Design And Performance Analysis Of An Adaptive Smart Power Factor Correction And Load Monitoring System With A GSM-Based Remote-Control Interface

Stephen Eduku*

*Department of Electrical and Electronic Engineering, Faculty of Engineering, Takoradi Technical University, Ghana
*Department of Nautical Studies, Faculty of Maritime and Nautical Studies, Takoradi Technical University, Ghana

DOI: 10.29322/IJSRP.16.01.2026.p16925
https://dx.doi.org/10.29322/IJSRP.16.01.2026.p16925

Paper Received Date:25th December 2025
Paper Acceptance Date: 25th January 2026
Paper Publication Date: 29th January 2026

Abstract- *A low power factor increases current flow, raises copper and core losses, and accelerates thermal and mechanical stress on electrical equipment, posing a major concern to utilities, industries, and sensitive installations such as hospitals. Power factor values predominantly range from 0 to 1 (lagging or leading), and operating close to unity is preferred to minimize losses and voltage drops. Furthermore, inductive equipment, such as motors and transformers, inherently draws reactive power to established magnetic fields, but their net power factor can be improved using compensating devices such as capacitors. Nevertheless, many facilities continue to experience low power factor, resulting in higher energy costs, increased losses, and unnecessary strain on distribution infrastructures. Meanwhile, traditional monitoring methods rely on manual checks, which are time-consuming and often fail to provide timely warnings. Hence, this paper presents the design and implementation of a microcontroller-based power factor correction and load monitoring system to address these aforementioned challenges. The prototype utilizes an Arduino Nano, equipped with voltage and current sensors, for continuous measurement. Furthermore, the proposed system automatically switches capacitor banks through relays whenever the power factor drops. Besides, real-time parameters are displayed locally through the LCD and transmitted via a GSM module for SMS alerts. Moreover, the system was modelled in Proteus, programmed in C++, and analyzed in Microsoft Excel. Finally, both simulation and prototype experimental tests confirmed reliable performance, demonstrating a practical means of improving power factor, reducing losses, and minimizing manual intervention in industrial and commercial settings.*

Keywords*- Capacitor Bank, Energy Efficiency, Load Monitoring System, Microcontroller-Based System, GSM-Based Remote Monitoring, Smart Power Factor Correction*

I. Introduction

Power factor in its displacement is defined as the cosine of the angle between voltage and current when harmonics are negligible. However, harmonics from modern or advanced power electronics equipment or devices make complete elimination impractical. Moreover, for devices operating on either a three-phase or single-phase grid system, the power factor serves as an indicator or a measure of how efficiently electricity or electrical energy is utilized. Besides, enhancing the power factor via correction techniques minimizes or decreases the demand on transformers and distribution networks or conductors, which in turn lowers the transmission losses and supports a more stable and sustainable power network. Nonetheless, this aforementioned improvement or enhancement also carries or bears significant financial benefits. For instance, electric motors running or operating with no or minimal mechanical load typically exhibit a lower power factor. Also, by implementing the power factor correction (PFC) at the common coupling point, utilities or consumers can minimize or reduce costs by preventing or avoiding penalty chargers. Besides, the merits of PFC equipment include its long service life and uncomplicated or straightforward installation procedure or process [1].

Moreover, electrical power or energy has become an invaluable resource in today's era of rapid technological advancement. It is therefore essential to identify the factors contributing to power losses and those that enhance the power system's efficiency. Besides, with increasing industrialization, the prevalence of inductive loads has led to a decline in system efficiency. Consequently, improving the power factor through appropriate automatic power factor correction methods is crucial [2]. Meanwhile, electrically designed systems across industries and households mainly use alternating current (AC) power, where inductive loads supply a lagging power factor that lowers efficiency and increases losses. Moreover, because power factor directly affects system performance, keeping it as close as possible or feasible to unity is essential for maximizing efficiency and minimizing losses [3].

Since the late 19th century, the rapid progress of science and technology has ushered in the electrical technology era, with countless equipment or devices dependent on power supplies to convert and deliver electrical energy. Besides, many of these devices, particularly high-frequency electronic equipment, act as nonlinear loads that generate significant content of harmonics. Furthermore, these harmonics distort the current in power networks, lowering the power factor, reducing the grid utilization, and potentially damaging equipment or causing supply failures. To comply with harmonic standards and improve efficiency, power factor correction (PFC) technology is now widely applied in DC power conversion systems [4]. Nonetheless, the nonlinear direct current (DC) loads, such as light-emitting diodes (LEDs) and electric vehicle batteries, cause current distortion, low power factor, high total harmonic distortion (THD), and reduced efficiency. Meanwhile, passive PFC uses simple but bulky and less efficient inductive filters, while active PFC employs complex controllers, yet these controllers often struggle with nonlinear system dynamics [5].

Furthermore, in a dynamic electric vehicle (EV) charging via inductive power transfer (IPT), coils embedded under the roadway supply power from the grid through a primary compensator, while onboard compensators may vary in design or frequency and can drift further due to capacitor aging. To ensure reliable power delivery under changing impedance and coupling at resonant and non-resonant conditions, reactive power in the high-frequency inverter must be minimized to prevent system oversizing or reduced power transfer [6]. Moreover, because of dynamic grid loading and the nonlinear behavior of electricity or electrical equipment, current waveforms deviate from a perfect sine wave and cannot continuously track voltage changes, resulting in phase shifts and waveform distortions. Also, the harmonic pollution produced in the power system is significant and cannot be ignored, as it introduces numerous issues or limitations that disrupt normal grid operation [7].

