Bulletin of Electrical Engineering and Informatics
Vol. 15, No. 1, February 2026, pp. 39~47
ISSN: 2302-9285, DOI: 10.11591/eei.v15i1.8657

Using LabVIEW software for remote voltage, current, and THD measuring and improving in the electrical grid

Gentian Dume[1], Alfred Pjetri[1], Andi Hida[2]
[1]Department of Automation, Faculty of Electrical Engineering, Polytechnic University of Tirana, Tirana, Albania
[2]Department of Electric Power System, Faculty of Electrical Engineering, Polytechnic University of Tirana, Tirana, Albania

Article Info

Article history:

Received May 4, 2024
Revised Nov 17, 2025
Accepted Dec 6, 2025

Keywords:

Filter
Harmonics distortion
LabVIEW
Remote
Virtual instrument

ABSTRACT

The increasing penetration of photovoltaic (PV) systems has raised concerns about power quality due to the harmonic distortion injected during DC–AC conversion by inverters. These harmonics can interfere with nearby electrical devices and compromise grid stability. This paper presents a LabVIEW-based virtual instrument designed specifically for real-time monitoring, analysis, and mitigation of voltage and current harmonics in grid-connected PV systems. The core contribution of this work lies in the development of an interactive, software-based platform that not only measures total harmonic distortion (THD) in real time but also allows users to design and simulate harmonic filters dynamically. The system achieved a reduction of current THD by 52% and voltage THD by 73% under tested conditions, demonstrating its effectiveness in improving power quality. Unlike conventional hardware-dependent solutions, the proposed tool offers a low-cost, easily customizable, and scalable approach suitable for educational laboratories, field diagnostics, and smart grid applications. By enabling remote control and filter tuning through LabVIEW, this solution supports the growing demand for intelligent power quality management and facilitates the seamless integration of renewable energy into modern electrical grids.

Corresponding Author:

Gentian Dume
Department of Automation, Faculty of Electrical Engineering, Polytechnic University of Tirana
Mother Teresa Square No 4, Tirana, Albania
Email: gentian.dume@gmail.com

1. INTRODUCTION

The increasing integration of renewable energy sources, such as photovoltaic (PV) systems and wind turbines, has accelerated the transition toward smart grids, where power quality is a critical parameter for grid reliability, efficiency, and stable operation. Inverter-based power electronic converters, essential for integrating DC-based renewable generation into AC grids, inherently produce harmonic distortions that degrade power quality by causing equipment overheating, increased losses, and malfunctioning of sensitive devices [1], [2]. Ensuring high power quality standards in modern grids is necessary not only for operational efficiency but also for extending equipment lifetime and minimizing maintenance costs. Therefore, real-time monitoring and effective mitigation of power quality issues have become major concerns for utilities and researchers alike.

Power quality disturbances including current and voltage harmonics, flicker, voltage instability, and transient imbalances remain significant challenges in electrical distribution systems [3]-[9]. These issues are further aggravated by the increasing penetration of inverter-based renewable energy sources and nonlinear loads, which introduce asymmetry and dynamic voltage fluctuations in networks originally designed for balanced, steady-state operation. Bellan [5] analytically examined transient phenomena in unbalanced three-phase four-wire networks and demonstrated their complex influence on voltage and current waveforms. Malik *et al.* [6] highlighted that voltage instability is a growing concern in wind-integrated systems, emphasizing the need for reactive power compensation and robust control mechanisms. Moreover, studies such as Łowczowski and Nadolny [7] have shown that voltage flicker in prosumer PV systems is highly dependent on network parameters and time-varying irradiance, underscoring the importance of continuous monitoring and adaptive mitigation strategies.

According to Digalovski *et al.* [10], total harmonic distortion (THD) in distribution networks can reach levels exceeding 10%, which leads to substantial efficiency losses in generators (up to 6%), transformers (2–15%), and capacitors (15–16%). Although modern inverter designs incorporate harmonic suppression techniques, high penetration of PV systems often results in THD levels that surpass regulatory limits, stressing the grid infrastructure and accelerating the degradation of key components [11]. These ongoing challenges highlight the need for advanced harmonic monitoring and adaptive mitigation solutions tailored to dynamic smart grid environments.

Various harmonic mitigation strategies have been proposed to improve power quality, influenced by factors such as grid impedance, transformer characteristics, system topology, and load profiles [12]-[14]. Hardware-based devices like active power filters (APF) [15], passive filters [16], electronic inductors (EI) [17], unified power quality conditioners (UPQC) [18], and D-STATCOMs [19] have proven effective in reducing harmonic distortion. Complementary digital filtering algorithms including infinite impulse response (IIR) and finite impulse response (FIR) filters have also been successfully applied for harmonic suppression [20]. Moreover, harmonic estimation techniques such as fast Fourier transform (FFT) [21], particle swarm optimization (PSO) [22], Bayesian inference [23], and harmonic state estimation (HSE) [24] have enhanced real-time harmonic detection and analysis. However, many existing solutions rely heavily on hardware components or static control schemes, which limit flexibility, scalability, and cost-effectiveness for practical deployment, especially in small-scale or educational settings.

