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Single-Phase Induction Motor Control Panel

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Abstract: This research paper presents the design and implementation of a Single Phase Induction Motor Control Panel using Arduino technology. The control panel integrates various components such as connecting wire, DP Pole MCB, connector, AC voltage sensor, current sensor, power supply sensor, Arduino Uno, temperature sensor, and float sensor. The Arduino serves as the central control unit of the panel, enabling precise measurement and control of voltage, current, and temperature. The panel is designed for portability and ease of use, making it suitable for educational purposes and practical experiments in motor control applications.
Keywords: Single-phase induction motor, Control panel, Control strategies, Starting mechanisms, Speed control

I. INTRODUCTION

The integration of technology into physical objects has revolutionized various industries, enabling objects to respond to human presence, motion, and other automatic physiological behaviours. In line with this trend, the paper introduces a Single Phase Induction Motor Control Panel utilizing Arduino controller. The panel comprises several essential components, with Arduino serving as the core control unit. By leveraging Arduino's capabilities, the panel aims to provide accurate measurements of voltage, current, and temperature, thereby enhancing safety and efficiency in motor control applications. The portability and user-friendly design of the panel make it suitable for educational purposes, enabling students to conduct practical experiments with ease.
The working principle of a single-phase induction motor is grounded on the interaction of magnetic fields to produce a rotating magnetic field that drives the rotor.

A. Stator

The stator is the stationary part of the motor and is generally equipped with a winding connected to an AC power source. In a single-phase induction motor, this winding is generally a single set of coils, creating a single- phase AC magnetic field.

B. Rotor

The rotor is the rotating part of the motor, and it can be either a squirrel- cage rotor or a wound rotor. In single- phase induction motors, squirrel- cage rotors are more common due to their simplicity and reliability.

C. Working Principle

Start-Up: When AC power is applied to the stator winding, a magnetic field is generated. In a single- phase motor, this field is not rotating but oscillates back and forth.
Induction of Current in Rotor: The oscillating magnetic field induces a current in the rotor operators. This induced current produces its own magnetic field.
Interaction of Fields: The interaction between the magnetic fields of the stator and rotor creates a torque, causing the rotor to start moving.
Direction of Rotation: Due to the nature of the single- phase AC force, the original torque generated is not sufficient for nonstop rotation. Still, the motor can start in one direction, and fresh mechanisms (similar as a starting capacitor or other supplementary bias) may be employed to give the necessary torque for sustained rotation.
Creation of Rotating Magnetic Field: As the rotor begins to move, it tries to catch up with the rotating glamorous field. The interaction between the stator and rotor fields causes the rotor to continue rotating.

D. Limitations

Single-phase induction motors have limitations in terms of starting torque and self- starting capabilities. They may bear fresh components (starting capacitors, centrifugal switches, etc.) to overcome these limitations [1]-[2].

II. LITERATURE REVIEW

We reviewed the numerous research papers presented by the researchers and mentioned below findings from the literature review.

Kavin Mullai Kalki et al. presented the research paper entitled as "Over voltage and under voltage protection system using Arduino board". This study presents the operational efficiency of a single-phase induction motor through the integration of Arduino technology. The Arduino system is employed to monitor the speed feedback signal and subsequently generate a pulse width variation signal. This PWM signal is utilized to control the gate voltage of a Buck chopper, regulating the input voltage for achieving the desired motor speed. The input voltage is controlled through a fully managed single-phase isolated gate bipolar transistor (IGBT) bridge inverter, utilizing pulse width modulation (PWM) techniques to supply the motor with AC voltage. In the research work, a protective circuit for the induction motor has been devised to safeguard against over voltage conditions. Notably, this protective mechanism is implemented without the reliance on conventional protective devices like circuit breakers or microcontrollers. The integration of these technologies and protective measures targets to enhance the overall performance and safety of the single-phase induction motor [3].

Deepesh Namdev presented the work in the paper "Power Factor Improvement by Automatically Engaging Appropriate Number of Shunt Capacitor for Inductive Load". The main goal of this paper is to develop a fault detection and protection system for a single-phase induction motor, addressing issues such as overvoltage, under-voltage, over-temperature, undercurrent, and overloading. In instances where the motor temperature deviates from the required conditions, the LCD display will indicate the result. To mitigate this, we employ a heater or cooling fan to regulate the temperature and resolve the issue. Additionally, when the supply voltage to the induction motor falls below 200 volts or exceeds 240 volts, a fault will be detected, prompting the motor to cease operation [4].

