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Semiautomatic Hosiery Printing Machine

Ananthi K, Priyadharshini R, Arun Kumar P.M, Indirapriyadharshini J, Jaipraba V

Abstract – Every industry needs skilled labor to manually operate the machine effectively. But this need may cost high and the production rate will also be low in hosiery printing industries which runs in small scale. This paper introduces semi-automatic hosiery printing machine which helps in reducing the problems faced. The PLC controls the machine and the timings are programmed to make automatic operation. The bottom arm of the machine is moved or rotated using the pneumatic cylinder. Semiautomatic movement is initiated by pedal.Sensors make the notification that all the screens are lifted .This setup is for safety purpose as the supply is given only when the sensors are sensed. This machine will help the industries to increase the production rate without any skilled labors.

Index Terms: Screen Printing, Semi-automation, Sensors, Pneumatics, PLC, Hosiery

I. INTRODUCTION

A popular method of printing technique is Chest rotary printing machinein which a screen is needed to apply necessary colored ink onto a cloth. But the ink is not applied in the areas made resistant to the ink which is by a blocking stencil. A squeegee or blade is made to movetransversely the screen and it will fill open mesh openings with ink, and a reverse stroke will also cause the screen to touch the substrate(T-Shirt) momentarily along a line of contact. This helps in penetration of ink onto the T Shirt which is substrate here and the mesh springs back when the blade is removed. Screen printing is another popular method to print on a screen of polyester or fine mesh where a design will be imposed, empty areas are coated with an impermeable substance.

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***** Correspondence Author
Ananthi K, Assistant Professor, Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India
Priyadharshini R, Assistant Professor, Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India
Arun Kumar P.M, Assistant Professor, Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India
Indirapriyadharshini J, Assistant Professor, Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, India
Jaipraba V, Assistant Engineer, Magnificent Engineers, Coimbatore, India

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The squeegee forces ink into mesh pores and it wets the substrate; In each squeegee stroke, ink is transferred into the printing surface. The ink remains on the fabric even afterremoving the screen from the substrate and makes beautiful patterns on the fabric. Only one color can be printed at a time, manynumbers of screens are needed to produce a multicolored image as in the design.It is discussed by Gbadegbe Richard Selase. [1]

The author Adu-Akwabo [2] describes screen printing as a process of transferring a paper or computer designonto a fabric. He stated that, it can be achieved by using opaque ink to transfer the design onto the tracing paper.
A separate printed tracing paper is needed for each color on the design. In other words, a separate mesh screen is required for each color to be printed. In photographic method of printing, UV and florescent light is used to transferdesign from the tracing paper to the screen. In the photographic development of the screen, the blocked areas are intentionally opened fordye to penetrate through it, dye penetration in negative areas are blocked. Tortora and Merkel [3],outlines screen printing as a process where the patterns are reproducedby the design out on a mesh fabric or screen when the paint is squeezed through, open meshareas are penetrated by it. A squeegee is used to force paint through the screen. A separate screen is required for each color in the pattern.
In the manual Hoisery Screen Printing Machine the top arm is used to fit the screen and the palette at the bottom is used as a stand for the substrate. As each color in the pattern requires a separate screen top arm is set according to it (4/6/8/10/12-varients).Excess heater is required to dry the paint.The palettes are rotated by human and it is difficult to stop as it results in shoulder pain.To alleviate the problems affiliated with the manual printing machine, the "Semiautomatic hosiery printing machine" had beenproposed. It comes with a pneumatic setup at the bottom frame that helps in rotating the palette area without human effort. The pneumatic cylinder works as a stopper as well. A special mechanism is provided to make this work done. The machine reduces human effort and labor cost to get an effective production rate.

II. PRINTING METHODS

In olden days printing was done using Table printing machines in which the cloth will be placed on the table and the screen is used to print the required design by applying color paints[4]. Only one color is used at a time. The cloth will be dried for hours. Then came the flat bed printing machine which was a little advanced one. Now most of the smallscale printing industries in Thirupur are using the manual chest rotary printing machine.

This paper explains the ways by which the existing Chest Rotary Printing Machine can be semi-automated.