The trend toward software-centric architectures offers a promising alternative by enabling flexible, modular, and programmable platforms for power quality monitoring and control [25]. LabVIEW is a leading graphical programming environment that facilitates the rapid development of customizable virtual instruments capable of real-time data acquisition, signal processing, and interactive control [26]. Such software-based systems allow for dynamic filter design, adaptive harmonic mitigation, and remote monitoring without requiring extensive physical hardware modifications. This flexibility supports not only advanced laboratory experimentation but also practical smart grid applications, including distributed generation diagnostics and educational training.

This paper proposes a LabVIEW-based virtual instrument for real-time measurement and reduction of voltage and current THD in PV-integrated power systems. Unlike conventional hardware-heavy methods, our software-defined solution offers interactive filter design, adaptive harmonic compensation, and remote operation capabilities. The system is designed to be easily replicable, cost-effective, and scalable, making it suitable for applications in power quality monitoring, renewable energy integration, and engineering education [26], [27]. By addressing current gaps in integrated control-feedback mechanisms, this work contributes a novel platform to enhance power quality management in evolving smart grid environments.

2. MATERIALS AND METHODS

2.1. Overall system for total harmonic distortion monitoring and reducing

To build the applications in the laboratory, all engineering problems deal with some physical quantities such as current intensity, voltage, pressure, temperature, moisture level, mechanical torque, position, and speed. These quantities can be seen by using a PC interfaced with the physical environment by data acquisition, transducers, conditioning circuits, and a software. The acquired data, can be stored, processed, and published on the internet. Figure 1 illustrates an experimental test bed connected with a real-time PC [26].

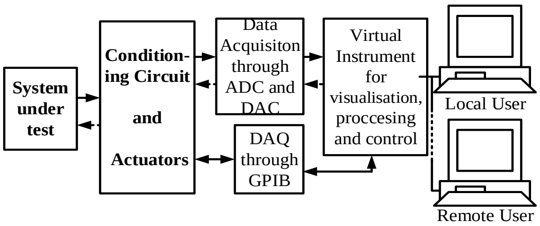


Figure 1. Block diagram of a laboratory test bed based on PC

Based on the block diagram of Figure 1 we created a system for the purpose of electrical grid voltage, current, and THD measuring and improving. Figure 2 illustrate this system. It consist of a solar inverter (power source) [28], [29], an electrical quantities measuring module (measuring interface) [30], data acquisition card (DAQ) [31], portable notebook (computer) with the proposed virtual instrument running in it, a real filter composed with inductors and capacitors, and a block of relays to insert the filter in the electrical grid point of connection (PoC) automatically from the virtual instrument.

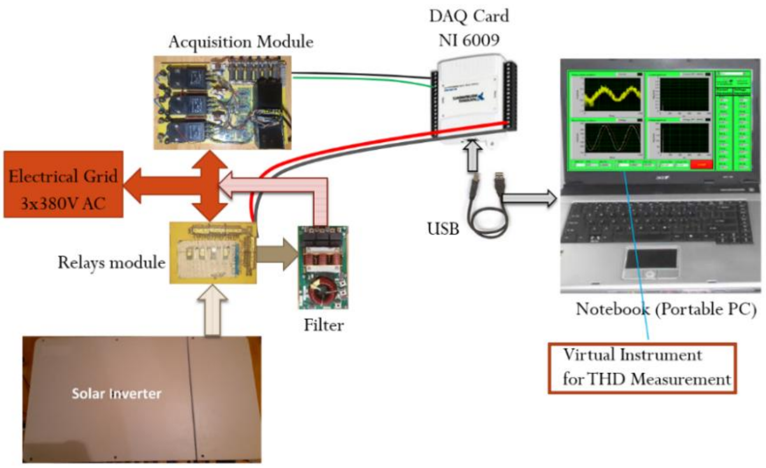


Figure 2. Proposed system for THD measuring and reducing system

2.2. System components integration and programming in LabVIEW

Based on the system illustration of Figure 2 and the NI 6009 DAQ documentation [31] we built the virtual instrument for voltage, current, and THD measuring and filter design in LabVIEW, showed in Figure 3.

