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مؤلفين آخرين:	Nagarajan, R.(super)
التاريخ الميلادي:	1988
موقع:	البصرة
الصفحات:	1 - 128
رقم MD:	575969
نوع المحتوى:	رسائل جامعية
اللغة:	English
الدرجة العلمية:	رسالة ماجستير
الجامعة:	جامعة البصرة
الكلية:	كلية الهندسة
الدولة:	العراق
قواعد المعلومات:	Dissertations
مواضيع:	الهندسة الكهربائية، التيار الكهربائي، الحاسبات الإلكترونية
رابط:	https://search.mandumah.com/Record/575969

ABSTRACT

This thesis proposes a microprocessor based scheme for evaluating the performance of a low power armature controlled DC motor.

A NEC personal computer(NEC-PC-6001 BMK II) is employed as the main part of this performance evaluation scheme. The motor is thyristor driven and the responses of the motor are measured by suitable transducers. The motor is coupled to a DC generator for the purpose of loading.

The proposed scheme conducts two performance tests : The first is the transient response test in which the scheme applies a step input disturbance to the motor, collects the transient response data and computes the electrical and mechanical parameters of the motor. The second performance test is the load test. The scheme loads the motor in a controlled manner and measures motor response due to loading.

The scheme then evaluates the performance of the motor from the load test data and from the motor parameters. The performance of the motor is monitored interms of performance characteristics on a video screen or on a plotter.

The usefulness of this computer based evaluation scheme is established by comparing the accuracy of its results with those of two other methods of DC motor testing.

ملخص البحث

تبرز الحاجة لمنظومة اوتوماتيكية لايجاد خواص العناصر الصناعية لكل من المنتج والمستهلك، وفي هذا البحث تم تقديم احدى هذه المنظومات التي استخدمت لايجاد اداء احدى العناصر الصناعية ـ محرك تيار مستمر ذات القدرة الواطئة.

وقد استخدم الحاسب الشخصي (NEC)كعنصر رئيسي في منظومة ايجاد الاداء. وقد اعتمد في تشغيل المحرك على مغيرات القدرة باستخدام الثايرستور. كما تم قياس استجابة المحرك بواسطة محولات طاقة (transducers)مناسبة، ولغرض التحميل ،عشق المحرك مع مولد تيار مستمر ،سيطرت على خرجه دائرة مقطع (chopper)تعتمد في تشغيلها الثايرستور والتي مكنت من السيطرة على تحميل المولد وبالتالي على المحرك .

وتهيء هذه المنظومة اختبارين على المحرك ، الاول هو اختبار الاستجابة العابرة ، وفيه تسلط المنظومة اضطراب الخطوة (step disturbance) عبر دخل المحرك ، وتجمع معلومات الاستجابة العابرة للمحرك وبالتالي عرض هذه الاستجابة على المعارضة التلفزيونية او الراسم الرقمي ، ويستمر عمل المنظومة في هذا الاختبار في تحليل المعلومات لايجاد العناصر الكهربائية والميكانيكية الخاصة بالمحرك .

اما الاختبار الثاني فهو اختبار التحميل ، وفيه تسيطر المنظومة على تحميل المحرك ، وتقيس استجابة المحرك وتحلل ادائه لعرض خصائص الاداء على المعارضة التلفزيونية او الراسم الرقمي .

ولغرض تحقيق متطلبات عمل المنظومة في تعديل القدرة ، وموائمة ربط الدوائر

الرقمية مع التماثليه ، وقياس متغيرات المحرك ، وتحميل ذاتي ، واخيرا السيطره على تجهيز القدره ، فقد انجز بناء عدة دوائر لهذه المنظومة . ولاكمال متطلبات العمل في التشغيل فقد هيأة البرامج المطلوبة على شكل انسياب اللائحه في استصحاب المشغل ، وكرس الجهد في تقليل تعامل المشغل ومهارته في تشغيل المنظومة في اداء الاختبارات .