The 8 Color Chests rotary printing machine is widely used in hosiery textile industries. It consists a total of 8(pallets & screen frames), base frame, gas or electric heater, squeegee (To &fro) for dye. Here one of the operator fits the cloth on the pallet and pushes it to the next operator where the cloth is printed by applying dye using the screen which has design. Then the cloth is sent to the heater where it is heated to dry the paint. A separate laboris placed to stop the pushed pallets. The movement of the pallets is manual in which the operator should use his strength in stopping the pallets when pushed. This cause a severe pain in hands and the cost for labors is high with low production rate.

Fig. 1 Table Printing Machine

III. EXISTING SYSTEM

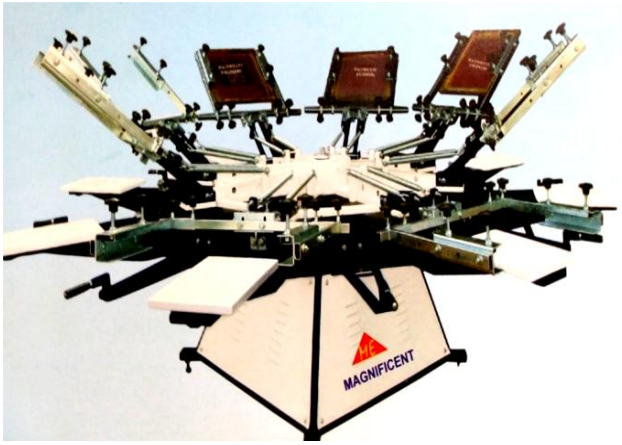

Fig.2 Manual Rotary Chest Printing Machine

IV. SEMIAUTOMATIC TECHNIQUES

The disadvantages of the existing systems can be reduced by converting it into a semi-automatic system.This can be done in the following methods.

1.Motor and Gears.
2.Rotary Index Table Mechanism.
3.Special mechanism with Pneumatic cylinders.

A. Motors and gears:

Here a motor controls the rotation of the bottom arm that is connected to the gears. The gear that is connected to the shaft of the motor drives the gear that is connected to the frame. Sensors are connected to all the screen frames which is connected to the microcontroller programmed with a condition that when all the sensors has no signal the motor should run and even a single signal from a sensor will not allow the supply to motor. Both forward and reverse movements are possible and can be controlled using a pedal.

Advantages:

- Smooth operation.
- Good accuracy.

Disadvantages:

- High cost.
- If any failure it costs high replacement.
- Stepper motor can't be operated on heavy load.

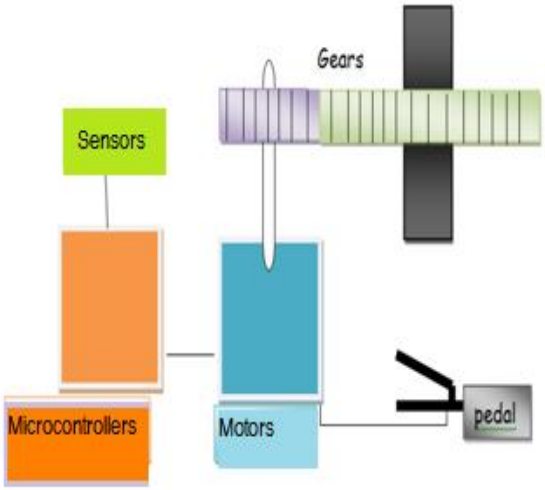

Fig.3 Motor and Gear setup

B. Rotary Index Table Mechanism:

A rotating motion is transformedto a continuous step movement of the output link or shaft by Indexing mechanisms. This mechanism is called **Ratchet and pawl mechanism.**In a ratchet device, linear or rotary motion is allowed in only one direction. It finds application in rotary machines to index pneumatic operated indexing tables.Ratchetsconsist of a gearwheel and a pivoting spring loaded pawl (lever like) that engages the teeth. The teeth which is also known as the pawlare placed at an angle in a mannersuch that when the teeth are moving in a direction the pawl moves in between them.The spring takes the responsibility to force pawl back into the depression between the succeeding coming teeth. Also ratchet mechanism is based on a wheel that has teeth cut out of it and a pawl that follows as the wheel turns. The ratchet wheel is allowed to turn in only one direction either in clockwise anticlockwise. There is no mechanical interlocking between the ratchet and the pawl so they are easy to set up. If the table is heavy when they are disengaged, the table may travel beyond its limit. This system also requires less maintenance. [5,6]

