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# WIRELESS SPEED CONTROL FOR INDUCTION MOTOR

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## ABSTRACT

*Many motors are used for particular reasons in the vicinity, from home appliances to machine tools in manufacturing installations. These motors require comprehensive range features and efficiency, and the speed of the electric motor is often required for most applications. While this is not an issue for motors installed at readily available places, severe problems are presented with powered motors installed in dangerous areas, elevated altitudes, or off-site monitoring of these motors' speed. The design of a wireless speed control system for these motors is therefore necessary. In addition to ensuring that the wireless speed control of electric motors can readily regulate motors that are moving at high speed, the motor is also easy to use for off-site activities. The precise goal of this study is to create a wireless-based speed control system for an induction motor and to evaluate the finished product. Mechanical loads should not only be driven in industries, but they should also be driven at the desired speed. As a result, techniques for controlling the speed of induction motors are required. After implementing the use of arduino microcontroller and wireless module, we were able to control an induction motor which is an electric fan in this case.*

**Keywords:** Speed Control, Wireless, Induction Motor, Arduino, TRIAC.

## INTRODUCTION

Induction motors are widely utilized in a variety of housing, industrial, commercial, and service applications, and are known as the "workhorse" of the moving industry. The one-phase inductor is the engine for fridges, washers, alarms, boilers, compressors, engines, et al., which is the most widely used. When energy is provided to an induction motor, it works at its assessed speed at the suggested requirements. Many applications, however, require variable speeds. For instance, for every laundry process, a washing machine may use various rates. In the past, variable speed was obtained with mechanical equipment technologies.

Electronic energy and regulate technologies have recently matured to enable them to be used for motor control instead of mechanical equipment. These devices can improve the vibrancy and stability of the motor in addition to limiting its speed. Furthermore, electronics can decrease the average energy consumption of the system and the motor noise production.

Induction motor control is difficult due to its nonlinear characteristics. VVVF which is Variable voltage variable frequency or V/f is the most popular speed management technique in an open-loop, while there are distinct command techniques. This procedure is best suited for appliances without demands for location command or the need for high-speed test precision. For example, ventilation, air conditioning, vents, and blowers are included. It is also possible to use low-cost PIC microcontrollers instead of expensive DSPs for implementing the V/f command. A laminated iron base with two perpendicular windings is placed in the one-phase motor stator. The first is the principal tuning, and the second is the subsidiary tuning.

The "one phase" motors are genuinely double phase motors. The motor utilizes a rotor with an iron heart with holes and a squirrel cage. On holes, aluminum cans are attached and shortened with a loop at both sides. These motors have the principal benefit of being able to function from a single-stage power supply. Since the use of inductive motors is every day, speed controls in many apps may be necessary. Various induction motor speed limit techniques are feasible.

Speed Control of induction motor can be done on stator of an induction motor by:

- Changing the Voltage Applied
- Changing the Frequency Applied
- Constant V/F Control
- Increasing or decreasing the number of stator poles

Speed Control of induction motor can be done on rotor of an induction motor by:

- Rotor Rheostat Control
- Cascade Operation
- Adding EMF to the Rotor Circuit

The rotor must spin at a lighter speed (or quicker) than the simultaneous speed to generate torque. There is, therefore, a mildly lower speed than the spinning flow that offers sufficient torque to remove the friction and winding of the shaft. Asynchronous motors are also used because the rotor speed does not match the swinging stator flux. The loading torque that is the torque to switch on the rotor blade determines the quantity of break.

This project aims to build a wireless speed control system centered on a microcontroller to monitor interface thyristors' shooting angle with the single-phase induction motor.

## LITERATURE REVIEW

As part of their research in intelligent motion control and power electronics, many researchers have created microcontrollers and digital signal processing-based controllers for three-phase induction motors. They investigated the need for, benefits of, and uses of intelligent motion control in power electronics and drives, and they have published many publications as a result of their research.

The researchers conducted a number of theoretical, experimental, and simulation studies that are quite valuable in comprehending the controller's various strategies for three-phase induction motors. Certain researchers used the VLSI embedded system; some used algorithms, while others used programs, automation, and electronic applications. A synopsis of previous research on intelligent motion control, power electronics, and their applications is shown here.

Soft starting of large induction motors at constant current with low initial torque pulsations was proposed by Zenginobuz et al. (2001). The experimental setup demonstrated that utilizing simple control techniques and a microcontroller, a voltage-controlled thyristorized soft starter for an induction motor may be accomplished. The performance of the soft-starter motor-load combination in the dynamic situation was studied using a hybrid induction machine model. It accounts for the machine's unconnected two-phase and three-phase working modes, and it includes basic control approaches for keeping the current constant at any fixed value during starting. Perfect torque and current profiles were acquired at starting point as a result of this.

