A NEW MICROCOMPUTER-BASED REEL SERVO SYSTEM IN THE INSTRUMENTATION MAGNETIC RECORDER

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ABSTRACT

This paper describes the design of a adaptive microcomputer-based reel servo system in the instrumentation magnetic recorder. When the reel parameters and load characteristics might vary during recording, the newly designed adaptive reel servo system is capable of compensating for these variations. The new reel servo system consists of a single-board microcomputer (QJ-80) and two D.C. motor actuators. A model reference adaptive control was chosen as the basis for adaptive reel controller design. The experiment results show that the new microcomputer-based reel servo system effectively eliminates the affect of the parameter variations. The performance of the whole transport system is improved therely.

INTRODUCTION

The purpose of the reel servo system with tension arm in the instrumentation magnetic recorder provides constant tape tension so that the whole tape transport system moves the tape in constant speed. However, the design procedure for the overwhelming majority of reel servo system with tension arm is that the system is considered as time-invariant, then, the classical control theory is applied to control system design. One of drawback of this type of reel servo system design is that the reel diameter variation is ignored so that it affects the performance of the system during operation. Actually, it is a problem of design for time-variant system. So, it is very difficult that this reel servo system designed by classical control method has a better control performance.

Now, a type self-adapting controller which can compensate for the parameter variations might solve this type of time-variant system problem. The experimental results show that this type of new control system can act to maintain better system performance.

For improving the performance of reel servo system, in our work, we have studied the application of an adaptive cotroller for the reel system and the possibility of using a single-board microcomputer to implement the adaptive controller.

THE ADAPTIVE REEL CONTROL

As the transport running, reel diameter changs. If power amplifier, drive motor and reel are considered to be a combined controlled plant, then it would be a time-variant system of a slow-variant process. In the controller design, a model reference adaptive control (MRAC) system was chosen as the basis for adaptive controller design in this project. This was done, it can give a exact definition of the desired response of the system in term of a linear reference model. This reference model is the desired system operating in parallel with the controlled plant in reel-time. The basis MRAC system used for the reel control is illustrated in the block diagram of Fig. 1. By modifying parameters in the adjustable controller, the adaptive mechanism makes the combined controller and plant response match the response of the linear reference model. During operation, this adaptive mechanism continually act to drive the state error ϵ to zero. In the diagram, the phase compensator is used to compensate for the fast dynamic response of the system.

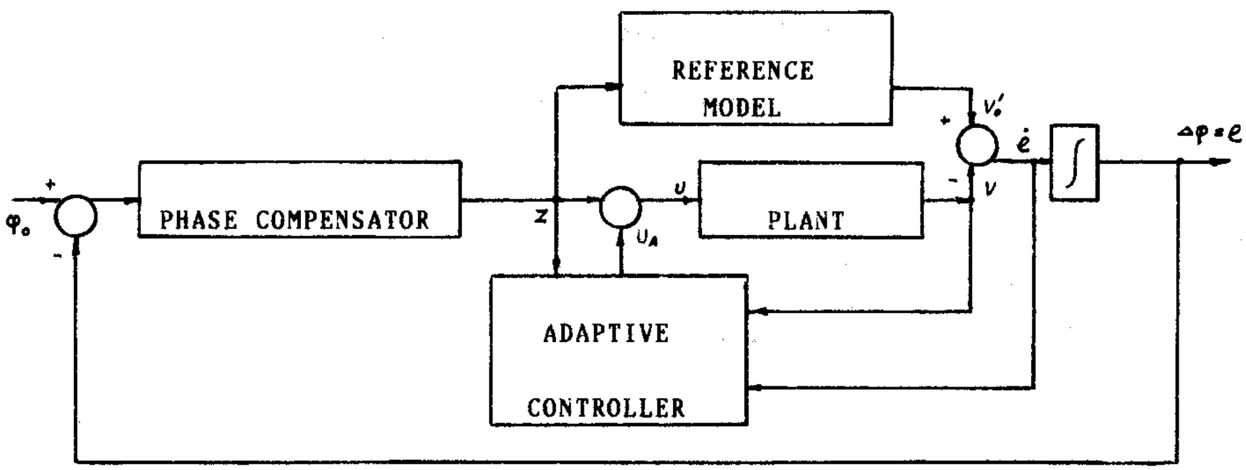

Fig. l. Model reference adaptive control applied to reel control.

