International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 10, October- 2014

PC Controlled Wireless Multipledrive System

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***Abstract*—Multi drive system is playing a prominent role in the industry today, the application of the system is wide enough in Industrial Automation . Industrialists had a problem in controlling multiple drives simultaneously using a single software. In this paper a novel model of multiple motor drive system has been developed using PMDC motors. The system consists of PMDC motors, an intelligent microcontroller unit, and wireless transceivers. This model is implemented using LabVIEW software package. GUI (Graphical User Interface) has been developed for easy control of these drives. Model proposed offer a proper tool for multiple motor drive systems.**

***Index Terms*—Multiple motor drive Systems, LabVIEW, Control systems, PWM speed control for multi drive system, Embedded systems, Power Electronics.**

I. INTRODUCTION

THE MULTIPLE MOTOR DRIVE CONTROL SYSTEMSare playing a major role in manufacturing industries where automation is necessary. Controlling multiple systems simultaneouslyby manual methods is a hectic process. Automation with proper timing makes it easier, less complicated and easy to control. From abeverage company to an automobile company today everything is automated, with the advancement of technology in the field of multiple drive control systems. This system includes

- *Control systems*
- *Embedded systems*
- *Analog Electronics*
- *Power Electronics*

This paper focuses mainly on implementing a control system using LabVIEW GUI and a microcontroller through the wireless medium. Zigbee® protocol has been used in the communication between the computer and the microcontroller for various applications.

Arduino development board has been used for the implementation of the project. ATmega328 chip has been used as the microcontroller. Since it has 6 PWM (Pulse Width Modulation) pinsADC and DAC modules are special features for sensing the environment and is used for the feedback in the control system, to make it as a stable closed loop system. It has an UART module, which was used to communicate with the computer via ZigBee®. Multiple motors (i.e Servo motors, DC motors, PMDC motors) are simulated using simulation platforms like PSPICE/Proteus. Controlsignals

have been simulated in Proteus and verified withoutputs (i.e voltage, current, speed, position).

II. CONTROL SYSTEM FOR DRIVES

Control systems can be classified into two general categories

- Open loop control system (Manual Control)
- Closed loop control system (Automatic Control)

In an industry, though 75% of the system is automated, Human monitoring is mandatory for certain applications.

Manual control using a GUI is necessary to check and to act so.Automatic control plays a major role in fail safe arrangements, accuracy, error minimization etc.

III. NEED FOR AUTOMATION

For multiple operations (controlling multiple drives), it is not very easy to handle all the details by human being simultaneously. If the system is automated (sequence of operations has been loaded along with the variable), the variable alone can be changed by human being for activating the sequence.

IV. EMBEDDED SYSTEM

Execution of a closed loop control system can be implemented using embedded systems. Here we have implemented the system in Arduino© UNO development board. We are going to control multiple DC motors with speed as feedback. All the sensor inputs will be given to the microcontrollers through signal conditioning circuits. Control signals for the motors have been given to the motors through driver circuits.

V. POWER ELECTRONICS (DRIVER CIRCUITS)

Since the microcontroller can handle power not more than milliwatts(mW), we needdriver circuits for handling higher currents. We used MOSFETs because of its higher response rate.

VI. SYSTEM MODELING AND DESIGN

A. Graphical User Interface:

This is a Human machine interface using a medium like a computer, so that controlling of these complex systems will become easier. It has been designed in such away to handle it as we do in real-time. Graphical Knob, display, analog meters, switches, control panel, all other indicators and controls.

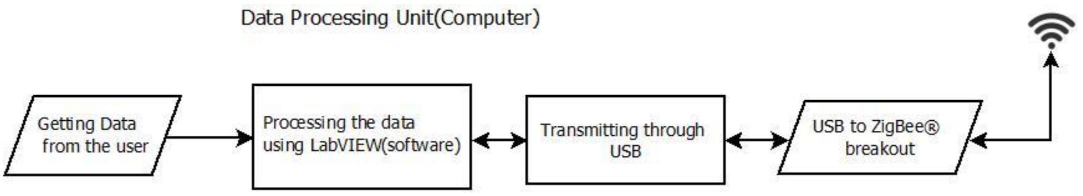


Fig. 1. Flow chart of the Data Processing Unit and transceiver module.

