A Survey Paper: Knitting Machine and its Microcontroller based Automization

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Abstract— **The paper describes types of knitting machine with and without automation. Knitting machines are designed to produce a continuous length of knitted fabric, socks undergarments, in course wise direction wherein knitting needles are mounted for reciprocating knitting movements in needle-carrying sections linked together to form a continuous oval unit. Those machines are classified according to their construction. Simple machine without needles is used to permit knitting for toys or other hobby purposes. Flat and Circular bed machines produce larger and more complex knitted items such as garments. 20th century domestic/studio models typically use Machines with latch-hook needles. Automatic patterning machines can knit two- color Fair Isle patterns automatically and has machine stitch patterning features such as plating and knit weaving. Paper also describes the problem with existing machines and the suggested solution to overcome those problems. This solution is nothing but automation of knitting machine by providing electronic control. The electronic control system will consist of yarn detector system to indicate breakage of yarn and data processor to imprint the design on the sock as per the selection.**

Keywords— **knitting, plating, weaving, yarn, weft, warp, cam,**

I. INTRODUCTION

Knitting concept- Knitting is the process of manufacturing fabric by transforming continuous strands of yarn into a series of interlocking loops, each row of such loops hanging from the one immediately preceding it. The basic element of knit fabric structure is the loop intermeshed with the loop adjacent to it on both sides and above and below it.

This process eventually results in a final product, often a garment.[1,2] Knitting can be done by hand or by machine. There exist several styles and methods of knitting. Different yarns and knitting needles possibly will be used to achieve different end products.

Types of Knitting-

There are two main varieties of knitting: weft knitting and warp knitting. i) Warp Knitting: In weft knitting, the wales are perpendicular to the course of the yarn. the complete fabric may be produced from a single yarn, by adding stitches to each wale in turn, moving across the fabric as in a raster scan.[1] weft knitting is done by both hand and the knitting machine.

ii) Warp Knitting: In a   warp knitted structure, each loop in the horizontal direction is made from a different thread and the number of threads are used to produce such a fabric is at least equal to the no of loops in a horizontal row.[4]The wales and courses run generally parallel. By contrast, in warp knitting, one yarn is required for every wale. Since a typical piece of knitted fabric may have hundreds of wales, warp knitting is typically done by knitting machine. [2, 3]

II. KNITTING MACHINE

It is a machine which is designed to produce a continuous length of knitted fabric , hosiery, sweaters, hand gloves, socks undergarments. [7]Knitting machines use latch hooks set into the machine to produce knit stitches. The placement of these hooks and the size cannot be changed. in course wise

direction wherein knitting needles are mounted for reciprocating knitting movements in needle-carrying sections linked together to form a continuous oval unit. The needle carrying sections are rotated relative to a plurality of threads and to reset cams which reciprocate the needles in a knitting movements. A plurality of hooks are fixed for movement in a continuous oval path with a straight portion thereof extending adjacent a straight portion of the needle carrying sections, with the hooks cammed to engage the knitted fabric as it comes from the needles to provide a wale–wise bias on the fabric as it is knitted. Knitting machines are primarily differentiated by yarn weights, with some machines able to handle heavier yarns than others. Knitting machines allow you to quickly and efficiently produce a variety of knitted fabrics.

III. TYPES OF KNITTING MACHINES-

There are numerous types of knitting machines, ranging from the simple, and non-mechanical, to the highly complex and electronic. All, however, produce various types of knitted fabrics, usually either flat or tubular, and of varying degrees of complexity. Pattern stitches can be selected by hand manipulation of the needles, or with push-buttons and dials, mechanical punch cards, or electronic pattern reading devices and computers.

1) Simple machine without needles-

A few simple devices permit knitting without needles for toy or hobby purposes. [6]The simplest of these is spool knitting, followed by knitting boards or knitting looms, which consist of two rows of pins mounted in two parallel rows approximately 0.5 inches (1.3 cm) apart. Yarn is wound around the pins; various patterns of winding produce different textured knitting. A needle or special tool is then used to transfer the loops of yarn from around the pins, either off the pins or to other pins, to produce the knitting. Knitting boards can produce complex designs. Other semi-mechanical knitting devices are available.

2) Flat and Circular bed machines-

To produce larger and more complex knitted items such as garments, domestic and industrial machines, with either flat or circular beds that produce rectangular or tubular fabrics are needed. Double bed machines have two flat beds facing each other, in order to produce purl and plain rib fabrics plus a variety of multi patterns. Ribbing attachments can be added to single bed machines to achieve a similar result.

