Engineering Technology
Open Access Journal

Juniper Publishers
key to the Researchers

Research Article
Volume 4 Issue 4 - February 2023
DOI: 10.19080/ETOAJ.2023.04.555649

Eng Technol Open Acc

Modern Areas of Artificial Intelligence Applications in the Textile Industries Using Mechatronics

Elsayed Ahmed Elnashar[1]*, Assem Ali Mohamed Ahmed[2] and Amr Elsayed Elnashar[3]

[1]Professor, Textiles & Apparel, Home Economics Department, Kaferelsheikh University, Egypt

[2]Lecturer in textile Department, faculty of Technology& Education, Suez University, Egypt

[3]Student at Faculty of Computers and Information, Tanta University, Egypt

Submission: December 08, 2022; **Published:** February 16, 2023

***Corresponding author:** Elsayed Ahmed ElNashar, Professor, Textiles & Apparel, Home Economics Department, Kaferelsheikh University, Egypt

Abstract

Mechatronics in modern areas of artificial intelligence, as a discipline, has been around for a long time in textiles industries, applications mechatronics in the design of textile machinery, such as 3-D braiding; weaving and LAN systems for weaving; yarn tension compensation; texturing; spinning: measurement automation and diagnosis, knowledge-based expert systems; automated garment manufacture and assembly; and Apparel manufacture. Indeed, most early workers in which branch of textiles industries which was to become electrical engineering were equally at factures with electronic and mechanical artifacts and combined them in various experiments and products. Mechatronic design in textile Engineering contains a selection of contributions to the advanced search which took place in the introductory sections on the mechatronics concept and design methodology and the impact of advance in technology on the mechatronics concept; the importance of the mechatronic design in the textile industries is highlighted, together with many applications in the textile industries & Passementerie stripes. These include mechatronics in the design of textile machinery. In Which respect it will serve as a reference article for inventors and designers as well as for Industries of textile technology and engineering.

Keywords: Mechatronics; Artificial Intelligence; Textile Industries; Passementerie

Introduction

What Is Mechatronics?

Mechatronics, as a discipline, has been around for a long time. The combination of mechanical rastering with electronic image production used by John Logie Baird in his early TV research was a good example of integrated design. Indeed, most early workers in that branch of physics which was to become electrical engineering were equally at home with electronic and mechanical artifacts and combined them in various experiments and products. However, as a name, Mechatronics is only about 45 years old. It was coined in the later 1970s by an employee of the Japanese Yasukawa company - a major manufacturer of industrial robots. In Japan today

Mechatronics is often taken to be synonymous with Robotics and many Mechatronics laboratories are devoted entirely to robotics research. However, the rest of the world has tended to use the word to encompass a far wider spectrum of products and systems which includes as a very important subclass that of the modem industrial robot. If we consider the definition of Mechatronics, it is easy to see why the robot is an outstanding example of the class. There are many definitions - as might be expected of a discipline in a state of evolution and self-determination. We give three:

The first is the 'EEC' version. "The synergistic integration of mechanical engineering with electronics and intelligent computer control in the design and manufacture of products and processes." Here the emphasis is on 'synergy' - a word which conveys the idea that the final product is greater than the mere sum of its parts. The design integration has led, in some sense, to a product which exceeds previous performance levels by something more than just being better - a new dimension of performance has been attained.

The design and manufacture of products and systems possessing both a mechanical functionality and an integrated algorithmic control." Here we attempt to differentiate between Mechatronics and other intersecting fields such as Information Technology and Electromechanical Design. The Mechatronics product has "mechanical functionality", i.e. parts of it move in a purposeful manner to achieve some function. By contrast, Information Technology has concentrated upon the mere processing of data. Often even the transducers and sensors which provide the data to be processed are ignored by the Information Technologists, who are concerned only with algorithms for converting the data into new forms and architectures for optimizing the conversion process (usually by speeding it up).

The Mechatronics product has ‘algorithmic control’. By this is meant control implemented by means of a more or less complex computing programme. By contrast, Electromechanical engineering has been more usually concerned with systems in which the control actions have been by means of simple switches, solenoids and similar on-off actuators, and in which the controls have been implemented by fixed parameter analogue controllers typical of which is the ‘3-TERM’ PID type. The third definition should be considered if only for its succinctness “The Design of Intelligent Machines”. Mechatronic Design in Textile Engineering contains a selection of contributions to the Egyptian universities and industrial textiles.

In addition to the introductory sections on the mechatronics concept and design methodology and the impact of advance in technology on the mechatronics concept; the importance of the mechatronic design in the textile industries is highlighted, together with many examples of artificial intelligence applications in the textile Industries include:

i. mechatronics in the design of textile machinery, such as 3-D braiding

ii. weaving and LAN systems for weaving

iii. yarn tension compensation

iv. texturing

v. spinning: measurement automation and diagnosis, knowledge-based expert systems

vi. automated garment manufacture and assembly

vii. Apparel manufacture

This presentation is unique in that it brings together many applications of mechatronics in textile machinery and system design. In engineering technology of mechatronics in textiles sectors

i. Mechatronics in textiles sectors

ii. The Mechatronics Design Process

iii. Design Models and Methods for Mechatronics

iv. Advancements in Technology and its Impact on the Future Developments of Mechatronics Concept

v. Intelligent artificial Textile Machines and Systems

vi. Recent Developments in Yarn and Fabric Forming Machines

vii. Some Aspects of Control of Textile Processes

viii. Constant Bulk False Twist Texturing

ix. Measurement Automation and Diagnosis in Spinning

x. Monitoring and Knowledge-Based Expert Systems in Spinning

xi. Mechatronically Designed Magnetic Bearings for High-Speed Spindles and Rotors

xii. Tension Compensation for Fixed Delivery Cone Winding: A Mechatronic Approach

xiii. Mechatronics in the Design of Textile Machines

xiv. Mechatronics Applications in Three-Dimensional Braiding

xv. Design of An Automatic Weaving Machine For 3-D Net Shapes

xvi. Development of a Lan System for Weaving Factories

xvii. Computer-Aided Design and Manufacturing: A Textile-Apparel Perspective

xviii. Mechatronics in Automated Garment Manufacture

xix. Sensing in Garment Assembly

xx. Mechatronics in the Devises Design of Textiles testing (Figure 1).

