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Speed Synchronization of Multiple Motors by Using Microcontrollers

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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

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dynamic speed and load regulating response. DC drives have reliability, simplicity, ease of application and favorable cost because of all these it become backbone of industrial applications.

A) Need of Speed Synchronisation

The major problems in applying a traditional control technique in speed controller are the effects of non-linearity in a DC motor. The non-linear characteristics of a dc motor such as saturation in friction could humiliate the performance of traditional controller. In textile industry, rolling of clothe should be synchronized with the speed of weaving spindle to avoid damage. Large load variations cause hunting or oscillatory behaviour in DC machine.

II.LITERATURE REVIEW

Mohamed S. Zaky [1] "A self-tuning PI controller for the speed control of electrical motor drives" says that PI controller gains are the adjustable parameters and depending on the speed error that will be updated online. PI controller gives a high degree of accuracy in the presence of external disturbance. PI controllers is not simultaneously meeting good step reference tracking and also not provide good load torque rejection as well as it gives slow response large overshoots and oscillations.

Xiaoyuan Zhu, Hui Zhang, Zongde Fang [2] "Speed synchronization control for integrated automotive motor transmission power train system with random delays" says that integrated motor transmission power train system in which driving motor and multi-gearbox is directly connected. Controller Area Network (CAN) is used in that system with random delays in both feedback and forward channel and the speed synchronization is done and motor speed is control. The drawback is that transient performance of control system is reduce with significant overshot and produce vibrations in the power train system. The steady state speed synchronization error is very high and can not be stabilized because of random oscillations.

Ganiyu, R. A., Shoewu, O. , Olatinwo, S. O. , Omitola, O. O. "Development of a Micro controller Based Motor Speed Control System Using Intel 8051" says that the motor speed control system requires a closed loop real time system where a very high optical encoder is connected to motor shaft and provide a feedback signal through micro controller. Microcontroller is acts as a proportional controller. At very high gain causes the speed response of the control loop becomes steady state oscillations and increase in gain causes speed up the motor and be damaged.

III.EXPERIMENTAL DETAILS

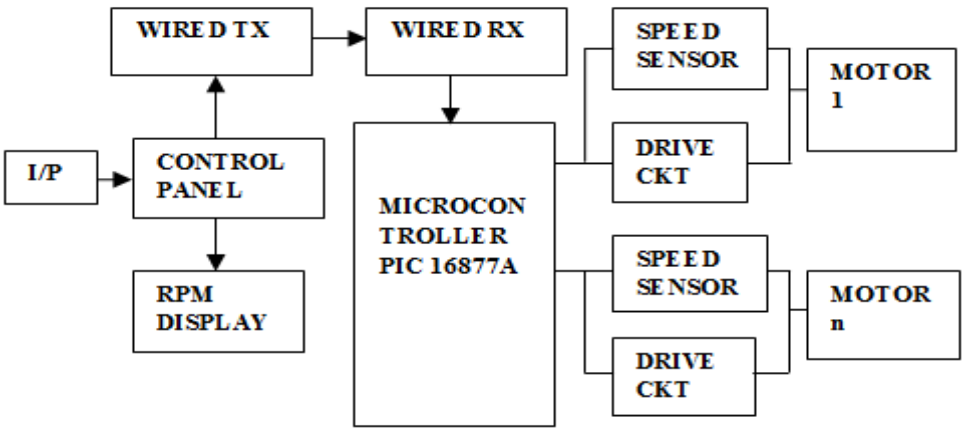

Fig.1 Block diagram of speed synchronization of multiple motors by using microcontroller.

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

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PIC controller. These controller developed variable speed drives with minimum external hardware thus increasing the reliability. Synchronization error is reducing by master-slave technique.

IV.RESULT AND DISCUSSION

Table1.Speed synchronization of two motors

	RPS		EXPECTED		ACTUAL	
Sr.No	**SL 1**	**SL2**	**SL1**	**SL2**	**SL1**	**SL2**
1	0.4	1.2	30	30	29.34	29.34
2	0.7	1.9	42	42	41.08	41.08
3	0.9	1.6	96	96	93.90	93.90
4	1.3	1.4	100	100	97.72	97.72
5	1.6	1.0	60	60	58.68	58.68

The above table represents the speed synchronization results of two motors. The table indicate that the SL1 is the master motor, according to the master motor the second motor adjust its speed and the speed synchronisation is done.

