A Review Paper On Synchronization Speed Control Of Multiple Motors

Prof. S. D. Lavange[1], Vaibhav D Kakar[2], Gaurav H Bhagat[3], Abhishek S Rodhe[4], Aarti S Kale[5], Ujvala A Thorat[6]
[1, 2, 3, 4, 5, 6] Dept of Electrical Engineering
[1, 2, 3, 4, 5, 6] Padm. Dr. VBKCOE, Malkapur, Maharashtra, India

Abstract- *This paper presents a pioneering project focused on enhancing industrial automation through a novel system for synchronizing and controlling the speed of multiple motors. Key components include advanced control algorithms, robust communication protocols, and sensor integration for real-time monitoring. The project aims to improve efficiency, reduce energy consumption, and minimize equipment wear. With a centralized control system and user-friendly interface, the successful implementation promises increased production efficiency, reduced downtime, and improved product quality, contributing to advancements in industrial reliability and sustainability.*

Keywords- Speed synchronization, Microcontroller, BLDC motor, electronic speed controller.

I. INTRODUCTION

This paper addresses the challenge of controlling the speeds of various motors simultaneously in industrial settings. To streamline speed control for different motors, we devised a single controller capable of adjusting their speeds from a central location. This approach minimizes the need for multiple controllers and enhances efficiency. The project focuses on maintaining a constant water flow at the motor output, adjusting speed in response to varying water input. A relay is employed to safeguard the motor by shutting it off when water flow drops below a critical level. Traditional control systems encounter difficulties due to the non-linear nature of DC motors, impacting their performance. In applications like the textile industry, where garment movement must sync with the weaving axle speed, variability in load can lead to oscillatory behavior in DC machines. Recent advancements in control technology enable the effective operation of various applications, necessitating practical control methods for electric motors. This project introduces a microcontroller-based speed control system to address these challenges, emphasizing closed-loop PWM techniques for efficient motor speed regulation. The implementation demonstrates the adaptability and reliability of the proposed control strategy across diverse industrial applications.

II. PROBLEM FORMULATION

There are a plethora of alternative methods available to address this issue. However, they are not very trustworthy. This task can be controlled, operated, and synchronized using a microcontroller to minimize human intervention and save labor costs and time. The method that combines both hardware and software is compatible when compared to the conveyor belt method. In this section. The microcontroller can be configured to regulate its speed and to establish the desired speed by potentiometer to complete our task. Here, synchronization has been achieved by wireless technology. RF correspondence Wireless communication has been enabled here thanks to technology. The master-slave approach is used to synchronize motors. The motor speed is received at the receiver side via PWM technique after being communicated by the transmitter using an RF Module. As a result, the motors will operate at synchronized speed.

III. PROPOSE SYSTEM METHODOLOGY

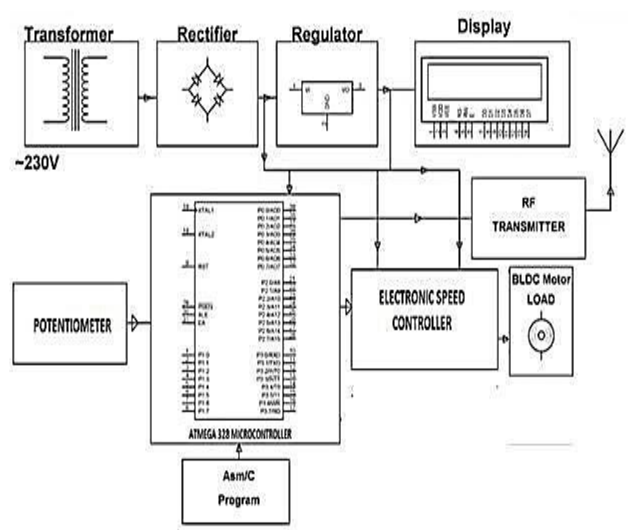

Figure 1 Block diagram of the transmitter system

The block design for the transmitter is depicted in figure 1 above. It includes a potentiometer that serves as the input device, providing the transmitter motor with the speed input. The speed signal is sent to the radio frequency receiver module via the radio frequency (433 MHz) transmitter. The analog input provided by the potentiometer is converted into a digital signal and sent to the electronic speed controller via the analog to digital converter. The BLDC motor receives a pulse signal from the electronic speed controller, which modifies its width to control speed.