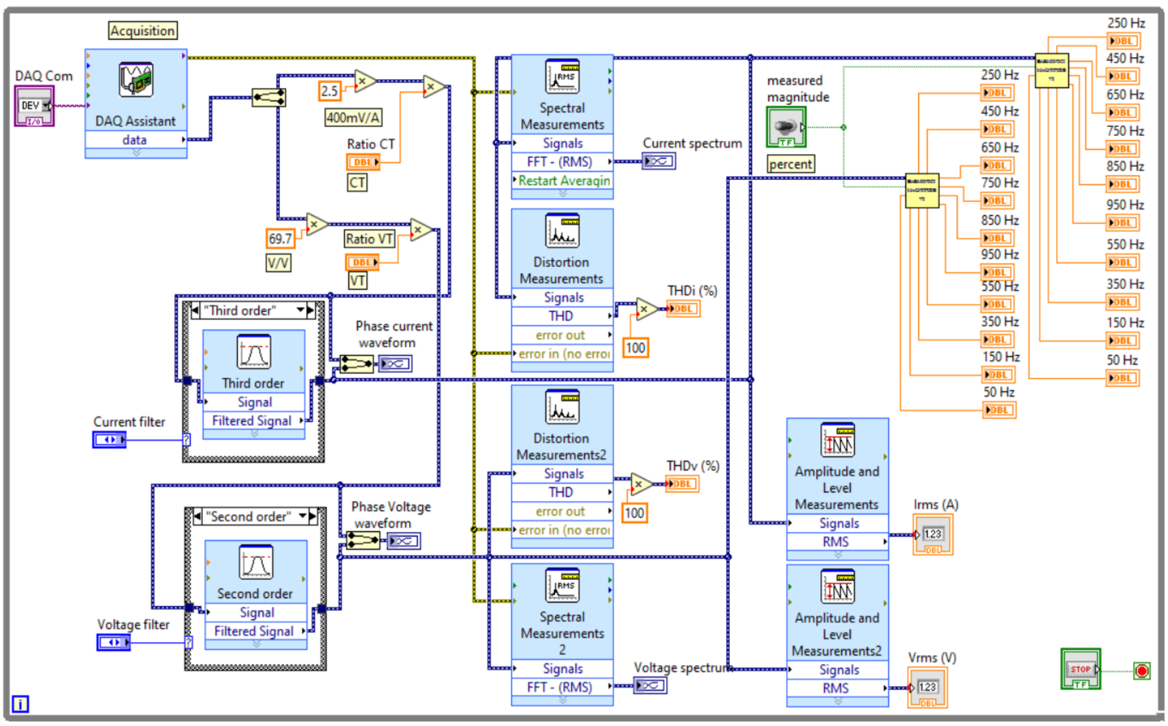


Figure 3. Proposed virtual instrument graphical code in LabVIEW

First, we need to configure the NI DAQ 6009 card to acquire voltages and currents for the 3 phase system. Since this card has a maximum sampling frequency of 48 kS/s divided for 6 analog inputs (3 voltages and 3 currents) we will have a sampling frequency of 8 kS/s per channel. This frequency is not enough, and we will lose significant amplitude multiple harmonics of fundamental 50 Hz of electrical grid based on Shannon sampling theorem [32].

To overpass this DAQ hardware limitation, we opted to use only 1 voltage sensor and 1 current sensor, so to monitor only 1 phase of 3 phases of the grid in the PoC of the solar inverter. This will be enough to verify the virtual instrument performance during test. If its response is satisfied for one phase, from programming point of view will be very easy to generalize that it will work as it should in m-phase system. Changing the input DAQ card later with a higher sampling frequency DAQ card is very easy in LabVIEW through DAQmx driver [33].

So, we divided the sampling frequency in 2 analog inputs each at 24 kS/s. Also, since this card has 8 analog inputs, we can configure it as 2 channel differential analog inputs, in order to protect the card for any ground loop to the sensors conditioning circuit.

After configuring DAQmx driver using DAQmx assistant VI, we split the signals in voltage and current channel. Then we multiplied each signal with the voltage and current sensors calibration coefficients [30]. In spite of, we have multiplied then each channel signal with a coefficient using 2 numeric knobs in LabVIEW, so the instrument can be upgraded easily if the measurement module is connected to the electrical grid through voltage and current transformers (voltage transformer (VT) and current transformer (CT)).

After this part of the code, voltage and current are plotted in 2 waveform charts and also processed in a case structure in LabVIEW. Inside the case structure we placed different types of digital filters from the built-in VIs, like Butterworth, Chebyshev, and Bessel (Figure 4). The filter can be changed during application running through Enum control connected to the case structure.

Figure 4. Setting filter parameters in LabVIEW

For the current THD_i and voltage THD_v the equations for calculation are done through LabVIEW using (1) and (2) [2]:

$$THD_i = \frac{\sqrt{\sum_{n=2}^{\infty} I_n^2}}{I_1} \tag{1}$$

where THD_i is current harmonic distortion, I_n is current harmonic in root mean square (RMS) and I_1 is fundamental current in RMS.

$$THD_v = \frac{\sqrt{\sum_{n=2}^{\infty} V_n^2}}{V_1} \qquad (2)$$

where THD_v is voltage harmonic distortion, V_n is voltage harmonic in RMS, and V_1 is fundamental voltage in RMS.

