Proceedings of
INTERNATIONAL CONFERENCE ON COMPUTING, COMMUNICATION AND ENERGY SYSTEMS (ICCCES-16)
In Association with IET, UK & Sponsored by TEQIP-II
29th -30th, Jan. 2016

Paper ID: E&TC03

AUTOMIZATION OF KNITTING MACHINE IN TEXTILE INDUSTRY BASED ON ADVANCED MICROCONTROLLER

Mrs. Patil Bhagyashri Manoj ,
Department of Electronics engineering ,
TKT Warananagar, Maharashtra,India,

Prof . D.G.Chougule
Department of Electronics engineering ,
TKT Warananagar, Maharashtra,India,

Abstract: The Paper describes an atomized knitting machine based on advanced microcontroller named Atmels Atmega 328. The automation is provided to a sock knitting machine that is completely mechanical and is not supported by any electronic stop motion and computerized pattern design. The system consists of a yarn detector system which buzzer alarm when yarn breakage occurs. The control system receives computerized patterns for drum of a 5 step machine, causing the desired patterns to be imprinted on the sock in selected area.VB.net is used to prepare design and communicate with user and system. Various patterns can be created, modified and downloaded into the system. Magnetic pickup is used to sense the cam position so that patterns to be imprinted on the sock by actuating specific needles. Five actuators are used to actuate needles on 5 step machine. Overall system increases the efficiency and throughput of the knitting machine.

Keywords: knitting, Yarn, Control system, Selector lever, cam, fabric, needle cylinder, actuator etc.

I. INTRODUCTION

Knitting a method by which a thread or yarn is turned into the cloth or other fine crafts. Knitted fabric consists of consecutive rows of loops, called stitches. As each row progresses, a new loop is pulled through existing loop [1].The active stitches are held on a needle until another loop can be passed through them. At present there exist numerous styles and methods of knitting. Different yarns and knitting needles may be used to achieve different end products by giving the final piece a different colour, texture, weight, and/or integrity. Circular knitting machines are designed to produce a continuous length of knitted fabric ,hosiery, sweaters, hand gloves, socks and undergarments, in course wise direction which consist of knitting needles mounted for reciprocating knitting movements in needle carrying sections[1].These needles are linked together to form a continuous oval unit .The needle carrying sections are rotated relative to the number of threads and to reset cam section which reciprocate the needles in knitting movements. A plurality of hooks is fixed forward movement in continuous oval path with straight portion. It also extends adjacent a straight portion of the needle carrying sections. The hooks are fitted in cam section to engage the knitted fabrics as it comes from the needles to provide a wale-wise bias of the fabric.In sock manufacturing yarn is the raw material that is used as per the required color and quality. This yarn is guided through yarn guides to the yarn feeder ; those are situated above circular cylinder[2].There are 168 needles placed on circumference of cylinder between the grooves for knitting purpose whose operation is to be controlled by a cylinder drum for designing purpose. Also there is a product part selector drum used for controlling the particular needles of cylinder and feed yarn for knitting on different parts of sock such as cuff, leg, foot, heel and toe. A carriage or cam box is passed across the bed of needles, causing the needle movements, that is required to produce each next stitch. By means of various selection methods of design e. g. punch cards particular needles get engaged to travel by alternate pathways through the cam box. Thus needles will knit and unknotted yarn portions will lie under or over the needle or be held in the needle hook.

II. RELATED WORK

In the present practices variety of automated knitting machines are available that differ by the cost and level of automation from each other. The fully automatic computerized knitting machines provide a high level of automation features. These machines are capable of manufacturing of high quality socks within less time to increase in production. [2] The control device of these machines is fed with computerized required design.. Fully computerized machines are faster than semi-controlled and mechanical machines. Those costs around 3.50 hundred thousand.