Meanwhile, an extensive study presented in [8] introduces a novel control strategy for power electronic converters to deliver ancillary services to the grid through power factor compensation. However, this approach uses a nonlinear control scheme with nested loops that combine super-twisting sliding modes and nonlinear optimal tracking to ensure the converter output follows a desired reference current, thereby injecting the required reactive power at the power system node. Besides, simulation results demonstrate the method's effectiveness in maintaining a unity power factor even under sudden load changes. Moreover, with the widespread use of AC/DC converters in modern power systems, harmonics generated by nonlinear electronic devices have become a significant concern. Also, PFC can be applied to mitigate these harmonics and enhance transmission efficiency [9].

Nonetheless, recent research investigated harmonic distortion in power systems caused by nonlinear loads such as power electronic converters and inverter drives, which can damage the power factor correction capacitors, overheat cables and transformer bushings, and produce non-sinusoidal input currents due to the charge and discharge action of capacitor filters in AC-DC rectifiers. Although passive and active filters have been widely applied to address these issues, they remain bulky and costly, and turning nonlinear controllers for PFC boost converters is often complex. Moreover, in response, the study developed and tested a fuzzy-controlled PFC boost converter implemented on an Arduino microcontroller. Besides, experimental results showed that this low-cost digital platform effectively improved power factor, reduced AC input current harmonics, regulated DC output voltage, and simplified controller parameter design while enabling network interfacing [10].

However, low power factor and high harmonic content are persistent issues in modern power systems supplied by power converters. Besides, a fuzzy logic-based boost converter for power factor correction was implemented and evaluated. Moreover, the controller was designed and simulated in MATLAB/Simulink to drive the converter in continuous conduction mode, achieving near unity power factor while reducing input current harmonics and regulating output voltage. Also, comparative analysis with conventional P, PI, and PID controllers demonstrated that the proposed approach provided superior power factor improvement and harmonic mitigation [11]

Furthermore, the growth of nonlinear loads and renewable energy sources increasingly challenges power factor and voltage stability in electrical networks. Besides, an enhanced control strategy for Electric Spring (ES) circuits is introduced, combining a double fuzzy logic controller with a fuzzy PI controller to improve power factor correction and maintain voltage stability under varying conditions. Moreover, MATLAB/Simulink simulations show power factor improvements of up to 0.97 in overvoltage and 0.99 in undervoltage scenarios, confirming effective voltage and power stability. Nevertheless, the approach demonstrates a strong potential for advanced power factor correction and voltage regulation in practical systems [12].

Nonetheless, power factor is a critical parameter in power transmission systems. Meanwhile, a lower power factor increases line current for the same transmitted power, necessitating large conductors, raising manufacturing costs, increasing transmission losses, which are proportional to the square of the current, and causing greater voltage drops that degrade the voltage profile and overall efficiency. Moreover, electricity utility companies also impose penalties on consumers with poor power factors, making corrections at the point of common coupling (PCC) essential. Besides, the controller of a dynamic voltage restorer (DVR) is enhanced to correct the power factor at the PCC while maintaining voltage sag and swell compensation on the load side [13].

Furthermore, alternating current to direct current (AC-DC) grid-connected off-line power converters are extensively used in industrial, domestic consumer, and automotive applications, but inherently draw non-sinusoidal currents. Nonetheless, while PFC is not mandatory in the United States, incorporating a front-end PFC stage reduces current harmonics and stabilizes the input voltage, typically 380 – 420 VDC, thereby simplifying the design of resonant DC–DC stages. Meanwhile, in markets such as Europe, Japan, China, and Australia, a PFC stage is also required to comply with harmonic current limits specified by standards like IEC 61000-3-2. More importantly, the PFC stage must improve power factor without reducing conversion efficiency, conventional implementation uses an input rectifier followed by a boost stage [14].

Meanwhile, efficient use of electrical power or energy is critical in modern industrial systems, where power must be delivered reliably at stable frequencies and voltages. Moreover, a key determinant of this efficiency is the power factor, which is the ratio of real power performing useful work to the total apparent power from the supply. Besides, high power factors signify effective energy use, whereas low power factors increase losses, utility cost, and strain on generation, transmission, and distribution infrastructure. Furthermore, reactive power compensation can improve power factor, enhance phase balance, and reduce harmonics when paired with an appropriate filter design. Also, maintaining good power quality, therefore, requires careful management of reactive power to ensure stable voltage and current conditions [15].

Nevertheless, with the growing or ongoing concern about climate change, energy efficiency, and reduced carbon emissions have become global priorities, hence driving certification programs such as Energy Star and 80 plus to promote high-efficiency computer power supplies. Besides, modern switched-mode power supplies under digital control typically rely on analog-to-digital converters (ADCs) for feedback, but high-power-density, high-frequency converters often require lower resolution ADCs to shorten conversion times. Meanwhile, to address this, a digital ripple injection method is proposed, replacing ADCs with a comparator and a digital-to-analog converter (DAC). Also, a 500 W boost PFC rectifier is used to demonstrate the approach, showing effective sensing of grid voltage, inductor current, and DC output voltage without conventional ADCs [16].

