k} \quad (6)$$

The discrete wavelet coefficients of voltage and current are $c'_{jo,k}$ and $c_{jo,k}$ respectively, at the scaling level j_0 and k while $d'_{jo,k}$, $d_{jo,k}$ are the voltage and current discrete wavelet coefficients, respectively at any level j other than the scaling level j_0 and sample k.

Total active power (P) is [2]

$$P=P_{app}+P_{det} \quad (7)$$

Approximation apparent power is [2] $S_{app}=V_{app}\, I_{app}= V_{jo}\, I_{jo}$

Current Distortion Power (D_I) is [2]

$$D_I=V_{app}I_{det}= V_{jo}\left(\sqrt{\sum_{j\geq jo} I_j^2}\right) \quad (8)$$

Voltage Distortion Power (D_v) is [2]

$$D_v=V_{det}I_{app}=I_{jo}\left(\sqrt{\sum_{j\geq jo} V_j^2}\right) \quad (9)$$

Detail apparent power is [2]

$$S_{det}= V_{det}\, I_{det} = \left(\sqrt{\sum_{j\geq jo} I_j^2}\right)\left(\sqrt{\sum_{j\geq jo} V_j^2}\right) \quad (10)$$

Detail distortion power [2]

$$D_{\det} = \sqrt{S_{\det}^2 - P_{\det}^2} \quad (11)$$

The total apparent power S is [2]

$$S^2 = (VI)^2 = S_{app}^2 + D_I^2 + D_V^2 + S_{\det}^2$$

The non-approximation apparent power S_N can be defined as [2]:

$$S_N{}^2 = D_I{}^2 + D_V{}^2 + S_{\det}^2$$

The detail pollution DP can be defined as the ratio of the non-approximation apparent power S_N to the approximation apparent power S_{app} [2]

$$DP = S_N / S_{app} \quad (12)$$

The displacement power factor [2] is

$$dPF = P_{app} / S_{app} \quad (13)$$

The transmission efficiency power factor [2] is

$$PF = P / S = TEPF \quad (14)$$

The oscillation power factor [2] is

$$PF_{osc} = \frac{P}{\sqrt{P^2 + \frac{1}{2}S^2}} = \frac{PF}{\sqrt{\frac{1}{2} + PF^2}} \quad (15)$$

III. RQPF MODULE USING FUZZY INFERENCE SYSTEM [10]

The input to the RQPF module are DPF,TEPF and Pfosc for them three linguistic variable are used such as poor, medium and good. The author used seven number membership function for RQPF as very low(VL),low(L),medium low(ML),Medium(M), medium high(MH),high(H) and very high(VH).Fuzzy inference system has been used for calculation of single RQPF value.

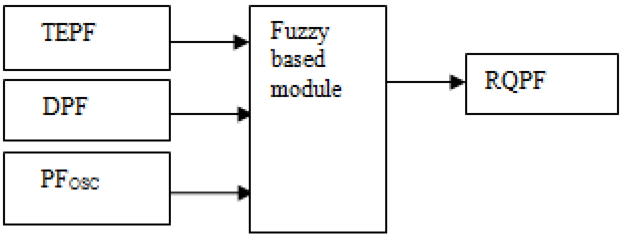

Fig.1. Block Diagram Of Rqpf Module

IV. THD MODULE

For fuzzification of total harmonic distortion(THD) module we have consider total harmonic distortion of voltage(THD_V) and also we have consider total harmonic distortion of current (THD_I) . Total five number of membership function has been considered for both THD_I and THD_V module such as very low(VL),low(L),Medium(M),high(H) and very high(VH) .Using fuzzy logic THD_V and THD_I gives the output as THD and for this THD total eight number of membership function we have used such as verylow(VL),low(L,lowhigh(LH),.mediumlow(ML),medium(M),medium high(MH),high(H),very high(VH) has been considered. Total 50 number of IF-Then rules has been written and the membership functions are shown in the figure.