The semi-automatic machine provides less automation as compared to fully computerized machines. Those machines provide stop motion for yarn and needle breakage and can be fed by various design patterns through software. These machines cost around 2.50 lakhs

Existing sock knitting machine is working fully on a mechanical principle with no optimization or any electronic stop motion. This is a circular blade, machine with mechanical drum provided for designing purpose.

III. SOLUTION

The drawback of existing mechanical knitting machines is that machines don't have stop motion indication when yarn breakage occurs. Also for imprinting designs on the sock an

Paper ID: E&TC03

operator has to draw designs on graph, and then does the trial on the drum. If the design is complicated then more time is required for trial and error. In this process sock can be a waste if proper design is not printed on that. This operator based printing method is not suitable for complicated designs that lead to wastage of raw material, less production time consuming process.

The automation of a knitting machine is proposed to overcome the drawbacks which are mentioned above. It consists of a control system and a detector system. [4] Control system is responsible to control the operation of the machine when yarn breakage occurs, and also provides selected ready-made design fed and assigned by computer. Controller buzzer alarm with indicators for the machine when yarn breakage occurs [5]. Designs are prepared by VB.net language using the help of sharp develop software. We can create complicated designs by using such software and transfer the same to the microcontroller. Microcontroller then actuates particular actuators as per design received. This process reduces working time of the operator and also rejection ratio, resulting in an increased production ratio. The proposed system will provide the desired level of automization for existing machines and with less cost as compared to computerized machines.

IV. PROPOSED SYSTEM

To provide automation to a traditional sock knitting machine, the patterning drum is replaced by a control system with actuators and a detector system .The Project has three stages:

Stage1: Designing of detector system for yarn and needle breakage.

Stage 2: Pattern designing and creating databases

Stage 3: Interfacing of microcontroller with detector system and machine

To obtain the desired result the proposed system is as shown below.

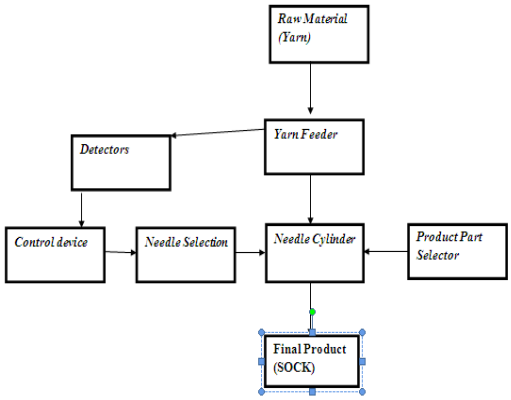


Fig.1.Block diagram of developed system

The proposed system will be designed so as to overcome the drawbacks given. In this a design drum will be replaced by a control system. The control system can be a microcontroller with required specifications. Design can be prepared by using VB.net and will be used to actuate the selector to push the needles at the time of design portion. Actuators (solenoids) will be used to actuate the selector to push the needles at the time of design portion.

Selection of Microcontroller:

Three major criteria in choosing microcontroller are –

1) Meeting the computing needs of the task at hand efficiently and cost effectively-factors to be considered are speed, packaging, power consumption, amount of RAM and ROM on the chip, ease of upgrade to higher performance or lower power consumption, versions, cost per unit etc.
2) Availability of software and hardware development tools such as compilers, assemblers, debuggers and emulators.
3) Wide availability and reliable source of microcontroller.

By considering above criterion I have selected Atmel atmega 328 microcontroller. For this project I need at least 16 I/O pins .Also to store designs and load that design sufficient memory will be required.