Circular knitting machine: The machines which are used here are circular knitting machines whose end product is seamless tube. Those machines are mainly used for manufacturing of socks. Varieties of socks are manufactured on those machines such as regular, ladies and school socks etc. Originally, circular knitting machines were done using a set of four or five double pointed needles. Later a circular needle was invented; the circular needle looks like two standard knitting needles connected by a cable between them. Machines also use individual latch-hook needles to make each stitch in a round frame.

3) Machines with latch-hook needles-

Late 20th century domestic/studio models typically use up to 200 latch-hook needles to hold the stitches in fine, standard, mid-gauge or bulky gauge needle.[6] A carriage or cam box is passed across the bed of needles causing the needle movements required to produce each next stitch. By means of various selection methods, e.g. punch cards, particular needles can be caused to travel by alternate pathways through the cam box. Thus needles will knit or not, and the unknitted yarn portions will lie under (slip stitch) or over the needle or be held in the needle hook (tuck stitch). Needles can be placed in holding position to allow short row shaping. In the most modern machines, punch cards have been replaced by computer control.

4) Automatic patterning machines-

Those can knit two- color Fair Isle patterns automatically, and have machine stitch patterning features

such as plating and knit weaving. Plating refers to knitting with two strands of yarn that are held in such a way that one is in front of the other. Plated effects can be particularly striking in a ribbed fabric. [6]Knit weaving refers to a technique in which a separate piece of yarn, often heavier than the knitted fabric, is carried along and caught between stitches to produce an effect like weaving. With knit woven fabric, the purl side (usually the wrong side) is the right side of the fabric. The fine and standard gauge models have the option of a lace carriage, where stitches can be transferred from one needle to the next. The yarn passes through a tensioning mechanism and down through the knit carriage, which feeds the yarn to the needles as they knit.

IV. PROBLEM DEFINITION

Existing sock knitting machine is working fully on mechanical principals with no atomization or any electronic stop motion. This is a circular blade machine with mechanical drum provided for designing purpose .It has total 168 needles for knitting with running speed 300-380 rpm. Knitting needles are mounted for reciprocating knitting movements in needle carrying sections linked together to form a continuous oval unit. The needle carrying sections are rotated relative to a plurality of threads and to reset the cams which reciprocate the needles in a knitting movements.

V. SPECIFICATION OF MACHINE

Following are the features and technical parameters of the machine.[4]

Machine Details

V.i Features-
1. Make :   Soloman (Delhi)
2. Model- 5 Step all in one
3. Circular bed machine
4. Mechanical socks knitting machine
5. Machine can produce Platting design, Tuck design, False rib & various types of jacquard designs
6. Drum is provided for designing purpose.

V .ii   Technical Parameters-
1. Knit type- plain
2. Cylinder Diameter: 3 1/2"
3. Needle Range: 108 to 168
4. Running Speed: 300-380 RPM
   Power Required: Drive Motor: 0.85kw/set
5. Weight-250-300Kg

Fig1. Knitting Machine
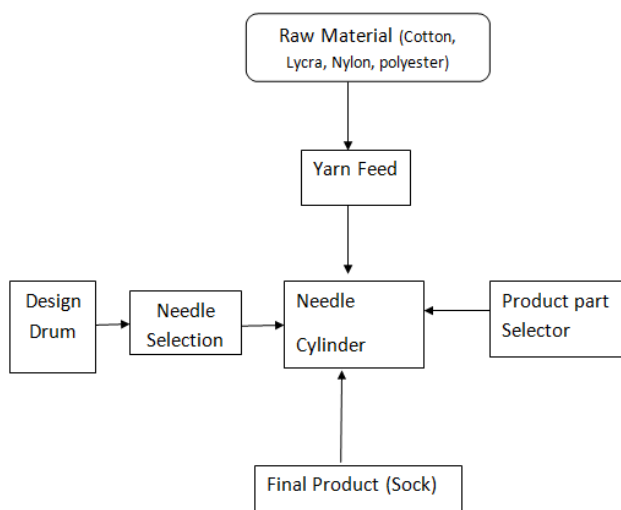
VI.   WORKING OF A MACHINE

a)   Block Diagram:

Fig.2.Block Diagram of Kniting machine

Fig.2 shows the detailed block diagram of a sock manufacturing process   using a circular knitting machine. The different parts included in this are raw material, yarn carrier, yarn feeder, needles, cylinder, design drum, part actuator etc. The end product is a sock, a seamless tube. The remaining process of   socks such as seaming, finishing, packaging is done when product is ready and out of machine. After all these process the sock will be ready for use.