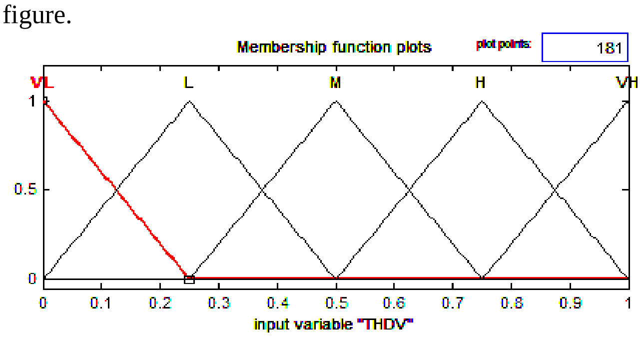

Fig 2.(a). Membership function of THDv

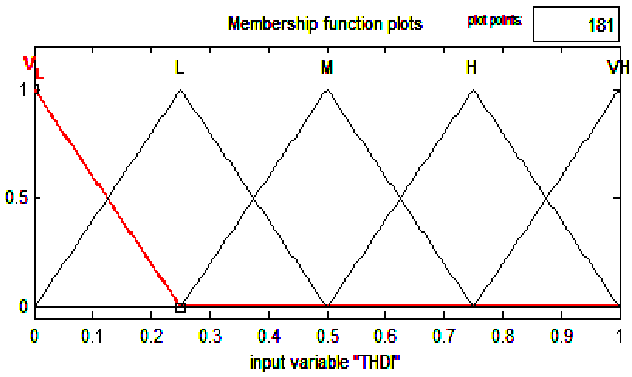

Fig 2.(b) input variable THD_I

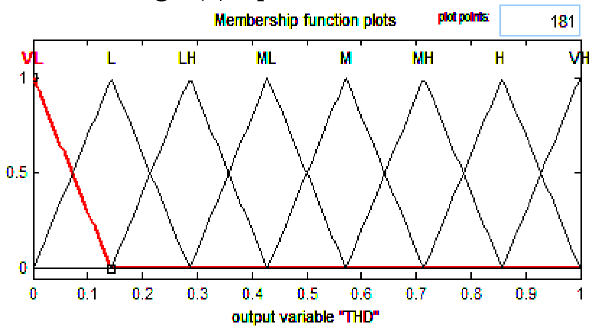

Fig 2.(C). Output Variable Thd

After doing the defuzzification of THD value are given in the table below.

TABLE I. THD CALCULATION WITH THD_V AND THD_I

THD_V	THD_I	THD
0.0912	0.051	0.100
0.153	0.130	0.120
0.180	0.200	0.133
0.253	0.273	0.180
0.300	0.273	0.225
0.500	0.340	0.335
0.608	0.520	0.650
0.730	0.700	0.815
0.849	0.823	0.85
0.933	0.949	0.916

V. THDSCL MODULE

After creation of THD module another parameter known as short circuit level which also affect the power quality index has been considered and fuzzy inference of THD and SCL module occur.SCL have three membership and assigned as low, medium and high and symbolized as (L,M,H).The THDSCL has total eight number of membership function as THD. The membership function of SCL and THDSCL module is shown in the figure bellow.

