Wireless Speed Synchronization of Motors in Industry

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Abstract— *In textile industry many processes require speed synchronization of more than one motors involved in the process. Rolling of cloth should be synchronized with the speed of weaving spindle to avoid damage and motor speed synchronization is vital in conveyor belt driven by multiple motors. Abrupt load variations may cause hunting or oscillatory behavior in d. c. machines. This behavior can be detrimental to the process. The digitally controlled d. c. machines can have much aggravated phenomenon owing to poor sampling period selection. Traditionally processes are synchronized through mechanical transmission system consisting of a line shaft gears, pullers etc. This project is synchronization of multiple motors using wireless technology.*

This project uses radio frequency to synchronize motor speeds. One motor acts as transmitter and all the rest as receivers. Thus, if a particular speed is set in the transmitter then all other motors speed would be matched to the same speed of the main motor.

The mode of communication is radio frequency. BLDC motors used operate on the basis of PWM control. Each motor has a closed loop feedback mechanism providing RPM reference by a shaft mounted IR sensor arrangement whose output is fed to the controller in the circuit. A display unit displays the full speed and one can enter the desired percentage with help of a keypad to obtain the required speed for all the motors. Manpower and time is also saved in this system.

Keywords— Micro controller, IR sensor, RF module, BLDC Motors and LCD.

I. INTRODUCTION

Direct current (DC) motors have been widely used in many industrial applications such as electric vehicles, steel rolling mills, electric cranes, and robotic manipulators due to precise, wide, simple and Continuous control characteristics. The development of high performance motor drives is very important in Industrial as well as other purpose applications. Generally, a high performance motor drive system must have good dynamic speed and load regulating response. DC drives, because of their simplicity, ease of application, reliability and favorable cost have long been a backbone of industrial applications. DC drives are less complex with a single power conversion from AC to DC. DC drives are normally less expensive for more horsepower ratings. DC motors have a long tradition of use as adjustable speed machines and a wide range of options have evolved for this purpose. In these applications, the motor should be precisely controlled to give the desired performance traditionally rheostat armature control method was widely used for the speed control of low power dc motors. However the controllability, cheapness, higher efficiency, and higher current carrying capabilities of static power converters brought a major change in the performance of electrical drives.

II. EXISTING SYSTEMS

2.1 Multi-motor synchronization techniques

A multi-motor application has become very attractive field in industrial applications replacing the traditional mechanical coupling. Applications can be found in paper machines, offset printing, textiles; differential rives, to name some examples. Multi-motor techniques are used where matched speed during acceleration, deceleration and changes in load requires "truly" speed and angle synchronization between at least two axes. Several synchronization techniques has been developed in order to fulfill those necessities, in this work the master-slave, cross coupling technique, bi-axial cross-coupled control method, electronic (virtual) line-shafting and the relative coupling strategy are compared for different industrial applications. [1]

2.2 Motors Speed Asynchronization in Nonlinear Process by Selective State Feedback & Integral DC-Motor Controller

In textile industry many processes require speed synchronization (or asynchronization) of more than motors involved in the process. Rolling of cloth should be synchronized with the speed of weaving spindle to avoid damage and similarly motors-

speed synchronization is vital in a conveyor belt driven by multiple motors. Abrupt load (or power-supply) variations may cause hunting or oscillatory behavior in dc machines. This behavior can be detrimental to the process. The digitally controlled dc machines(or motors) can have much aggravated phenomena owing to poor sampling period selection applications require higher performance, reliability, variable speed due to its ease of controllability.

2.3 Microcontroller based speed control system

It consists of electronic component, microcontroller and the LCD. AT89C51microcontroller for speed control of DC motor fed by a DC chopper has been investigated. The chopper is driven by a high frequency PWM signal. Controlling the PWM duty cycle is equivalent to controlling the motor terminal voltage, which in turn adjusts directly the motor speed. This work is a practical one and high feasibility according to economic point of view and accuracy. In this work development of hardware implementation of the close loop dc motor speed control system have been explained and illustrated. The desired objective is to achieve a system with the constant speed at any load condition. That means motor will run at a fixed speed instead of varying with amount. [2]

2.4 Real-Time Digital Control Using DSP of a Multiple Motor System

Multiple Motors System - A method for achieving the co-ordination and synchronization of multiple motors on line using DSP is described. The co-ordination and synchronization control of motion of multiple motors is a challenging problem, since the synchronization of each individual motor can be influenced by many factors. This paper presents the concept and implementation of a scheme that uses a real time control approach to realize drive synchronization of the multiple motors.