Vaez-Zadeh (2001) developed a Digital Signal Processor (DSP)-based single-phase induction motor torque management system. An experimental configuration was created using DSP. The results show that employing a switching capacitor in the motor auxiliary winding, single-phase induction motor torque management may be optimized. Over the whole speed range, the switching capacitor is adjusted to produce high average torque and low peak pulsing torque. The results show that the motor performance under the suggested system is significantly better than that of a constant capacitor motor.

For speed control applications, Umanand and Bhat (1996) presented an online estimate of an induction motor's stator resistance. The authors addressed the issues with flux estimation and control caused by variations in induction motor stator resistance. They designed and demonstrated a stator resistance estimation technique that uses variables obtained from the motor's terminals alone to estimate stator resistance online under steady-state operating conditions.

The research done by Issa (2010) optimized the stator current of a three-phase induction motor. An attempt was made to improve the performance of the induction motor by evaluating and developing an optimum stator current controller for the induction motor that will lower stator current under varied loading conditions. The traditional optimum control system approach, which takes torque information from the motor to create the proper voltage amplitude that reduces induction motor stator current, was described as the first of two mathematically-based optimum control methods for induction motor drives, with current optimization and energy savings as a result. The second is a genetic algorithm-based optimum control system. It also uses the motor's torque to generate the required minimum stator current using the fitness function. The simulation was run using the MATLAB/Simulink toolbox, and the results demonstrate that stator current reduction has improved, resulting in energy savings.

Nallanthambi et al. (2019) describes a way for building a single-phase cyclo-converter using a single-phase matrix converter topology with sinusoidal PWM. The MATLAB/Simulink (MLS) software package was utilized to develop a computer simulation model for a Cyclo converter running on SPMC in this study. It entails using SPWM to synthesis the AC output supply for a given AC input.

The authors Abrahamsen et al. (2001) agreed on the efficiency optimized control of medium-sized induction motor drives. The authors have demonstrated an experimental setup with a 90 KW drive to show that a variable-speed induction motor drive's efficiency can be made better by adapting the ratio of motor flux to load torque. The impact of converter losses on medium-size drive efficiency optimization was investigated. The converter and motor loss are taken into consideration. The influence of converter loss on loss minimization is studied, and new efficiency optimizing control strategies are proposed, i.e., displacement power factor control and model-based control.

Using a digital signal processor, Leksono (2004) created an adaptive speed controller for induction motors. They devised a simple adaptive speed control of the induction motor using a customized digital signal processor. The adaptive control structure's design is based on a vector control technique for converting three-phase motor currents into flux and torque-generating current components. The three-phase current components were used to control the induction motor. The findings show that induction motor adaptive speed control based on DSPs provides good transient and steady-state responses.

Induction motor performance optimization during voltage-controlled soft starting was presented by Zenginobuz et al. (2004). An 8-bit microcontroller was used to implement this, which helps to avoid torque pulsations at the supply frequency while keeping the line current constant at the present value. Starting torque pulsations are minimized by activating back-to-back-connected thyristors at appropriate periods throughout the initial supply voltage cycle.

Mahapatra et al. (2015) described a new adaptive neural fuzzy-based soft beginning technique for determining thyristor firing angles in voltage-controlled induction motor drives. They demonstrated that the proposed technique primarily worked in an open loop, eliminating the need for voltage sensors. Voltage sensing between thyristors is likewise unnecessary. The proposed method's simulation techniques and results were provided, and they were compared to the results of standard soft starters. They demonstrated that the proposed soft starting technique is simple, stable, precise, and quick to respond.

For comprehensive and accurate speed control, Mineo Tsuji et al. (2012) developed a new V/f induction motor control. The auto-boost voltage methodology for balancing the voltage drop of stator impedance and a slip frequency compensation method for decreasing the speed error caused by the load shift are described by computing the d-q currents of the induction motor. The motor cannot be run at shallow speed using the constant V/f control approach. When the load is increased from zero to the rated load, the suggested innovative V/f control approach achieves speed control at very-low-frequency operation, such as 30rpm.

Eltamaly et al. (2010) developed microcontroller-based soft starters for a three-phase induction motor. A polyphase induction motor was modeled and simulated, and several starting strategies were investigated. The implementation was done in two ways: one with a PIC16F84 and a reactor, and the other using an AC voltage controller starting with a PIC16F877. These are compared to the commercial soft starter LH4-N2, and it has been shown that both proposed soft starts are more effective, simple, and less expensive.