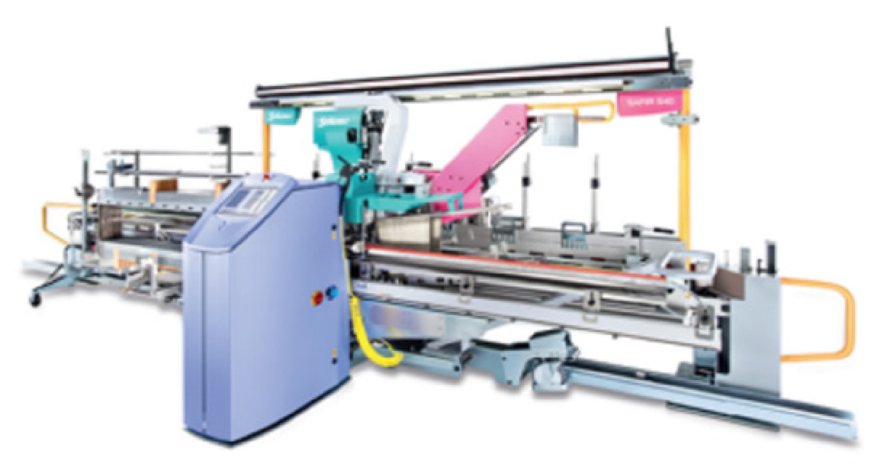

Figure 1: A mechatronic system described as a structure of functions.

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The Robotics

The Breeding Ground The crucial difference between simple electromechanical thinking and mechatronic thinking can be seen clearly in the impact made on robotics by the genius of Bruce Shimano [1] who was responsible for the conception and development of the VAL programming language.

The Mechatronics Design Process

Design is a complex process, which cannot be described as a simple sequence of activities or as a computer algorithm. It may be regarded from many different points of view: planning, organization, creativity, design tools, task assignment etc. When proposing methods and procedures to aid the designer, we must be very distinct about the viewpoint we take, and about the scope within which the methods are valid. A suitable framework for describing design has been suggested by Andreasen & Hein [2]. It distinguishes three levels of resolution:

i. Problem solving, based on the human way of thinking.

ii. Product synthesis, based on the characteristics of technical systems.

iii. Product development, based on the company organization.

Any design task will require activities related to all three levels. For each level we can divide the design activities into phases and recommend a suitable sequence of working a design procedure and we can attach various design methods and models to each phase. The following sections will describe each of the three levels in turn. We shall see that the design of mechatronic systems or products mainly differs from machine design or electronics design on the level of product synthesis.

Problem Solving

Designer's Mental Activity We will use the term problem solving for the activity carried out by humans, when finding and deciding on a solution to a complex problem. By complex we mean 'open-type' problems which have many possible solutions, as opposed to 'closed-type' problems with only one or two solutions that can be found by some calculation method. To suggest a method for solving problems, one must study how a designer as a human think: creativity, decision making etc. The phase plan of 'General Problem Solving' presented in (Figure 1) recommends a sequence of five activities to be completed for any problem during a design work, [3]. It implies that evaluating a number of ideas will always yield a better result than considering only one, intuitively found solution. In order to limit the field of possible solutions, the problem should be defined in advance, and criteria should be determined for the evaluation of alternatives (Figure 2).

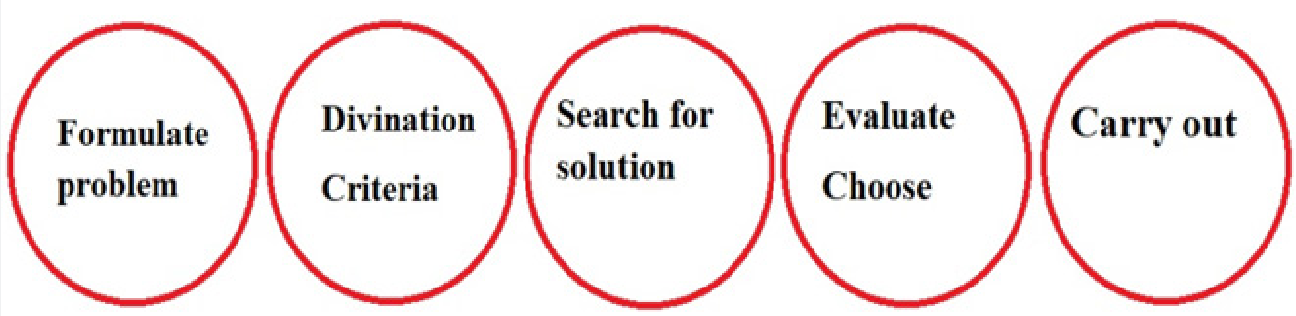

Figure 2: The five phases of general problem solving.

Problem solving may be regarded as an elementary activity to be applied to every sub-problem and in every iteration cycle of the design work. Naturally the number of necessary alternatives and the care taken in evaluation must be determined by the priority of the problem and the degree of innovation. In each phase of general problem solving, a number of design methods and tools may be applied.