THD_i and THD_v are calculated in percent of the fundamental frequency. Since the THD calculation express VI used can show only one harmonic at a time, we built a VI composed of 10 blocks with different order of harmonics in increasing order and configured it as a subVI using patterns in LabVIEW (yellow blocks in Figure 3). The subVI block diagram is shown in Figure 5. It is to be noted that this code should not be placed inside a while loop in LablEW, because it is a processed as a subVI and the program will get stuck inside this part of the code and nothing will be displayed on the main VI.

Then, all the specific harmonic amplitudes are displayed in the front panel of the main VI, shown in Figure 6. Also, the comparison of different filters can be done from this interface, because as it can be seen; voltage and current unfiltered and filtered are plotted in the same graph respectively.

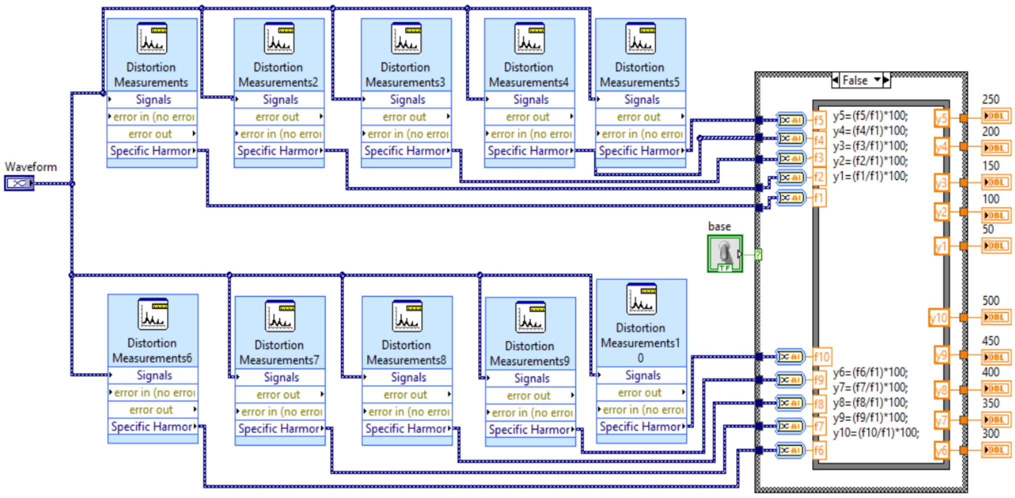


Figure 5. Inside amplitudes subVI

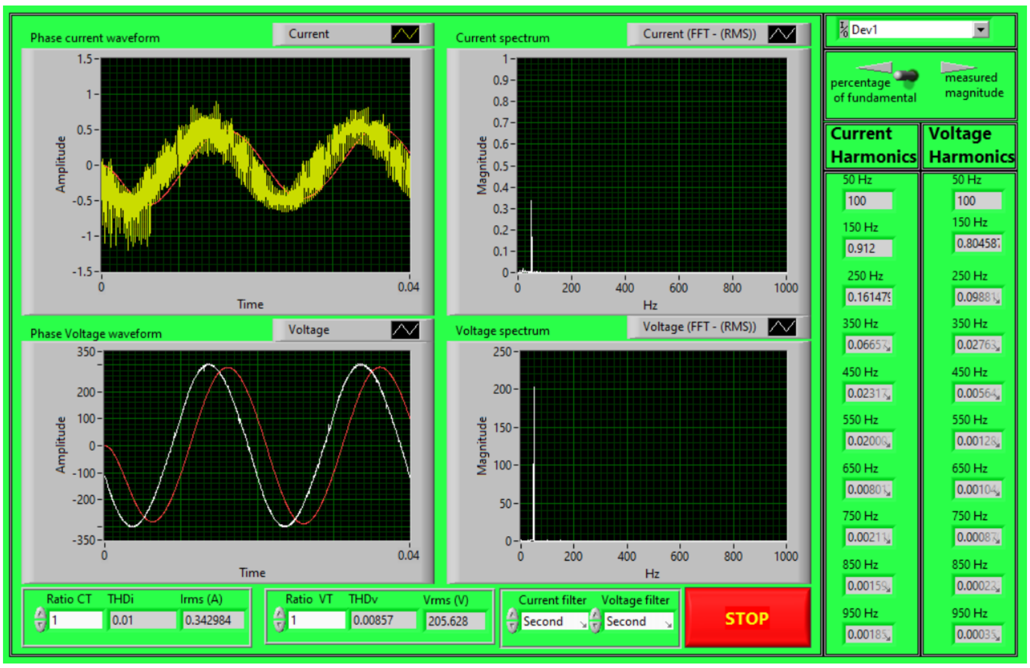


Figure 6. Proposed instrument front panel (main VI)

Finally, we can publish the virtual instrument online using LabVIEW G Web Server, so the operator can access online the virtual instrument to perform different tasks such as voltage and current monitoring and filter design to improve THD. The procedure for configuring the virtual instrument to be published on a web page is shown in [34].