Srilad et al. (2006) offered a PI controller design concept for controlling the induction motor's speed in. A voltage source inverter with space vector pulse width modulation was used in this system. The frequency and amplitude of the input voltage are adjusted in this system to change the motor's speed. The ratio of the stator's input voltage to frequency was kept constant in this case. The experimental set-up has been finalized. Its results were studied when a 120-watt induction motor was tested from no-load to rated condition. The induction motor's speed may be operated at the required speed without generating the steady-state inaccuracy, according to the findings. The speed of the motor is demonstrated to remain constant while the load changes.

Demirtas (2009) looked towards fault-tolerant soft starting control of induction motors with lower transient torque pulsations. Simulation and actual testing were carried out on a 1.492KW, 460V, four-pole, three-phase induction motor. According to the test results, the recommended fault-tolerant soft starting control reduced motor inrush current magnitude, and this technique is applicable to any soft starts that operate small to big integral horsepower induction motors.

Trupti and Tembhekar (2009) investigated scalar and vector control of induction motor drives and developed a Simulink-based simulation for open and closed-loop induction motor control using both scalar and vector constant V/f speed control approaches. Using the V/f approach, the author constructed a Simulink-based simulation for open-loop and closed-loop control of an induction motor. The simulation was thoroughly investigated first in open-loop mode and subsequently in closed-loop mode with slew rate application. The open-loop and closed-loop findings were presented, and the results revealed that increasing the slew rate reduces the transient time, which is beneficial to the machine's life. The steady-state reduced to zero, but the closed-loop approach has taken longer.

## METHODOLOGY

The project is being achieved with the aid of some electrical components, which will be discussed first.

Arduino Nano: The Arduino Nano is a tiny board based on the ATmega328 microcontroller. It's similar to the Arduino Uno in terms of functionality, except it uses a Mini-B USB connector for the DIP module packaging. The Arduino board works well with the Arduino IDE and cases. The Arduino Nano and the Arduino UNO are extremely similar. Because both utilize the same processor (Atmega328p), they'll run the same software. The biggest difference between the two is the size of UNO, which is twice as big as Nano and so takes up more room on your venture. Nano is adept at using the breadboard, but Uno is not.

ESP8266: The ESP8266 Wireless Module is a self-contained system on chip with an efficient Transmission Control Protocol/Internet Protocol stack that can connect any microcontroller to WiFi. The ESP8266 will either host applications or offload all WiFi networking features to a separate application processor. This module has sufficient storage and on-board processing capabilities, allowing it to be integrated with sensors and other application-specific devices via its general-purpose input/output with minimal setup and load during runtime.

Power supply unit: The term "power supply" refers to a source of electrical energy. A power supply unit is a device or system that provides a group of loads with electricity or other sources of energy.

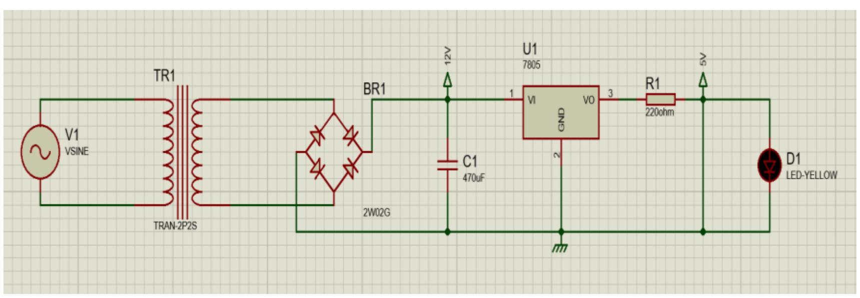


Figure 1. The circuit diagram for the power supply is shown in Figure

To obtain a 12V supply, a 230V, 50Hz single-phase AC power source is connected to a step-down transformer. A Bridge Rectifier is used to convert this voltage to DC. A 2200uf capacitor filters the converted pulsed DC power before sending it to the LM7805 voltage regulator for a consistent 5v supply. Figure [1] shows how this 5v supply is given to all circuit components. An RC time constant circuit is used to rapidly discharge all of the capacitors. To assure the power supply, an LED is connected for indication reasons.

TRIAC: This is a device that transfers an electronic signal between circuit elements, typically a transmitter and a receiver, using a brief optical transmission route while keeping them electrically isolated. There is no need for an electrical connection between the source and destination because the electrical signal is converted into a light beam, transported, and then converted back to an electrical signal.