Design Models and Methods for Mechatronics

In order to discuss and compare design ideas at an early stage in the design process, we need ways of describing (or Modelling) such ideas long before the system exists in hardware. With mechatronic systems, this is particularly difficult, because one idea will usually involve considerations of both mechanical, electronic and software subsystems. We will use the term design concept for such a principle solution. This deals with methods for generating and describing mechatronic design concepts. We will limit the discussion to the functional interaction of mechanics, electronics and software since methods needed for the spatial arrangement of subsystems (e.g. electronics packaging) are usually of a different kind. Otherwise we cannot describe abstractly what we want before we start looking for detailed technical solutions. In particular three terms need to be defined more closely:

a. Transformation functions: i.e., the transformations of inputs into outputs performed by the mechatronic system.

b. Purpose functions: i.e., the effects required in the mechatronic system for performing the transformations.

c. States of the system: i.e., the logical situations, which determine what transformations will be performed by the mechatronic system.

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In the following study these terms and the relations between them [1].

The Mechatronic System Transforms Material, Energy and Information A mechatronic system can be described by its ability to transform material, energy, or information. A robot for instance moves material, a motor transforms energy, and a telephone transmits information. We may regard the mechatronic system as a structure of transformation functions, which processes one of the following types of transformation operands: material, energy, or information (Figures 2 & 3).

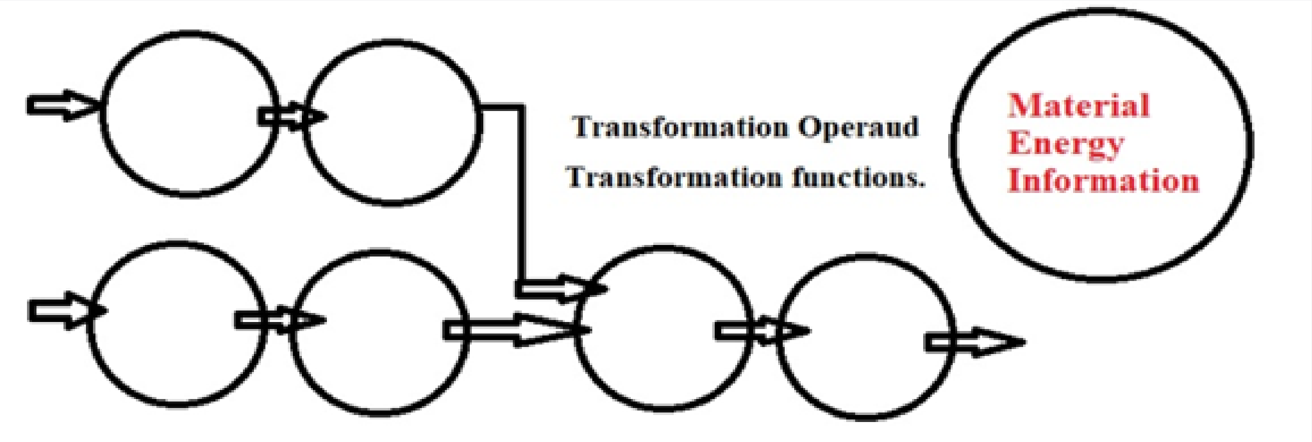

Figure 3: A mechatronic system described as a structure of transformation functions.

The transformation function concept is well suited for describing the purpose of both mechanical, electronic, and software systems. It is worth noticing, however, that electronics can transform information only. Therefore, the diagram is independent of technical realizations, so it can be used for creating alternative designs on a high level of abstraction. Typical ways of creating alternatives are to:

a. relocate the systems border

b. subdivide one transformation into sub-functions

c. integrate sub-functions

d. change the sequence of sub-functions

e. establish parallel branches of transformations

f. insert transformers or conductors

g. relocate information inputs or change information carriers.

Mechatronics systems primarily transform information, either as their main purpose (e.g. a telefax) or when controlling material or energy processes (e.g. an electronic sewing machine, an intelligent motor). Note that information can only exist in mechatronics systems, if attached to either material (e.g. a photocopy. a blood sample) or to energy.

Advancements in Technology and its Impact on the Future Developments of Mechatronics Concept

The interconnections between mechanical and electrical engineering and computer science are characterized by the term mechatronics. Such interconnections are the basis for an "intelligent" behavior of a machine, depending on its ability to pick up information about its environment, and to process it in such a way that it reacts according to the situation. This potential for "intelligent interaction" will be one of the most dominant trends in future machinery. In our working environment most often an interaction with a human operator will be necessary or desirable.

The "intelligence" of a machine for such work depends on its ability to pick up information about its environment and to process it in such a way that it reacts according to the situation. This desired extension of flexibility and autonomy sooner or later will always require an interaction with a human being and an "intelligent" behavior of the machine. Other modem machinery, too, has the definite need of communicating with the operator in a convincing and accepted way.

The "Intelligence" of a Machine

We are used to thinking of machines as part of the technical world: production lines, consumer goods, robots. And one might think that robotics, or in a broader sense, mechatronics, is just another way to make machines work: faster and produce cheaper. This, however, is only one aspect of the medal, and presumably not even the most important aspect. The other side is:

We know that machines are part of our daily life, i.e., technical systems coexist with biological systems. This symbiosis will come to cooperation, which is cooperation with biological or to some extent "unregulated" systems where the use of mechatronics will be a paramount necessity. In such cases, there is little chance of circumventing the use of "smart" machinery as is the case nowadays in the industrial world, for example by redesigning a product in such a way that it can be more easily handled, packaged, or assembled.

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So, we'll have to invent machines with some kind of intelligence. But inevitably this intelligence will never be enough. There will always be a need to handle exceptions, i.e., situations that were not expected. The best exception handler we can think of is a human.

There are several questions arising in that project. How does it work?

What are the areas where the essential difficulties lie?

What ideas can be derived from that project for future research in robotics and intelligent machines?