3. EXPERIMENTAL TESTING OF THE VIRTUAL INSTRUMENT

In order to validate the effectiveness of the virtual instrument proposed, we arranged a laboratory test bed according to Figure 2. It consists of four quadrant dynamometer/power supply model 8960 [28] used to simulate a PV plant. The DC voltage output generated is processed in insulated gate bipolar transistor (IGBT) chopper/inverter model 8837-B5 [29]. The custom-build acquisition measurement module is then connected to the solar inverter output. In Figure 7 is shown the experiment in laboratory.

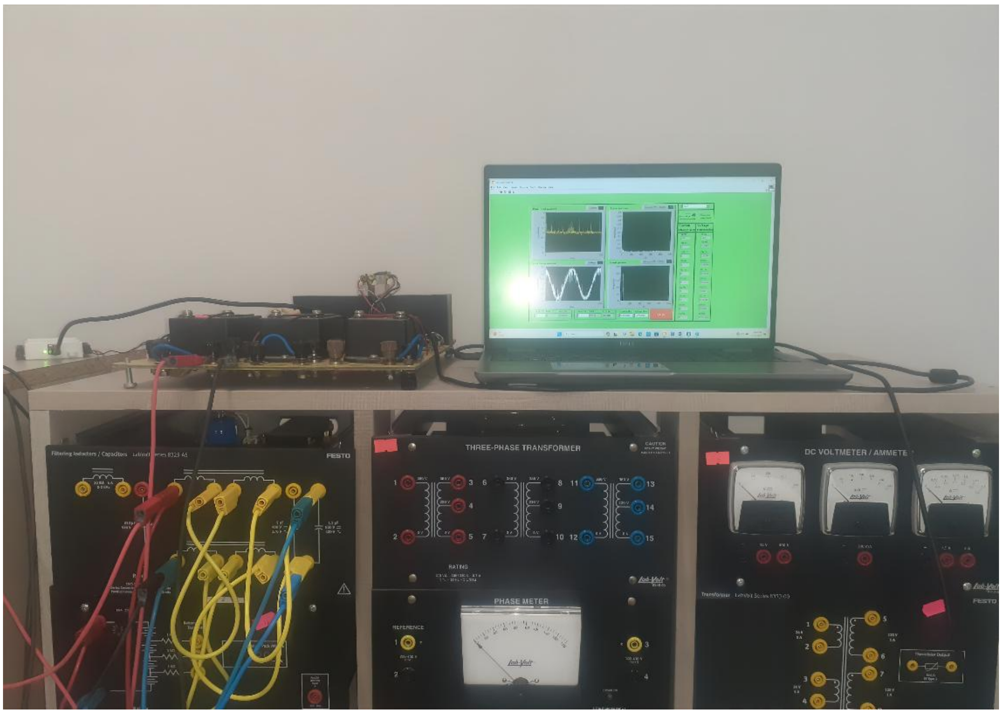


Figure 7. Experimental test of THD virtual instrument

In Table 1 are collected the measured and calculated values of harmonics present in the solar inverter output for unfiltered current and voltage and also for different order of IIR lowpass filter for a cutoff frequency of 40 Hz. In Table 2 are collected the respective V_{rms}, I_{rms}, and THD for each filter.

Table 1. Online filter design for THD reduction using LabVIEW

Frequency (Hz)	Current amplitude in % of fundamental				Voltage amplitude in % of fundamental			
	Unfiltered Current	1st order Bessel	2nd order Bessel	3rd order Bessel	Unfiltered voltage	1st order Bessel	2nd order Bessel	3rd order Bessel
50	100	100	100	100	100	100	100	100
150	8.519	6.907	4.981	4.684	0.864	0.514	0.465	0.312
250	0.739	0.865	0.337	0.123	0.161	0.049	0.064	0.035
350	2.043	0.667	0.28	0.158	0.443	0.098	0.07	0.018
450	0.722	0.034	0.013	0.017	0.172	0.054	0.015	0.002
550	0.487	0.233	0.035	0.004	0.495	0.135	0.039	0.011
650	1.368	0.184	0.036	0.008	0.113	0.022	0.006	0.001
750	0.333	0.111	0.011	0.003	0.27	0.045	0.008	0.003
850	0.375	0.047	0.003	0.002	0.155	0.02	0.005	0.001
950	0.492	0.126	0.011	0.003	0.098	0.01	0.001	0

