INC15

Development of a Ceiling Fan Control System with Energy Monitoring and Data Logging

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Abstract

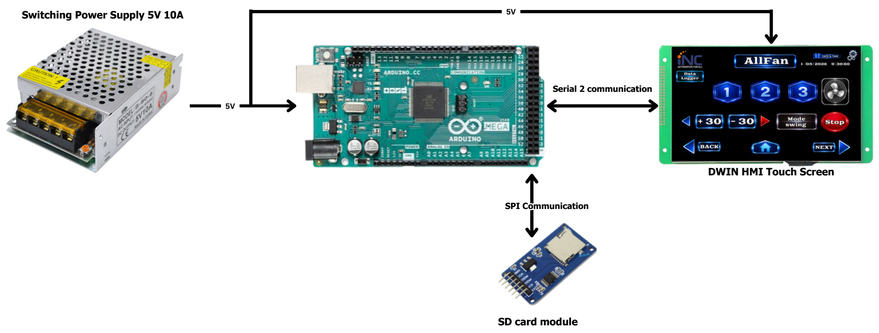
Ceiling fans in the 6th and 7th-floor corridors currently suffer from inefficient control and a lack of energy management. The conventional switch-based system requires manual operation for each fan, leading to inconvenience and wasted energy. To address these issues, this project develops a centralized ceiling fan control system featuring energy monitoring and data logging. The system utilizes a microcontroller and a touchscreen HMI, enabling users to manage all fans (ON/OFF, speed, oscillation, and timers) from a single display.

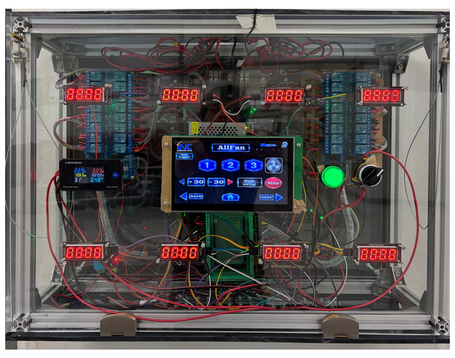
Additionally, integrated energy sensors measure real-time power consumption, logging the datato a MicroSD card. Experimental results demonstrate that this developed system effectively streamlines multi-fan control and provides critical

energy data to support energy-saving initiatives and preventive maintenance.

Project Overview

This project addresses the inefficient manual control and lack of energy management of ceiling fans in the 6th and 7th-floor corridors. By replacing conventional switches with a centralized system, we enhance user convenience and eliminate energy waste. The system is divided into three main components:





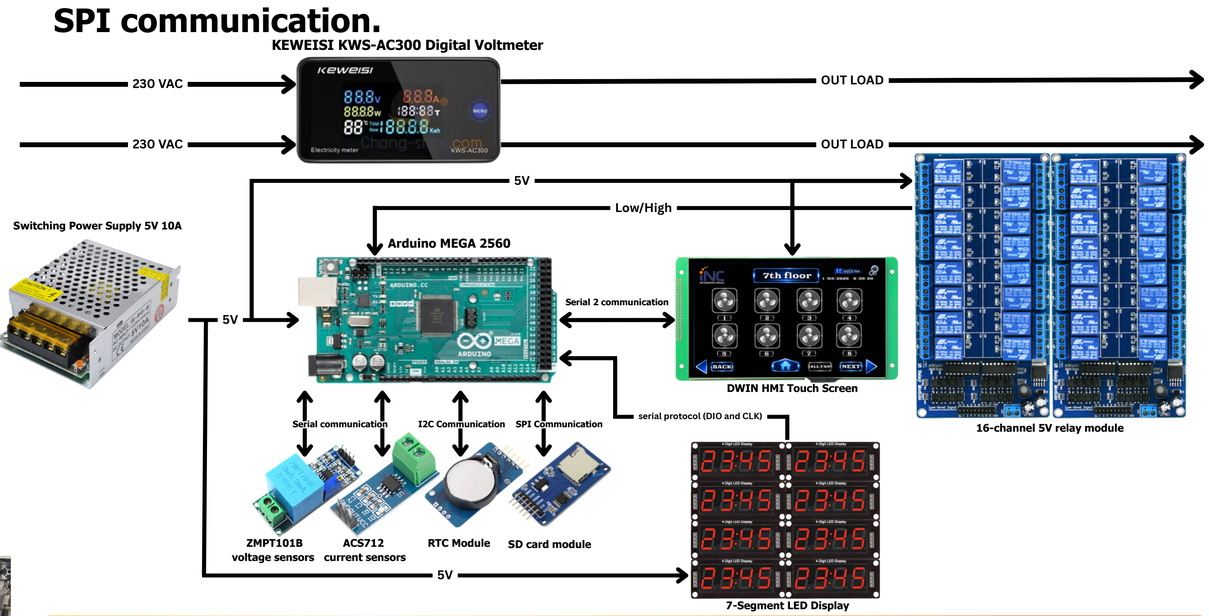
- **Human-Machine Interface (HMI): A centralized 7-inch DWIN touchscreen replaces traditional push-buttons, allowing users to control all fans (ON/OFF, speed, oscillation, timers) and view real-time energy usage from a single display.**
- **Controller & Processing Cabinet: Powered by an Arduino Mega 2560, this core unit receives user commands, processes sensor data, controls relay modules, and systematically logs energy data to a MicroSD card.**
- **Fan & Sensor Unit: Equipped with ZMPT101B voltage sensors and ACS712 current sensors, this unit continuously measures electrical parameters.**

Timestamp	Voltage (V)	Current (A)	Active Power (W)	Power Factor	Energy (kWh)	Status
2026-05-02 12:00:00	230.1	0.45	89.5	0.86	0.022	ON
2026-05-02 12:15:00	230	0.46	90.1	0.85	0.044	ON
2026-05-02 12:30:00	230.2	0.32	60.5	0.82	0.059	ON
2026-05-02 12:45:00	230.1	0.31	59.2	0.82	0.074	ON
2026-05-02 13:00:00	230	0	0	0	0.074	OFF
2026-05-02 13:15:00	230.1	0	0	0	0.074	OFF

Key Results: The system effectively streamlines multi-fan control and provides critical energy data to support energy-saving initiatives and preventive maintenance.

Method

Data AcquisitioThe system architecture is designed for precise measurement and centralized control. For data acquisition, the system measures AC voltage and current using the integrated sensors, and the analog signals are processed by the Arduino Mega 2560 using discrete-time True RMS calculations to ensure accurate measurement for inductive loads. The control mechanism relies on the microcontroller sending digital signals to a 16-channel 5V relay module, which operates alongside dual capacitors (4 µF and 5.4 µF) to regulate fan speed and control oscillation. The DWIN resistive touch screen communicates with the Arduino via UART to display real-time parameters such as voltage, current, power, and energy while receiving touch commands. Furthermore, an RTC DS3231 module provides accurate timestamps so that the measured electrical parameters can be reliably saved to a MicroSD card in CSV format via SPI communication.



Results

The system was tested under real operating conditions to verify both control functionality and measurement accuracy. Testing confirmed that the microcontroller and the 16-channel relay module successfully operated multiple fans simultaneously, handling speed levels 1 to 3 and oscillation without failure. In terms of measurement accuracy, the energy monitoring system demonstrated reliable precision when compared to a standard digital multimeter, showing minimal measurement error for both voltage and current readings. For data logging and visualization, the system successfully logs daily accumulated energy data, which is then visualized on the HMI screen as a bar chart, allowing for a clear analysis of historical energy consumption trends for up to 31 days

Conlusion

The development of the 3rd generation ceiling fan control system effectively resolved the physical and functional limitations of the previous switch-based models. By integrating a centralized touchscreen HMI and True RMS energy monitoring, the system provides a more organized, user-friendly, and efficient solution. The ability to log accurate power consumption data lays the groundwork for better energy management and preventive maintenance within the department building.

Reference

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