Intelligent artificial Textile Machines and Systems

Textile Machinery Industry

The desire to increase machine productivity inevitably leads to faster production speeds. This can be achieved at the design stage by reducing the moving parts on the machine and/or inertia and thus reducing wear and tear. This desire, of course, offers ample opportunities to integrate microcontrollers, sensors, and information technology with precision-engineered machine components in order to reduce fast-moving mechanical parts. Modem textile machines, one of the world's largest industrial sectors, contrary to popular perception, reflect state-of-the-art technology in integrated machine design and incorporate the latest technology. This is because of the diversity and large scale of products that require versatile machines to respond to changes in a highly competitive market. The days of electronic additives in textile machinery are now gone and mechatronic design concepts are finding suitable fertile ground and a major field of application in the textile machinery industry. ITMA '91 in Hannover was the scene of engineering excellence, design mastery, and the integration of microelectronics, sensing, control, and information technology into high-speed machinery, with Japanese companies leading the field, closely followed by major European companies.

Fibre And Yarn Production Machines

Fully automated synthetic fiber plants were demonstrated at ITMA'91 where robots carried out all processes from feeding the machine with raw materials to grading and packing the finished product. Networks of interconnected sensors and computers provided the required information to plant managers. Winders or drag units are typical examples of high-speed operations, where speeds of 6000 m/min are typical in the industry. Crossing mechanisms for such windings have been the focus of interest and a digital crossing system that installs an adjustment on the crossing speed to avoid decoration has been demonstrated. A new device for measuring the velocity of the non-contact was also shown, which gives a measurement of the mass of the yam. To give an example, we can mention the module for automatically changing travelers on a loop frame. Due to higher spindle speeds and shorter traveler life, automated traveler changing may become the future of high-speed circular spinning tires.

Weaving Machines

In the textile machinery sector, there has been significant growth in the integration of advanced microprocessors with engineering excellence in the design of machine components in order to automate large-scale aspects of textile production. This integration improves weft insertion rates and versatility, reduces downtime when changing fabric, allows weft breakage detection and repair, and removes defective wefts. For example, increases in weft insertion rates and reductions in compressed air consumption for air jet looms have been achieved as a result of improvements in nozzle designs and integration of microcontrollers. With these integrated systems, it is now possible to make automatic adjustments to:

i. Pressure on the main nozzles and relay nozzles according to the structure of the yam, and

ii. The start and duration of the nozzle blowing when a new pattern is woven. Intelligent weft accumulators can now measure yam force during rewinding and axial exit brake systems help maintain specific core tension in order to reduce peak tension.

A typical example of a textile machine mechatronic is the take-off motion. This led to the following results:

i. The ability to control is improved and the oscillation of the stamens is reduced,

ii. The machine structure is simplified because the mechanical transmission gears used to drive the peripheral devices have been removed, and

iii. Remote operations are made possible.

Filling motion control is another area of application of the mechatronic design. In the case of full mechanical systems, it was very difficult to adjust the timing precisely. Mechatronization of the filling motion system enables the operator to set the timing easily, quickly, and precisely by means of key-input at the operation panel or downloading the timing data using a LAN (Local Area Network) system. This improves the productivity of the machine. Intelligent weaving machines designed and built with a view to be networked with a central processing unit and integrated information control systems are paving the way towards complete process monitoring via LAN systems.

Recent Developments in Yarn and Fabric Forming Machines

In many respects the textile art of making yarn and fabric structures is older than humankind itself, spiders, caterpillars, and silkworms drew out fine threads, and birds wove intricate nests long before humans arrived and learned how to imitate them. Indeed, the Textile Institute recognizes this by featuring weaver birds on its coat of arms. Textile manufacture was the first mechanized industry. Consequently, it was not surprising that by

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the middle of the nineteenth century the machines for processing cotton and wool staples had achieved a high degree of efficiency. It is true to say that they have shown very little change in principle over the subsequent years.

Ring Spinning - the Product becomes an Element of the Machine

The ring-spinning machine (the ring frame) was pioneered in the United States around 1828 by Charles Danforth and John Thorp who each took out separate patents for this deceptively simple but highly ingenious continuous spinning device. It perhaps also owed some of its origins to Arkwright's Water Frame because, imagine the bobbin in Arkwright's machine to be fixed to the rotating spindle, and the flyer above to revolve freely; the bobbin would pull the flyer round - a reversal of the usual condition. This was another excellent example of the textile product actually forming part of the machine which often occurs in textile machinery.

Some Aspects of Control of Textile Processes

Process control of textile production is not trivial, as the raw materials vary enormously. Fibers, which constitute the fundamental building block of any textile, vary in length, diameter, and physical properties. Further variability is introduced in conversion to fabric in dyeing and finishing. Dealing with such irregularities provides a continuous challenge to the textile engineer to maintain product regularity and uniformity. The production speed of textile machinery in all fields of textiles has increased enormously over the past 30 years. High operating speeds in textiles usually result in deterioration of product quality unless more sophisticated control systems are employed. Process control in textile machinery has been applied for many years before the introduction of electronics.

Examples can be found in the regulation of slivers on cards and draw frames, tension control in looms etc. The first impact of electronics and microprocessor control has been in the field of programmable actuators; mainly rotary speed drives for the control of, for example, loom or card cylinder speed. The Monitoring of Web Uniformity Using Laser Scanning (MWULS), the requirement of the system is to detect variation in fiber distribution (uniformity) both along and across the webs. Optical technology is based on variation in light transmission which relates to variation in weight for a given blend of fibers. Although the technology was proven right in principle, back in the sixties, it was prone to drift. This meant that for a constant web the output signal varied over time because of one or more of the following reasons:

I. Change in light intensity of the source itself.

II. Instability of the electronic systems.

Optical systems with one measuring head were based on one source and two detectors (one for calibration). Another non-commercial system was based on one fluorescent light across the web width with multiple detectors. Another non-commercial system was based on one source divided equally across the web using fiber optics with multiple detectors including one for calibration. All those systems were prone to drift. To facilitate across-the-web detection with those devices based on single head detection, the head itself had to be moved. This required a complex and expensive mechanical system. In addition, the cycle of scanning across the web was limited by the system inertia.