Advantages:

- Smooth operation.
- Easy to understand
- Moderate cost
- Easily repairable

Disadvantages

- Clearance problem while breaking
- Reverse operation needs an additional setup

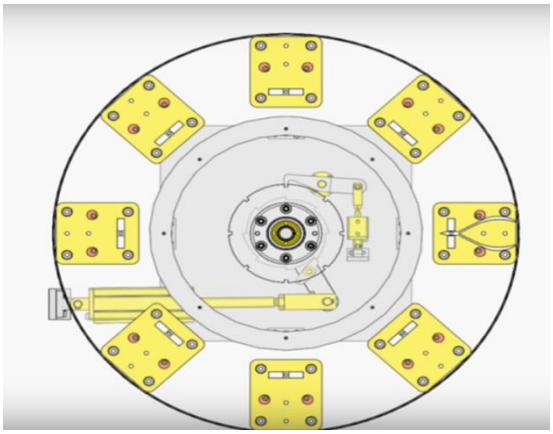

Fig. 4 Rotary Index Table Mechanism

V. PROPOSED SYSTEM

The above mentioned two methods have its own limitations in case of cost, load etc.,so a special mechanism is required in order to reduce the limitations of the existing systems.

C. Special Mechanism With Pneumatic Cylinders:

In this method a octagonal plate is provided in the bottom where a kind of indexing plate is fitted to it. This setup is fixed to thebush of the top frame. Thiscan be used for both forward and reverse rotation. Four pneumatic cylinders are placed in the lower frame. Two pneumatic cylinders are placed for providing forward and reverse rotation. The other two for positioning (stopper/break).The proximity sensors are connected to the top arm, so when they are not sensed the supply is given to the cylinders and it pushes the plate and so the rotation takes place. After 2 sec the positioning cylinder works to stop the rotation. Reverse rotation is done when required. The whole setup is controlled by a pedal.

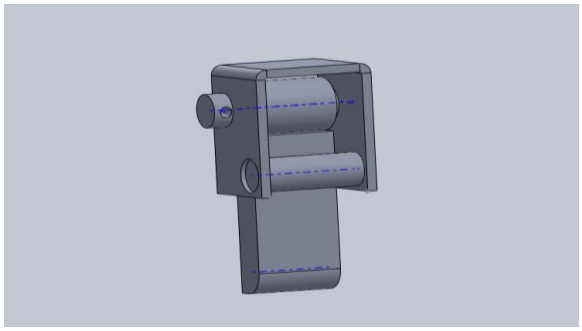

Fig. 5 Indexing plate

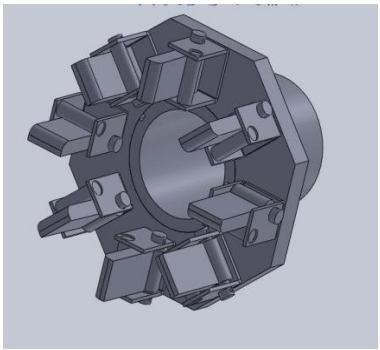

Fig. 6 Assembly of Mechanism

Fig. 7 Real time assembly

D. Bearing:

Bearing is a tool that enable the machine to rotate or move linearly. It reduces friction between themoving surface and the bearing surface e. The bearing is designed in such a way that the moving part can move freely or rotate freely around a fixed axis. One important function of bearing is to provide a required movement by minimizing friction. These are divided according to the operation type, based on the movements, or to the directions in which the loads are applied to the parts. Here two types of single row tapered roller bearing used in the machine with the series number 32212 and 32309.

Dimensions for 32212:
Bore:60 mm
Outer diameter :110 mm
Width :29.75 mm
Dimensions for 32309:
Bore : 45 mm
Outer diameter : 100 mm
Width : 38.25 mm

Fig. 8 Taper roller bearing.

