Application of Arduino for Current Sensorless Self Regulated Power Factor Correction

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Abstract:
It is well known that the power factor (PF) will decrease as inductive loads are introduced to the market. If the PF drops, the price of electricity will increase. Our system's automated capacitor sets are activated when the PF drops, and they restore the PF to a predetermined level. Our research is distinctive in that an IoT (Internet of Things) technology was employed to carry it out. In addition to monitoring from the research work display, it will be able to monitor and control the research work from any location on the Internet. An Arduino Uno Microcontroller has been used as the programming tool. The PF can be improved to boost equipment voltage, increase current carrying capacity, reduce power losses, and lower electricity costs. PF correction capacitors are reactive current generators. By balancing the nonworking power used by inductive loads, we help to raise the PF. The PF of a load is measured in this article using an Arduino Uno microcontroller, after which the required capacitors are triggered to account for reactive power and bring the PF closer to unity.

Keywords:
Arduino Uno, power factor, active power, reactive power, voltage converter, relay module.

1. Introduction:

Electrical energy efficiency is highly valued by industrial and commercial businesses competing in today's cutthroat markets. The most effective use of plants and equipment is one of the main issues that businesses work to resolve with regard to vitality effectiveness for both justifiable and environmentally friendly reasons. Because everyone can do it, tumbling energy use is a goal that is becoming more and more important as society becomes more concerned with protecting the environment. Utilizing measurements like electricity usage to optimise PF adjustments leads to lower energy consumption and CO_2 greenhouse gas discharges. However, its application depends on the fixing's size and the range for which the factor of power adjustment is necessary. Automatic PF adjustment procedures can be worn in power systems, industrial units, and even homes by maintaining the system's dependability.

As a result, the system develops more steadily and the efficiency of the structure and apparatus increases [3].

To address issues with reactive power supervision and power savings, capacitor sets for single phase use in industry and residential solicitations were created. Building a microprocessor-based control system to enhance and advance the operation of single phase capacitor sets is the aim of the research work. The control unit will manage the capacitor set. The current converter, which is used frequently to measure the load current for the sampler, is crucial to this process. We completed our research using IoT (Internet of Things) technology, which makes it special. In addition to observing from the research work display, we will be capable to control and monitor the research work from anywhere via the Internet. The intelligent control of this microcontroller control unit ensures even capacitor step use, which lowers the quantity of switching tasks and enhances PF correction [2].

The main objective of this plan is to create a system for spontaneous PF control in order to create a smart system that will enable us to gain multiple benefits from a single endeavour. (a) Monitoring the load PF continuously enhances the power quality. (b) Build a correction device of the Arduino Uno type to increase the system PF to the desired level close to 0.95. (c) To lessen the punishment. (d) To catch the anomaly in advance of it happening. (e) Using the IoT, use an online programme to monitor the system's parameters. A system for examining and adjusting IoT devices.

2. Literature Survey:

A new topology is proposed by Shirly and her team to automatically improve the PF by injecting the reactive power produced by the capacitor array connected with a load. Shirly and her team investigate the various PF correction techniques used in industrial loads. They failed to provide the correct circuit diagram for their research work and instead used a PWM inverter and dynamic compensation [5]. K. Naresh et al. present a model for a spontaneous PF correction (SPFC) scheme for 1 phase native loads that is simple and cost-effective. They carried out research that was distinct from ours by using opt couplers and capacitive loads [6]. To reduce power loss in the industry, M. Siva sai Prasad et al. primarily promoted using PF correction via a large number of by-pass capacitors. The cost of their work was reduced, but cost analysis was not mentioned [7]. Nanda.P.1, Sunil Rathod discussed the drawbacks of a lagging PF, the benefits of improving it, the working method, and its potential future applications. The results section was not clearly displayed in their paper, but it is now [8]. A model for PF adjustment was put forth by Balamurugan K. and Gowsika M. [9] and used SEPIC and boost converters.

The simple Arduino Uno, relay module, ESP8266 wifi module, simple Blynk server and app, and some basic equipment have been used in this paper to plan a low-cost hardware and software model. Our next improvement will be to take the PF value higher than 0.95.