Laser Scanner Development

Preliminary Consideration, The drift mentioned above can be minimized to some extent by proper design of the electronic circuitry and careful selection of sources and detectors. However, from the beginning it was clear to us that to reduce long term drift to an acceptable level we would have to use one source and one detector which could be periodically automatically calibrated in a zone outside the main detection area.

Mechatronics in the Design of Textile Machines

Textile machines have been rapidly mechatronized in Japan to save labor or improve the productivity and the quality of the fabrics. This trend is also placed in a part of total automation in the weaving factories. In this, introducing some examples of the mechatronization of a weaving machine, we consider the problems concerning it (Figure 4).

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Figure 4: A mechatronic system as a structure of functions.

The mechatronization of textile machines has been improving very rapidly in Japan. The background of such trends in Japanese textile industry is represented by the following facts. Because most weaving factories are located away from city area due to noise pollution and the working conditions are not so good, the textile industry is always suffering from a lack of hands. Therefore, the mechatronization of weaving machine is much desired in order to try to save labor. In addition, demanding quality of the products is increasing year after year and the inspection of fabrics is getting stricter. In order to pass such strict inspection, fine adjustments of weaving machine are required. Moreover, the trend that new-field products (fabrics) are developed in weaving factories is remarkable. However, traditional full-mechanical weaving machines cannot meet such needs. These factors have accelerated the mechatronization of weaving machinery. The weaving machines mechatronized with high performance are mainstream at present in Japan. We introduce some examples of the mechatronization of weaving machines and point out the problems concerning it.

Motion of weaving machine First of all, we briefly address the basic motions of weaving machine. Though we take up Nissan air-jet loom for an example among many kinds of looms (Figure 5).

Figure 5: A mechatronic system as a functions.

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the fundamental structure is common to all of them. (Figure 1) shows a schematic of the traditional air-jet loom. In general, the motion of the loom can be divided into five main motions as follows:

i. Shedding motion

ii. Filling motion

iii. Beating motion

iv. Let-off motion

v. Take-up motion

a. Through

b. Are periodic motions synchronizing with the rotation of the main shaft of the loom? Since one woof is inserted into the warp every one rotation of the main shaft, the productivity of the loom is usually represented by revolutions of it. Weaving motion starts with the shedding motion. The warps adjacent to each other are pulled up or pushed down respectively due to the vertical motion of the heddles (Shedding motion). At the same time, the reed swings backward and a space through which the woof passes is taken. Then, the woof of the same length as the reed width, which has been pooled in advance, is inserted into the space between the warp with an air-jet stream (Filling motion). After the insertion has completed, the reed returns forward and thrusts the woof into the cloth-point (Beating motion).

I. Is the motion in which the warp wound on the yarn beam (spool) is unrolled keeping its tension constant?

II. Is the motion in which the cloth just woven is wound on the cloth-roller at a constant velocity? These are not periodic but continuous motions.

Mechatronization of weaving machine

In the case of the traditional full-mechanical weaving machine, all the motion including the main motions mentioned above were generated by the mechanical coupling with the rotation of the main-shaft by means of gears, cams, and links. That limited the movements and caused complicated transmission mechanisms and difficulty in fine adjustment of the movements. To overcome these limitations, the newest machines are mechatronized to separate some main motions from the rotational motion of the main shaft, that is, they are composed of several independent devices. Each device has a microprocessor (microprocessors) to control the actuators and sensors to generate exact motions instructed by the operator. the configuration of the control system of the mechatronized weaving machine. Though these control devices basically work independently of each other, they can make synchronous motions using the signals on the control bus. In this section, we present in detail the following systems, the let-off motion, and the filling motion control systems.

Let-off motion control system, the full-mechanical let-off motion control system and the mechatronized one. In the mechanical system, the rotation of the main-shaft is transmitted to a continuous speed-change gear whose output shaft rotates the yam-beam using the reduction gears. The change of the warp tension is converted into the displacement of the backrest roller. The displacement is transmitted to the lever of the speed-change gear through the spring and the links. The warp tension is set by varying the weight hung on the lever A. The speed-change gear requires that the rotational speed change ratio of the input to the output is more than five times which is the same as the ratio of the radius of the yarn beam which is almost empty to that which is fully rolled up. The speed-change gear which is capable of changing the speed with such a wide range is very expensive.

Mechatronics Applications in Three-Dimensional Braiding

This discussion addresses the application of mechatronics to braiding processes, particularly, those processes that afford a measure of flexibility in controlling braid patterns, three-dimensional braider and which relied heavily on the application of mechatronics. The impetus for the study was the need for complex and variable yam patterns in textile preforms used for fiber reinforced composite materials [4,5]. These notes also include a brief description of several non-conventional braiding processes that have been proposed as methods of producing three-dimensional structures of the type used for composite preforms. Both the nature of past efforts at developing advanced braiders and the potential for applying mechatronics in such endeavors should be apparent from the discussion.

Finally, we conclude that, in most cases, the application of mechatronics can be described in one of two ways. One category includes cases where electronic elements are adapted to an existing machine or process, largely mechanical, as a natural evolutionary step. The second category consists of those machines or processes in which both the mechanical and electronic aspects of mechatronics are closely and indivisible in a complementary manner from the start. Where the basic concept is the integration of mechanical and electronic functions and really has no basis other than the mechatronic process (Figure 6).

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Figure 6: A mechatronic system described as Braiding Processes.