Moreover, scholars in [17] conducted an extensive case study on the reduction of electricity costs or bills using a capacitor. However, the study results depict a relatively higher cost of electricity bills when the capacitor is not connected. Nonetheless, when the capacitor was connected to improve the power factor, the results unveil a reduction of voltage drop, indicating a reduction in power losses, also showing a savings reduction in electricity bills. Therefore, demonstrating that the utilization of the capacitor to enhance or increase the power factor in the power system is very imperative in ensuring a significant reduction in the cost of electricity, making it a more or very economical approach in electrical lines or transmission and utilization. However, a case study of an engineering problem and solution has incomplete or inadequate facts in solving the problem at hand. Hence, a need to design, simulate, verify, and consider the possible implementation of the results.

Nonetheless, scholars in [18] extensively analyzed power factor improvement using a three-phase, designed induction motor via auxiliary stator winding of the three-phase motor by exploring the capacitance injection technique. Moreover, the scheme enhances the operating power factor and the starting currents while maintaining a lower level of supply current distortion. Nevertheless, the operating efficiency of the proposed or new design motor was not satisfactory; hence, future research work should take into account further optimization. Besides, the experimental result of the proposed design modification on a diverse range of measured power should be carried out.

Nevertheless, from the aforementioned analysis via the extensive literature review considered in this research work, it is clear that much research work has been carried out in the field of power factor correction, but there is still a gap, indicating that operating efficiency is not satisfactory. Also, other issues identified are that much attention has been given to the manually operated power factor correction system compared to the automatic power factor correction system. Nonetheless, some automated power factor correction (PFC) systems are sluggish in their operation. Hence, the proposed design in this research aims to introduce an effective smart power factor correction and load monitoring system with GSM GSM-based remote-control system, which is capable of enhancing the power factor near unity to improve the operating efficiency and fast switching time to ensure reliability.

The novelty of the proposed automated microcontroller or Arduino-based power factor correction and load monitoring system integrated with GSM technology is its ability to improve or enhance the power factor near unity to ensure an enhanced operating efficiency by reducing losses, with a fast-switching time ranging between 2 to 3 seconds. Hence, addressing the research gap identified in the existing literature concerning both manual and automated power factor correction systems.

II. MATERIALS AND METHODS

To ensure effective programming and operation of the proposed system, a control logic was written in C++ using the Arduino IDE and uploaded or transferred via USB to an Arduino Nano. Moreover, the circuit was first modeled in the Proteus design Suite to capture schematics, simulate the microcontroller code, and verify timing, logic, and system behaviour under various load conditions before hardware assembly. Furthermore, in the prototype, the Arduino Nano continuously measures inductive and resistive loads with a ZMPT101B voltage sensor and an ACS712 current sensor. Besides, a relay module switches capacitor banks in or out to improve power factor, while an LCD real real-time values and a GSM module transmits SMS notifications of load changes and correction events. Also, the control algorithm samples the network every 2 to 3 seconds (s). Meanwhile, when the power factor drops below 0.90, the controller confirms the event, then sequentially engages capacitors to raise it above 0.95, releasing them in reverse order to avoid overcompensation. Also, in the absence of a load, the system remains in passive monitoring mode. Moreover, the block and circuit diagrams of the proposed system are presented in Figures 1 and 2, respectively.

ISSN 2250-3153

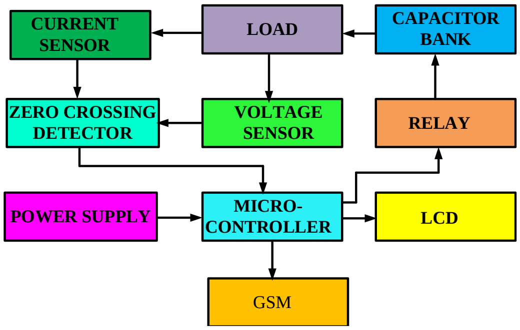

Fig. 1 Block diagram of the proposed design

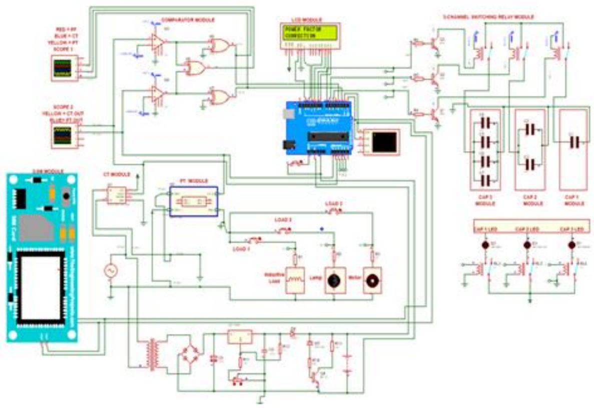

Fig. 2 The circuit diagram of the proposed design

A. Construction procedure of the proposed design

All the design modules, including the Arduino Nano, GSM unit, relays, LCD, Sensors, buzzer, and power supply, were pre-tested with a multimeter before integration. Meanwhile, a regulated 5V switched-mode power supply (SMPS) fed all components, which were mounted and connected on a Veroboard inside the enclosure with proper grounding. Arduino Nano or the microcontroller acted as the central controller, acquiring voltage and current data from ZMPT101B and ACS712 sensors. Calculating power factor and driving relays to switch capacitor banks. Moreover, the SIM900 GSM module sent SMS alert, the buzzer with a driver circuit providing the audio alarms, and the LCD displaying the real-time parameters. Also, jumper wires or connectors and soldered links distributed power and signals, and the Arduino was programmed via the IDE to execute sensing, correction, display, and notification tasks. Nonetheless, after wiring and coding, the system was powered on, tested with resistive and inductive loads to confirm automatic capacitor switching and GSM alerts, and finally arranged and secured in the enclosure with external terminals routed through metallic glands as shown or presented in figures 3 (a) and 3 (b), respectively.