Priya Kale et al. demonstrated in the paper "Protection of Induction Motor using Classical Method". Ensuring the protection of a motor from overheating involves safeguarding its winding against excessive temperatures. Overheating is typically induced by motor overloading, bearing seizure, or a locked motor shaft impeding rotation. When a motor encounters difficulties in starting, it may be attributed to faulty start winding within the motor. Our findings affirm that safeguarding a three-phase induction motor from overvoltage, under-voltage, single phasing, overheating, and phase reversal contributes to smooth motor operation, enhancing its longevity and efficiency. These issues typically arise when the supply system exceeds its specified rating. When a three-phase induction motor operates within its rated voltage, current, and load parameters, these faults are generally absent. Therefore, to ensure the motor's smooth operation, it is imperative to maintain the supply voltage within prescribed limits and ensure that the load driven by the motor adheres to specified limits [5].

III. METHODOLOGY

The methodology for designing and assembling the Single Phase Induction Motor Control Panel using Arduino encompasses several key steps to ensure its functionality and usability. A block schematic of the proposed system is shown in Fig. 1.

Firstly, the process commences with the identification and acquisition of the necessary components. These components include the Enclosure box, connecting wire, DP Pole MCB, connector, AC voltage sensor, current sensor, power supply sensor, Arduino Uno, temperature sensor, and float sensor. Each component plays a vital role in the operation and control of the induction motor.

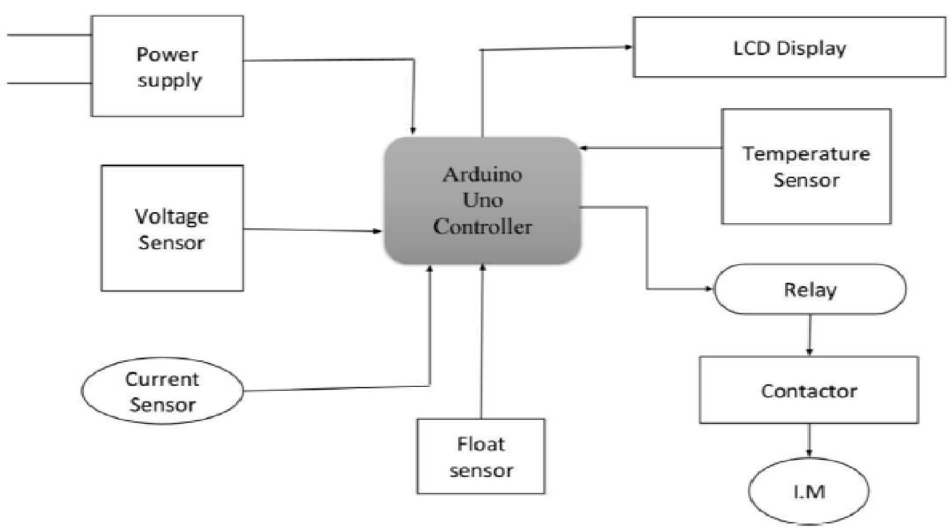

Fig. 1 Block schematic of Arduino based single-phase induction motor control panel

Once all the components are gathered, the assembly process begins according to the specified design. This involves arranging and connecting the components in a systematic manner to form the control panel. The Arduino Uno is positioned as the central control unit within the panel, responsible for coordinating and controlling the motor's operation based on input signals from the sensors [6].

Following the assembly, the panel undergoes calibration to ensure accurate measurement of voltage, current, and temperature. Calibration involves adjusting the settings and parameters of the sensors and control algorithms to align with the desired specifications. This step is crucial to ensure precise control of the induction motor and maintain optimal performance under varying conditions.

Moreover, special attention is given to optimizing the panel's portability and user-friendly interface. The layout and design of the panel are carefully crafted to facilitate ease of use and accessibility for practical experiments and educational activities. Clear labelling, intuitive controls, and ergonomic features are integrated to enhance usability and ensure a seamless user experience.

Overall, the methodology focuses on meticulous planning, precise assembly, thorough calibration, and thoughtful optimization to create a Single Phase Induction Motor Control Panel that meets the requirements of reliability, accuracy, and usability for educational and practical purposes.

IV. RESULT AND DISCUSSION

The implemented Single Phase Induction Motor Control Panel demonstrates effective measurement and control of voltage, current, and temperature. Arduino's capabilities enable seamless integration and operation of the panel, enhancing its functionality and versatility. The panel's portability and user-friendly design make it suitable for educational purposes, allowing students to conduct practical experiments with ease. Furthermore, the accurate measurement of overvoltage and overcurrent ensures enhanced safety and efficiency in motor control applications. Overall, the results indicate the successful implementation of the control panel, fulfilling its intended objectives.

