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Multiple Non-Identical Four DC Motor Synchronous Speed Control: Initial Hardware and Control Scheme

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Abstract – This paper highlights the initial research in controlling speed of multiple DC motors synchronously. One of the motors tested for speed control are non-identical thus the dynamics of the motor is different. The modelling of the motor, drivers and output sensors is explained with dynamics clearly described. The control scheme used is PI control and the result showed. Although the research is in its prime, the result shows promising result.

Keywords – Multiple Motor, Synchronous Speed Control, Non-identical Motor, PID.

1. Introduction

Multiple motor drives are used numerously in unmanned system application such as Unmanned Aerial Vehicle (UAV), Unmanned Ground Vehicle (UGV) and Unmanned Underwater Vehicle (UUV). In this application synchronizing all motors is essential for navigation.

In the field, if a UGV was immobilize where by one of the motors was damaged, the user can changed the motors. If a correct motor were not available, the changed motor will not have a correct response. Thus, the overall control will not perform as designed. A solution for optimize and automatically synchronizing all motor need to be found even if all motors is not identical.

This paper explained about the initial development towards optimize and automatically synchronizing non-identical motors. The initial setup is that the reference signal is given by higher order controller and the motor should follow with all motors exhibiting the same control characteristics such as rise time and settling time.

2. Literature

Paper form D.Z.Zhao et. al. have developed a control scheme to synchronize four motor using cross-coupled sliding mode control [1]. In the paper, the motor is presumed identical and only caters for disturbance affected by one of the motors. That motors is than synchronous with the other motors. The result shows good stabilizing of the sliding mode control compared to PI control. Speed error for coupling control also shows good result compared to decoupling control.

Houcine Zeroug et. al. in their paper [2], shows a possible way to control two dc motor using a master and slave technique. It is presumed that the two dc motor have the same characteristic since the paper did not explicitly mention 'different/non-identical motors'. The speed variation and load variation is accessed with good tracking result of the slave based on the master.

The usage of DSP in multiple motor speed controllers is also used in paper from K. Boudjit [3]. He uses a master-slave technique which is almost similar to paper from [2]. He uses PID based controller with more in depth equation formulation. The speed variation and load variation is accessed with good tracking result of the slave based on the master.

Paper [4] by P.R.Moore et.al, describes a method for establishing the coupling between decoupled independent drives in multi-axis configuration via fuzzy logic [4]. The coupling is done on two identical servo motors which resulted in a good regulation of speed between the two motors.

Unfortunately, all the paper sited above and to the authors' knowledge, none of them have cater for multiple different motor control with different dynamics. This paper shows the initial development of a multiple non-identical four motors speed control scheme.

3. Hardware Development

The hardware was developed using four motor where three of them is identical. The specification for the motors can be seen in Table 1. Each motor comes with its own speed encoder which is then connected to a microcontroller. The microcontroller used is an Arduino UNO. Once the speed value has been acquired by the microcontroller, the microcontroller will generate the PWM value which is then inputted into the MD10C motor driver. The MD10C can drive a motor at a continuous current of 13A. The block diagram of the hardware can be seen in Fig. 1. The PC is only used for data acquisition. The fully developed hardware can be seen in Fig. 2 where all motors are fixed vertically on the wood board.

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