Braiding Processes Briefly stated, braiding consists of the interlacing of several yam to form a structure. Obviously, most weaving processes would be encompassed by so general a definition and no clear, accepted distinction between braiding and weaving appears to exist. Products having components that are reasonably termed the "warp" and the "weft" are often referred to as woven structures. Others are usually considered braids or knits. Sometimes the classification is based more on the machine than on the process and depends on whether the machines are composed of loom-like or of braider-like elements [4].

However, the distinction blurs when the process evolves into a 3-dimensional weaving process. The semantic dilemma is further revealed by examining a generalized interweaving process. For instance, the general, ideal process could be thought of as a procedure in which the interwoven structure can be produced by the successive exchange of positions of any of many individual yarns arranged in a spatial array. A conventional braider executes a subset of the possible interchanges, and this subset is fixed by the mechanical construction of the machine. Conventional weaving consists of a subset of exchanges. The shedding operation in weaving is the repeated, simultaneous interchanging of complete rows of yarns. Weft insertion is likewise an exchange of position. For example, ordinary looms are built to yield materials of a certain type but are limited to that type (Figure 7). The (3D) Three-Dimensional Braiding Processes, several non-conventional braiding processes be described, The examples given as were to convey an appropriate overview and to provide a context for discussions to follow.

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Figure 7: A mechatronic system described as Braiding Processes.

Row and Column Shifting Processes

Several braiders have been developed that involve the sequential shifting of rows and columns of yams. Some of these processes accommodate both a rectangular array of rows and columns and a circular arrangement having radial and circumferential rows (Figure 8).

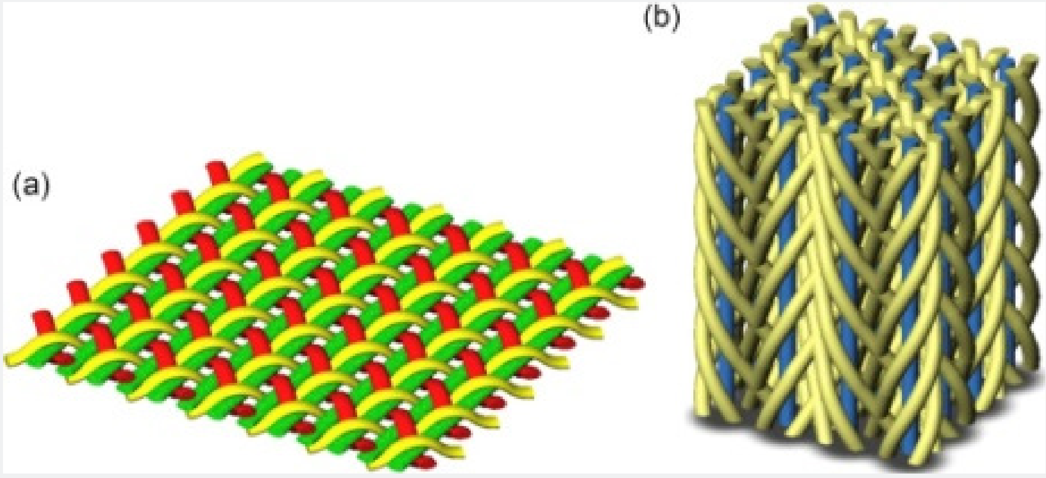

Figure 8: A Braiding structure Processes.

Design of an Automatic Weaving Machine for 3-D Net Shapes

This paper reviews existing 3-D weaving processes and presents the properties of different composites made from carbon fibers for space applications will be discussed. Comparison of the properties of the new materials with existing ones showed superior performance (Figures 9 & 10).

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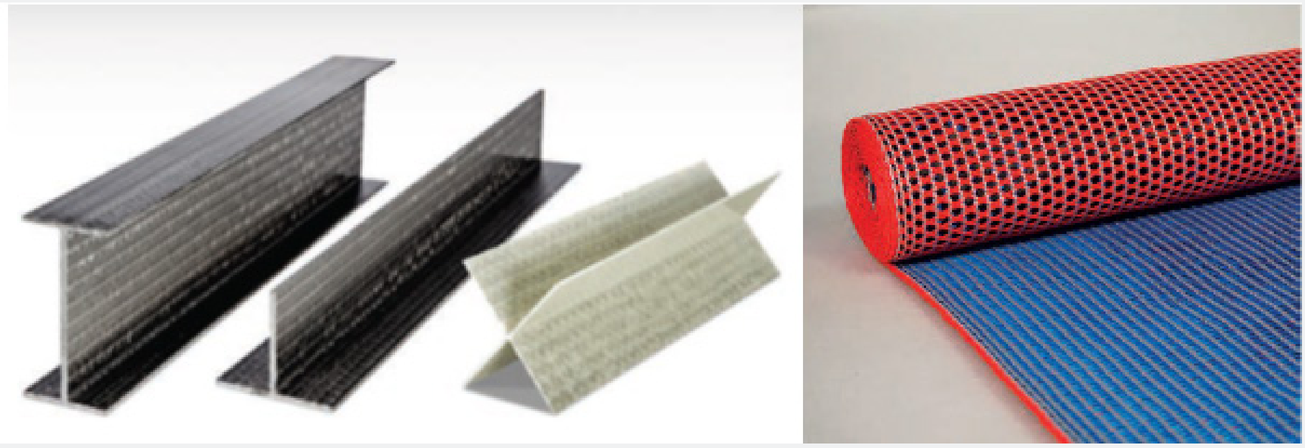

Figure 9: described as Braiding Processes.

Figure 10: A mechatronic system described as Braiding Processes.

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The use of high-performance textile structural composites is becoming increasingly popular in many engineering applications. Examples include aerospace and aircraft structural components, deep submergence vessels, sports equipment, textile machinery and automotive parts. The rate of growth of composite use is expected to continue to increase rapidly with new developments in fiber and matrix materials and manufacturing technologies. Fiber reinforced composites basically consist of two fundamental components: the reinforcing fibers and the surrounding matrix.