The derivation of the adaptive control law derived on the basis of the Lyapunov stability approach. The adaptive controller algorithm uses Parks' design method. The design of resulting continuous-times adaptive controller was converted into discrete-time form for direct implementation on the microcomputer-based controller. The complete sampled-data adaptive reel control system model is shown in Fig. 2. Adaptive compensation for change of reel system gain is achieved through the adjustment of gain K2. Adaptive compensation for change of tape speed is achieved through adjustment of gain K1. Adaptive controller gains B1, C1 and B2, C2 determine the adaptive response time of the system.

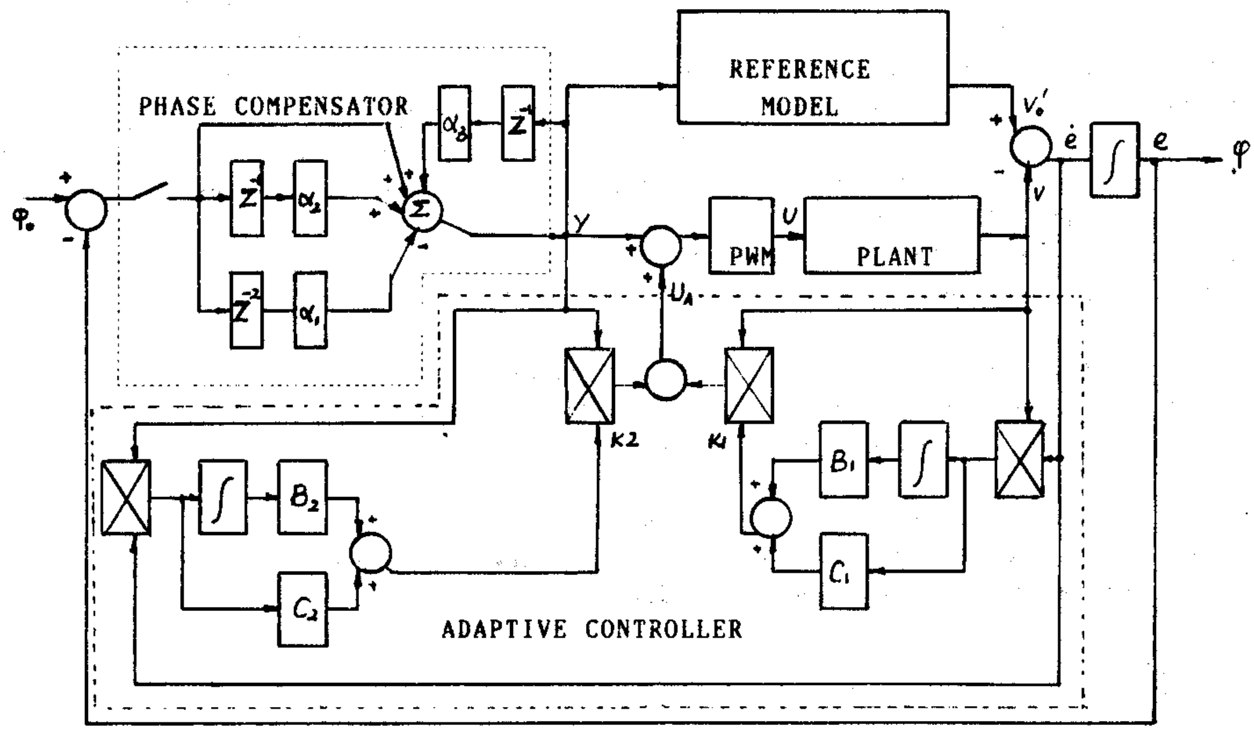

Fig. 2. Complete model of the sampled-data adaptive reel control system.

THE MICROCOMPUTER CONTROLLER

Consequendly, microcomputer incorporates all the hardware and software required to implement the sampling operation, A/D conversions, pulse width-modulated (PWM) output, and the arithmetic operations of the controller for this application uses a QJ-80 single-board microcomputer in which there are 16K bytes of RAM for program and variable storage, a 8-bit A/D converter and two PIO (parallel I/O port). The A/D converter converts the position error (e) of the tension arm into the digital signal. Z80-CTC provides tape velocity input signal. The velocity transducer is a digital tachometer. PWM output provides the controller output to the power amplifier driving D.C. motor.