ولتقييم عمل المنظومة هذه ، فقد اعتمد في هذا البحث على طريقتين استخدمتا في ايجاد خصائص المحرك واداءه ومقارنة دقة هذه النتائج مع النتائج المقدمة من المنظومة .

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UNIVERSITY OF BASRAH

DESIGN OF MICROPROCESSOR CONTROLLER FOR MEASUREMENT AND ANALYSIS OF ARMATURE CONTROLLED DC MOTOR

A THESIS SUBMITTED TO THE COLLEGE OF ENGINEERING, UNIVERSITY OF BASRAH, IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE DEGREE OF MASTER OF SCIENCE IN ELECTRICAL ENGINEERING

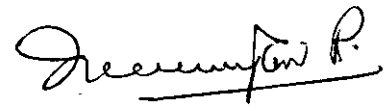
BY

WALEED A. M. RASHEED

B. Sc. in Elect. Engg.

JANUARY 1988

I certify that this thesis was prepared under my supervision at the University of Basrah, as a partial requirement for the degree of Master of Science in Electrical Engineering.

Signature : 

Advisor name : Dr. R. NAGARAJAN

Date : 10, Feb, 1988

In view of the available recommendations, I forward this thesis for debate by the Examining Committee.

Signature : 

Name : Dr. Kais B. Mirza
Head of Electrical
Engineering Dept.

Date :

COMMITTEE REPORT

We certify that we have read this thesis as Examining Committee, examined the student in its content and that, in our opinion, it is adequate as a thesis for the degree of Master of Science in Electrical Engineering.

Signature :

Name Dr. K.A.S. ALUKAIDEY

Member :

Signature :

Name : (Dr R. NAGARAJAN)

Member :

Signature : D. H. Jereu

Name : Dr. Dakhil H. Jereu

Chairman :

Approved for the University.

Signature :

Name : Dr. Adel D. Alwan

Dean of the College

Of Engineering.

TO

MY DEAR PARENTS

AND SISTERS

WITH

LOVE AND RESPECT

ACKNOWLEDGEMENT

The author would like to express his gratitude to Dr. R. Nagarajan for his supervision and guidance during the progress of this work.

He would also like to express his thanks to Dr. Kais B. Mirza, Head of Electrical Engineering Department, and Dr. Adel D. Alwan, Dean of the college of Engineering for offering him their invaluable encouragement.

He would like to thank Dr. Aleksander Zgrzywa , Technical University of Wroclaw, Poland, for initiating this research work.

He would also like to express his gratitude and thanks to Dr. Sabah Abdul-Aziz, Head of Computer Science Department and Mr.Sabah S. Al-Shuraidah for offering him the invaluable facilities to support this work.

He would also like to thank the staff of Department of Electrical Engineering and the staff of library for their assistance and help during the course of this work.

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CHAPTER ONE

INTRODUCTION

1.1 Microprocessor Applications

The first microprocessor, Intel 4004, was introduced by Intel Corporation in 1971. Very soon, a variety of microprocessors, produced by several manufacturers, having varied characteristics and architectures spread in the semiconductor industry. Few years after its birth, it began to play an important role in the general digital systems design and in computer technology for its evident features [1].

Several advantages and features of microprocessor could be clearly recognised through its offer to the construction of complex systems and from the overall system performances. The microprocessor-based system is considered to be the only alternative if a system to be designed has to satisfy features such as, [2]

(i) the system is fairly complex and needs hundreds of gates, flip-flops and counters for implementation of hard-wired logic.

(ii) the operating speed to perform system functions is high enough so that a microprocessor could be used.

(iii) many decision- making operations are required.

(iv) the system requires a storage for many logic states and a large data.

(v) more functions may need to be added to the system in the future.