IDE: Figure [2] shows the Integrated Development Environment, a cross-platform (Windows, macOS, Linux) program created in C and C++ functions. The IDE is used to create and upload programs to Arduino-compatible boards as well as other manufacturer-specific development boards with 3rd-party cores.

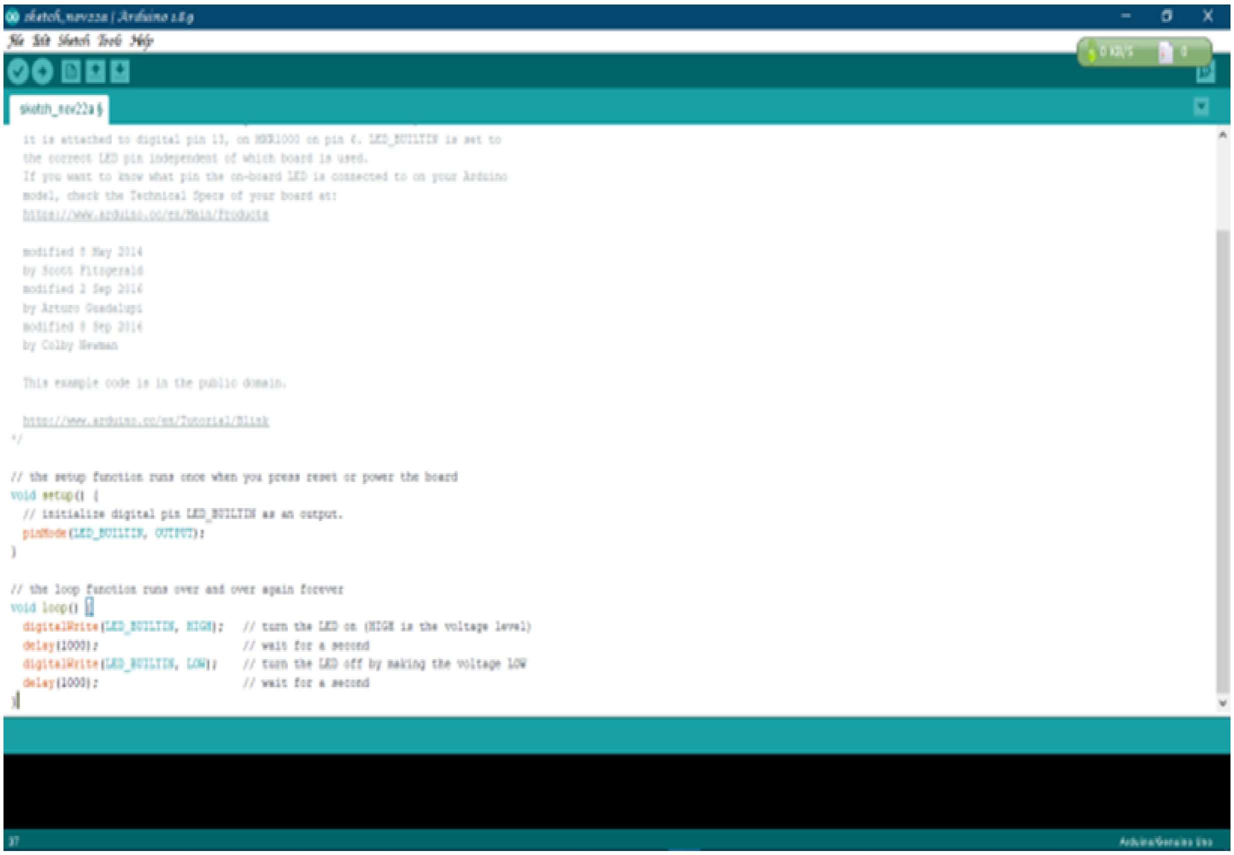


Figure 2. Integrated Development Environment

Design Construction:

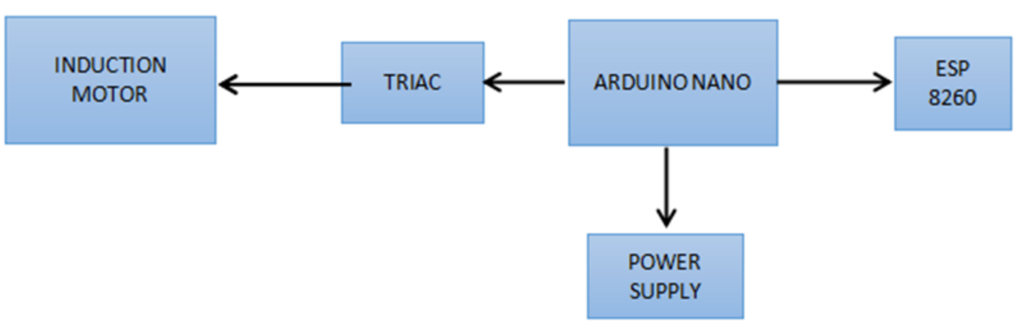


Figure 3. Arduino nano controls all the operations.

