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# Real-Time Auto 3 Phase Load Balancing System with IoT Integration

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**Abstract**: *In modern electrical distribution systems, maintaining equal load across three phases is essential to ensure stability, efficiency, and safety. However, unequal load distribution is a common issue that leads to voltage fluctuations, excessive losses, overheating of conductors, and potential damage to connected equipment. To address this challenge, the Real-Time Auto Three-Phase Load Balancing System Integrating IoT has been designed.*
*The system continuously measures the current in each phase using current sensors and detects any imbalance through the ATmega2560 microcontroller. When an overload is identified on a particular phase, the controller activates relay circuits to transfer a portion of the load to a phase with lighter loading, thus maintaining equilibrium across all three phases..*

**Keywords**: Three-Phase Load Balancing, Real-Time Monitoring, Smart Power Distribution

## I. INTRODUCTION

All electrical energy is divided into three phases: generation, transmission, and distribution. After the electrical energy has been sent to the sub-system, the following step is to distribute it to all of the consumers.
In this work, a three-phase load balancing technique combining microcontrollers, switching relays application is employed to balance three-phase loads. When overloading occurs, this strategy focuses on automatic load balancing and shifting/sharing of loads between phases. The load is automatically shifted via relays, which feed all three lines with power. In this proposed approach, the energy utilized on each line will be the same.
In most distribution networks, the load distribution is uneven, resulting in phase imbalance. Such imbalance leads to overheating, voltage fluctuations, increased system losses, and potential damage to electrical equipment

## II. PROBLEM STATEMENT/ OBJECTIVE

The main objective of this project is to design an intelligent system that can automatically monitor and balance the load across all three phases in real time. The system aims to maintain equal load distribution to improve efficiency, stability, and safety of the electrical network.
Increased losses
Overheating of transformers
Voltage imbalance
Reduced equipment life
The main objective of this project is to design and develop an automatic three-phase load management system that can continuously monitor and balance the load across all three phases in real time.
During load unbalancing, the proposed system will automatically shift the load from the overloaded phase to the underloaded phase to maintain equal distribution and ensure stable operation.
The Cloud application or server acts as an Internet of Things **(IoT)** platform capable of connecting and controlling microcontroller-based devices like Arduino, Node MCU, or ESP32. This platform provides functionalities such as equipment control, real-time data storage, and graphical display of sensor data.
In the future, Artificial Intelligence **(AI)** can be integrated into the system to analyze load data and predict overload conditions in advance, allowing preventive action and improving system reliability.


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## III. PROPOSED METHODOLOGY

**Data Sensing**

Current sensors (CT sensors) are installed in all three phases (R, Y, B).
These sensors continuously measure the load current of each phase.

**Data Processing**

The sensed data is sent to a microcontroller (Arduino/ESP32).
The controller compares the current values of all three phases.
If the difference between phases exceeds a preset limit, it detects **load imbalance.**

**IoT Integration**

The system is connected to an IoT platform via Wi-Fi (ESP32).
Real-time data (current, voltage, status) is sent to the cloud.
Users can monitor and control the system remotely using a mobile app or web dashboard.

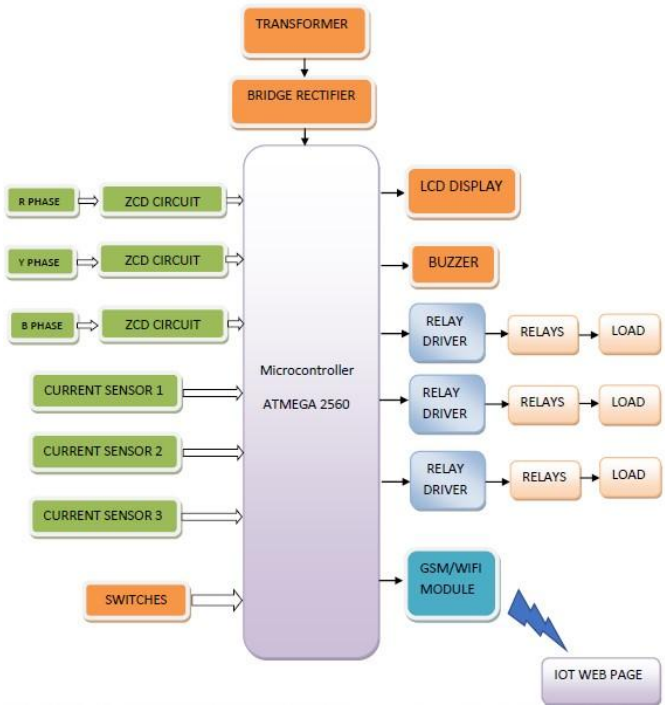
**Safety & Protection**

Overload and short-circuit protection is included.
Alerts/notifications are sent through IoT if abnormal conditions occur.

**Monitoring**

Users can monitor:
Phase currents
Voltage levels

## IV. BLOCK DIAGRAM



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## V. CONCLUSION

Domestic load is single phase while connected to three phase distribution network The three phase distribution system suffers from unbalancing due to overloading of one phase as comparing to the remaining two phases. To overcome this problem, distribution system requires equal sharing of load on each phase.

When equal sharing is obtained, due to which in 3-pahse unbalancing, energy losses, overload situation and return current flow in neutral is reduced. The automatic three phase load balancing system is possible by the proposed hardware which is micro-controller and relay based hardware. The hardware is installed in the incoming of three phase lines and will accordingly switch the domestic load to the least crew. loaded phase using fast switching relays.

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