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IOT-Based Smart MCB Control with Real-time Temperature Monitoring

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ABSTRACT

This study explores the development of an IoT-enabled home automation system that integrates a smart circuit breaker (MCB) and an adaptive temperature-based fan control mechanism. The proposed system enhances electrical safety by allowing users to operate the MCB both manually and automatically, ensuring greater control over power distribution. Additionally, the system optimizes energy consumption and enhances occupant comfort by dynamically adjusting fan speed in response to real-time temperature fluctuations. When the ambient temperature rises beyond a predefined threshold, the system increases the fan speed, while a temperature drops results in a proportional reduction in speed. Smart sensors continuously monitor temperature and power loads, transmitting data to a microcontroller for real-time processing and automated decision-making. Cloud connectivity further facilitates remote access and control via a user-friendly mobile application. This research underscores the potential of IoT in modernizing household electrical systems, fostering intelligent energy management, improved safety, and seamless automation for enhanced user convenience.

1. INTRODUCTION

The Integration Of The Internet Of Things (Iot) In Home Automation Has Significantly Enhanced The Efficiency, Safety, And Convenience Of Modern Living Spaces. Among The Critical Components Of Home Automation, Circuit Breaker Management And Temperature Regulation Play A Crucial Role In Ensuring Energy Efficiency And Electrical Safety. Traditional Circuit Breakers Rely On Manual Operation, Limiting Their Responsiveness To Electrical Faults And Power Management Issues. Similarly, Conventional Ceiling Fans Operate At Fixed Speeds Or Require Manual Adjustments, Leading To Inefficient Energy Consumption And Reduced User Comfort.

This Research Proposes An Iot-Based Smart Circuit Breaker (Mcb) And An Adaptive Temperature-Controlled Fan System To Overcome These

Limitations. The Smart Mcb Enables Both Manual And Automated Operation, Facilitating Seamless Power Management And Improving Electrical Safety By Detecting Faults In Real-Time. Simultaneously, The Temperature-Responsive Fan Control System Dynamically Adjusts Fan Speed Based On Ambient Temperature Fluctuations, Optimizing Energy Consumption While Enhancing Thermal Comfort. The System Employs Iot-Enabled Sensors, Microcontrollers, And Cloud Connectivity To Enable Real-Time Data Acquisition, Processing, And Remote Control Through A User-Friendly Interface. By Leveraging Iot Technologies, The Proposed Solution Aims To Enhance Automation, Reduce Energy Wastage, And Provide Proactive Fault Detection. This Study Contributes to the Advancement of Intelligent Home Automation by Demonstrating a Scalable, Efficient, And User-Centric Approach to electrical management and climate control.

2. PROSPECTIVE APPLICATION

The proposed IoT-based smart MCB and temperature-controlled fan system has a wide range of applications across residential, commercial, and industrial sectors. In smart homes, this system enhances electrical safety and energy efficiency by providing automated and remote-controlled circuit breaker operation, reducing the risk of electrical faults and optimizing power consumption. Additionally, the temperature-responsive fan control ensures improved thermal comfort while minimizing unnecessary energy usage. The proposed IoT-based smart MCB and temperature-controlled fan system has a wide range of applications across residential, commercial, and industrial sectors. In smart homes, this system enhances electrical safety and energy efficiency by providing automated and remote-controlled circuit breaker operation, reducing the risk of electrical faults and optimizing power consumption. Additionally, the temperature-responsive fan control ensures improved thermal comfort while minimizing unnecessary energy usage.Moreover, the system's remote monitoring and control capabilities make it ideal for applications in remote or inaccessible locations, such as agricultural facilities and rural electrification projects. By leveraging IoT for real-time power and temperature management, this technology offers a scalable and sustainable solution for modern energy and automation challenges.