Table 2. V_{rms}, I_{rms}, and THD values during filter design for THD reduction

	Unfiltered Current	1st order Bessel	2nd order Bessel	3rd order Bessel	Unfiltered voltage	1st order Bessel	2nd order Bessel	3rd order Bessel
Vrms (V)					207.4	178.9	184.3	184.2
Irms (A)	0.4	0.29	0.3	0.3				
THD (%)	10.3	7.62	5.36	4.93	1.61	0.67	0.53	0.43

As it can be seen from Tables 1 and 2, current waveform for solar inverter is significantly more distorted than the voltage waveform. Also, the second order filter has almost the same effect in the THD reduction as the third order one. So, we can deduce that the first and second order filters are enough to be inserted in the instrument block diagram.

We must emphasize that the filtered signal is only displayed on the instrument front panel. The real inverter output is not really filtered. The next step is to add in the block diagram of the virtual instrument a DAQmx driver configured as digital output and to use the same DAQ 6009 card to send control signal to relays module (Figure 2). It will switch then the real filter in the path which connects the solar inverter output in the electrical grid.

4. CONCLUSION

This paper successfully developed and demonstrated a LabVIEW-based virtual instrument for real-time measurement and analysis of voltage, current, and THD in power systems. The system enables interactive filter design and adaptive harmonic mitigation resulting in distortion lowering current THD up to 52% and voltage THD up to 73%, offering a flexible and replicable software solution. LabVIEW made easy the objective achievement because it is very easy to use this software as a programming language to build the instrument and also to configure and control the DAQ card through DAQmx drivers. Applied to PV plants and other distributed energy sources, the instrument effectively monitors and reduces THD, contributing to improved power quality and grid stability. While the software-centric approach provides significant advantages in flexibility and scalability, the current implementation depends on the availability and performance of data acquisition hardware, which may limit measurement accuracy and speed in large scale or highly dynamic networks. Additionally, the real-time processing capability is constrained by computing resources, suggesting that optimization or dedicated embedded platforms could enhance performance. Future research will focus on extending the system for multi-node THD measurement and control across complex distribution grids. Incorporating machine learning and artificial intelligence (AI) techniques for predictive harmonic analysis and adaptive filtering promises to further improve mitigation efficiency and system resilience. Moreover, deploying the virtual instrument on distributed computing environments will enable scalable and remote power quality management, aligning with smart grid modernization goals.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Gentian Dume	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
Alfred Pjetri	✓	✓		✓	✓	✓		✓	✓	✓	✓			
Andi Hida	✓	✓		✓	✓	✓	✓		✓	✓	✓			

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, [GD].

REFERENCES

[1] R. O. Anurangi, A. S. Rodrigo, and U. Jayatunga, "Effects of high levels of harmonic penetration in distribution networks with photovoltaic inverters," *2017 IEEE International Conference on Industrial and Information Systems (ICIIS)*, Peradeniya, Sri Lanka, 2017, pp. 1-6, doi: 10.1109/ICIINFS.2017.8300335.

[2] P. Sanjeevikumar and C. Sharmeela, "Power System Harmonics," in *Power Quality in Modern Power Systems*, Elsevier, 2021, pp. 61–103, doi: 10.1016/B978-0-12-823346-7.00002-5.

[3] K. Peng, W. Guo, W. Huang, J. Le, and T. Mao, "Power Quality Problem and Key Improvement Technology for Regional Power Grids," *International Journal of Emerging Electric Power Systems*, vol. 21, no. 3, 2020, doi: 10.1515/ijeeps-2019-0243.

[4] S. Upadhyaya, C. N. Bhende, S. Mohanty, and R. Pati, "Evaluation of Power Quality Disturbance in PV-Connected IEEE-14 Bus System Using Lifting-Based Wavelet Transform and Random Forest," *Electrical Engineering*, vol. 104, pp. 2345–2354, 2022, doi: 10.1007/s00202-021-01460-w.

[5] D. Bellan, "Analytical Investigation of the Properties of Transients in Unbalanced Three-Phase Four-Wire Networks," *Energies*, vol. 15, no. 23, p. 9122, 2022, doi: 10.3390/en15239122.

[6] F. H. Malik *et al.*, "A Comprehensive Review on Voltage Stability in Wind-Integrated Power Systems," *Energies*, vol. 17, no. 3, p. 644, 2024, doi: 10.3390/en17030644.

[7] K. Łowczowski and Z. Nadolny, "Voltage Fluctuations and Flicker in Prosumer PV Installation," *Energies*, vol. 15, no. 6, p. 2075, 2022, doi: 10.3390/en15062075.

[8] Y. Liu, M. Stevens, and R. Bettinelli, "Three-Phase Unbalanced Transient Dynamics and Power Flow for Modeling Distribution Systems with Synchronous Machines," *IEEE Transactions on Power Systems*, vol. 31, no. 1, pp. 367–375, 2016, doi: 10.1109/TPWRS.2015.2436040.

