Advanced Synchronization of Multiple Machines

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***Abstract* — In textile industry many processes required speed synchronization of more than one motors involved in the process. Speed control of motor is very important especially in the fields including industrial applications, robotics, textile mills, etc. In all these application motor speed synchronization is invigorate in conveyor belt driven by multiple motors. Sudden changes in load cause hunting and oscillatory behaviour in DC machine. This behaviour can be harmful to the process. There are so many methods which is used for controlling the DC machines. Among all these method master-slave synchronization is a widely used technique. So, speed control of DC motors at different load conditions is essential to achieve a robust system. The synchronization is done by using microcontroller chip which controls the master slave whose speed is followed by the other motors which all have to be synchronized. For PWM generation PIC microcontroller is used. The ADC is available in microcontroller chip which create feedback loop. This ADC checks the voltage level of the motor and accordingly the voltage level of the motor can be maintained at a fixed level. A driver circuit is used to drive the motor. Hence, a closed loop motor speed control circuit is designed and the total amount of power delivered to the motor is varied depending on load conditions. In this technique, the regulation of motor's speed is achieved by changing the voltage of the motor which is adjusted by the duty cycle of PWM.**

Keywords: Microcontroller chip, PWM technique, driver circuit, speed synchronization.

I.INTRODUCTION

In the last few years has made it possible to apply modern control technology to control efficient and reliable operation of many applications such as the paper mills, cruise, electric vehicles, textiles mills, floor mills and robotics. Many of these operations including electric motors and therefore there is a need for feasible effective control strategies with digital control of these motors. In traditional processes motors are synchronized through mechanical transmission system consisting of a line shaft gears, pullers. So for variable load condition speed control is important to achieve a robust system. This project presents the design and implementation of microcontroller based speed control of motors.

For PWM generation PIC microcontroller is used. The ADC is available in microcontroller chip which create feedback loop. This ADC check the voltage level of the motor and accordingly the voltage level of the motors can be maintained at a fixed level. A driver circuit is used to run the motor. Hence, the total amount of power delivered to the motor is varied depending on load conditions using closed loop motor speed control circuit. In this method, the regulation of motor's speed is achieved by changing the voltage of the motor which is adjusted by the duty cycle of PWM. The speed of DC motor is directly proportional to armature voltage (Va) and inversely proportional to field flux (Φf). Therefore adjustable speed drives can be operated over a wide range by controlling armature or field excitation. For motors speed control, closed-loop PWM technique is widely used and most efficient. In this technique, the regulation of motor's speed is achieved by changing the voltage of motor which is adjusted by the duty cycle of PWM. In order to enhance the performance of motor, motor speed regulation and to reduce the steady-state error of the rotational speed of motor, a high- performance PIC microcontroller is used for implementation. The great advances of microcontroller based control system are due to microcontroller flexibility and different abilities. This is because all the control strategies can be implemented in the software. The PWM duty cycle is generated using timer of microcontroller by varying pulses of input voltage for the on and off duration which causes the PWM voltage control with high accuracy. The development of high performance motor drive is very important in industrial applications

as well as drive system must have good dynamic speed and load regulating response. DC drives have reliability, simplicity, ease of application and favourable cost because of all these it become backbone of industrial applications.

II. LITERATURE REVIEW

2.1 MULTI-MOTOR SYNCHRONIZATION TECHNIQUES

Multi-motor applications 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. Practical results in a two 1.5 kW induction machine test ring are presented, showing advantages and limitation of those techniques during different load conditions. The work reported in this paper makes use of a V/Hz motor control scheme, but conclusions drawn can be applied to any motor control technique. Parallel research is ongoing; results are reported on future publications.

2.2 MOTORS SPEED A SYNCHRONIZATION IN NONLINEAR PROCESS BY SELECTIVE STATE FEEDBACK AND INTEGRAL DC-MOTOR CONTROLLER

In textile industry many processes require speed synchronization (or A synchronization) 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 behaviour in dc machines. This behaviour 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. Microcontroller based speed control system consist of electronic component, microcontroller and the LCD. In this paper, implementation of the ATmega8L microcontroller for speed control of DC motor fed by a DC chopper has been investigated. This work is a practical one and high feasibility according to economic point of view and accuracy. In this work d, envelopment of hardware and software 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.

2.3 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 project 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.

III. PROPOSED SYSTEM

There are so many other different techniques for the solution this problem. But those are not that reliable. In order to reduce man intervention and save the labour cost and time both can use microcontroller to control, operate and synchronize this task. As compared to conveyor belt method is compatible as it involves hardware as well as software in this module. The microcontroller can be programmed to control its speed and also can set the required speed through potentiometer to get our work done. Synchronization has been done here using wireless method. RF communication technology has been used here for wireless communication. Motors are synchronized with the master slave method. The motor speed is

transmitted using the RF Module from the transmitter and using PWM Technique the speed is received in the receiver side and the motors will run at synchronized speed.

A. System Architecture

The figure 1 shows the block diagram for the transmitter which consists of a potentiometer which acts as the input device (i.e.,) is used to give the speed input to the transmitter motor. The Radio frequency (433 MHz) transmitter is used to transmit the speed signal to the Radio Frequency receiver module. The analog to digital converter is used to convert the analog input given by the potentiometer into digital signal to the electronic speed controller. The electronic speed controller regulates the speed by adjusting the width of the pulse signal given to the BLDC motor.