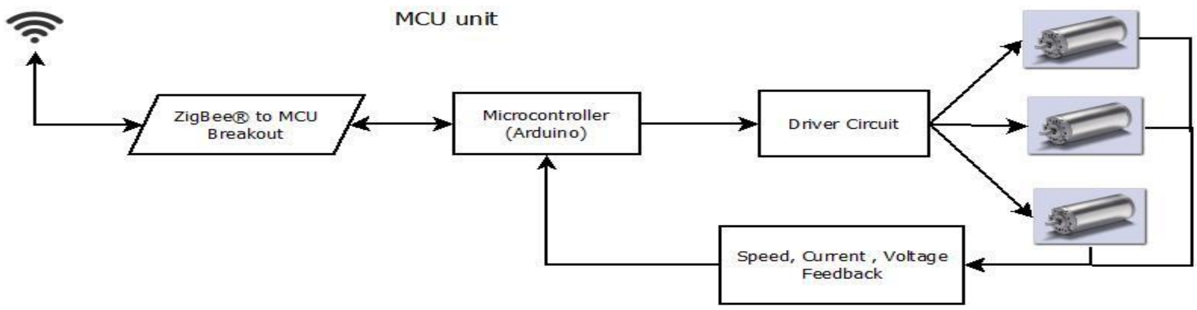


Fig. 2. Flow chart of transceiver module, MCU and Actuator Unit.

B. *Data processing Using LabVIEW*

The data from the front panel has been taken and it is processed for the data needed to control the motors i.eMultiple drives. Numerical data like speed or voltage has been converted into control signals(Duty ratio) using LabVIEW functions. For a PMDC motor voltage can be adjusted using PWM techniques. Since voltage is proportional to speed,

$$V = R_a I_a + L\frac{di}{dt} + E_b$$

$$E_b = \frac{P\Psi NZ}{60A}$$

The current in the motor is determined by the load of the motor. Since the load is constant, Current through the motor is constant. Inductive effect can be neglected. So applied voltage is directly proportional to the back EMF(E_b). Back EMF is directly proportional to the speed.

$$V_a = DV_s$$

By varying applied average voltage using PWM techniques, Speed can be varied linearly.

1) *Alarm system using LabVIEW*

Costliest system in the unit are the drives or motors. Primary motive is to reduce the complexity of the system and safety of the system. Motor can be handled safely using the current and voltage feedback system. If the motor is overloaded an alarm system will start beeping and a failsafe action of tripping has been done, by using the MCU controlled switches.

LabVIEW functions are arranged and configured to get the value for D(Duty Ratio) and that value has been transmitted through VISA block.

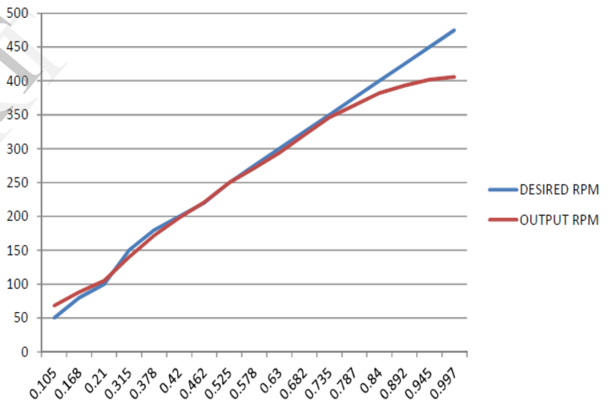


Fig. 1. Speed(N) in RPM as a Function of Duty ratio(D). Blue colored values are desired(calculated) values, Red colored values are actual output values.

C. *Transmitting through USB*

VISA block has been configured to the COM port of the computer. The communication from/to the LabVIEW software will be handled by the VISA block (i.e COM ports).

D. *USB to ZigBee® breakout:*

USB 5 V logic has to be converted to 3.3V logic for transmission through ZigBee®. A breakout board is needed along with FT232, Data converter to connect with ZigBee®. Data will be transmitted through the antenna of the ZigBee.

E. *Microcontroller(Arduino)*

Microcontroller (ATmega328) has an UART module for serial communication. It can be communicated using Tx(Transmitter) and Rx(Receiver) pins. Baud rate of the UART module has to be configured as same as the baud rate of the COM port. The motors are connected through the driver circuit. Microcontroller has to give the Pulse Width

Modulated control signal to the driver circuit according to the character received in the Rx Pin. Microcontroller has been programmed in such away to adjust the duty ratio according to the character.

F. Analog Tachometer(Speed)

Analog Tachometer has been connected to the ADC Pin of the microcontroller for a feedback. It will check the speed corresponding to the control signal and the real speed of the rotor, then it will be adjusted automatically to the desired duty ratio for the corresponding speed.