Technical specifications:

1. Microcontroller ATmega328
2. Operating Voltage 5V
3. Input Voltage (recommended) 7-12V
4. Input Voltage (limits) 6-20V
5. Digital I/O Pins 14 (of which 6 provide PWM output)
6. Analog Input Pins 6
7. DC Current per I/O Pin 40 mA
8. DC Current for 3.3V Pin 50 mA
9. Flash Memory 32 KB of which 0.5 KB used by the bootloader ,SRAM 2 KB ,EEPROM 1 KB
10. Clock Speed 16 MHz

- BASIC SETUP

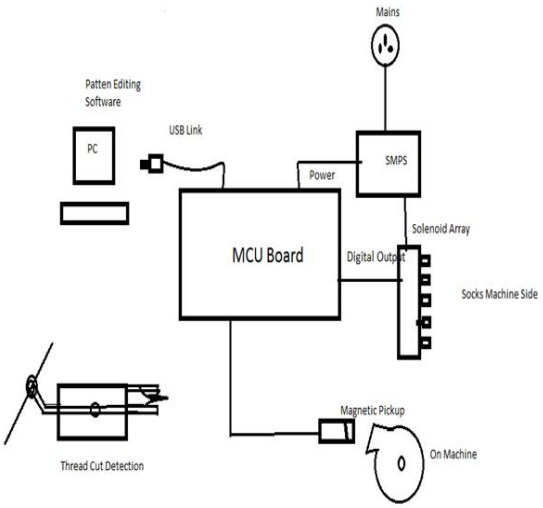


Figure 2: Basic setup of proposed system

The basic setup has Atmel Atmega 328 microcontroller. This will be communicating with the PC using USB connection. We have the pattern editing software based on

Paper ID: E&TC03

VB6.This will run on PC and pattern will be downloaded on MCU board. Up to 10 patterns can be stored in the MCU controller board. Once the pattern is loaded on the board you can select the pattern to be executed. Once pattern is chosen the MCU will be configured in the execution of that pattern. The action of the socks machine i.e. starts of drum and timings are to be taken off by magnetic pick-up which will start giving pulses as soon as the flywheel starts rotating. Once we get the timing from the magnetic pick-up, we will provide the solenoid plungers according to the pattern in execution. Also thread cut detector will be simple switch which sense thread cut and send signal to controller which then buzzers alarm.

V. DESIGN AND IMPLEMENTATION OF THE SYSTEM

A.HARDWARE DEVELOPMENT:

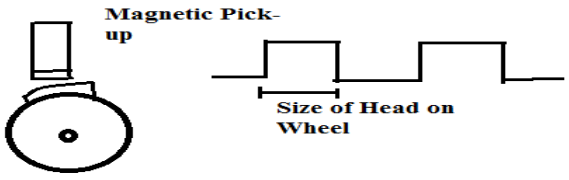
- Microcontroller Board:

The Arduino Uno is a microcontroller board based on the Atmega 328 . It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.[11] It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

- Magnetic Pickup

Starting of drum and execution of pattern depends on the machine cam. Whenever cam position is arrived puller moves drum and according to pins mounted on design drum needles are get activated. In this system the action of the socks machine, i.e. starts of drum and timings are to be taken off by magnetic pick-up which starts giving pulses as soon as the flywheel starts rotating. Once we get the timing from the magnetic pick-up, we provide the solenoid plungers according to the pattern in execution. Pattern will be send only for rising edge of the pulse means if magnetic pickup output is high (rising edge), data or design get transmitted to activate solenoid. Those solenoids then activate corresponding needles to imprint the design. For falling edge it remains in idle condition. For next rising edge , next pattern will be sent on the solenoid to activate needles. Figure shows how magnetic pickup sense cam position and generate pulses.

Figure 3.Function of magnetic pickup



SOLENOID PLUNGER:

A solenoid is a simple electromagnetic device that converts electrical energy directly into linear mechanical motion, but it has a very short stroke (length of movement), which limits its applications. The linear solenoid works on the same basic principal as the electromechanical relay. A "Linear Solenoid" is an electromagnetic device that converts electrical energy into a mechanical pushing or pulling force or motion.

Solenoids are interfaced with relay through diode. Relay plays important role to activate solenoids as per design. As magnetic pick up sends signal relays get energized and activate that particular solenoid.