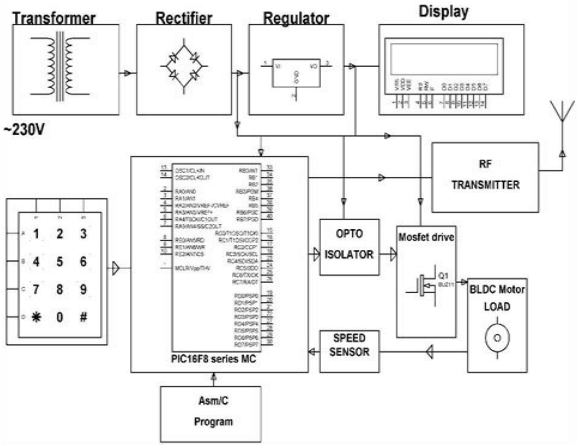

Fig. 1 Block diagram of the transmitter system

B. Hardware Components

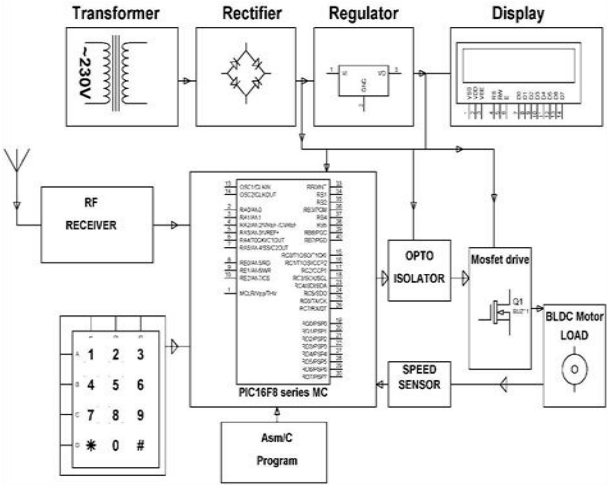

Fig. 2 Block diagram of the receiver system

The figure 2 shows the block diagram for the receiver system. The receiver system consists of the Radio Frequency receiver module which is used to acquire the signal transmitted in the RF transmitter from the transmitter motor. The signal received has been given to the microcontroller as input. The pulse signal is generated which is given to the electronic speed controller. The width of the pulse signal is varied based on the received signal from the RF receiver module. Thus, pulse signal has been given to the receiver motors accordingly through the electronic speed controller. *B. Hardware Components*

1) *Brushless DC Motor*: The Brushless DC (BLDC) motor is the ideal choice for applications that require high reliability, high efficiency, and high power-to-volume ratio. Generally speaking, a BLDC motor is considered to be a high performance motor that is capable of providing large amounts of torque over a vast speed range. BLDC motors are a derivative of the most commonly used DC motor, the brushed DC motor, and they share the same torque and speed performance curve characteristics. The major difference between the two is the use of brushes. BLDC motors do not have brushes (hence the name "brushless DC") and must be electronically commutated.

2) ATmega 328 microcontroller: The Atmel AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in a single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

IV .EXPERIMENTAL DETAILS

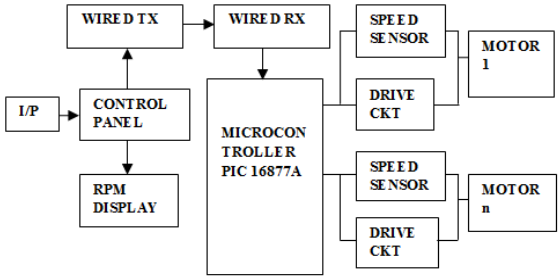

Fig. 3 Block diagram of speed synchronization of multiple motors by using microcontroller.

ZIGBEE:

ZigBee is a protocol that uses the 802.15.4 standard as a baseline and adds additional routing and networking functionality. The ZigBee protocol was developed by the ZigBee Alliance. The ZigBee Alliance is a group of companies that worked in co-operation to develop a network protocol that can be used in a variety of commercial and industrial low data rate applications. Because ZigBee was designed for low power applications, it fits well into embedded systems. Zigbee is basically a communication IC; in our project we are using this for the communication between transmitter unit and receiver unit.

The main principle of the control is the speed of master and slaves are measured and compared in such a way to get speed synchronization of multiple motors. A new Master-Slave configuration is developed. This paper discusses an working where a continuously variable speed operation is provided for the multiple motors by using a single low cost PIC controller. These controller developed variable speed drives with minimum external hardware thus increasing the reliability. Synchronization error is reducing by master-slave technique.

ADVANTAGES OF THE PROPOSED SYSTEM

- Multiple motors are synchronized wirelessly
- One motor acts transmitter and rest as receiver hence only one motor is to be controlled for controlling for units
- The Regulation of motors speed is achieved by changing the voltage of the motor is adjusted by the duty cycle of PMW
- The mode of communication is radio frequency in this project
- In this project motors will be synchronized easily by master motor speed
- ADC circuit is used to run the motor hence the total amount of power delivered to the motor is varied depending on load conditions using closed loop motor speed control circuit

APPLICATIONS

- Such as used in paper mills, cruise electric vehicle, textiles mills, flour mills and robotics
- Many of those operation including electric motors and therefore there is need for feasible effective control strategies with digital control of those motors
- In traditional processes motors are synchronized through mechanical transmission system consisting of line shaft gear pullers. So for variable load condition speed control is important to achieve a robust system.

V. CONCLUSION

In this experimental study, motors can be synchronized easily by controlling master motor speed. The PI controller causes poor step reference tracking and load torque rejection, slow response, large overshoots and oscillations. This can be reduced by using PIC micro controller. By using this master controller sets required speed & control other slaves. Sensors used for speed sensing. Master motor is adjusted at set point of speed and when system is started then slave motor trying to achieve required speed. Feedback system is used & required speed can be achieved by using PWM technique by controlling firing angle. Keypad provides flexibility & easy calibration of the system. Hence this technique of speed synchronization can be used in robotics, textile industries, paper mills, rolling mills etc. This system can be implemented by using DSP & wireless technique.

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