V. CONCLUSIONS

The Single Phase Induction Motor Control Panel developed using Arduino technology offers an efficient and versatile solution for motor control applications. By accurately measuring voltage, current, and temperature, the panel enhances safety and efficiency in motor operations. Its portability and user-friendly design make it an ideal tool for educational institutions and practical demonstrations. Moving forward, further enhancements and refinements can be made to optimize the panel's performance and expand its applications in various industries.

VI. ACKNOWLEDGMENT

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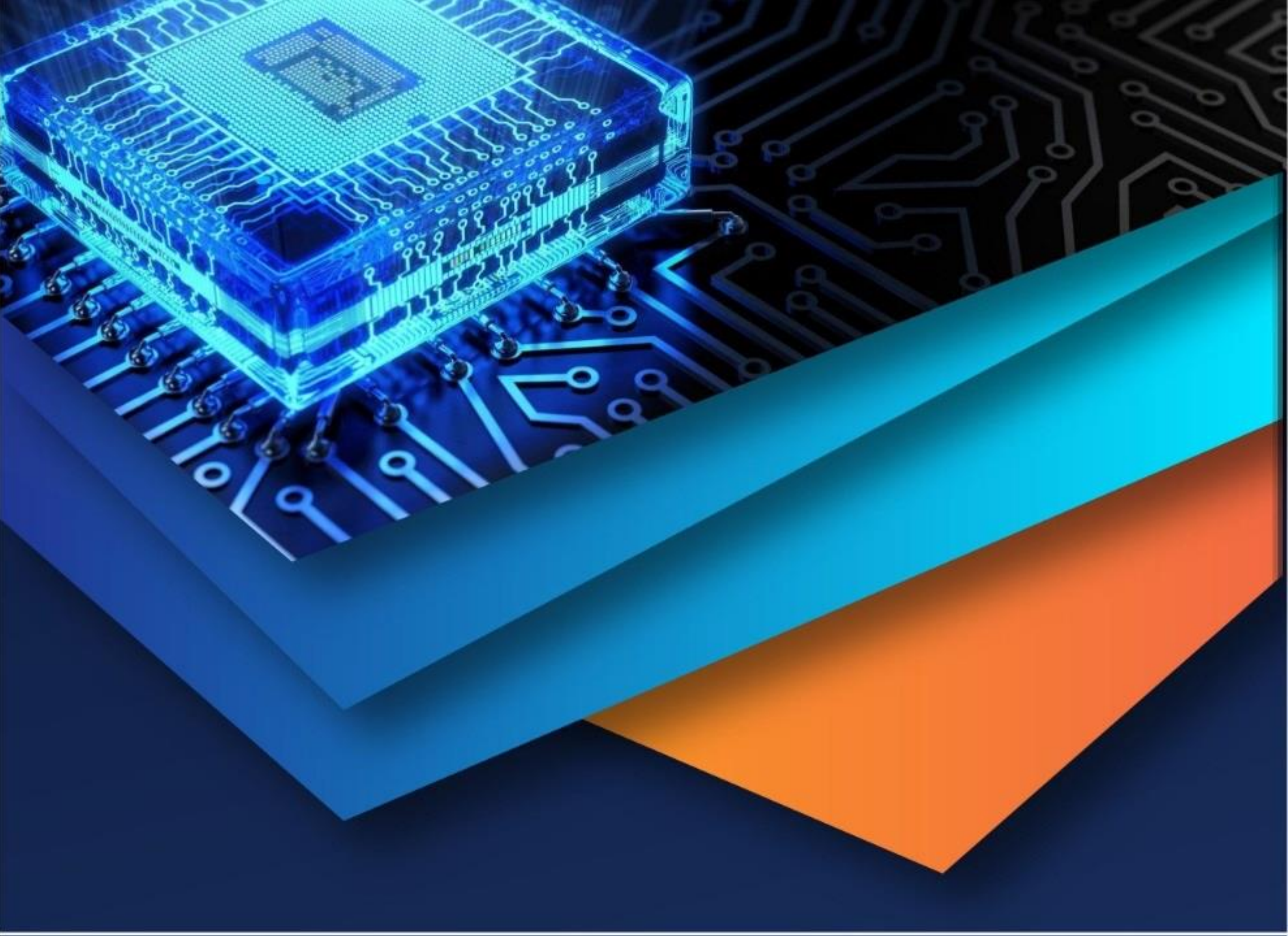

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