- RELAY

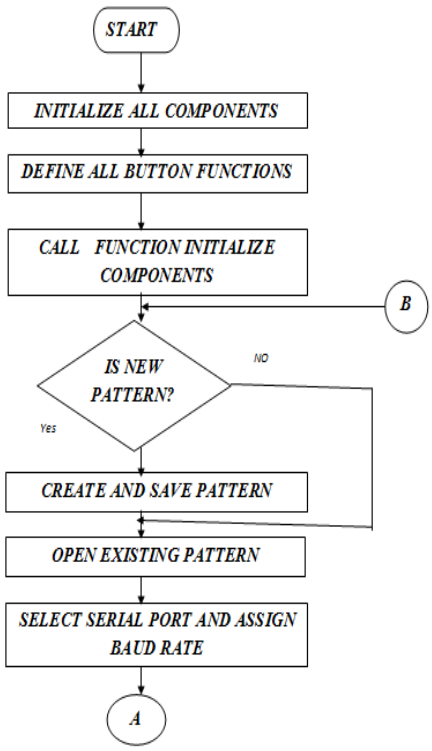
A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays.

- THREAD CUT DETECTOR

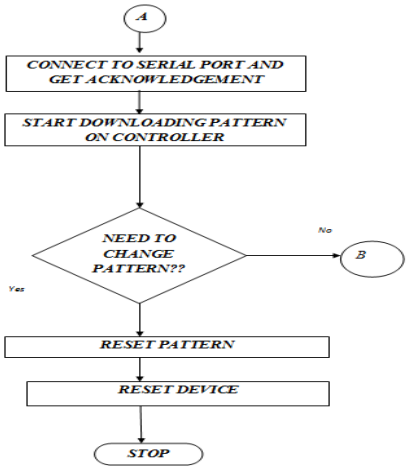
A sensor is a transducer whose purpose is to sense (that is, to detect) some characteristic of its environs. It detects events or changes in quantities and provides a corresponding output, generally as an electrical or optical signal.Here sensors are required to detect thread breakage when machine is in running condition. At running condition yarn is travelling on yarn guide with sufficient tension. Here a simple switch is used to make and break contact. Once it get cut that tension releases and switch gets closed which sends signal to pin no 3 on microcontroller board. Buzzer is connected to pin 8 which is configured as output. As pin no 8 become high buzzer starts and we get alert that thread got cut.

B. SOFTWARE IMPLEMENTATION

- FLOWCHART FOR VB PROGRAM



Paper ID: E&TC03



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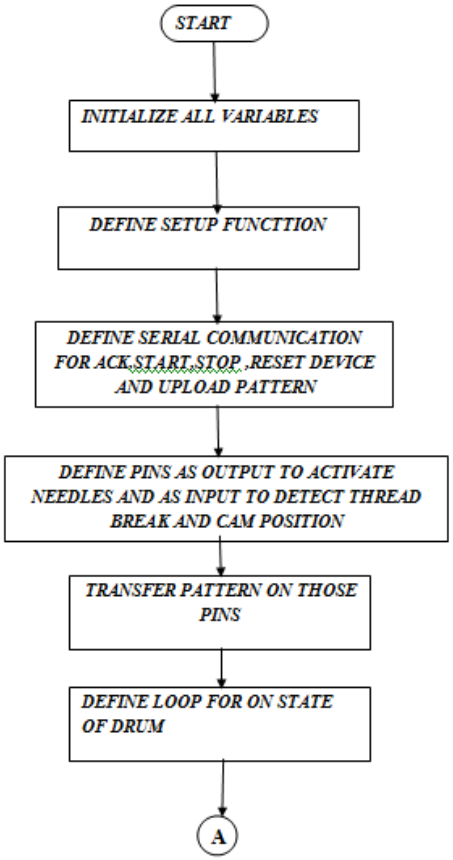
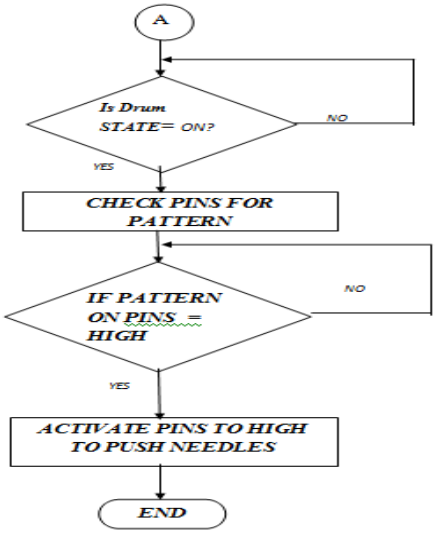
Flowchart for Main program of Microcontroller