Many of the applications of microprocessors are of common nature across industrial boundaries. They are mostly confined to such products as data acquisition systems, decision making systems, control systems and flexible and high expandable systems [3]. All these applications are mainly to meet the needs of automation. Automation in industry has relentlessly replaced to a great extent, the human power in the production line. The advent of microprocessor in controlling major automatic systems leads to the typical benefit of " mass - production and cost - falling " [4].

Automation, in general, comprises of varied means of techniques, such as automatic measurement, testing and analysis. Microprocessor based automatic system offers fast, accurate, reliable and economical methods in many fields. Microprocessor based systems have been developed for electronic component testing [5],instrument calibration [6], determination of parameters [7,8], and data acquisition [9]. However, literature in the recent past shows a void in the works on computer based scheme for evaluating performance of electrical machines.

Such an ever increasing application of microprocessors in industrial automation have motivated the author to design and develop a suitable microcomputer based automatic system to test, analyse, evaluate and monitor the performance of an industrial component- an armature controlled DC motor.

1.2 DC motor performance evaluation procedure

The current and speed of an armature controlled DC motor at any load are governed by two equations -the voltage balance equation and the torque balance equation- which are written respectively as [10]

$$L\, di/dt = V(t) - i(t)\, R - K\, w(t) \qquad ...(1.1)$$

$$J\, dw/dt = K\, i(t) - TL(t) - B\, w(t) \qquad ...(1.2)$$

where i(t) is the armature current

V(t) is the applied armature voltage

w(t) is the speed of the motor

R and L are respectively the armature circuit resistance and inductance of the motor

J and B are respectively the motor moment of inertia and its viscous constant

TL(t) is the load torque, and K is the E.M.F or torque constant.

If the parameter B, and torque constant K are known, measurement of steady state values of current (i) and speed (w) facilitates the computation of steady state torque (TL) from Equation (1.2), as

$$TL = K\, i - B\, w \qquad ...(1.3)$$

The power output (Po) and the efficiency (η) can then be obtained from the computed value of TL as

$$Po = TL\, w \qquad ...(1.4)$$

and

$$\eta = (Po/Pi) \times 100\% \qquad ...(1.5)$$

where Pi is the input power.

Hence, the computation of motor performance such as TL, Po, and η , requires the values of motor parameters and K. These values can be obtained by conducting a step - input transient response test on the motor at no - load. In this transient response, there are two conditions at which (di(t)/dt) = 0 - one at an instant where the current reaches its maximum value (i_m) and the other when the current and the speed reach their respective steady state values, (i_s, w_s) At these conditions, Equation (1.1) and (1.2) offer the values of R, K and B as

$$R = (w_m - w_s)/ (i_s w_m - i_m w_s) \qquad ...(1.7)$$

$$K = (V - i_s R) w_s \qquad ...(1.8)$$

and

$$B = K i_s / w_s \qquad ...(1.9)$$

wherein w_m is the speed when $i(t)=i_m$.

Hence this approach of performance evaluation requires two tests - the transient response test to compute motor parameters and then a load test to compute motor performance

It is to be noted that in both of these tests, only two measurements are required - a measurement of current and a measurement of speed. Consequently, only two transducers are sufficient to evaluate the performance of the motor.

1.3 Outline of the proposed scheme

The proposed scheme of performance evaluation has three main subsystems (Fig 1.1). The first of these subsystems is of analog, consisting of the DC motor under test and its associated circuitries. The circuitries include a loading device and input power circuits, all having facilities for control. The circuitries also include transducers to measure speed and armature current of the motor.

The second subsystem is of digital which comprises the computer and its associated hardware.This subsystem controls the power circuitries and loading device of the motor so that the motor is subjected to step input for its transient performance and then to a controlled loading for its load performance. In both cases,this subsystem collects the speed and current data and computes the performance of the motor. Performance characteristics are monitored on the plotter.

The third subsystem connects the first and the second subsystems. Obviously, this subsystem is to have facilities for Analog to Digital (A/D) and Digital to Analog (D/A) conversion. The facilities enable the transfer of command from computer to motor and the transfer of data from motor to computer.