- Raw Material

First process is the selection of the raw material. Raw material which is used is the Yarn or thread. Yarn:-There are different varieties of knitting yarns. Yarn is a continuous strand of interlocked fibers, suitable for use in the production of textiles, sewing, crocheting, knitting and weaving. While yarn is any fiber used to construct a fabric, thread is any fiber used to sew two pieces of fabric together. The various types of knitting yarn are distinguished by their weight, purpose, ply, source fiber, texture, color, and pattern.

- Yarn Guide:-

It is an upright attached to the gear ring which supplies yarn to the needles as Ittravels around the cylinder with the clam shell.

Used to guide the yarn supply to proper feederwith proper tension.

Fig.3 Yarn Guide

- Yarn Feeder:-

An upright attached to the gear ring which supplies yarn to the   needles as it travels around the cylinder with the cam shell. Total 12 yarn feeders are available .Only required number of yarn feeders are used for making socks. Minimum 2 yarn feeders are required.[4]

Fig.4

Yarn Feeder

- Cylinder:-

Hollow cylinder slotted outside to hold the long needles .Around 168 needles are mounted on the cylinder. The cylinder is steady with diameter3.5". Only needles are moving in circular direction. This cylinder is attached with design drum.[4]
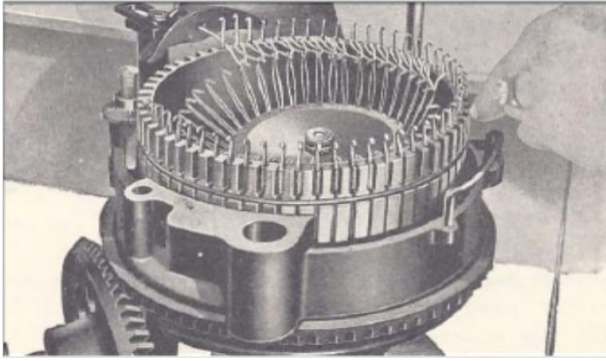
Fig. 5.Cylinder with needles

• Design Drum:

Fig. 6. Design Drum

It is a circular drum with pins mounted on it according to required design. This drum is attached with needle cylinder or designing purpose there are pins situated on the drum in 5 rows as it is a 5 step machine. According to the required design those pins have to be arranged .The selector attached with drum press the needles below to catch the yarn when pin is not available on the drum. The process of making designs on graph and then implementing it on drum is tedious and time consuming. This may also lead in improper design resulting in wastage of time, material and cost.

• Needles:

Those are steel wires provided with hook and latch on one end and a projection called 'butt' on other end.Double pointed needles (or dpns) are used for knitting in the round in an area that would be too small for normal circular needles, such as when knitting socks. They have two tapered ends, so

that each end can be used to knit to another needle without having to go through an entire row. They can also be used to attach smaller pieces to larger pieces of knitting, such as when attaching ear flaps to a knit hat.[7]
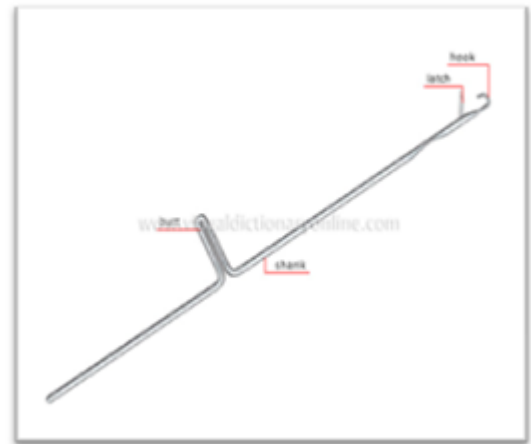

Fig.7.Needle

VII.   SOLUTION

The automation of a knitting machine is proposed to provide stop motion for yarn breakage and to provide readymade designs suitable for five step machine. [10]Controller will generate stop signal and buzzer alarm with led indication for the machine when yarn breakage occurs. Designs will be prepared by any related software such as Knitpro software, visual basic or c programming. Those designs will be stored in the memory bank. [11]According to requirement of the product, respective design will be selected .This reduces the working time of the operator and also rejection ratio, resulting in increase in production ratio. The proposed system will provide desired level of atomization for that machine with very minimum cost as compared to computerized machines.

VIII. APPLICATIONS

• The proposed system will be useful for detection of thread or yarn breakage in knitting machine that will reduce rejection ratio.

- This system will reduce manual work by means of computerised designs and also helps to increase the production.

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