Arduino Nano is the main component of the project as it can be shown in figure [3].

**Design Operation**

Induction motor speed control is accomplished wirelessly by using a mobile phone or computer to operate the induction motor. The steps below demonstrate how to achieve it:

- The constructed device has an outlet and inlet. The inlet has to be connected to an Ac power source of around 230V and 50Hz, while the outlet is connected to an induction motor. Induction motor used in this case is a standing fan because of its size.
- When the device is turned on, the WiFi module in the device is activated, sending WiFi signals. The induction motor is controlled by a mobile phone that is connected to the device's WiFi.
- Establish a WiFi connection between the module and the mobile by inputting the IP address (The IP address is 192.168.4.1). The IP is routed to the wireless speed control page while the mobile phone is connected to WiFi and the IP is typed, as illustrated in figure [4]. The induction motor's speed is controlled using this page.
- The speed variation is being done through a mobile device via the browser page. The connected motor's speed can increase or decrease by making adjustments to the slider on the resulting web page. The more the increase on the device, the more the speed of the induction motor. This shows that the device can be controlled using a mobile device.


Figure 4. Wireless Speed Control

**Design Consideration**

Since this work aims at designing and constructing a cheap and relatively efficient microcontroller based wire speed control system for single phase induction motor:

- Portability: Since the device is meant to provide an easy means of efficiently controlling the induction motor's speed. The device should be portable and easily integrable.
- Maintenance: The device should be relatively maintenance-free, requiring little or no maintenance
- Low cost: The device's overall price should be relatively cheap to ensure its economic viability when produced on a large scale.
- Easy to Operate: The device should require little or no technical –know-how to operate.

Concerning the above considerations, the device will thus be developed on the Raspberry Pi platform due to its relatively low cost, portability, ease of setup, and high processing speed.

## TESTING AND DISCUSSION OF RESULT

As the project work had been designed and implemented in previous sections giving a detailed description of all components, the testing's output result is presented in this section. Various tests were carried out, including the connectivity as well as speed variation about the relay.All components were correctly put and soldered onto the circuit board during the practical experimentation, from which numerous tests were conducted at various stages. The components were examined using a digital multimeter to ensure that they functioned properly and provided the anticipated results. Faulty components were thrown away.

In the implementation of the project, the following steps were taken;

- Creating a list of all the materials and components required.
- Using an ohmmeter, check the resistance of the components purchased before connecting them.
- Creating a schematic diagram to show how the components should be connected.
- Testing the completed system to ensure that the design is functional, and
- Finally, putting the project plan into action.

After gathering all of the materials, I positioned the components on the circuit board, followed by proper soldering of the pieces. All of the components were soldered to the board.

### TESTING

Every new assembly requires testing before being connected to power supply to ensure it will function adequately (IEE Regulation, 1988). The following tests were carried out on this device.

- Continuity test is required to detect all sections that have open circuits.

This was carried out before connecting the system to the power supply. The test revealed open circuit faults, which could be due to:

- I. A break in the circuit.
- II.A component's failure leads to unusually high resistance or
- III. Increased insulation at specific points caused by dirt or corrosion.

- Polarity test is required to avoid short-circuits.
- Speed control test: Speed control test Continuity Test This was carried out before connecting the system to the power supply. The test revealed open circuit faults, which could be due to a break in the circuit. A component's failure leads to unusually high resistance or increased insulation at specific points caused by dirt or corrosion.

## CONCLUSION

The project "Single phase induction motor speed controlling based on Arduino Uno technology using any device with WiFi wireless communication" was created with the goal of controlling the AC motor speed using WiFi control technique by employing the resistance control method to control the induction motor speed using any device with WiFi wireless communication. The rate can be held at four different speeds ranging from 0% to 100%. We can also detect high temperature, high voltage, low voltage, and MCB tripping phases using a feedback network. This method is less expensive and easier to build than other ways such as frequency control, PWM method, TRIAC control, and Thyristor firing angle control.

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