Technologies for the manufacture of the reinforcing fibrous preforms include a number of conventional textile processes as well as several specialty techniques developed mainly for the composites industry. Laminating several layers of a woven fabric, cross-laying of tapes of continuous filaments or filament winding the fibers into the required shape were most common in the late seventies and early eighties.

However, because of failure by delamination of the materials, several systems of producing three-dimensional integral shapes have been developed over the last decade. The new textile systems include 3-D braiding, 3-D weaving, and 3-D knitting. Other systems were developed especially for bodies of revolution or for the manufacture of billets which have to be machined to the required shapes after consolidation. Recently stitching multiple layers of multi-axial warp knitted 2-D fabric into 3-D shapes has improved the availability of structures with several fiber orientations as well as enhanced damage tolerance. Considerable development work is taking place in industry, research institutes and universities to automate 3-D braiding machinery using the 2-step and 4-step processes [1,3,6].

Developments in 3-D weaving of net shapes have not been given sufficient attention by the industry. This lack of activity was the driving force behind the effort which will be described in this paper. Composites made with 3-D integral structures woven or braided into net shapes offer considerable advantages over laminated composites. The properties which made composite materials so attractive include their high specific strength, high specific modulus, and low thermal expansion coefficient among others [7]. However, the high cost of advanced composites has limited their use mostly to space and military applications, where the performance of these materials has been unmatched by metals.

18.1. The New 3-D Weaving Process

The New 3-D Weaving Process [8] developed a new process for fonning variable cross sectional shaped three-dimensional fabrics. This method of weaving 3-D net shapes utilizes different weft yam insertion from at least one side of the warp layers for selectively inserting weft yarns into different portions of the fabric cross-sectional profile defined by the warp yam layers. If inserted from both sides of the warp yam layers, the weft yarns may be inserted simultaneously or alternately from each side of the warp yam layers.

Development of a Lan System for Weaving Factories

The productive method in weaving factories has been changing from mass production to small scale production of various kind of textile fabrics. To keep high productivity, new production management system suitable for weaving factories has been much desired. In this paper, introducing the Nissan LAN System, one of the most widespread LAN system in Japanese textile industry, we consider the essentials of the management system for weaving factories. In order to keep the productivity from lowering, the development of a new monitoring system (total production management system) suitable for weaving factories has been much desired. As compared with general production lines such as TV assembly lines, the textile production in weaving factories has some peculiarities as follows:

i. There are many causes of forcing weaving machines to stop working. Since the time necessary for restarting the stopped machine depends on the causes, it is difficult to precisely predict the time on which the textile on the machine will be finished.

ii. The quality of the product is approximately proportion to the number of times the weaving machine stopped. In other words, the machine halt affects not only the productivity but the quality of the products.

iii. There are many old factories in which the installation of LAN system is not taken into account.

iv. The installation cost of LAN system per weaving machine must be as cheep as possible because weaving factories usually have many weaving machines.

v. There are many old machines without capability of communication with external equipment's.

Taking these circumstances into consideration, we need a flexible management system suitable for many weaving factories. Nissan Motor Co. Ltd., one of the Japanese manufacturers of weaving machinery, has developed a LAN system for weaving factories to improve the textile productivity. In this paper, introducing the Nissan LAN System (hereafter referred to NLS), we consider the essentials of the management system for weaving factories.

Computer-Aided Design and Manufacturing: A Textile-Apparel Perspective

Today's textile-apparel industrial complex is characterized by a multitude of conflicting demands: smaller lot sizes, increased product flexibility, higher product quality and decreasing delivery times. The textile/apparel industry must deploy state-of-the-art manufacturing and information management techniques to operate successfully in such a demanding and highly competitive global market. In this context, the role and scope of mechatronics in textile-apparel production systems are discussed with specific examples. The need for techniques and tools such as information engineering, electronic data interchange and knowledge-based

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systems technology is established and their relevance to the textile-apparel complex is discussed. An overview of major research endeavors including the development of enterprise architecture, knowledge-based systems and product data standards is presented. Finally, some topics for further research in areas ranging from distributed design and manufacturing to the development of product data exchange standards are proposed.

Mechatronics and the Textile-Apparel Complex

Mechatronics, identification by Japanese researchers, is commonly defined as the efficient integration of mechanical and electronic engineering to create an optimum product. The ultimate objective of any enterprise is to produce the right product, of the right quality, in the right quantity, at the right price and at the right time [8]. The application of the mechatronics philosophy, viz., the effective utilization of state-of the-art technology (be it mechanical or computing) in all facets of its operation -- design, development, planning, production, distribution, marketing and business -- will enable the enterprise to achieve its goals in the highly dynamic and competitive global market. Integration and the Textile-Apparel Complex: An enterprise that effectively integrates the various functions through a common intonation/knowledge base is generally referred to as a Computer-Integrated Enterprise (CIE) [9].

The key to achieving a computer-integrated-textile apparel complex lies in a careful study and adoption of the principles of mechatronics by the industry. Moreover, to achieve true integration, the traditional lines that have separated the major components or building blocks (fibers, textiles, and apparel) must disappear [10-12]. The word integration is used in a broader context than just physical proximity or co-location. (Figure 1) shows the three major functions associated with a typical scenario in the textile-apparel life cycle [13].

The product design activity may be physically located in any of the major fashion centers of the world, viz., Milano, Paris, or New York; the plant to carry out the product manufacturing function and product marketing can take place in retail stores around the world, as lead times become shorter and demand for product variety increases, coordination and control or conceptual integration of the three major activities become critical [14-16]. It is therefore clear that mechatronics has a vital role to play in the textile-apparel complex. the state of the textile-apparel industrial complex vis-a-vis the mechatronics philosophy is examined., specific applications of mechatronic elements in textile apparel production systems are discussed., the roles of infonnation engineering, electronic data interchange and knowledge-based systems technology in developing mechatronic solutions are discussed [17-20].