The QJ-80 has an internal assembly language interpreter and a serial I/O port, which provide a simple user interface for entering or modifying control parameters from a standand terminal. All the softwares are written in assembly language with fixed-floating-point arithmetic. A block diagram of the single-board microcomputer-based controller is shown in Fig. 3.

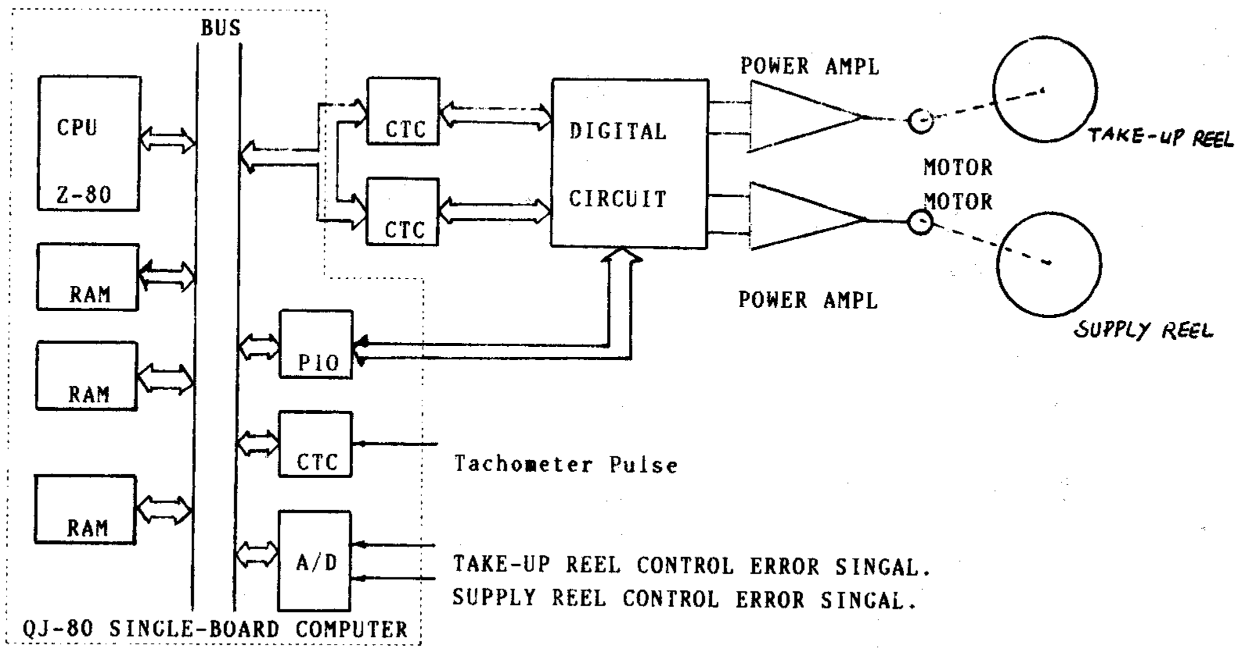

Fig. 3. A block diagram of the single-board microcomputer-based controller.

EXPERIMENTAL RESULTS

Laboratory tests were performed on the complete adaptive reel servo system to evaluate the adaptive performance under the conditines of varying reel diameter during operation. A sampling period of 10 ms was used in the controller. Figure. 4 shows tension arm position state error from the experiment test.

Fig. 4 (a) shows the state error of reel servo system without adaptation when the reel tape diameter is changed when the reel takes up tape. In the same case, when the adaptive control law is enabled, the controller automatically adjusts the gain to compensate for the increase in the reel diameter to make the state error cut, as shown in Fig. 4 (b). Fig. 4 (d) and (c) show the state error with adaptive and without adaptive respectively, when the reel diameter vary when the reel supplys tape. The adaptive controller appears to cut the state error as desired. In both cases, stability of the system operation was observed, in case the digital controller algorithm adapted to the changes in reel diameter was employed.