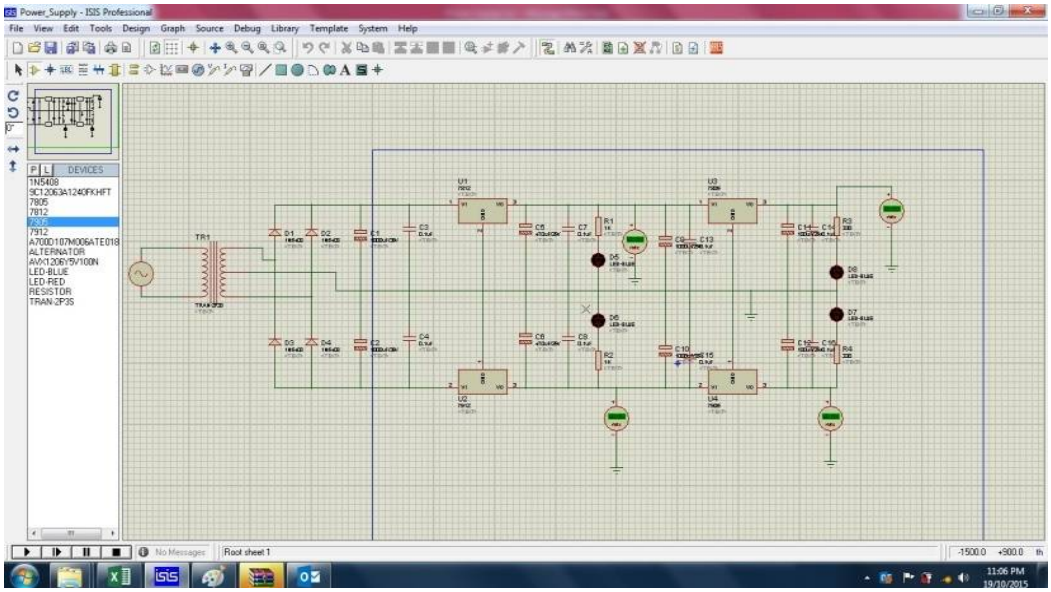

Fig. 2 Power Supply Design

The Fig. 2 shows that simulation of power supply design in the proteus software. We get +12V/-12V & +5V/-5V output voltage which is required to input for motors and microcontroller. It uses 15-0-15 transformer, output voltage of

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transformer is 15V. the circuit uses the 4 different ICs 7812,7912,7805 and 7905. In this simulation different voltage & current measuring scopes are used

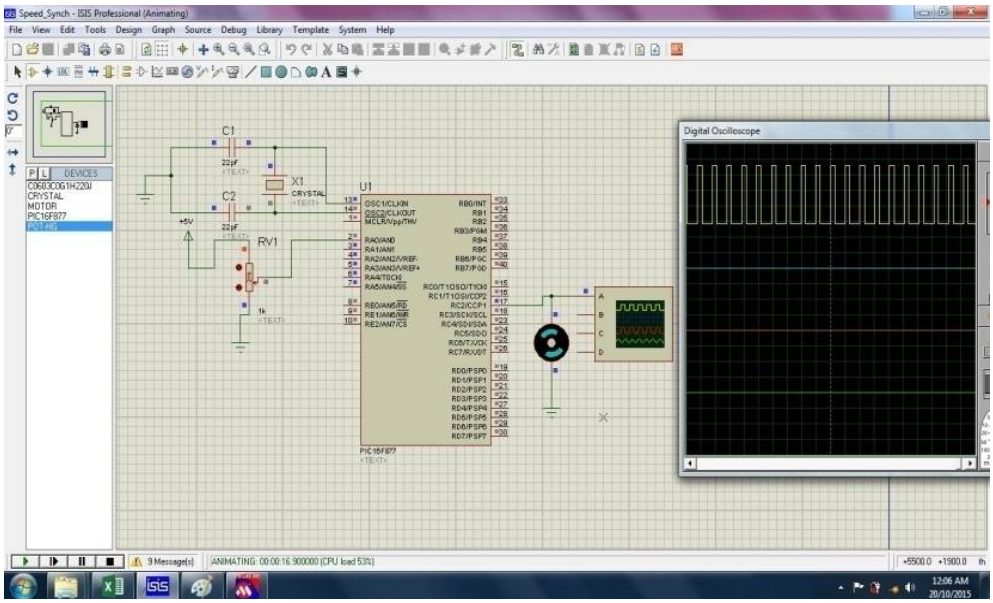

Fig. 3 PWM generation

The above figure shows that PWM generation required for the speed synchronization of motors. The PIC16F877A microcontroller is used for PWM generation. Its CCP module and TIMER2 is used to generate PWM output. In the simulation module the digital oscilloscope is used to observe the PWM generating pulses. The crystal oscillator is used for giving the crystal frequency input to the microcontroller.

VI.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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