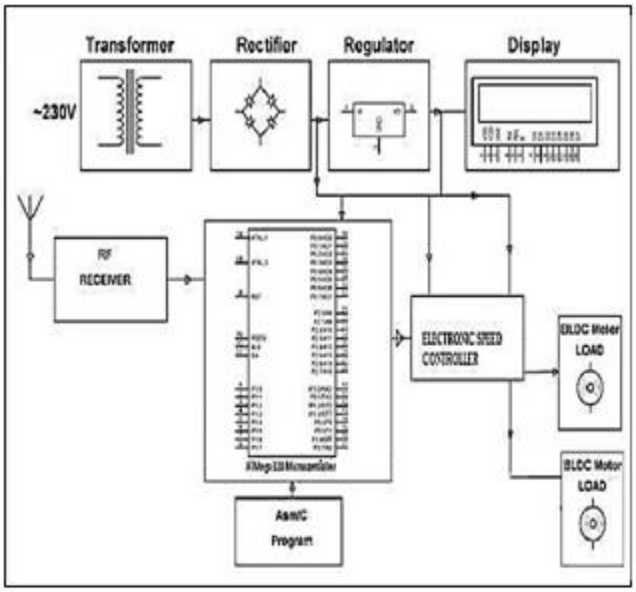

Figure 2 Block diagram of the receiver system

The receiver system's block diagram is displayed in figure 2. The Radio Frequency Receiver Module, which is utilized to obtain the signal transmitted in the RF transmitter from the transmitter motor, makes up the receiver system. The microcontroller has received the received signal as input. The electronic speed controller receives the generated pulse signal. The RF receiver module's received signal determines how wide the pulse signal should be. Consequently, the electronic speed controller has provided the receiver motors with a pulse signal in accordance with that.

IV. COMPONENTS REQUIREMENT

1) Brushless DC Motor: For applications requiring a high power-to-volume ratio, high efficiency, and high dependability, the Brushless DC (BLDC) motor is the best option. All things considered, a BLDC motor is regarded as a high performance motor that can deliver significant torque throughout a wide speed range. The torque and speed performance curve features of BLDC motors are similar to those of brushed DC motors, the most widely used type of DC motor. The use of brushes is where the two diverge most. Because BLDC motors lack brushes, they are referred to as "brushless DC" motors and require electronic commutation.
2) ATmega 328 microcontroller: The Atmel AVR core has 32 general-purpose working registers in addition to a robust instruction set. The ArithmeticLogic Unit (ALU) is directly connected to all 32 registers, enabling the access of two separate registers with a single instruction that is completed in a single clock cycle. In comparison to traditional CISC microcontrollers, the resulting architecture achieves throughputs up to ten times faster while being more code efficient. The following functions are offered by the ATmega328/P: A 32Kbyte In-System Programmable Flash with Read-While-Write capabilities, 1Kbyte EEPROM, 2Kbyte SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with PWM and compare modes, 1 serial programmable USART, 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages), a programmable Watchdog Timer with internal oscillator, an SPI serial port, and six software-selectable power-saving modes are all included. The SRAM, Timer/Counters, SPI port, interrupt system, and CPU are all left operational in the Idle mode. The Oscillator is frozen in the power-down mode, preventing any further chip operations until the next interrupt or hardware reset, but it preserves the contents of the registers.
3) Electronic Speed Controller (ESC): An electronic circuit that modifies an electric motor's speed, path, and ability to function as a dynamic brake is known by this acronym. These are commonly found on electrically powered radio controlled models. The variation that is most commonly applied to brushless motors essentially creates an electronically generated three-phase low voltage electric power source for the motor. As is the case with the majority of toy-grade R/C vehicles, an ESC can be a separate unit that lumps into the throttle receiver control channel or united into the receiver itself. Some R/C manufacturers use complex electronics that combine the two on a single circuit board to connect exclusive hobbyist electronics in their entry-level cars, containers, or aircraft.
4) 4) Radio Frequency Module: There are numerous reasons why transmission via RF is preferable to IR (infrared). First of all, RF signals can travel farther, which makes them appropriate for long- range applications. Furthermore, although infrared (IR) signals are primarily transmitted in a line-of- sight mode, radiofrequency (RF) signals can pass through obstacles to reach their destination. That being said, RF transmission is more robust andconsistent than IR transmission. RF communication operates on a fixed frequency, in contrast to infrared signals that are influenced by other infrared emitters. An RF transmitter and an RF receiver make up this RF module. The frequency at which the

transmitter/receiver (Tx/Rx) pair operates is 434 MHz. An RF transmitter receives serial data and uses its antenna connected to pin 4 to transmit it wirelessly through RF. The transmission rate ranges from 1 Kbps to 10 Kbps.An RF receiver using the same frequency as the transmitter receives the transmitted data. The RF module is frequently utilized in conjunction with two encoder/decoders.