SUMMARY

The results of study in this paper show that time-variant control system design problem, such as that of reel system, can be solved by adaptive cotrol techniques. By using a relatively simple single-board microcomputer-based controller, it is possible to implement adaptive reel servo system in the instrumentation magnetic recorder. Only a small amount of hardware and software are required for the full implementation of the scheme. So, the new microcomputer-based reel servo system is effectively availabe for the magnetic recorder.

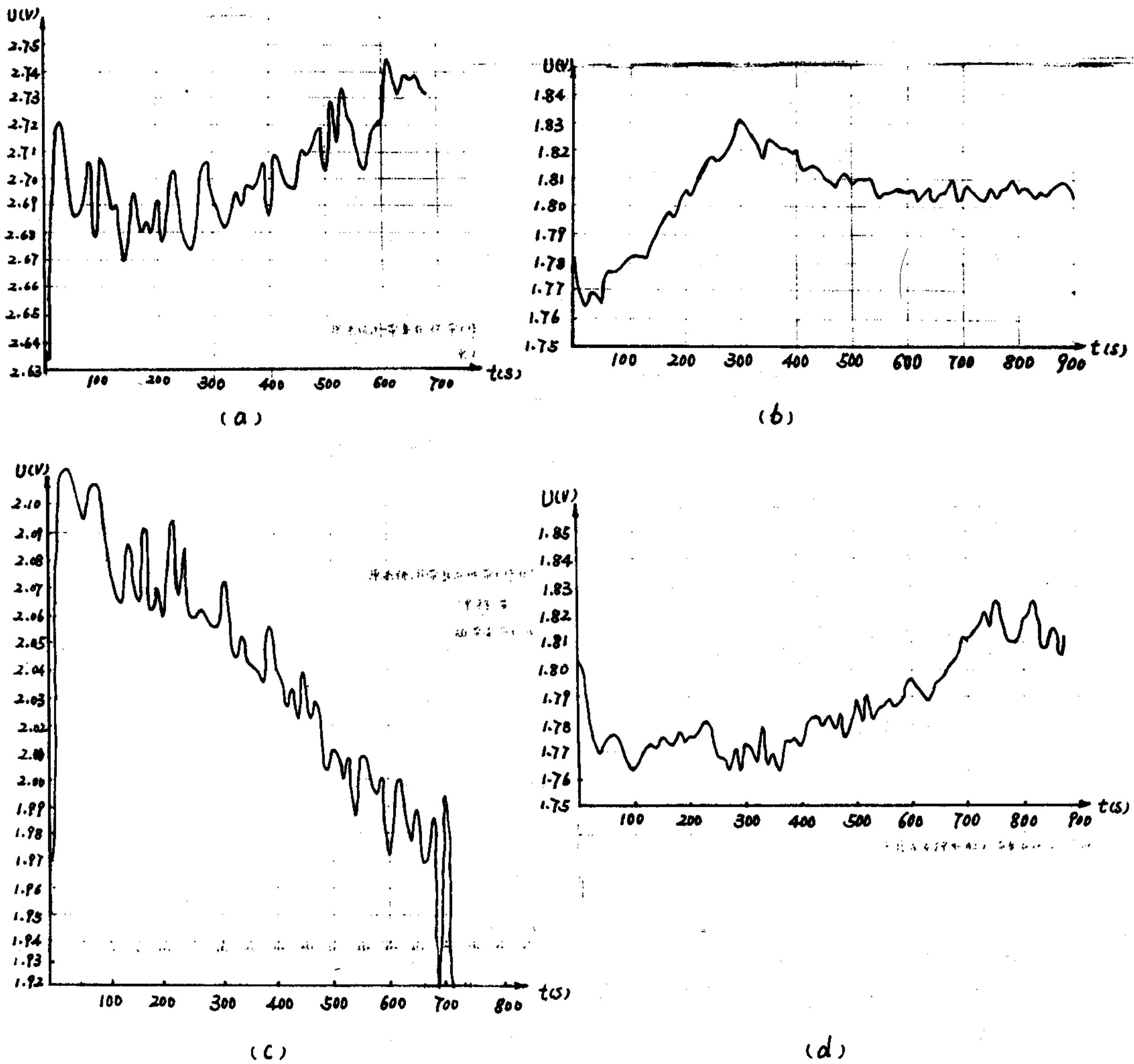

Fig. 4. The tensioh arm position state error from the experimental test.