[9] I. Alhamrouni, M. A. Hairullah, N. S. Omar, M. Salem, A. Jusoh, and T. Sutikno, "Modelling and Design of PID Controller for Voltage Control of AC Hybrid Micro-Grid," *International Journal of Power Electronics and Drive Systems*, vol. 10, no. 1, pp. 151–159, 2019, doi: 10.11591/ijpeds.v10.i1.pp151-159.

[10] M. Digalovski, K. Najdenkoski, and G. Rafajlovski, "Impact of Current High-Order Harmonics on Core Losses of Three-Phase Distribution Transformer," in *Proceedings of the IEEE EUROCON 2013 – International Conference on Computer as a Tool*, 2013, pp. 1531–1535, doi: 10.1109/EUROCON.2013.6625181.

[11] L. K. Nam, L. H. Lam, T. T. Hieu, and N. H. Hieu, "Active Filter Harmonic Compensator with Proportional Resonant Current Controller for Photovoltaic Inverter," *Bulletin of Electrical Engineering and Informatics*, vol. 13, no. 6, pp. 3809–3820, 2024, doi: 10.11591/eei.v13i6.8167.

[12] Y. Yang, K. Zhou, and F. Blaabjerg, "Current Harmonics from Single-Phase Grid-Connected Inverters—Examination and Suppression," *IEEE Journal of Emerging and Selected Topics in Power Electronics*, vol. 4, no. 1, pp. 221–233, Mar. 2016, doi: 10.1109/JESTPE.2015.2504845.

[13] A. S. Abbas *et al.*, "Optimal Harmonic Mitigation in Distribution Systems with Inverter-Based Distributed Generation," *Applied Sciences*, vol. 11, no. 2, p. 774, 2021, doi: 10.3390/app11020774.

[14] D. Li, X. Zhang, X. Deng, and C. Li, "An Inductive Active Filtering Method for Low-Voltage Distribution Networks," *Machines*, vol. 9, no. 11, p. 258, 2021, doi: 10.3390/machines9110258.

[15] A. Abaza, R. A. El-Sehiemy, M. Said, R. M. Ghoniem, and A. F. Barakat, "Implementation of an Electronically Based Active Power Filter Associated with a Digital Controller for Harmonics Elimination and Power Factor Correction," *Electronics*, vol. 11, no. 14, Art. no. 2205, 2022, doi: 10.3390/electronics11142205.

[16] R. N. Beres, X. Wang, F. Blaabjerg, M. Liserre, and C. L. Bak, "Optimal Design of High-Order Passive-Damped Filters for Grid-Connected Applications," *IEEE Transactions on Power Electronics*, vol. 31, no. 4, pp. 2083–2098, Mar. 2016, doi: 10.1109/TPEL.2015.2441299.

[17] P. Davari, F. Zare, and F. Blaabjerg, "Pulse Pattern-Modulated Strategy for Harmonic Current Components Reduction in Three-Phase AC–DC Converters," *IEEE Transactions on Industry Applications*, vol. 52, no. 4, pp. 3182–3192, Jul. 2016, doi: 10.1109/TIA.2016.2539922.

[18] S. K. Yadav, A. Patel, and H. D. Mathur, "Study on Comparison of Power Losses Between UPQC and UPQC-DG," *IEEE Transactions on Industry Applications*, vol. 58, no. 6, pp. 7384–7395, Nov./Dec. 2022, doi: 10.1109/TIA.2022.3191985.

[19] E. Hossain, M. R. Tür, S. Padmanaban, S. Ay, and I. Khan, "Analysis and Mitigation of Power Quality Issues in Distributed Generation Systems Using Custom Power Devices," *IEEE Access*, vol. 6, pp. 16816–16833, 2018, doi: 10.1109/ACCESS.2018.2814981.

[20] B. Singh and P. Shukl, "Control of Grid-Fed PV Generation Using Infinite Impulse Response Peak Filter in Distribution Network," *IEEE Transactions on Industry Applications*, vol. 56, no. 3, pp. 3079–3089, May–Jun. 2020, doi: 10.1109/TIA.2020.2968287.

[21] H. S. Jiang, Y. Li, Z. Liu, G. Wu, and Z. Liu, "Harmonic Measurement Algorithm of Power System Integrating Wavelet Transform and Deep Learning," *EAI Endorsed Transactions on Energy Web*, 2023, doi: 10.4108/ew.7536.

[22] Y. Xi *et al.*, "Harmonic Estimation in Power Systems Using an Optimized Adaptive Kalman Filter Based on PSO-GA," *IET Generation, Transmission & Distribution*, vol. 13, no. 17, pp. 3968–3979, Sep. 2019, doi: 10.1049/iet-gtd.2018.6148.