A new Master-Slave configuration is developed. Imperfect synchronization can be corrected on-line using DSP. Also, this paper shows the advantages of using DSP controllers for such applications. [3]

2.5 PWM Based Automatic Closed Loop Speed Control of DC Motor

Many industries like textile industries, automation industries, and paper mills etc, conveyer belts are often used. These conveyer belts are used to transfer the raw material or the produced material from one place to another. For a feasible operation, the conveyer belt must run at exact speed at all locations. This means motors should run at a synchronized speed.

This demonstrates a prototype to achieve synchronization of multiple motors such that the motors can run exactly at the same speed, as desired by the user. The speed is set for the master motor at the desired rate. Here a RF communication method is used to transmit this speed to the other slave motors, so that those motors can run at the same speed. For each motor, a speed sensing unit is attached to sense the speed. The speed controls of the motors are achieved by each microcontroller connected with a MOSFET. [4]

III. PROPOSED SYSTEM

In our speed synchronization project, we use AT89C51 micro-controller has been used. RF communication technology for wireless communication. We can program microcontroller to control its speed and also can set the required speed through keypad to get our work done. Motor drive (ULN) is used to operating the BLDC motor.

PROTEUS software coding has been used for controlling the speed of the motor. The required speed is entered using a keypad which is interfaced with MC. Lcd which is used to display the speed.

3.1 Wireless Control of a Dc Motor

The wireless control of a DC Motor involves the design and implementation of microcontroller based control unit to use RF (radio frequency) to wirelessly control a DC Motor. DC motors have played a vital role in the development of industrial power transmission systems. It was the first practical device to convert electrical power into mechanical power.

Inherently straightforward operating characteristics, flexible performance and high efficiency encouraged the widespread use of DC motors in many types of industrial drive applications. With the advancement in the field of wireless communication technology has thus encouraged their use in other fields such as military drones, surveillance systems, toy cars among others. The successful design and implementation of the Wireless DC Motor control will enable the wireless supervision of robots and machines that utilize DC Motors.

3.2 RF module

An RF module (radio frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and/or receiver. [7-8]

Advantages:

1. They are fairly inexpensive.
2. Greater Efficiency and the ability to remove signal variations and noise.

Disadvantages:

1. Bandwidth would depend on the actual IR/RF devices being used.
2. Radio Frequency devices, however, need to be operated in accordance with the FCC.
3. Interference could be an issue, RF due to other RF emitting devices. In our proposal we use RF module for wireless communication.

3.2.1 Transmitter modules

An RF transmitter module is a small PCB sub-assembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which can be transmitted. RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics and band edge requirements.

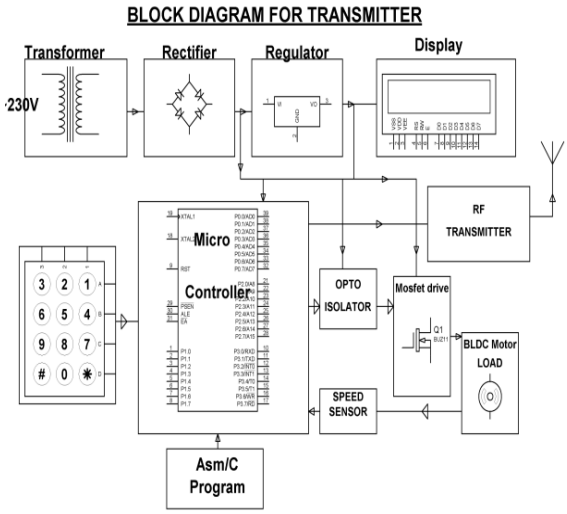

FIG1. BLOCK DIAGRAM OF TRANSMISSION SECTION

FIG2. HARDWARE MODULE FOR SPEED SYNCHRONIZATION UNIT

3.2.2 Receiver modules

An RF receiver module receives the modulated RF signal, and demodulates it. There are two types of RF receiver modules: super hetero dyne receivers and super-regenerative receivers Super-regenerative modules are usually low cost and low power designs using a series of amplifiers to extract modulated data from a carrier wave. Super-regenerative modules are generally imprecise as their frequency of operation varies considerably with temperature and power supply voltage. Super heterodyne receivers have a performance advantage over super-regenerative; they offer increased accuracy and stability over a large voltage and temperature range. This stability comes from a fixed crystal design which in turn leads to a comparatively more expensive product.

