IOT BASED REACTIVE POWER CONTROL FOR VOLTAGE REGULATION USING ARDUINO

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Abstract: The project is designed to minimize penalty for industrial units using automatic power factor correction unit. In this proposed system, two zero crossing detectors are used for detecting zero crossing of voltage and current. The time lag between the zero-voltage pulse and zero-current pulse is duly generated by suitable operational amplifier circuits in comparator mode is fed to two interrupt pins of a micro controller. It displays time lag between the current and voltage on an LCD. The program takes over to actuate appropriate number of relays from its output to bring shunt capacitors into load circuit to get the power factor till it reaches near unity. The capacitor bank and relays are interfaced to the microcontroller using a relay driver. Furthermore, the project can be enhanced by using thyristor control switches instead of relay control to avoid contact pitting often encountered by switching of capacitors due to high in rush current.

Keywords: Distributed Energy Resources, Arduino UNO, Reactive power control, Power Factor.

I. INTRODUCTION

Power systems are increasingly reliant on distributed generation (DG). External, nonelectric factors such as appropriate geographic locations of wind and solar resources influence the location of DG units. As a result, whether planned or not, they are frequently attached to distribution networks at the closest location.

Furthermore, all energy producers now have access to distribution networks as a result of energy market deregulation laws that include incentives for renewable energy production. As a result, much research has been conducted to analyze issues concerning DG market access, such as locational fixed costs, the long-term implications of feed-in tariffs, and a carbon tax strategy forsystemcost-effectiveness.ManystrategieswereproposedconcerningtheconnectionofDGs to the networks. A strategy proposed a fair and equitable electricity tariff for the calculation of the distribution network usage fee. Another one suggested providing DGs with an incentive to locatethemselvesinthemostneededareasofthenetwork.Optimizationtechniqueswereutilized for the optimization of the insertion of DGs into the network. The voltage is effect, particularly in weak distribution networks, is the most critical factor restricting the capacity of connected DGs.

II LITERATURE REVIEW

Several research papers and articles have focused on reactive power control and its role in voltage regulation. Some of the most notable studies highlight the use of traditional control methods, such as capacitor banks, synchronous condensers and static VAR compensators, but these systems often require manual intervention or are not responsive in real-time.

Recent advancements have incorporated smart grid technologies, where IoT devices are used to monitor and control voltage fluctuations remotely. Studies have demonstrated that IoT-based systems, combined with microcontrollers such as Arduino, can offer real-time data monitoring, automation, and improved control over power systems.

Moreover, research on communication protocols for IoT in electrical systems shows the importance of low-latency, reliable data transmission for optimal reactive power control. The integration of sensors, actuators, and cloud computing in IoT-based systems provides a promising approach to solving power quality issues.

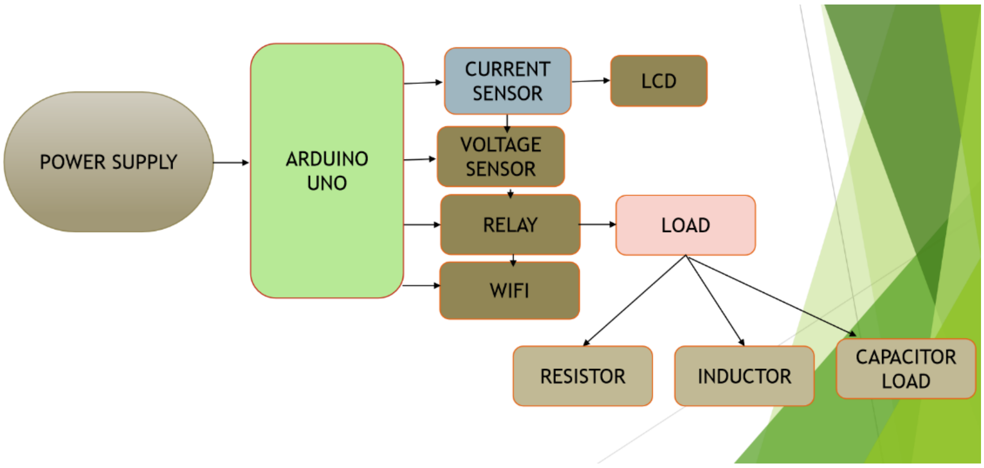

Figure2: Basic block Diagram

The diagram in the image represents a Basic Block Diagram of an IoT-based power control system using an Arduino Uno microcontroller. It illustrates the connection between different components, including:

Power Supply: Provides the required voltage to the system.