[23] W. Zhou, Y. Wu, X. Huang, R. Lu, and H.-T. Zhang, "A Group Sparse Bayesian Learning Algorithm for Harmonic State Estimation in Power Systems," *Applied Energy*, vol. 306, Art. no. 118063, 2022, doi: 10.1016/j.apenergy.2021.118063.

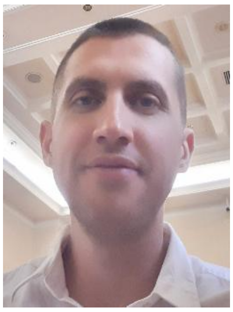
[24] W. Sepulchro and L. F. Encarnação, "Harmonic State Estimation in Power Systems Using the Jaya Algorithm," *Electronics*, vol. 13, no. 17, 2024, doi: 10.3390/electronics1317359.

[25] F. Yıldırım, Y. Yalman, K. Ç. Bayındır, and E. Terciyanlı, "Comprehensive Review of Edge Computing for Power Systems: State of the Art, Architecture, and Applications," *Applied Sciences*, vol. 15, no. 8, p. 4592, 2025, doi: 10.3390/app15084592.
[26] G. Dume and J. Metalla, "Revolutionizing Engineering Education: Leveraging LabVIEW Virtual Instrumentation in Electrical Machines Real-Time Control for Distance Learning," *Engineering Applications*, vol. 3, no. 1, pp. 36–44, Feb. 2024.
[27] G. Dume, "Real-Time Control of Synchronous Generator in Island Mode Based on LabVIEW Software for Education Purposes," *WSEAS Transactions on Advances in Engineering Education*, vol. 13, pp. 50–63, Jun. 2016.
[28] FESTO Didactic, *Four-Quadrant Dynamometer/Power Supply with Manual and Computer-Based Control 579651 (8960-C5)*, FESTO LabVolt Series, Datasheet, Windsor, ON, Canada, 2024.
[29] Festo, *IGBT Chopper/Inverter 579626 (8837-B5)*, 2024.
[30] G. Dume, "Real-Time Control of Synchronous Generator Based on LabVIEW Software," Ph.D. dissertation, Dept. of Automation, Polytechnic University of Tirana, Tirana, Albania, 2016.
[31] "NI-DAQmx 21.3 Readme," National Instruments, Oct. 2021, [Online]. Available: https://www.ni.com/pdf/manuals/374768ak.html. (Accessed: Oct. 14, 2025).
[32] H. F. Zhou, "Compressive Sampling for Spectrally Sparse Signal Reconstruction," *Signal Processing*, vol. 151, pp. 136–145, 2018, doi: 10.1016/j.sigpro.2018.03.033.
[33] "NI-DAQmx Express VI Tutorial," National Instruments Knowledge Base, Apr. 2, 2024. [Online]. Available: https://knowledge.ni.com/KnowledgeArticleDetails?id=kA03q000000x0QHCAY&l=en-AL. (Accessed: Mar. 23, 2025).
[34] "Publish a LabVIEW VI to a Web Page with the Web Publishing Tool (Archived)," National Instruments Knowledge Base, Apr. 7, 2024, [Online]. Available: https://knowledge.ni.com/KnowledgeArticleDetails?id=kA03q000000YHeGCAW&l=en-AL. (Accessed: Mar. 23, 2025).

BIOGRAPHIES OF AUTHORS

Gentian Dume is an Assoc. Prof. and a senior lecturer at the Department of Automation of Polytechnic University of Tirana, Albania where he has been a faculty member since 2006. He completed his Ph.D. in Electrical Engineering from the Polytechnic University of Tirana with thesis "Real-Time Control of Synchronous Generator based on LabVIEW software". His research interests include real-time control of electrical machines, virtual instrumentation and power electronics. He can be contacted at email: gentian.dume@gmail.com or gentiandume@fie-upt.edu.al.

Alfred Pjetri is an Assoc. Prof. and a senior lecturer at the Department of Automation of Polytechnic University of Tirana, Albania where he has been a faculty member since 2005. He completed his Ph.D. in Electrical Engineering from the Polytechnic University of Tirana with thesis "Sensorless speed control of three-phase asynchronous motors". His research interests is focused on the speed control of induction motors, distributed generation and special electrical machine. He can be contacted at email: alfredpjetri@gmail.com or alfredpjetri@fie-upt.edu.al.



Andi Hida is a lecturer at the Department of Electrical Power Systems, Faculty of Electrical Engineering, Tirana, Albania. He received the M.Sc. degree form Polytechnic Univeristy of Tirana in 2013. Actually, he is a Ph.D. student in the third year of the study. His research interests include renewable energy resources and smart grid technologies. He can be contacted at email: andihida@fie-upt.edu.al.