VI. RESULT AND CONCLUSION

- RESULT OF PROGRAM
- Main window output for design

In this project vb.net is used to create designs which are to be imprinted on the sock. Atmel Atmega 328 microcontroller is used to interface with machine to control it and activate needles for designing. To create, compile and debug the code sharp develop 4.4 software which is open source and easily available is used. By pressing F5 program can be run and following window appears on the window.

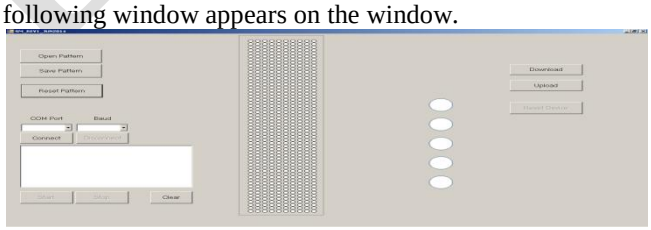


Figure 5. Main window of design

By clicking on each hollow circle the design/pattern can be created. Once it is created the pattern will be saved by tab “Save Pattern”. To reset the pattern tab “Reset Pattern” is used. By using “Open Pattern” tab we can open previously saved file from disc. Result of Open Pattern tab

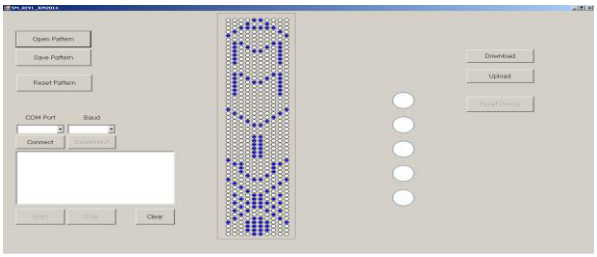


Figure 6. Result of Open Pattern tab

Paper ID: E&TC03

Once the pattern is ready it will be downloaded on microcontroller via serial port by selecting proper baud rate. After connecting we get the message "Port Com3" connected and after that while downloading we get the message as device Id check ok and acknowledgement received.

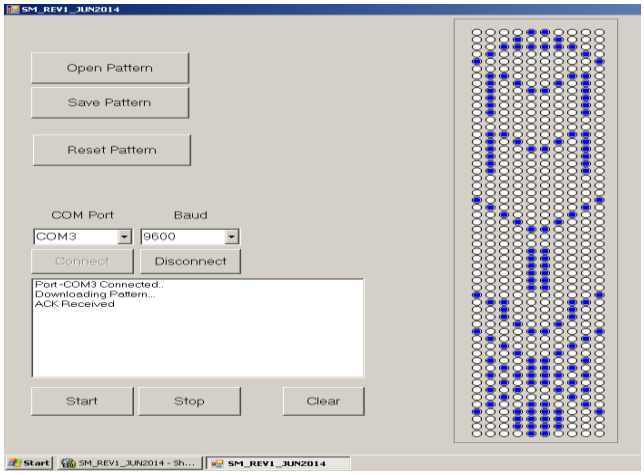


Figure . .Acknowledgement received

- Result of Pattern transmission

Once we click on start pattern start to print by activating relays and thereby solenoids. As solenoids get high signal, that particular solenoid actuate that needle and design start to imprint on the sock. Total 56 rows and 5 pins on each row are used to create the design/pattern. Following snapshots showshow this pattern will be sent to the needles.