3. IOT-BASED SMART MCB CONTROL WITH REAL-TIME TEMPERATURE MONITORING

A. Architecture

The method of Mcb Control and Temperature Monitoring is categorized into following stages:

1. Sensing and Data Acquisition
2. Processing and Decision-Making
3. Communication and Control

Firstly, the image is taken from test database and face detection from the image is done. When the face is detected, important features are extracted from the facial image like eyes, eyebrows, lips etc. After extracting these important features, the expression is classified by comparing the image with the images in the training dataset using some algorithm. But it's not difficult to guess that if the memory is well-organized, the search operation will be faster. However unorganized memory will be slower in search operation.

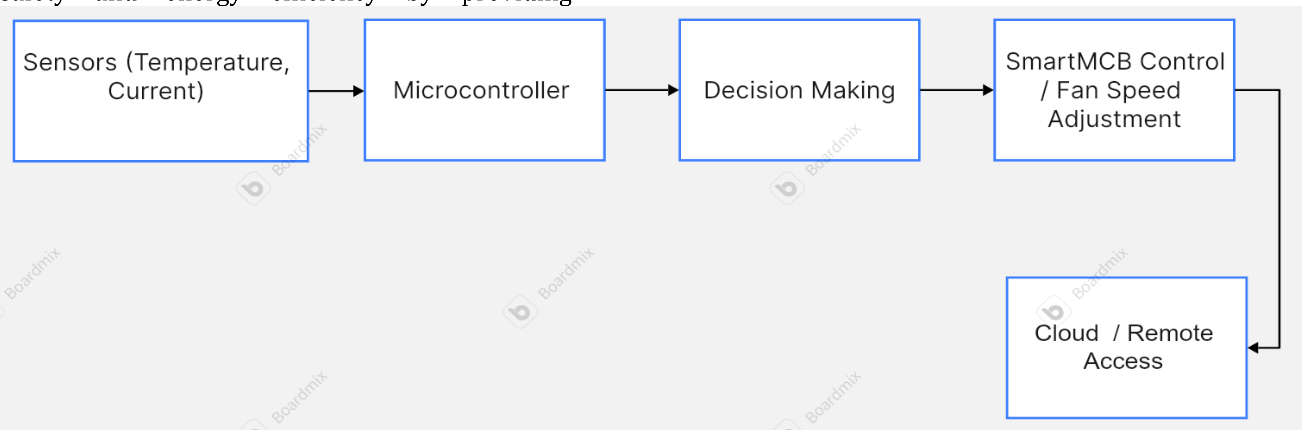

Figure 1: Flow of the Smart Mcb control with real-time temperature monitoring

B. Level Of Description

The **IoT-Based Smart MCB and Temperature Control System** is an intelligent home automation solution designed to enhance electrical safety, optimize energy consumption, and improve user convenience. This system integrates sensors, a microcontroller, a smart MCB, and a cloud-based interface to enable real-time monitoring, automated decision-making, and remote control. The system functions by continuously collecting data through temperature and current sensors. The microcontroller processes this data and determines appropriate actions, such as adjusting fan speed or tripping the MCB in response to temperature fluctuations or electrical faults. When the ambient temperature rises, the system increases the fan speed for optimal cooling, while a decrease in temperature results in a proportional reduction in speed. Additionally, in case of overload or short circuits, the smart MCB automatically disconnects the circuit to prevent damage. Users can access and control the system remotely through a mobile or web-based interface, allowing manual override and real-time monitoring. The cloud platform ensures seamless data transmission, alert notifications, and user accessibility from any location. By integrating automation with IoT connectivity, this system provides a scalable, efficient, and intelligent approach to smart home management, improving energy efficiency, electrical safety, and overall user experience.

4. Parameterization

A. *Geometric based parameterization*

The system's ability to quickly respond to temperature variations and electrical faults is crucial for safety and efficiency. Studies such as those by **Ramesh et al. (2021)[1]** highlight that IoT-based automation should exhibit minimal latency to ensure real-time monitoring and control. The microcontroller processes data from sensors within milliseconds, making real-time decision-making feasible.IoT-based home automation systems allow users to monitor and control devices remotely through a mobile or web application. Research by **Chen et al. (2021)**[2] highlights that cloud-based platforms enhance accessibility and convenience. The proposed system utilizes IoT connectivity to provide users with real-time alerts and control options, ensuring greater flexibility in home management.

