DESIGN AND FABRICATION OF COMPUTER CONTROLLED FANCY DRAWFRAME

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CERTIFICATE

This is to certify that the thesis entitled "Design and Fabrication of Computer Controlled Fancy Drawframe", being submitted by A.K. Battu, in fulfillment for the award of degree of Doctor of Philosophy in Textile Engineering, is a record of bonafide work done by him under our guidance and supervision at the Indian Institute of Technology, Delhi.

This work is entirely original and has not been submitted elsewhere for the award of any degree or diploma.

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to my parents

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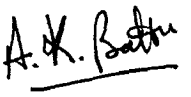

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ABSTRACT

Several ways exist, today, for producing fancy effects in yarns and fabrics. Different methods and different machines are used at different process stages for this purpose. Some of them are controlled regular effects and some are random. They have their own advantages, disadvantages and different cost-effectiveness.

In this work, an attempt has been made to develop a drawframe which is capable of producing a "fancy sliver" that can be used to produce a fancy yarn having a varying colour composition along its length. The aim of the work is to design and fabricate a drawframe, along with a complete digital control system, which is capable of blending slivers of two different colours to produce an output sliver such that the ratio of these two colours varies along the length of the output sliver in a desired manner.

Since no existing drawframe does this kind of blending, a new roller drafting system, having a new arrangement of the drafting rollers, has been proposed and designed. An appropriate drive mechanism for the rollers has been designed and fabricated. A digital control system consisting of power circuits for a multi-motor drive, controller circuits, a digital micro-computer, a Personal Computer (PC) and real-time control software, has been developed to control the operation of the fancy drawframe. The work also covers the testing of the slivers produced on this drawframe. Tests have also been performed on some yarns and fabrics produced from these slivers.

The work has been divided into eight chapters. The first chapter highlights the importance of the fancy effects in yarns and fabrics. It further defines the objective of this work and presents a brief description of the system which has been developed to meet the same.

Chapter 2 presents a literature survey of various issues related to the drafting process. Work done by a number of researchers to analyze and study the drafting process has been covered. Different theories related to the fibre motion during drafting have been discussed. The chapter also covers the work done on some other related issues such as the drafting force, drafting irregularities, hook removal during drafting, simulation of the drafting process and on-line measurement of errors and their correction on the modern drawframes.

Chapter 3 describes the process of blending and development of various automatic blending systems. The type of blending, which the present work attempts to achieve, has been discussed and its importance over the existing methods has been highlighted.

The chapter further describes the proposed new roller drafting system, having a special arrangement of the drafting rollers, for blending the slivers of two different colours, or fibre materials, on the drawframe. In the proposed drafting system, the input slivers of two different colours are first pre-drafted separately and then fed together into a main-drafting section. The blend ratio of the output sliver is controlled by varying the amount of the pre-drafts given to the input slivers

of different colours. The pre-drafts are varied in such a manner that the hank of the output sliver remains constant. Use of computer simulation has shown that the proposed method of blending does not have any adverse impact on the quality of the output sliver.

The remaining part of the chapter describes the design and fabrication of the proposed roller drafting system for the fancy drawframe. Drive scheme for the fancy drawframe has been discussed. Drive to different drafting rollers is provided by four motors. Drafts in different zones are controlled by changing the motor speeds with the help of the control system. Design of some important mechanical components and the drives for various drafting rollers has been described in detail.

Chapter 4 contains a survey of the issues related to different types of drives. A comparison of AC and DC drive technologies has been made from the point of view of complexity, reliability, and cost-effectiveness. In order to achieve the proposed blending, DC drive technology has been selected to meet the variable speed demands of the fancy drawframe. This has been done due to its greater simplicity, ease of control, and capability to provide variable speed over a wide range. The importance of the chopper controlled DC drives has been highlighted. A comparison of various power semiconductor devices, used in different types of converter circuits, has been presented.

The chapter also includes the selection of different motors for the fancy drawframe drives, according to the connected mechanical load on them. Based on the motor specifications, the

ratings of the power devices are selected. The chapter also describes the design of the chopper power circuit and the interface circuit between the micro-computer and the power circuit. The interface circuit mainly decides the chopper duty ratio and provides electrical isolation between the electronic control circuit and the chopper power circuit.

The controller response in the open-loop configuration has been described with the help of the oscillograms of voltage and current waveforms, under different operating conditions, and at various points in the circuit.

Chapter 5 deals with the closed-loop digital control of a fancy drawframe drive. Recent trends in the use of feedback control techniques in industrial environment have been described. The importance of the computer based control systems has been highlighted. Current trends in micro-processor technology have been discussed.

The chapter also discusses the design of the speed feedback circuit required for the closed-loop control. The drive requirements of the main and the pre-drafting sections have been identified. Discrete model of a fancy drawframe drive in the closed-loop configuration has been developed, incorporating the computer based control. Performance of the drawframe drives has been studied by simulating the developed discrete model. The optimum controller parameters, obtained in the simulation studies, are implemented on the drawframe drives and the actual response of the system is studied.

The machine level software, developed for the micro-computer for the closed-loop control of a drawframe drive using PI-control algorithm, has also been described in this chapter.

Chapter 6 describes the development of a digital control system for the real-time control of the fancy drawframe. The speed requirements of the drives, to achieve proper fancy blending effect on the fancy drawframe, have been highlighted. An outline of the basic requirements of a real-time multilayered computer control system, covering various aspects of the real-time system design, has been presented.

Hardware and software requirements of the real-time control system for the fancy drawframe have been discussed in this chapter. The control system developed in the present work consists of a two-level computer structure. A micro-computer at a lower level, samples the speeds of all the fancy drawframe drives and performs the direct digital control. A PC at a higher level performs the supervisory control and provides operator communication for the interactive control of the fancy drawframe operation.

The chapter further discusses the real-time control software which has been developed for the fancy drawframe control system. The control software can be divided into foreground and background programs which are executed simultaneously in the micro-computer and the PC respectively. Functioning of the software has been explained along with the description of various salient features of the software which include on-line control of speed and draft settings, and smooth switching between automatic and manual control modes. The machine can be programmed in terms

of simple-format input data files to produce various colour patterns in the slivers.

The chapter also describes the integrated tuning of the controller parameters of the drives used in the pre-drafting section to achieve the synchronized speed response of these drives.

Chapter 7 presents the description of the experiments which have been carried out to study the performance of the fancy drawframe. Tests have been conducted to study the influence of control and spinning parameters on the quality of output sliver and finally the yarn.

Further tests were conducted to study the effectiveness of blending by observing the distribution of fibres in the cross-section of the yarns made on ring and open-end rotor spinning machines.

Data files were created for producing fancy slivers and yarns with different colour patterns. Fabrics have been made from these yarns and fancy effects produced in these fabrics have been studied.

Chapter 8, which is the concluding chapter, summarizes the whole work and presents general conclusions based on the performance of the fancy drawframe. It describes the achievements of the present work along with the advantages and limitations of the developed system. The chapter also discusses the scope for further improvements in the system from various angles.

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