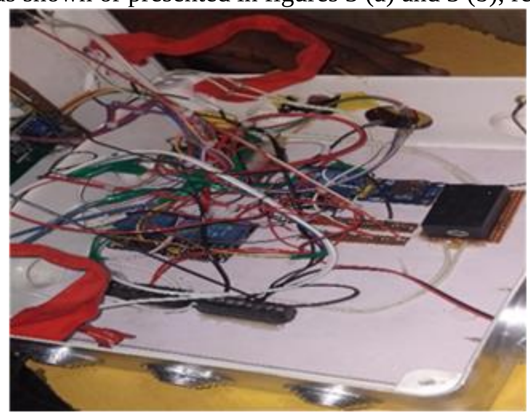

Fig. 3 (a) Pictorial of the construction procedure

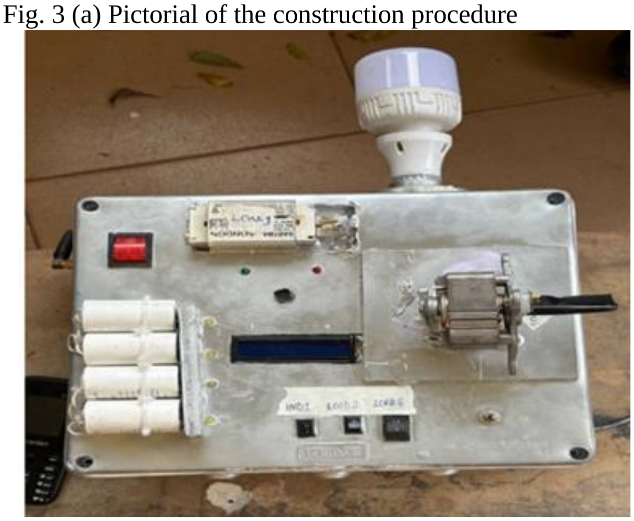

Fig. 3 (b) Pictorial of the final packaging of the proposed design

III. RESULTS AND DISCUSSION

A. Simulation Results

The proposed designed system was simulated in Proteus Software to assess its operation or functionality. Meanwhile, as shown in Figure 4, the simulation demonstrated that under low power factor conditions, the microcontroller activated the relay to connect the capacitor bank and improve the power factor, while simultaneously sending SMS notifications via the GSM module. Besides, the LCD displayed real-time current and power factor values for easy interpretation, and an audible alarm from the buzzer was triggered whenever the power factor fell below the set threshold, indicating corrective action by the controller. Moreover, for Load 1 (inductive), the simulation recorded a current of 3.1 A with a power factor of 0.85, confirming a low power factor condition as illustrated in Figure 4.

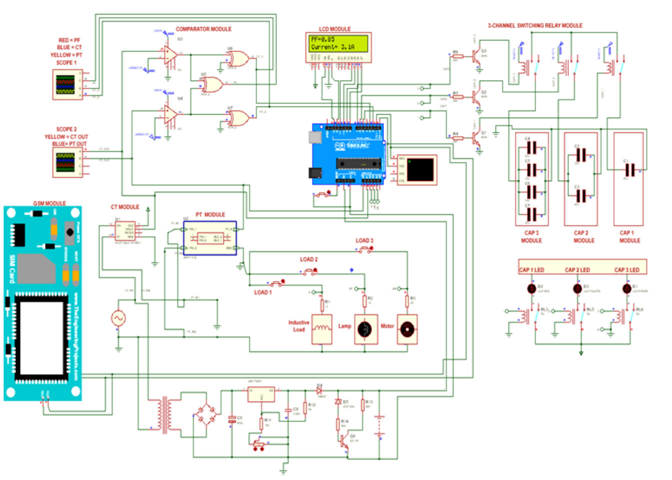

Fig. 4 Load 1 (inductive), Power factor, and current before correction

Meanwhile, after activation of the capacitor bank, Load 1 (inductive) showed or demonstrated a reduced current of 2.8 A and an improved power factor of 0.97, as illustrated in Figure 5.

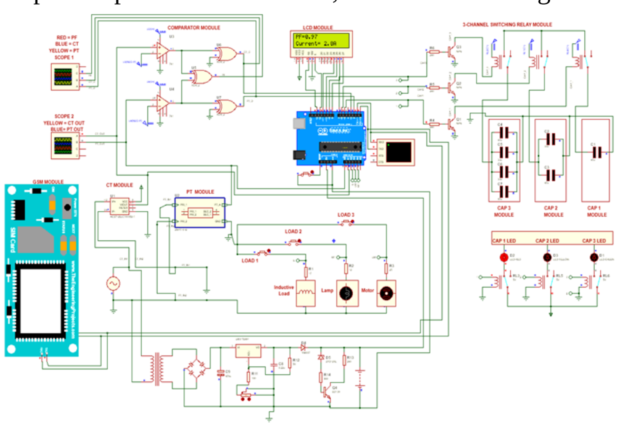

Fig. 5 Load 1 (inductive), Power factor, and current after correction

Moreover, for Load 2 (resistive), the design simulation recorded a current of 0.1 A with a power factor of 0.95, indicating efficient operation at a good power factor and no need for correction, as shown or presented in Figure 6.