V. RESULT AND DISCUSSION

Table 1Speed of motor in Transmitter and Receiver

Attem pts	TRANSMIT TER MOTOR SPEED (RPM)	RECEIV ER MOTOR 1 SPEED (RPM)	RECEIV ER MOTOR 2 SPEED (RPM)
1	2500	2470	2590
2	3300	3100	3120
3	3800	3710	3720
4	4500	4410	4690
5	6000	5890	6170

The table 1 represents the speed which was given as the input on the transmitter and the speed which was received on the receiver side. In this proposed method the speed are transmitted by the means of Radio Frequency module. The Proposed system has achieved the main scope of the project that power dissipation of the motors has been reduced and the motors are more or less synced with the transmitting speed.

VI. CONCLUSION

In conclusion, the existing systems for motor speed synchronization face a significant drawback as they struggle to achieve synchronization within a specific range. Numerous research papers have attempted to address this challenge, but many have fallen short of delivering a successful approach. The traditional conveyer belt method exhibited a speed variation exceeding 1000 RPM, while wired synchronization techniques showed improvements but still experienced variations ranging from 600 RPM to 900 RPM.

The proposed speed synchronization system presented in this paper successfully overcomes these limitations. By leveraging wireless RF communication and PWM techniques with a centralized control approach, the system achieves synchronization with the motor speed set at the transmitter side. Notably, this system has significantly reduced the speed variation, now ranging only from 100 RPM to 150 RPM. This improvement marks a substantial advancement over existing methods, offering a more reliable and precise means of motor speed synchronization.

The findings from this research underscore the effectiveness of the proposed system in mitigating the drawbacks of previous approaches. The achieved reduction in speed variation enhances the system's capability to synchronize motors within a specific and controlled range. This represents a notable contribution to the field of motor synchronization, paving the way for more accurate and dependable industrial automation processes. Future research endeavors could further refine this system and explore its applicability across diverse industrial settings.

REFERENCES

[1] N. K. Sinha and P. M. Tiwari, "Multiple motor synchronization using nonlinear PID control," 2017 3rd International Conference on Advances in Computing, Communication & Automation (ICACCA) (Fall), Dehradun, India, 2017, pp. 1- 6, doi: 10.1109/ICACCAF.2017.8344713.

[2] Wang, Y. Man, Q. Zhang and X. Yan, "Research on synchronization control method of networked multi-agent system of multiple manipulator- motors," 2017 29th Chinese Control And Decision Conference (CCDC), Chongqing, China, 2017, pp. 1719-1722, doi: 10.1109/CCDC.2017.7978794.

[3] Zhang and S. Liu, "Multi-motor synchronization control system for industrial robots based on hierarchical structure," 2016 IEEE International Conference on Robotics and Automation (ICRA), Stockholm, Sweden, 2016, pp. 3983- 3988, doi: 10.1109/ICRA.2016.7487457.

[4] Li, W. Li, W. Chen and L. Zhou, "Research on the Multi-Objective Synchronization Control of Multiple Motors for Industrial Manipulator," 2018 37th Chinese Control Conference (CCC), Wuhan, China, 2018, pp. 8586-8591, doi: 10.23919/CCC.2018.8483147.

[5] Wu, D. Zhang, J. Wang and X. Zhou, "Synchronization Control of Multiple Motors in an Industrial Control System," 2015 IEEE International Conference on Robotics and Automation (ICRA), Seattle, WA, 2015, pp. 2477-2482, doi: 10.1109/ICRA.2015.7139547.

[6] H. Sreenivas and K. V. Kumar, "Adaptive synchronization control of multiple induction motors in the presence of disturbances," 2019 IEEE 4th International Conference on Control, Automation and Robotics (ICCAR), Beijing, China, 2019, pp. 202-206, doi: 10.1109/ICCAR.2019.8813842.

[7] Lu, Z. Shi and H. Bao, "Synchronization control of multi-motor drives for tension system of continuous strip process," 2014 IEEE International Conference on Automation Science and Engineering (CASE), Taipei, Taiwan, 2014, pp. 738-743, doi: 10.1109/CoASE.2014.6899477

[8] Zhang, M. Li and L. Tian, "Synchronization control of multiple induction motors using super- twisting algorithm," 2015 IEEE International Conference on Robotics and Automation (ICRA), Seattle, WA, 2015, pp. 4481-4486, doi: 10.1109/ICRA.2015.7139821.

[9] Wang, H. Shi and Q. Li, "Synchronization Control of Multiple Permanent Magnet Synchronous Motors for a Six-Rotor UAV," 2018 IEEE International Conference on Robotics and Automation (ICRA), Brisbane, QLD, Australia, 2018, pp. 6160-6166, doi: 10.1109/ICRA.2018.8462908.

[10] V. Savkin, A. J. M. H. Suhail, and A. S. Giribabu, "Synchronization control of multiple induction motors in the presence of faults and uncertainties," 2021 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), Prague, Czech Republic, 2021, pp. 901-907, doi: 10.1109/IROS52619.2021.9734323.