3. PF Control Design:

Spontaneous PF Revealing and Correction operates on the standard of continuously monitoring system PF and initiating necessary corrections if the PF falls below a predetermined value. The voltage and current signals are sampled using instrument transformers connected in the circuit. These instrument transformers provide stepped-down current and voltage values that correspond to the voltage and current diagram. The zero overpass detection, which changes state at every zero-crossing point of the voltage and current measurements, converts these recorded analogue indicators to appropriate digital signs. [10].

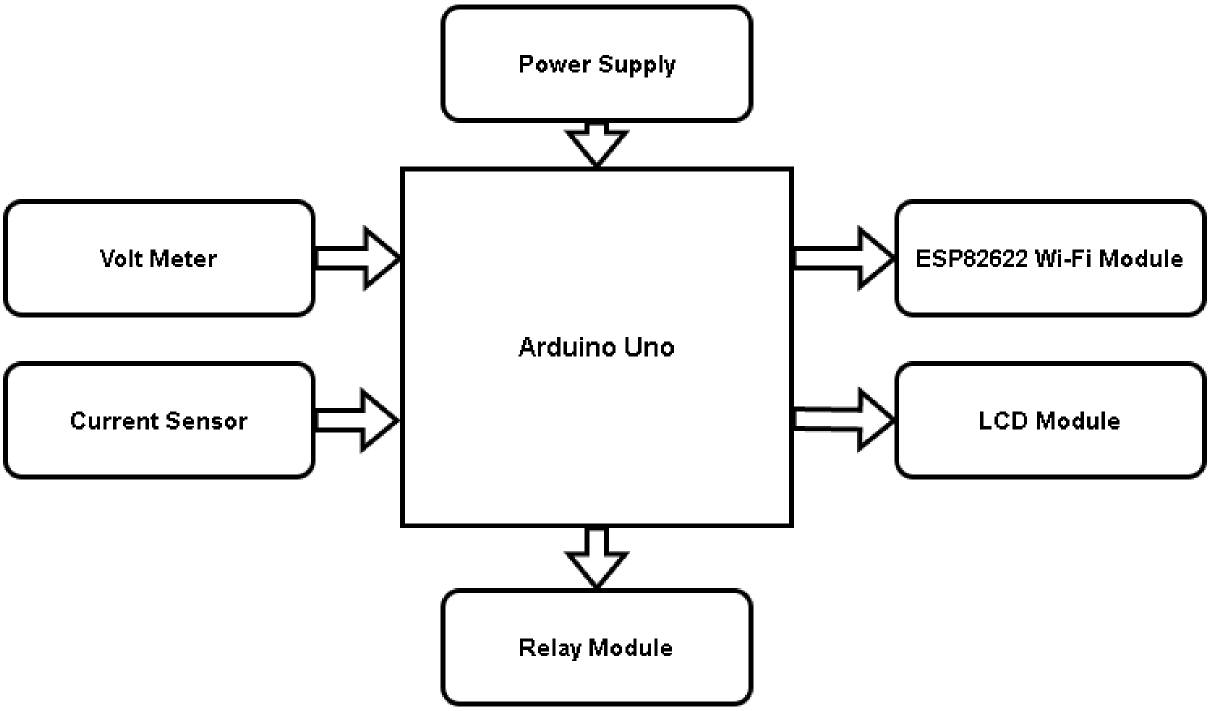

Figure 1. Block Diagram

In this projected system, the Arduino Uno development board, sensor, and Wi-Fi module were used. This study's system is entirely powered by electricity. The primary goal of IoT-based Self regulated PF Control. The block diagram above depicts the current sensor, voltage sensing system, LCD, relay module, and Wi-Fi module. The sensor's output is monitored by the microcontroller, which sends a signal to the IoT system circuit, which controls the applications.