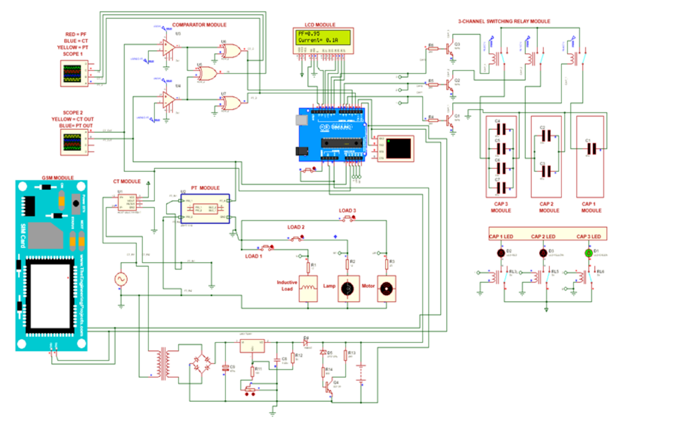

Fig. 6 Load 2 (resistive), already operating at a good power factor

Furthermore, Load 3 (inductive), the system measured a current of 3.6 A with a power factor of 0.73, clearly indicating operation at a low power factor, as illustrated or depicted in Figure 7.

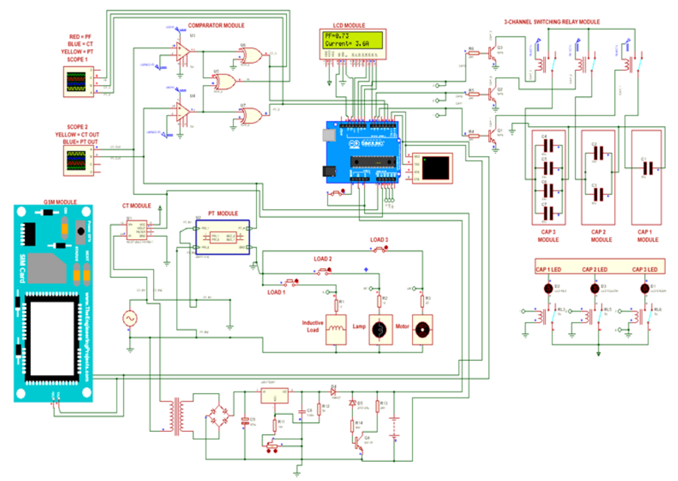

Fig. 7 Load 4 (inductive), Power factor, and current before correction

Nonetheless, after power factor correction, Load 3 (inductive) recorded a reduced current of 2.3 A and an improved or enhanced power factor of 0.94, as shown in Figure 8.

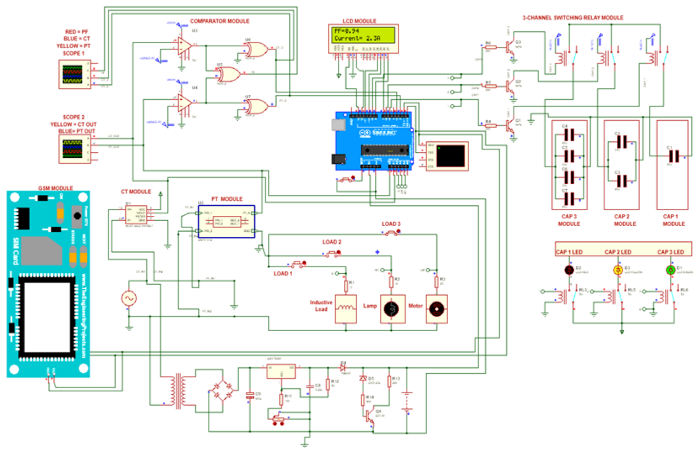

Fig. 8 Load 4 (inductive) Power factor and current after correction

Moreover, when all loads (Load 1, Load 2, and Load 3) were switched on simultaneously, the system measured a total current of 7.2 A with a power factor of 0.63, indicating operation under a low power factor condition, as illustrated or presented in Figure 9.

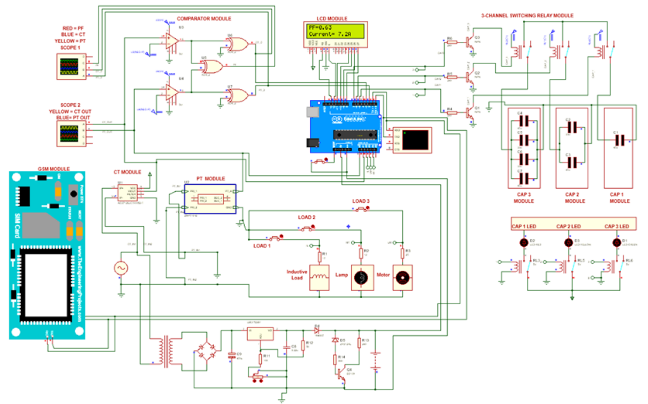

Fig. 9 All Loads (Mixed Loads), Power factor, and current before correction

Meanwhile, after power factor correction, the combined or synergy of the loads (Load 1, Load 2, and Load 3) recoded a reduced current of 5.7 A and an enhanced or improved power factor of 0.95, indicating efficient operation at a good power factor, as shown in Figure 10.