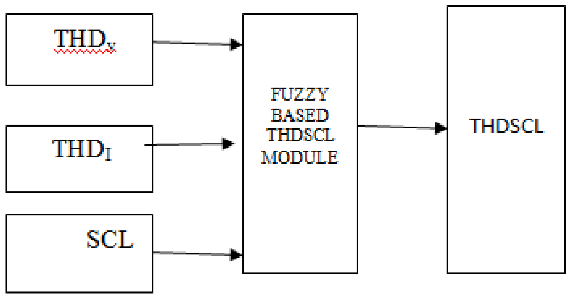

Fig 4.(a) THD SCL Module

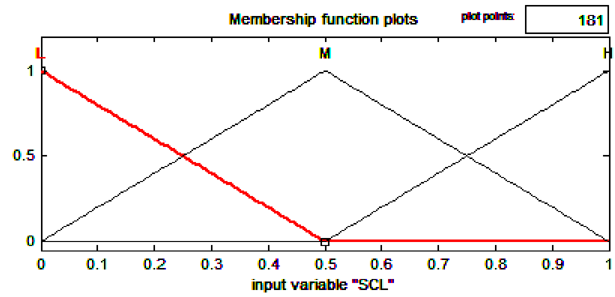

Fig 4.(b) input variable SCL

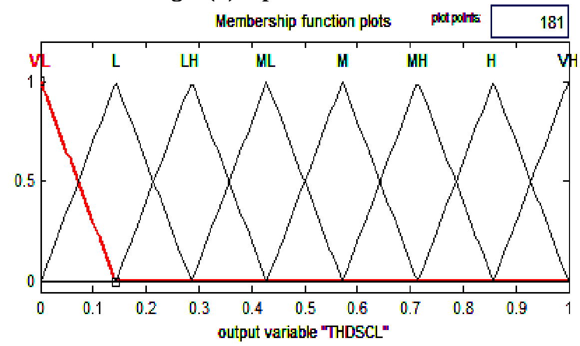

Fig 4.(C) Output Variable Thdscl

The values of THDSCL are given in the table below.

TABLE II. THDSCL CALCULATION WITH THD AND SCL

THD	SCL	THDSCL
0.100	0.0597	0.122
0.244	0.176	0.166
0.300	0.294	0.290
0.411	0.320	0.351
0.518	0.432	0.515
0.534	0.649	0.515
0.622	0.634	0.561
0.832	0.717	0.777
0.912	0.921	0.857

VI. SIMULATION RESULT OF INNOVATIVE THDSCL

For getting better accuracy in calculating new power quality index THDSCL plays a vital role. so various types of combination are being done for varying various parameter and PQI has been analyzed. The THDSCL has been calculated shown in the tables bellow by doing defuzzifiction. This parameter will helps in calculating Power quality index .

RQPF is varying, when both DP and RQPF are varying under sinusoidal and non sinusoidal condition if the THD,SCL and DP will increase in a signal then power quality will decrease and if RQPF will increase then PQI will increase. So total harmonic distortion, short circuit level and detailed pollution are negative factor for power quality index calculation.

VII. CONCLUSION

In the modern era as power quality index plays vital role for setting tariff so it is highly important to measure the power quality index. The PQI varies between zero to one . When the power quality becomes one that means it is a sign of good power quality index Here we have analyzed THDSCL which can act as input parameter for calculating the power quality index. This parameter measures proper quality of power, which helps to solve power system issues. Implementation of Fuzzy gives a better result in calculating the THDSCL for solving problems.

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AUTHORS PROFILE

Sanhita Mishra,Assistant Professor ,KIIT Deemed to be University has 8 years of experience in teaching and research published around 4 no of journal and 15 no of national and international conferences. She has research experience in optimisation technique, Solar PV system and AI technique, power system,Under ground cable. She is a member in IET. She has guided many number of B.Tech and M.Tech student for their research work. She has completed her M.Tech from VSSUT,Burla and now she is continuing her PhD in KIIT Deemed to be University.She is having

Dr.Sarat Ch.Swain, Ph.D in Electrical Engineering, Professor School of Electrical Engineering, KIIT Deemed to be University, has 23 years of experience in teaching and published around 100 research papers in reputed Journals and Conferences. He has research experience in Application of A.I. Techniques, Soft Computing, FACTS based Controllers, Power System Stability Improvement, PV Modeling, Grid Interconnection of Photovoltaic Solar system. He has guided many number of B.Tech and M.Tech student for their research work.

Dr Pampa Sinha Assistant Professor KIIT University, has around 10 years of teaching and research experience .She has completed her PhD from Jadavpur University. She has research experience in power quality, AI technique and energy storage device. She is a member .in IET. She has guided many number of B.Tech and M.Tech student for their research work.