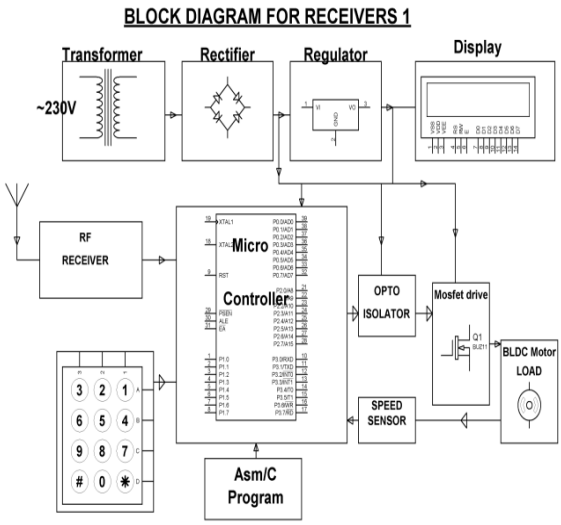

FIG3. BLOCK DIAGRAM OF RECEIVING SECTION 1

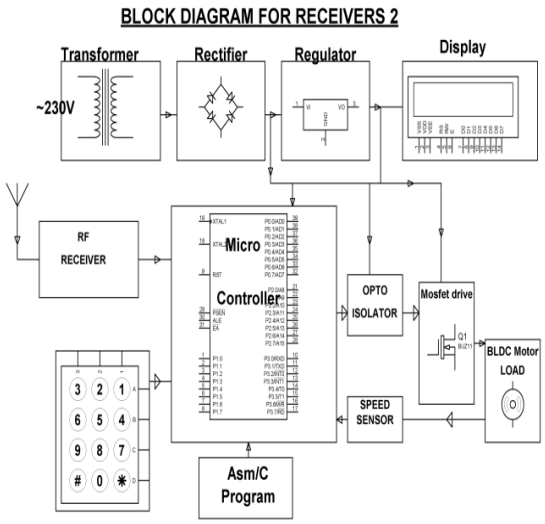

FIG4. BLOCK DIAGRAM OF RECEIVING SECTION 2

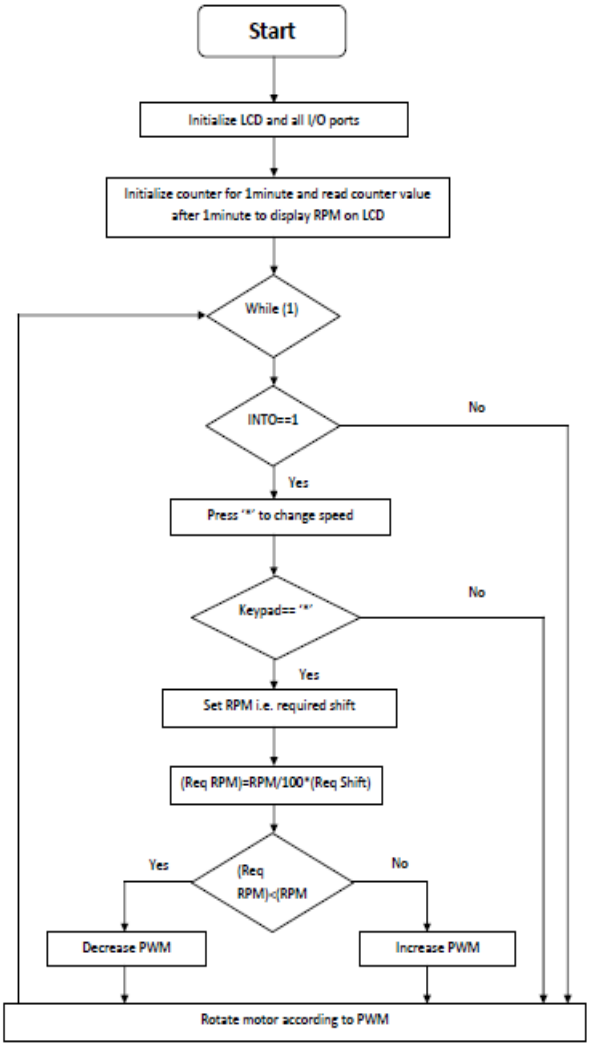

FIG 5. FLOW CHART DIAGRAM OF SPEED SYNCHRONIZATION OF MOTORS

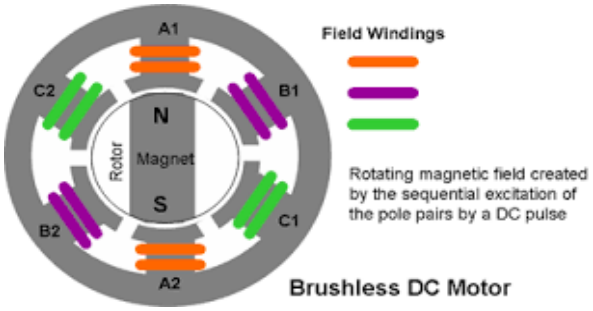

FIG 6. BRUSHLESS DC MOTOR

3.3 DC Motor

Here we are going to use 3 BLDC motors. Figure6. Shows the Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. In this context, AC, alternating current, does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform. Additional sensors and electronics control the inverter output amplitude and waveform (and therefore percent of DC bus usage/efficiency) and frequency (i.e. rotor speed). The rotor part of a brushless motor is often a permanent magnet synchronous motor, but can also be a switched reluctance motor, or induction [5-6].

Brushless motors may be described as stepper motors; however, the term "stepper motor" tends to be used for motors that are designed specifically to be operated in a mode where they are frequently stopped with the rotor in a defined angular position. This page describes more general brushless motor principles, though there is overlap.

Applications:

- Brushless motors fulfill many functions originally performed by brushed DC motors, But cost and control complexity prevents brushless motors from replacing brushed motors completely in the lowest-cost areas.
- Nevertheless, brushless motors have come to dominate many applications particularly devices such as computer hard drives and CD/DVD players.
- Small cooling fans in electronic equipment are powered exclusively by brushless motors. They can be found in cordless power tools where the increased efficiency of the motor leads to longer periods of use before the battery needs to be charged.