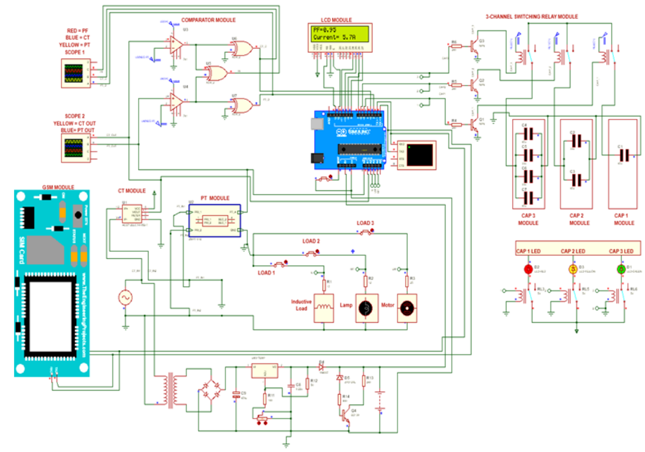

Fig. 10 All Loads (Mixed Loads), Power factor, and current after correction

B. Experimental Results of the Proposed Design

The practical or experimental tests of the circuit, illustrated in the following figures, were carried out to validate the simulation outcomes on the hardware or constructed prototype. Besides, for Load 1 (inductive), the system measured a current of 3.1 A with a power factor of 0.85, confirming operation at a low power factor as shown in Figure 11. Nevertheless, these measurements were also transmitted to a mobile phone via SMS, enabling convenient remote monitoring.

Fig. 11 Implemented System, Load 1 (inductive) at low power factor before correction

Furthermore, for Load 1 (inductive), after correction, the power factor improved to 0.96, and the current decreased to 2.7 A, as depicted or shown in Figure 12. Besides, the updated measurements were also transmitted to the mobile phone via SMS.

Fig. 12 Implemented system Load 1 (inductive) after power factor correction.

However, for Load 2 (resistive), the proposed system measured a current of 0.1 A with a power factor of 0.96, indicating efficient operation that required no correction, as shown in Figure 13. Meanwhile, the measured values were also transmitted to the mobile phone via SMS.

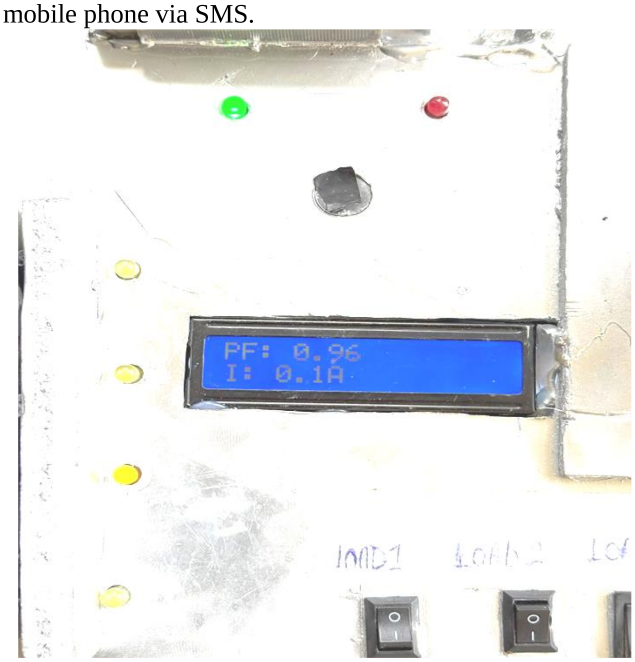

Fig. 13 Implemented system Load 2 (resistive) operating at a good power factor

Moreover, before correction, Load 3 (inductive) operated at a low power factor of 0.75 with a current of 3.4 A. Nonetheless, these readings were also displayed on the mobile phone, as shown in Figure 14.

Fig. 14 Implemented system Load 3 (inductive) operating at low power factor before correction

Furthermore, after power factor correction, Load 3 (inductive) marked or demonstrated improvement; for clarity, the power factor increased to 0.95, and the current decreased to 2.70 A. Besides, these updated readings were also transmitted to the mobile phone via SMS for easy remote monitoring, as shown in Figure 15.

Fig. 15 Implemented system, Load 3 (inductive) after power factor correction

Moreover, before power factor correction, all loads operating together drew a total current of 8.6 A at a low power factor of 0.61. Meanwhile, these readings were also displayed on the mobile phone, as shown in Figure 16.

Fig. 16 Implemented system, all loads (Mixed loads) operating at low power factor before correction

Nevertheless, after power factor correction with all three loads operating together, the proposed system showed a clear improvement or enhancement; the total current decreased to 5.7 A while the power factor increased to 0.93. Besides, these updated readings were also displayed on the mobile phone, as shown in Figure 17.

Fig. 17 Implemented system, all Loads (Mixed) after power factor correction

Table 1 presents the results comparison between the simulation reading and experimental measurements of the proposed design.