Figure 2 depicts a circuit created with an Arduino Uno. Here, the voltage was reduced and worked with some basic equipment such as a register, a current sensor to measure current, and a capacitor to improve the PF system to measure the line voltage. A LCD has been attached to monitor the output data, and a Wi-Fi module has been used to control and monitor over the internet. Loads will be restrained using relays, and an Arduino Uno will be used as a programming device [11].

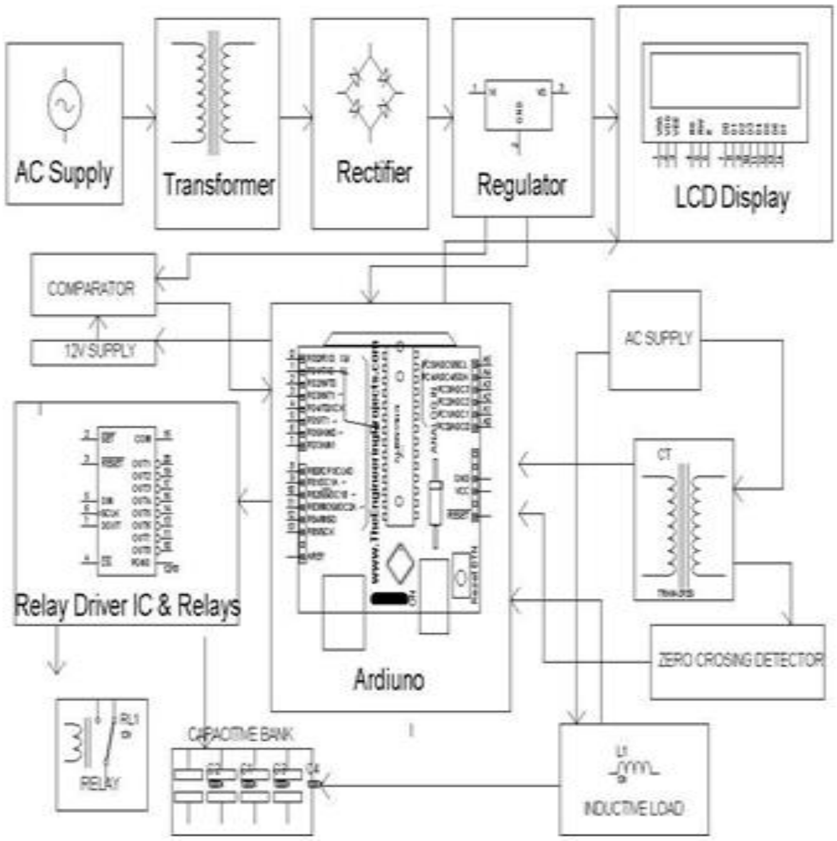

Figure 2. Arduino-based PF correction circuit

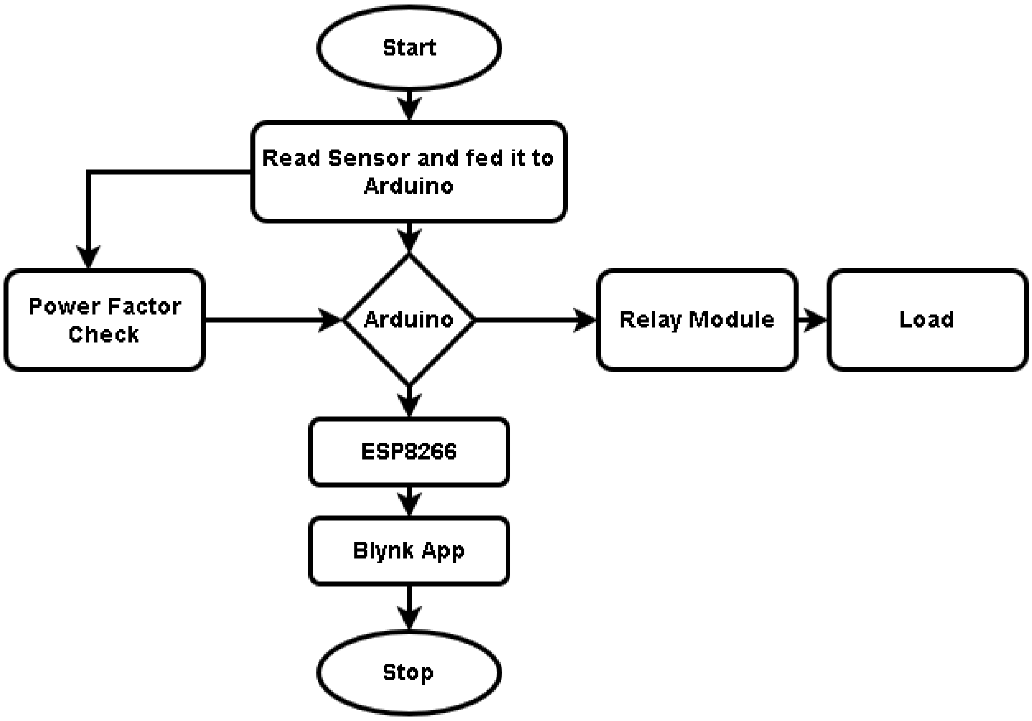

Figure 3. Flow Chart

The LM2596 voltage converter is a group of uniform integrated circuits that perform all active operations for a step-down switching controller capable of motivating a 3-A load through good line and load control. There are three stable output voltages available: 5 V, 3.2 V, and 12 V, as well as a modifiable output version. The ESP8266 is a low-cost Wi-Fi chip that includes both a full IP stack and a microcontroller. A relay, which is an electrically powered device, was also used.

It has both a control and a controlled system (also known as an input circuit) (also called an output circuit). A current sensor chip with an ACS712ELC-30A rating was also used to calculate the output current value. The output voltage is Vcc/ 2 because there is no test current. A capacitor set is a grouping of similar or non-identical capacitors that are connected in series or parallel. These capacitor assemblies are naturally used to rectify or counteract adverse characteristics of an alternating current electrical power supply, such as power lagging or phase shifting [12- 19].

To simulate the circuit, Proteus 7.0, a Simulated Arrangement Modeling that integrates circuit model, active apparatuses, and microprocessor copies to co-simulate entire microcontroller-based designs, was used [24]. This application allows users to intermingle with the scheme through onscreen indicators, LCDs, and controls and keys if a PC is connected. Circuit Simulation, one of Proteus 7.0's primary tools, is a tool that combines a SPICE3f5 analogue trainer with a digital simulator, allowing users to use any SPICE model from any vendor [25-27].