Proper software is to be developed so that the controlling of power input, loading of the motor, acquisition of current and speed data , computation of motor

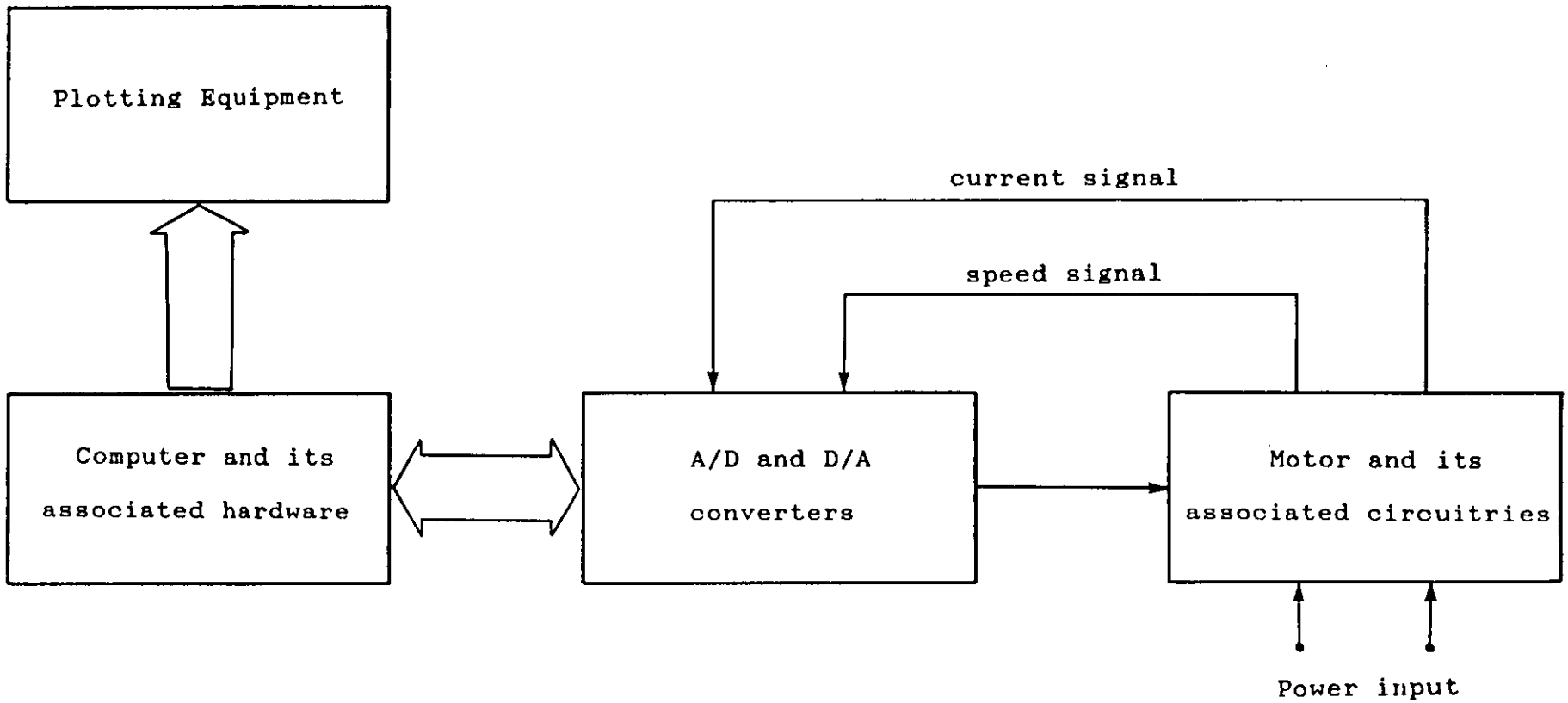

Fig 1.1 Block schematic of the proposed scheme

performance, and recording of performance characteristics are realized.

