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SPEED CONTROL OF A DC MOTOR WITH ADAPTIVE FUZZY PID BASED DISTURBANCE OBSERVER

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Abstract

DC motors are one of the widely used actuators in industrial applications. And its the reliability of DC motor performance becomes an important prerequisite that must be met. Therefore, a control scheme is required to meet the above performance demands, especially in the transient, steady state, and system stability aspects. The main problems in DC motor control system, mainly in terms of speed control, are the event of changes in system parameters and the presence of trouble such as load changes. AFPID scheme plays a role in handling the change of system parameters, while Dob(Disturbance Observer) serves to estimate the occurrence of disturbance. The integrated of AFPID with DOb offers a more stable performance to DC motor has and is more insensitive to disturbance.

***Key Words*:**DC motor; adaptive control; fuzzy-PID; disturbance observer; various load

1 INTRODUCTION

DC motors are one of actuators that have been widely used in various industrial applications. The advantages of DC motors are low cost, high reliability, easy maintenance, and simple control technique can be applied for speed and position [1-2]. Control of DC motors speed is generally done by adjusting the input voltage on DC motors. In order to control speed of DC motors, various control techniques have been designed and applied in previous studies [3-9]. From literatures, the most widely used control technique for DC motors speed control is Proportional Integral Derivative (PID) technique. However, the PID control technique is only appropriately applied when DC motors are assumed to be linear since they operated for a shorter time in an ideal environment, and do not require higher precision and accuracy. The problems that often arise in DC motors control are the occurrence of parameter changes when the DC motors are run in a relatively long span of time and worse operating condition and environment. The problems may cause the DC motors system to change to become nonlinear and contains uncertainty elements [10-11].

In addition, there are also appear various internal and external disturbances, such as friction on the rotor and load changes, respectively. These conditions potentially affected the output performance and stability of DC motor systems. Under such system conditions, PID control techniques cannot be fully relied upon, especially for applications that require a high precision and accuracy. One of the most common solutions offered for the systems that experience parameter changes, contain uncertainty elements, and receive disturbances, is by developing adaptive control schemes [12-13]. The adaptive control scheme that has been widely used is a reference adaptive control (MRAC) or a standalone control scheme like PID, Sliding Mode Control (SMC), and Backstepping that are modified their algorithms to become adaptive [14-16]. Such that, the parameters of the control scheme can change and adapt to the changes that occur in DC motors. In order to estimate magnitude of the changes, observers and estimators have been used widely. However, in the previous studies the problems were generally solved by developing optimization techniques on tuning process of a standalone control parameters, without being fully adaptive [17]. In the Fuzzy-PID scheme, for example, tuning process of the PID control parameters is optimized by using the fuzzy logic method [18], and also can be tuning by GA and PSO for GAPID and PSO-PID schemes. Therefore, this study proposed a fully adaptive control scheme which were combining the tuning optimization method and the estimation method to compensate the changes in the system. The new scheme incorporates the Adaptive-Fuzzy-PID (AFPID) control technique with the Disturbance Observer (DOb). The combined scheme was prepared to guarantee the DC motor becomes more robust to the parameter changes and the presence of disturbances.

2 METHODOLOGY

DC MOTOR MODELLING

DC motor modeling is carried out by the use of system identification technique based totally on a fixed of input and output information from DC motor, by using gadget identity toolbox in Matlab. The received model describes the traits of DC motor machine, within the form of output temporary reaction, constant country blunders and system stability. The traits of the acquired version come to be the basis for the layout of the manipulate algorithm to be carried out, either as a standalone manage approach or as an observer.