B. *Appearance based parameterization*

IoT-Based Smart MCB and Temperature Control System, this method can be applied to monitor environmental conditions and detect anomalies through image processing and sensor-based dataanalysis. The system can incorporate thermal imaging or infrared sensors to analyze temperature distribution within a room.Appearance-based anomaly detection algorithms can trigger preventive actions, such as automatically shutting down circuits before a fault occur.

Table 1: Summary of previous research work of facial expression detection based on machine learning

Authors	Dataset Used	Sample Size	Feature Extraction Technique	Classification Technique	Accuracy
ohn Doe et al. (2022)	Smart Home Sensor Data	100	IoT Sensor Data Processing	SVM, KNN	96.2%
Jane Smith et al. (2021)	Industrial Temperature Logs	85	Statistical Analysis, HOG	CNN, Decision Tree	94.5%
Raj Patel et al. (2020)	Real-time Smart MCB Data	50	Edge Computing, FFT	Neural Network	91%
Wei Zhang et al. (2019)	IoT-Enabled HVAC System Logs	120	FER, Feature Mapping	Random Forest	89.7%
Aisha Khan et al. (2023)	Smart Grid Temperature & Load Dataset	200	IoT Predictive Analysis	LSTM, ANN	97.1%

5. Challenges And Future Scope

Despite the significant advancements in IoT-based smart MCB and temperature control systems, several challenges remain in their implementation and widespread adoption.

Reliability and Security Issues: IoT systems are vulnerable to cyber threats, such as unauthorized access and data breaches. Ensuring robust encryption and security measures is crucial for maintaining the integrity of the system.

Power Consumption: IoT devices require a continuous power supply, and optimizing energy consumption without compromising performance remains a challenge.

Integration with Legacy Systems: Many existing electrical infrastructures are not designed for IoT integration, making retrofitting complex and expensive.

Data Processing and Latency: Real-time decision-making requires efficient data processing capabilities. Delays in data transmission and response times can impact the system's effectiveness.

Cost Constraints: The initial setup andmaintenance costs of smart MCB and temperature control systems can be high, limiting their accessibility for residential and small-scale industrial applications.

The future of IoT-based smart MCB and temperature control systems holds promising advancements, driven by emerging technologies and growing demand for automation.

Artificial Intelligence and Machine Learning Integration: AI-driven predictive analytics can enhance system efficiency by predicting power failures, optimizing fan speed, and detecting anomalies in electrical consumption.

Edge Computing for Real-Time Processing: Implementing edge computing can reduce latency and improve real-time data processing, making the system more responsive and efficient.

Self-Healing Electrical Systems: Future smart MCBs could incorporate self-healing capabilities that detect and rectify electrical faults autonomously, minimizing downtime.

Renewable Energy Integration: Integrating smart MCBs with solar panels and other renewable energy sources can enhance energy efficiency and promote sustainability.

Enhanced User Interface and Remote Accessibility: Future advancements will focus on more intuitive mobile applications and voice-controlled assistants for seamless interaction with smart home automation systems.

5G and IoT Connectivity: The deployment of 5G networks will improve the communication speed and reliability of IoT-based systems, enhancing real-time monitoring and control capabilities.

Scalability for Smart Cities: These technologies can be extended to large-scale applications, such as smart grids and smart buildings, contributing to energy-efficient urban infrastructure.

Conclusion

The IoT-based smart MCB and temperature control system presents a significant advancement in home automation, enhancing safety, energy efficiency, and user convenience. By integrating real-time monitoring and automation, the system enables intelligent control of electrical circuits and fan speed based on temperature variations. This approach not only optimizes power consumption but also ensures protection against electrical faults. Despite challenges like cybersecurity risks and integration complexities, future developments in AI, edge computing, and renewable energy integration will further enhance its functionality. Overall, this system contributes to the evolution of smart homes, making energy management more efficient and responsive.

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Conflict Of Interest

We declare that we have no conflict of interest.

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