EXPERIMENTAL RESULTS					SIMULATED RESULTS			
	BEFORE CORRECTION		AFTER CORRECTION		BEFORE CORRECTION		AFTER CORRECTION	
LOADS	I(A)	PF	I(A)	PF	I(A)	PF	I(A)	PF
LOAD 1	3.1	0.85	2.7	0.96	3.1	0.85	2.8	0.97
LOAD 2	0.1	0.96	0.1	0.96	0.1	0.95	0.1	0.95
LOAD 3	3.4	0.75	2.7	0.95	3.6	0.73	2.3	0.94
ALL LOADS	8.6	0.61	5.7	0.93	7.2	0.63	5.7	0.95

Figure 18 presents a graph of the designed smart power factor correction and load monitoring system using GSM technology, showing current and power factor values before and after correction for both simulation and experimental results.

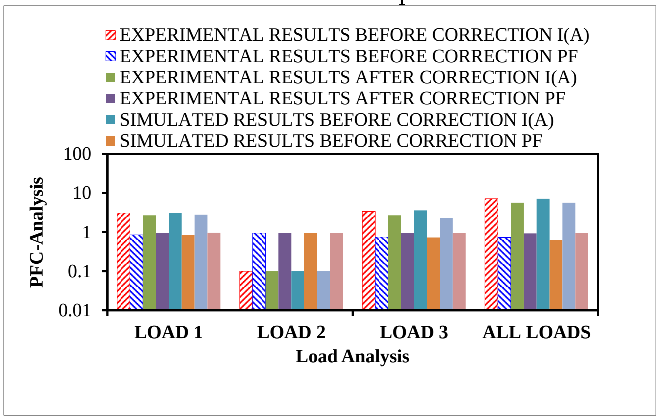

Fig. 18 Graph of current and power factor (Before and After Correction) for Simulation and Experimental results of the Smart Power Factor Correction and Load Monitoring System

IV. DISCUSSION

The simulation and experimental results, as presented in Figures 4 to 18, demonstrate that the power factor correction technique significantly enhances the proposed system's performance, reducing current demand and improving efficiency. Meanwhile, before correction, as presented in Figures 4 and 11, the power factor and current of Load 1 (inductive load) via the simulation were 0.85 and 3.1 A, and those of the experiment were also 0.85 and 3.1 A. Nonetheless, after the correction of Load 1 as presented in Figure 5 and Figure 12, the power factor of the simulation improved to 0.97 with a current of 2.8 A, and that of the experiment unveiled a power factor of 0.96 with a current of 2.7 A, hence, exhibiting effective compensation of its reactive components. Meanwhile, the power factor and current of Load 2 (resistive load) obtained from simulation and experimental analysis were 0.95 and 0.1 A, and 0.97 and 0.1, as presented in Figure 6 and Figure 13, respectively, depicting a very good power factor already close to unity with a reduced current, exhibiting little change, confirming limited benefit for load with high initial power factor. Furthermore, Load 3, before correction, which initially recorded the lowest values of power factor and current, 0.73 at a current of 3.6 A for simulation and 0.75 with a current of 3.4 A for experimental analysis, as presented respectively in Figure 7 and Figure 14. Meanwhile, after correction, the power factor improved to 0.94 with a reduced current of 2.3 A for simulation and 0.95 and 2.1 A for experiment as presented in Figure 8 and Figure 15, respectively. Nonetheless, before correction, the combined loads unveil a low power factor of 0.63 with a current of 7.2 A via the simulation and 0.61 and 8.6 A as presented in Figures 9 and 16. nevertheless, after correction, the simulation unveils a power factor improvement of 0.95 with a reduced current of 5.7 A, and a power factor of 0.93 with a reduced current of 5.7 A as presented in Figure 10 and Figure 17. Besides, the close agreement between simulation and experimental results or data, with only minor differences due to measurement tolerances and practical design losses, validates the proposed design or model reliability. Finally, these results confirm that power factor correction reduces line current, minimizes energy losses, eases stress on equipment, and improves voltage stability, with inductive loads at poor initial power factor gaining the most improvement.

V. CONCLUSION

The research work or design has demonstrated the effectiveness of an Arduino-based power factor correction and load monitoring system integrated with GSM technology. Moreover, the system continuously measures and displays the load power factor in real time, automatically switching capacitor banks when values fall below a set threshold. Meanwhile, the inclusion of the GSM module enables remote alerts, providing faster and more reliable oversight than traditional manual methods. Besides, experimental results were utilized to validate the simulation results of the design, showing that the inductive loads with initial poor power factors were corrected to near unity values without human or operator intervention. Furthermore, by improving power factor, the system reduces line losses, enhances energy efficiency, and strengthens power supply stability. Finally, its low cost and ease of implementation make it a practical solution for residential, industrial, and commercial applications, particularly in settings where energy efficiency and reliable power supply are critical.

REFERENCES

[1] Coman, C. M., A. Florescu, and C. D. Oancea. Improving the efficiency and sustainability of power systems using distributed power factor correction methods. Sustainability (Switzerland), vol. 12 (8), pp.1–20. 2020.

[2] Taye, Ararso. "Design and simulation of automatic power factor correction for industry application." *International Journal of Engineering Technologies and Management Research* 5, no. 2, pp. 10-21, 2018.

[3] M. S. Rahman, A. Memy, M. A. Mahmud, and S. Siddique, "Automatic Power Factor Measurement and Improvement Using Capacitor Bank," *2022 IEEE International Power and Renewable Energy Conference (IPRECON)*, Kollam, India, pp. 1-6,2022.