Arduino Uno: The central processing unit that manages various sensors and relays.

Current Sensor & Voltage Sensor: Measure electrical parameters.

Relay: Acts as a switch to control power flow.

WiFi Module: Enables communication for IoT applications.

LCD: Displays real-time data.

Load Components: Includes resistor, inductor, and capacitor load, representing different types of electrical loads.

This setup is likely used for monitoring and controlling power quality and load management in an IoT-based electrical system.

III CIRCUIT DESIGN

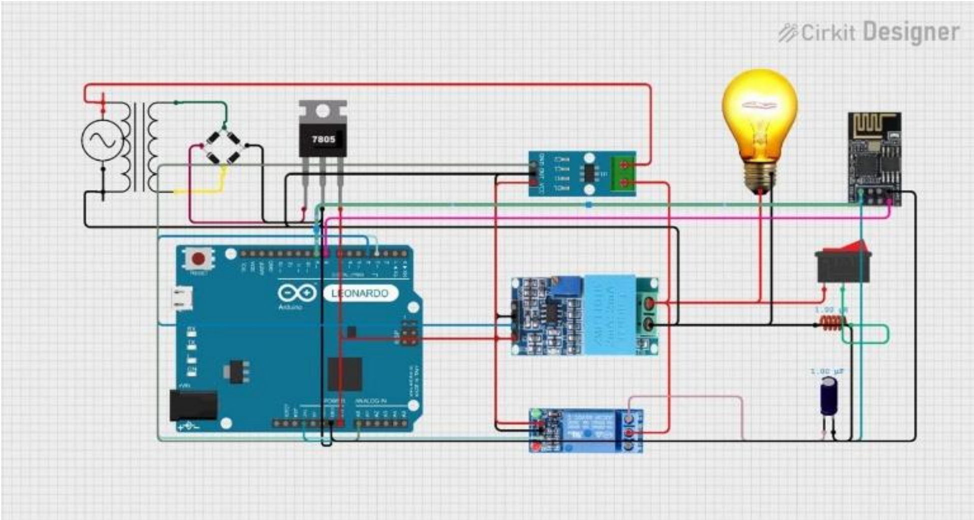

Figure 2:Iot based Reactive Power Control for Voltage Regulation using Arduino

A. METHADOLOGY

The circuit diagram illustrates an IoT-based reactive power control system for voltage regulation using Arduino. It integrates sensors to monitor voltage and current, a relay for switching, and a transformer for voltage adjustment. The system processes data through Arduino, enabling real-time control and monitoring via WiFi and an LCD display. Using Simulink modeling, it simulates power flow dynamics and analyzes the impact of load variations. The IoT integration allows remote monitoring, ensuring efficient power regulation and reliable microgrid operation.