Low speed, low power brushless motors are used in direct-drive turntable for gramophone records

IV. RESULTS AND DISCUSSIONS

FIG7. RECEIVING MOTOR SPEED

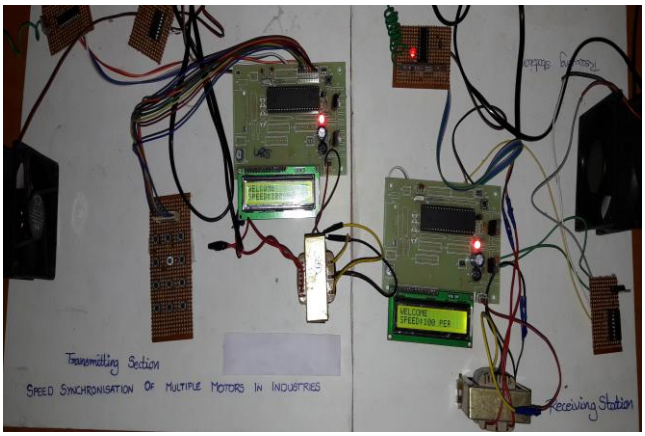

FIG8. SPEED SYNCHRONIZATION OF MAIN AND RECEIVING MOTOR

The synchronization of motors was obtained successfully. TABLE 1 shows the speeds that are achieved with the current configuration:

TABLE 1
SPEED SYNCHRONIZATION OF THREE MOTORS.

S.No.	Main motor speed in percentages (experimental values)	Receiving motor1 speed in percentages (experimental values)	Receiving motor 2 speed in percentages (experimental values)
1.	20%	20%	20%
2.	40%	40%	40%
3.	60%	60%	60%
4.	80%	80%	80%
5.	100%	100%	100%

The above table represents the speed synchronization results of three motors. According to the main motor the second motor and third motors adjust its speed and the speed synchronization is done. It is observed that the synchronized RPM's were accurate with very slight variations, which were nullified once the motor speed was stabilized. For higher RPM's the sensor first gives a pseudo measurement, which is then corrected for the actual RPM. The receiving end motors did not experience any significant delay in altering their speed.

V. CONCLUSION

The project "speed synchronization of multiple motors in industries using microcontroller". We can tabulate different speeds of motor as we keep on giving input from the Keypad and same speed change can be observed and displayed at the receiving motors. From this project we can successfully control the speed of multiple motors wirelessly through RF communication. Whatever the percentage of speed that we enter at transmitting unit of system same can be observed at the receiving motors. The whole operation is made simple by using wireless technology.

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