[4] T. Zhu and C. Deng, "Modeling Research of Three-Level Power Factor Correction Converter," *2025 8th International Conference on Energy, Electrical and Power Engineering (CEEPE)*, Wuxi, China, pp. 168-172,2025.

[5] K. Srichaiwong *et al.*, "Hamiltonian Control Law for Enhanced Power Factor Correction in Single-Phase AC/DC Boost Converters," *2024 International Conference on Materials and Energy: Energy in Electrical Engineering (ICOME-EE)*, Bangkok, Thailand, pp. 1-4,2024.

[6] S. Navaiyan-Kalat, S. Vaez-Zadeh, A. Babaki, and M. Pakzaban, "Model Predictive Control of a Single Stage Power Factor Correction for Inductive Power Transfer Systems," *2023 14th Power Electronics, Drive Systems, and Technologies Conference (PEDSTC)*, Babol, Iran, Islamic Republic, pp. 1-6,2023.

[7] J. Xu, D. Zhang, Y. Qi, Z. Liu, Z. Li, and S. Liu, "Research and Control of Active Power Factor Correction Based on Space Vector Pulse Width Modulation," *2021 China Automation Congress (CAC)*, Beijing, China, pp. 2571-2576,2021.

[8] S. Ramos-Paz, F. Ornelas-Tellez, and J. J. Rico-Melgoza, "Dynamic Power Factor Correction Through Power Electronic Converters Optimal

Control," *2021 North American Power Symposium (NAPS)*, College Station, TX, USA, pp. 1-6,2021.

[9] L. Bao, L. Fan, and Z. Miao, "Modeling and Analysis of Single-phase Boost Converter with Power Factor Correction Control," *2020 52nd North American Power Symposium (NAPS)*, Tempe, AZ, USA, pp. 1-6,2021.

[10] S. Rittijun and N. Boonpirom, "Power Factor Correction of Single-Phase Rectifier using Fuzzy Controller," *2020 International Conference on Power, Energy and Innovations (ICPEI)*, Chiangmai, Thailand, pp. 153-156,2020.

[11] K. Vinodhini, A. Sobiya, M. Gengaraj, M. Nanthini, M. Subashini, and L. Kalaivani, "Fuzzy Logic Controller based Power Factor Correction Converter for Industrial Applications," *2022 Second International Conference on Artificial Intelligence and Smart Energy (ICAIS)*, Coimbatore, India, pp. 1504-1510,2022.

[12] A. Agrawal, "Enhanced Power Factor Correction and Voltage Stability in Electric Spring Circuits Using Double Fuzzy Logic and Fuzzy PI Controllers," *2023 5th International Conference on Energy, Power and Environment: Towards Flexible Green Energy Technologies (ICEPE)*, Shillong, India, pp. 1-6, 2023.

[13] J. Ye and H. B. Gooi, "Phase Angle Control Based Three-phase DVR with Power Factor Correction at Point of Common Coupling," in *Journal of Modern Power Systems and Clean Energy*, vol. 8, no. 1, pp. 179-186, 2020.

[14] H. Ademane, R. Attanasio, and G. Vitale, "A GaN-based Totem Pole Bridgeless Power Factor Correction Circuit," *2024 IEEE Applied Power Electronics Conference and Exposition (APEC)*, Long Beach, CA, USA, 2024, pp. 1968-1972.

[15] M. Ayaz, S. M. H. Rizvi, and M. Akbar, "Dynamic Power Factor Correction in Industrial Systems: An Automated Capacitor Bank Control Approach," *2023 2nd International Conference on Emerging Trends in Electrical, Control, and Telecommunication Engineering (ETECTE)*, Lahore, Pakistan, pp. 1-6,2023.

[16] Y. -D. Fan and F. -Z. Chen, "Comparator-Based Digitally Controlled Power Factor Correction Rectifier Using Digital Ripple Injection," *2024 International Conference on Electrical, Computer and Energy Technologies (ICECET)*, Sydney, Australia, pp. 1-10,2024.

[17] [17] Wahab, K., Rahal, M., and Achkar, R. Economic improvement of power factor correction: a case study. *Journal of Power and Energy Engineering*, vol *9, no.* 6, pp.1-11, 2021.

[18] [18] Jimoh, A.A. and Nicolae, D.V. Performance analysis of a three-phase induction motor with capacitance injection, 2024.

AUTHORS

Stephen Eduku (Ph.D.) is a Senior Lecturer in the Department of Electrical and Electronic Engineering at Takoradi Technical University, Ghana, and a member of the IEEE. He obtained his Ph.D. in Power Electronics and Power Drives from Jiangsu University, China, in 2022. He also holds an M.Tech. and B.Sc. in Electrical and Electronics Engineering from the University of Education, Kumasi Campus, Ghana, and an HND in Electrical and Electronic Engineering as well as a Diploma in Instrumentation from Takoradi Technical University. Dr. Eduku's research interests include power electronics applications in power systems, renewable energy integration, smart grids, HVDC and FACTS technologies, electric drives, and the design and performance optimization of fault-tolerant permanent magnet flux-switching machines. He has over a decade of teaching and research experience and currently serves as Head of the Department of Nautical Studies at Takoradi Technical University. His work focuses on bridging academic research and industrial practice to advance innovations in modern electrical engineering.

Correspondence Author – Stephen Eduku, 5103180335@stmail.ujs.edu.cn/stephen.eduku@ttu.edu.gh, +223 503031643.