IV RESULT ACHIEVED

Figures 3 to Figures 7 show various stages of our practical kit outputs

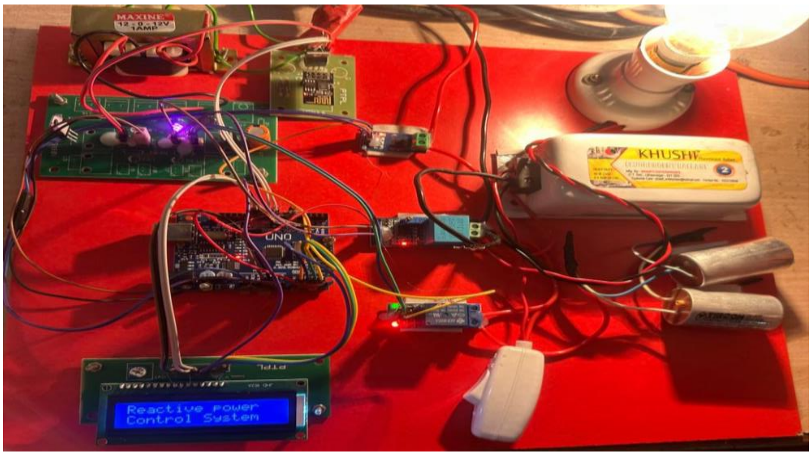

Figure 3. When Power supply is turned ON

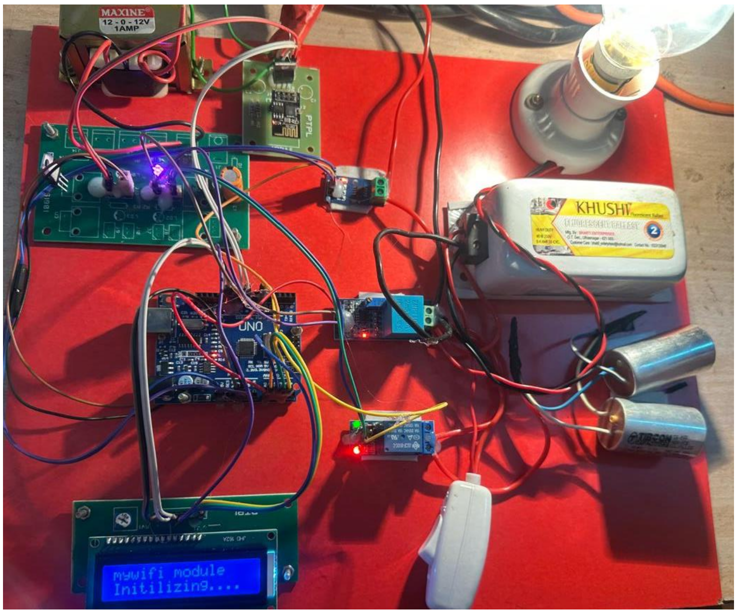

Figure 4: Wifi module start initializing

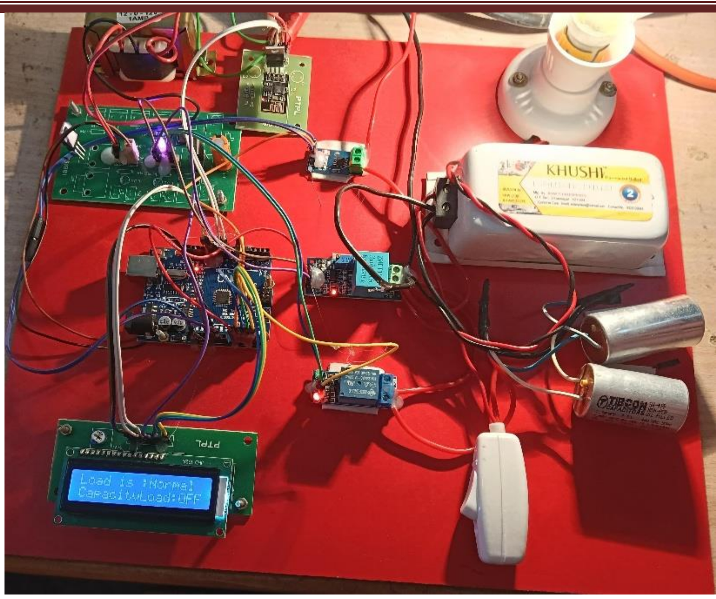

Figure 5. When resistive load is added

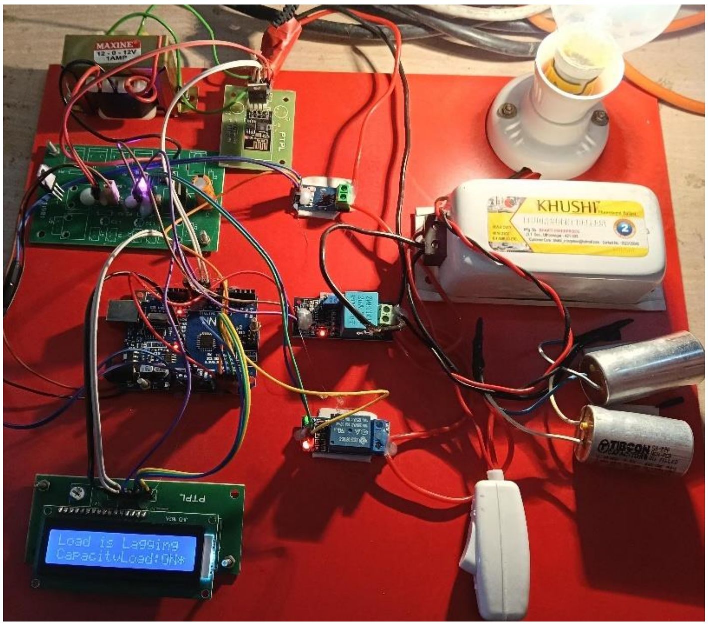

Figure 6 . When inductor is turned ON, capacitor compensates lagging P.F

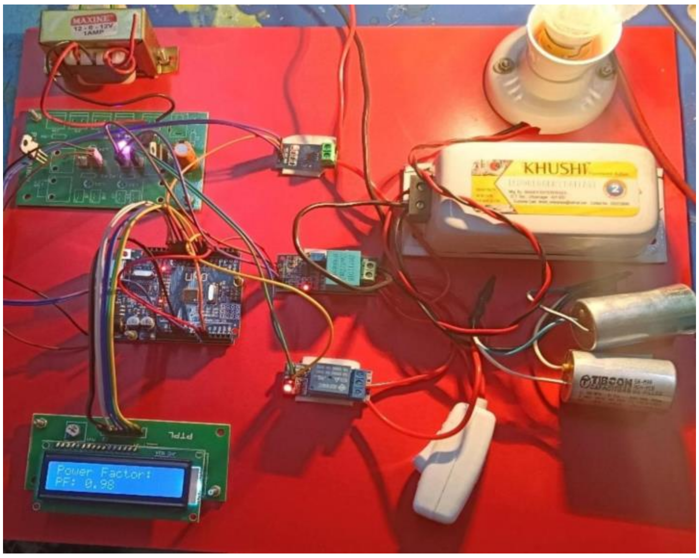

Figure6a. Power Factor comes to unity

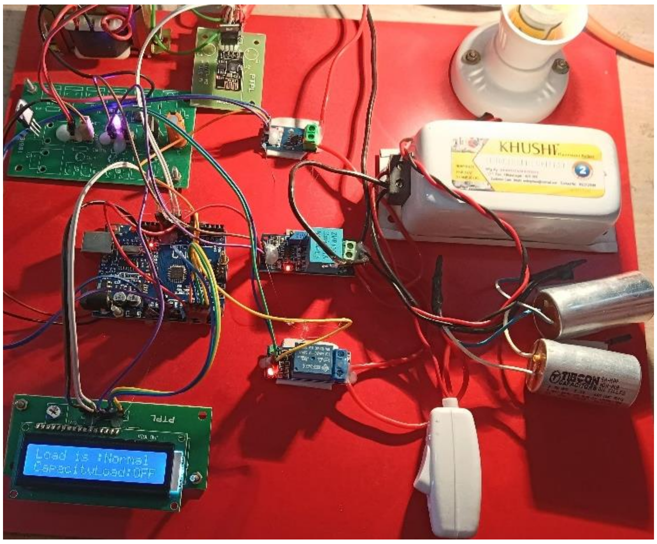

Figure 7. Capacitor turned off after compensation

Figure 7 displays that the lagging power factor of motor load is compensated by the capacitor load to get unity power factor using Arduino microcontroller.

V CONCLUSION

In conclusion, the implementation of an IoT-based reactive power control system using an Arduino platform successfully demonstrated its effectiveness in voltage regulation within electrical power systems. The system's ability to dynamically respond to load variations and voltage fluctuations improved overall grid stability while leveraging IoT technology for real-time monitoring and control. The experimental results validated that the proposed approach efficiently adjusted reactive power to maintain optimal voltage profiles, highlighting the feasibility of using low-cost microcontroller-based solutions for modern power systems. This project underscores the potential of IoT integration in power system automation, offering a scalable and efficient solution for enhancing grid reliability and performance.

ACKNOWLEDGMENT

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