Mechatronics and Textile-Apparel Production Systems

A detailed view of the interrelationships between the three major functions in the textile-apparel complex [21]. Two major types of entities flow through, and are processed by, the functions. They are physical entities such as fabrics and garments, and information entities such as design specifications and market trends. The flow of physical entities is predominantly in a single or forward direction [22-24]. In contrast, the flow of infonnation entities is bidirectional. In fact, as the industry becomes increasingly driven by what the consumer wants and demands, i.e., Consumer-Driven Design and Manufacturing (CDDAM) becomes the accepted in the industry, the infonnation flow in the reverse direction (from the consumer to the manufacturer and designer) will assume greater importance [25]. And the ability of an enterprise to successfully utilize this and other infonnation to rapidly reconfigure itself change designs, fabrics, styles, production, and marketing [26].

Mechatronics in Automated Garment Manufacture

Automated garment manufacture can be split up into various types of handling and joining operations once the fabric panels have been cut into various shapes. Each type of operation is studied, and various possible solutions described from a mechatronics point of view [27-29]. Problem case studies are then given showing why particular solutions are favored in certain circumstances. Such automation has greater potential if a series of automated modules can be integrated to solve a larger problem, e.g., a complete assembly or sub-assembly. Problems can then arise from the cumulative effects of uncertainties as the assembly proceeds [30]. There are, at present, three important aspects of the garment manufacturing industry which require immediate attention:

i. The cost of assembling a garment is estimated to represent between 20% and 30% of the total manufacturing cost. This can be reduced by taking the assembly abroad, where the labour costs are less, but a report on the attitudes of consumers towards clothing made in different countries indicates that goods made in Egypt are thought to be of a higher standard than those made elsewhere. The cheap labour factor will also become less important as wage rates rise in other countries [31-34].

ii. The consumer is looking for quality in the goods bought and is becoming more critical and selective when purchasing. It is therefore necessary for the industry in general to set and maintain standards as with the use of the Wool symbol [35,32].

iii. The garment manufacturing industry must be able to respond quickly to incoming orders, design, material, and size changes [36-38]. This can be accomplished by reducing the work in progress and using ‘Just in Time’ or ‘Quick Response’ systems.

There are six basic areas for automation [39-41]

a. Ply Separation

b. Transportation

c. Ply/sub-assembly position and orientation

d. Pick and place

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e. Joining

f. Manipulation

Many techniques have already been introduced to achieve, but it is important to observe that there is no ‘ideal’ solution to each problem [42]. Instead, a selection of solutions have been designed and implemented, dependent on the task and the properties of the fabric. These introduce some of the solutions to these six areas which have been developed and a brief overview of fabrics and their properties is given [43].

Sensing in Garment Assembly

Sensing demands in the automated assembly of garments differ considerably from those encountered in rigid materials handling. Attempts to automate in an ‘open loop’ manner, assuming knowledge and consistency of all relevant fabric properties, are usually doomed to failure because such properties are likely to vary from batch to batch, with time, environmental conditions, and can be dependent on the handling history [44,45]. Sensory feedback can provide information for the selection of appropriate corrective action.

i. Various sensing strategies have been proposed for the detection of presence, position and orientation of fabric stacks and individual panels, with the aim of preparing parts for joining. These are discussed in some detail with particular emphasis on the practicalities of different means with respect to the relevant properties of the materials and the environment. The applications of sensors during sewing operations, for error recovery and for inspection purposes are also described. Part of the problem of automating garment assembly is that the properties of the materials used are different from those used in areas of manufacturing where automation is already well established [46]. A further, major, area of sensor application is in inspection, both of the raw fabric and of the finished garments for quality control purposes.

ii. Detecting the Presence of Fabric The determination of the presence or otherwise of a number of fabric plies is a required element of a wide range of operations. One of the first stages in a garment assembly cell is to ascertain whether the material has been delivered and hence whether the process may begin [47]. The fabric may be presented as a single ply or as a stack of plies and this will have some influence on the sensing system used but often equally important is the mechanism by which the ply or plies are delivered.

iii. Force-based proximity sensors perhaps the simplest methods of detecting the presence of material, particularly when a stack of plies is expected, is to use a micro switch which is gradually lowered until the switch lever contacts an object and the circuit is completed [48]. If this occurs at a position above the level of the base then it is reasonable to assume that a stack of cloth has been detected [49,50]. This assumes that a gradual lowering of the sensor is achievable but, since the subsequent action is likely to involve the removal of the top ply of a stack, the destacking device must be positioned correctly, relative to that top ply and the required movement must therefore be achievable. The problem may be inverted with the stack moved up to the sensor [51].

Mechatronics in the Devises Design of Textiles testing

(Figures 11 & 12).

Figure 11: ElNashar Digital Test method for: Weight, Durability, stuffiness, Strength and Elongation of fabrics. In EGYPT.

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Figure 12: ElNashar Digital Thickness Test method, In EGYPT.

Conclusion

Sustainability of Modern Areas of Artificial Intelligence Applications in the Textile Industries Using Mechatronics, by promotion of incubation centers of multidisciplinary, provision of seed money for startups, and expansion of financing and other forms of support. Required by startup units, Sustaining leadership and management during (Research & Development training and education, and raw materials through of production through design and innovation, for technology and maintenance. of production through design and innovation of product consumption machinery for (fabrics - clothes - accessories). During marketing and promotion (with multiple languages and use of technology). During Sustainability of after-sales services, Finally International brands needs technology use.

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