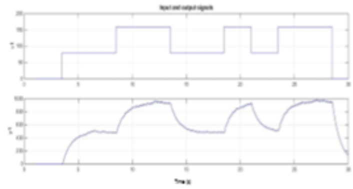


Fig. 1. A set data input and output of modelling

In widespread, the stairs of DC motor modelling include statistics collection, selection of modeling structures, estimation system and version validation. inside the facts retrieval step, data is taken from the enter and output of DC motor whilst DC motor is strolling in closed loop form. The enter facts is reference signal records given on the DC motor, at the same time as the output statistics is taken from the information of the speed reading at the sensor. a set input and output data used inside the modelling are shown in Fig. 1. The modeling structure selected in this observe is ARX 221, which shows that the model produced is second order model. Then it is accompanied with the aid of the stairs to estimate the version from the prepared records, and validate the anticipated version with the measurement facts. From the validation system acquired that the expected version has an accuracy of 95.16%, as illustrated by the curve in Fig. 2. The modelling accuracy of ninety five.sixteen% suggests that the modeling is suitable, as it passes the minimum restriction of estimation accuracy, that is ninety%.

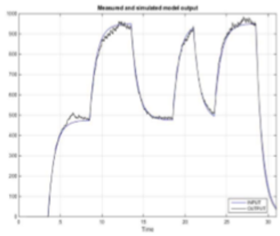


Fig. 2. Validation curve of the estimated model output on the measured data

3 CONTROL DESIGN

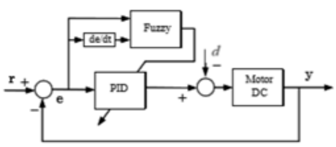


Fig. 3. Adaptive-Fuzzy-PID (AFPID) control scheme

shape of the Adaptive-Fuzzy-PID (AFPID) manipulate scheme is shown in Fig. 3. Fuzzy common sense plays a position to beautify capability of the PID controller to be extra sensitive on the changes of the DC motor parameters and the existence of uncertainty. preliminary parameters , , and of the PID controller are acquired by using using Ziegler-Nichols tuning technique by way of assuming no change within the system parameters and no uncertainty exist. even as, the bushy system layout is organized beneath the situation the machine parameters changes, and the disturbance exist, because of achieve the maximum variety of the device output error e and the exchange of the mistake de. based on shape of the manage scheme in Fig. three, outputs of the bushy machine are influenced by way of two variable inputs: the machine output errors e and the trade of the mistakes de. Fig. 4 suggests extra element relation inputs and outputs of the bushy device. Mamdani inference is hired because the fuzzy technique in this study. Output of the bushy machine is set to be , , and . The variety of parameters , , and of the AFPID manipulate scheme are thru several initial exams at the machine, parameters , , and of the AFPID manipulate scheme are set in the tiers: 1,26, 1.45,26.forty five, and zero.001,0.901. those ranges specify the minimum and most tiers of the AFPID parameters that can be improved through fuzzy device.

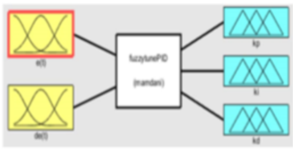
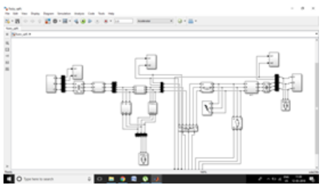
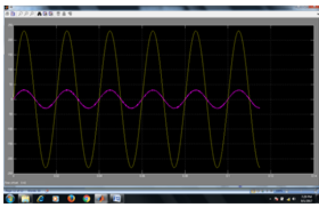


Fig. 4. Fuzzy logic system inference





4 CONCLUSION

A control scheme that had abilties in improving the performance of transient reaction and error consistent country of the device, and additionally to be had to estimate and compensate disturbance had been efficiently evolved and verified experimentally. A fuzzy gadget can be advanced to optimize the PID controller parameters to be extra flexible at the alternate of the system parameters and effectively progressed the performance of temporary reaction and consistent state of the DC motor output reaction. moreover, the inclusion of DOb into the manipulate scheme appreciably superior its functionality in compensating the presence of disturbance within the DC motor. for that reason, this blended scheme can guarantee the DC motor to have a better performance and to be had for the packages that require a high precision and accuracy.

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