1.4 Objectives of the thesis

The objectives of the thesis research is of four fold. They are :

(i) To design and implement a computer controlled scheme in order to conduct required tests for evaluating and monitoring the performance of a low power DC motor.

(ii) To record and monitor the transient response data of the motor and to compute its electrical and mechanical parameters.

(iii) To establish the usefulness of the developed computer controlled scheme by comparing its accuracy of evaluation with that of two other methods of DC motor testing.

(iv) To format the software and hardware of the scheme so that a minimum human effort and skill are needed in evaluating the performance of the motor

1.5 Organization of the thesis

The thesis consists of five Chapters. Chapter one has presented a method of evaluating the performance of DC motor and the objectives of this thesis research. Chapter two discusses hardware details of the proposed scheme. This Chapter views the scheme as an interconnection between the

Digital world and the Analog world. Various parts of these interconnecting hardware subsystem are designed and developed.The developed hardware in its complete form is given in this Chapter.

Chapter three explains the design of software which controls various sections of the hardware described in Chapter two. High level and low level languages are employed in control, data acquisition, analysis and monitoring. The Chapter gives various flow charts in order to explain the operator's interaction required in this scheme.

Chapter four deals with the results of performance evaluation tests.It introduces two other methods of DC motor performance evaluation. Results of all these three methods of performance evaluation are obtained and compared. Thereby the validity of the computer based testing scheme is ensured.

Chapter five brings out the conclusion and also the scope for future research work.

CHAPTER TWO

HARDWARE DESIGN AND DEVELOPMENT

2.1 Introduction

The development of microprocessor based systems in real world environment, has to comprise three main subsystems [11] :

(i) Digital signal processing,

(ii) Analog signal processing, and

(iii) Analog to Digital, Digital to Analog signal conversion.

These three subsystems are to be designed and implemented to meet the objectives of this research work.

The digital signal processing subsystem is chosen to consist of a main controller, the NEC-PC microcomputer with its peripherals.It requires an interface circuit and a timer in order to manage the data transfer and to organize the control signals through the signal conversion subsystem.

The analog signal processing subsystem has to incorporate several circuits which are designed to control the power input of the DC motor, to control its load and to sense its variables, all under the command of the main controller. The analog signal processing subsystem comprises three types of control circuits, namely, a starting switch, a converter circuit and a chopper circuit. In addition to these, the subsystem has transducers to measure the current and the speed of the motor.

This Chapter illustrates the need of these hardware circuits and details their design and implementation.

2.2 Digital signal processing subsystem

This subsystem is considered as the main part of the overall system. It represents the media of digital signal flow under microprocessor control. The data base managemant, including analysis and decision making processes,is achieved through the manager hardware - the NEC microcomputer. The complete details of NEC microcomputer are available in the manufacturer's literature [12]. However, details of bus expansion facilities, and those of memory management are most useful for the purpose of this research, and are discussed briefly hereunder.

2.2.1 NEC microcomputer facilities

The overall block diagram of the personal microcomputer NEC-6001 BMK II, is given in Appendix as Fig A.1. It is based on Zilog Z80 microprocessor chip. The personal microcomputer is assembled on a single board which contains the main CPU with its associated circuitries. The built in interfaces for peripheral equipment such as printer, cassette tape recorder and mini floppy disc drive are controlled by an I/O controller. The microcomputer has a total RAM capacity of 64 Kbyte used for main memory and for video display. It can execute machine code routines in addition to BASIC by means of an interpreter. The inter-

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تصميم

مسيطر باستخدام الحاسب الدقيق

لأغراض القياس والتحليل لمحرك تيار مستمر

رسالة مقدمة الى

مجلس كلية الهندسة في جامعة البصرة

كجزء من متطلبات درجة الماجستير في الهندسة الكهربائية

من قبل المهندس

وليد عبد الجبار محمد علي

بأشراف

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