Analog output from tachometer(V_s) can be conditioned using Operational Amplifier for a varied range of voltage. Non-Inverting configuration with the gain(G) can be used.

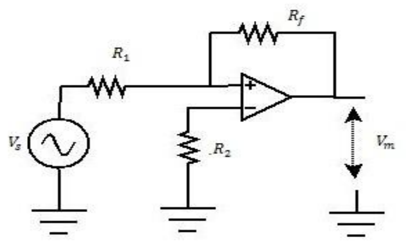


Fig. 3. Circuit diagram of Signal conditioning circuit.

$$G = 1 + \frac{R_f}{R_1}$$

$$V_m = GV_s$$

G. Current Transducer(CT)(Current)

Current transducer is used to convert the large value of current into measurable voltage range for the microcontroller (for ADC).This range can be varied by adjusting the Measuring resistance(R_m).

Primary current flows through the Current Transducer(CT) as I_1. Secondary Current flows through Current Transducer as I_2. Conversion ratio(k) can be determined from the datasheet of the CT.

$$I_1 = kI_2$$

Generally k is in the range of 1000's. If I_1 is in the range of Ampere then $I_2$is in the range of milliampere. Expected maximum measuring voltage V_m, and calculated measuring resistance R_m

$$V_m = I_2 R_m$$

H. Voltage or Potential Transducer(PT)(Voltage)

Voltage transducer is used to convert the large value of voltage into measurable voltage range for the microcontroller (for ADC). This range can be varied by adjusting the input resistance R_{in} and Measuring resistance R_m.

Primary Current limit for the Potential transducer has been mentioned in the data sheet asI_{1max}. Secondary current is mentioned as I_2.Primary voltage is mentioned as V_{1max}. Secondary Voltage or measuring voltage is mentioned as V_m. Conversion ratio(k) can be determined from the datasheet.

$$V_{1max} = I_{1max} R_{in}$$

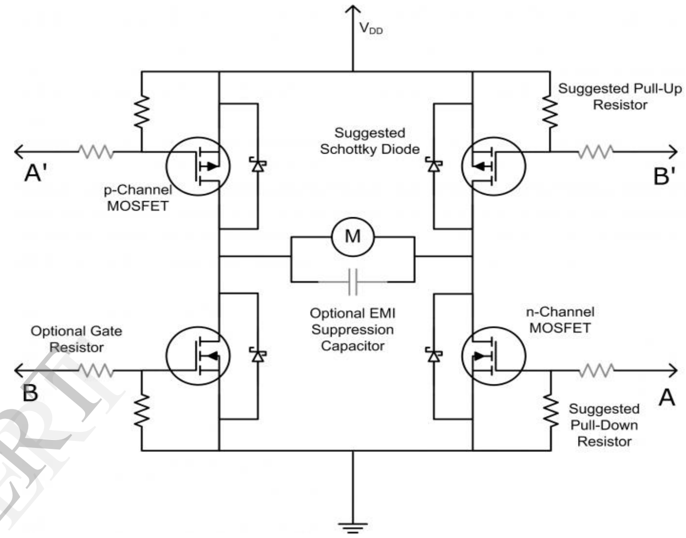
$$kI_{1max} = I_2$$

$$V_m = I_2 R_m$$

I. Driver Circuit

If a high power transistor or switching device has been driven by a low power controller or a circuit then the circuit is called as driver circuit.

Microcontroller cannot give current more than few milliamperes but motor needs several Amperes to run. Here comes the role of the driver circuit. MOSFET's which are the fastest switch available in the market, has been used as the driver circuit for the PMDC machines.



By changing the polarity of the control signals we can change the direction, by using PWM technique speed of the motor can be varied. The frequency of the PWM control signal has to be as high as 20kHz, so that the noise created is not in the audible spectrum. It should not be less than the frequency of the motor (speed) then the motor will start oscillating.

N-MOS and P-MOS complementary pairs are used for the driver circuits. Rating of the MOSFETS are selected according to the rating of the motor. For example, if a motor rated for about 10A , Each MOSFET has to be rated 1.25 times (i.e 12.5A)the rated current of the motor as a safety measure.

In order to avoid the failure of the microcontroller, for high current applications gate isolation techniques are mandatory. Optocouplers are used as the isolation medium.

VII. CONCLUSION

The design and fabrication of the control system for a multiple motor drive system were described in this paper. Multiple PMDC motors have been taken into account for controlling and a detailed procedure for selecting the transducers , design of signal conditioning circuits has been explained. Computer control using LabVIEW has been discussed along with the protocols.

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