Results and Discussion:

If Q enters the entrance after we give power to our research work, the research work will begin. Only when the inductive load is turned on will the PF fall. When the PF in this system falls under a certain level, the automatic capacitor bank is activated, and the PF is restored. The display on the research work and IoT system allows us to monitor it. We will be competent to observer all of our research data, including voltage, current, and PF, on a single display. We can control and monitor the connected loads from anywhere using the internet.

Figure 4. Hardware

Figure 5. Result

We can control the PF to 0.83 in this work, which is very effective in the power sector. We can continuously control this PF through our work and reduce voltage losses.

Conclusion:

PF adjustment is critical in conserving energy in this climate in order to save further energy for the future. As a end result, this article describes a system that uses IoT to continuously analyse several aspects of an induction motor and update the data on a webpage. We manage the PF to 0.83, which is exceptional in this environment, and if a fault occurs, the device sends an alarm message to the person responsible for the problem, and an electrical relay is activated. Because the PF decreases as the inductive load increases, this system includes a method for increasing the PF by swapping the capacitor banks. The ultimate goal is to develop Spontaneous PF Adjustment.

Load change units that can continuously monitor an induction motor's energy consumption and increase its PF. It will aid in the reduction of penalties associated with poor PF and services in the preservation of induction motors, as well as the identification of issues prior to failure. Under testing load conditions, the PF component increased the PF from 0.77 to 0.96. With a variety of loading conditions, the average power consumption savings were around 1.65% of the intended load. When the current drawn is reduced, the system capacity is freed only with the precise amount of PF correction. Conferring to the economic study, the payback period would be about 9 months, with significant energy cost savings.

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