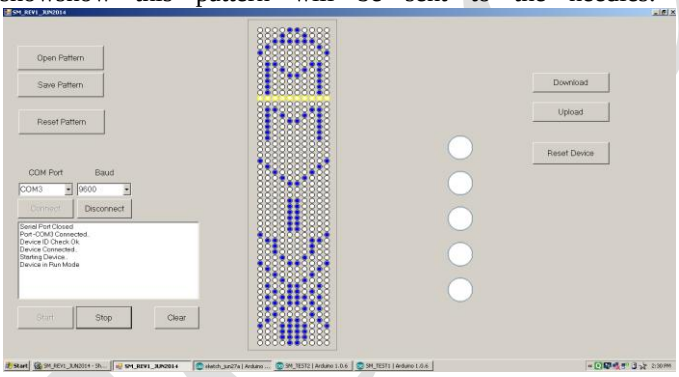


Figure 8.Graphical output for relay

The Figure shows the relation between magnetic pickup and pattern to be imprinted.

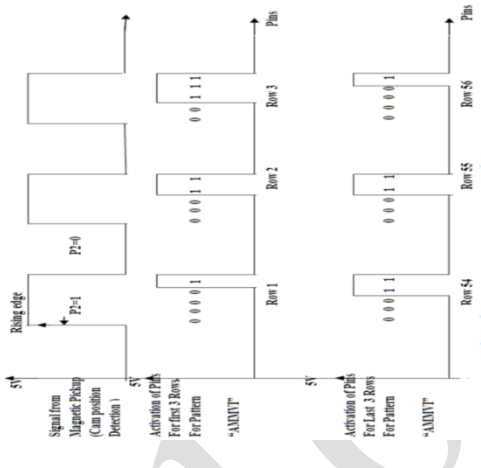


Figure 9. The Relation between magnetic pickup and pattern to be imprinted.

CONCLUSION

Knitting machine is the most important factor in knitting (textile) industry. Nowadays a lot of the requirement of knitted fabric is increased. One of the examples is socks. Those sock knitting machines are available in many varieties such as semiautomatic, fully automatic or computerized and mechanical. Present machines are fully mechanical with very less cost as compared to semi and computerized machines. Those machines are 5 step machines so again one more limitation was there that whatever be the design it should be adjusted on 5 pins in a row only. To solve this problem a new atomized machine is implemented successfully.To design such a system strong and freely available Arduino UNO software played an important role. It's easy commands and inbuilt Downloader helps lot to create the program and test as per requirement. Also GUI in VB.NET helps to create the pattern as per requirement and communicate the same serially with a microcontroller. HL SQC T73, 24 V DC relays are sufficient to drive solenoids .Those solenoids actuate needles on the cylinder. The timing of one by one printing was taken by a magnetic pickup. SIBASS limit switch plays an important role in this as those are also used in textile applications. As soon as head sense the cam, on its rising edge pattern will print. For next rising next row (pattern) gets printed. To start the magnetic pick up START button on GUI of VB.NET was used. Sharp develop 4.4 is an open source editor to write debug and compile VB programs. Thus,it was successfully implemented.Thread cut detection was also successful. Micro switch played an important role as a sensor to detect the thread cut. As soon as the thread got cut, the sensor sends signal to the microcontroller and buzzer gets on as an indication of the thread cut.Thus the system needs very less time without trial and error to prepare a pattern and upload or download it and print on the sock. Also, wastage is reduced due to thread cut detection. Thus,the overall

atomized system reduces time as well as costing and rejection ratio.

6. APPLICATIONS

- The proposed system will be useful for detection of yarn breakage, yarn roll over in a sock knitting machine, that will help to reduce rejection ratio.
- This System will reduce the manual work of designing by means of computerized designs.
- It will help in increase in production ratio by increasing efficiency of the machine.
- The system will improve the quality of product.
- The system will be having low cost as compared to other automatic knitting machines.

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