E. Pneumatic Cylinder:

Pneumatic cylinders are also known as air cylinders. They are mechanical devices in which the compressed gas is used to produce a force in a reciprocating linear motion. They are linear actuators to provide a linear movement with the help of compressed air.In pneumatic cylinders, there is a piston as a disc or cylinderand It is the function of piston rod to transfer the developed force to the object to be moved. As gas is used as operating fluid, leakage from a pneumatic cylinderand polluting the surroundings are avoided.It makes pneumatics more lookedfor technology where cleanliness needs to be maintained. So, when to do printing on the fabrics, using pneumatic cylinders are opted. [7-9]

Specification:
Bore Diameter :32mm, 50mm
Stroke length : 100mm, 200mm

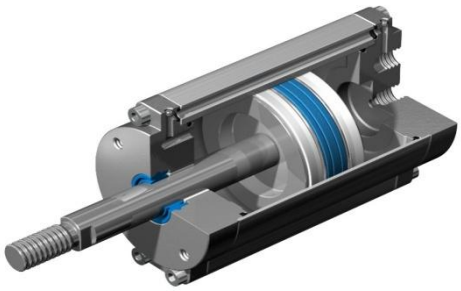

Fig 9. 3D model of a Pneumatic Cylinder

F. Solenoid Valve:

To operate valves electromechanically a solenoid valve is the best option. The electric current through a solenoidcontrols this valve. Here, the electrical energy is converted into mechanical energy which in turn opens and closes the valve. Spring loaded mechanism is present inside the valve. A 5/2 solenoid valve is used for to and fro movement. The solenoid valves are connected to the PLC.

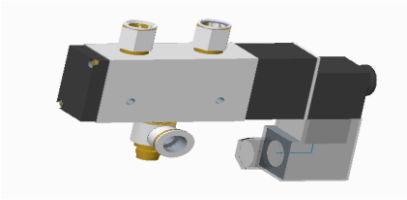

Fig. 10.Solenoid Valve

Specifications:
Voltage : AC220v
Range : AC187v – AC253v
Frequency : 50-60 Hz

G. Programmable Logic Controller (PLC):

In this semi-automation process, Delta PLC DVP-PS01(24V power supply), DVP-12SA PLC ,DVP-16SP (Extension module) is used to control the whole working process. The use of PLC helps to reduce the manual process with the help of solenoid valve, proximity sensorsetc. Both the solenoid valve and proximity sensors are connected to the PLC output module.PLC consist AC 230v relay which connects normally open and normally closed. PLC relays and wires are fixed inside the control panel for safety purpose. Program can be uploaded and downloaded from computer to PLC by using RS232 communication cable.

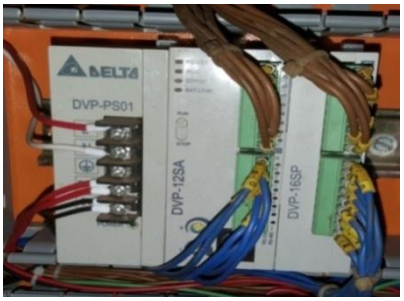

Fig. 11 Real time PLC

VI. DESIGN CALCULATION

PNEUMATIC CYLINDER (32 x100):
Minimum pressure applied in the pneumatic cylinder (p) :$2x10^5 N/m^2$
Bore Diameter (D) : 32 mm
Stroke length(l) : 100 mm
Area of the pneumatic cylinder (A) : $(3.14/4*(D^2)$
: $(.785x.032^2)$
Area: $8.0384 \times 10^{-4} m^2$
Force exerted in the piston (F) :Pressures applied x area of cylinder
Force : $(2 \times 10^5 N/m^2)*$ $(8.0384 \times 10^{-4} m^2)$

F: 160.68 N

For 1 kg weight lift, the force required is
Force = m x a
= 1 x9.81 = 9.81 N
And the pressure required for one pneumatic cylinder to lift I kg is given by,
Pressure, P = Force/ Area
= 9.81 N/8.0384 x 10^{-4} m^2
= 12203.92 N/m2
= 12203.92 pa
Pressure = 0.1220392 bar
Maximum load in the cylinder = F / a
= 160.68 / 9.81
= 16.37KG (Approx)

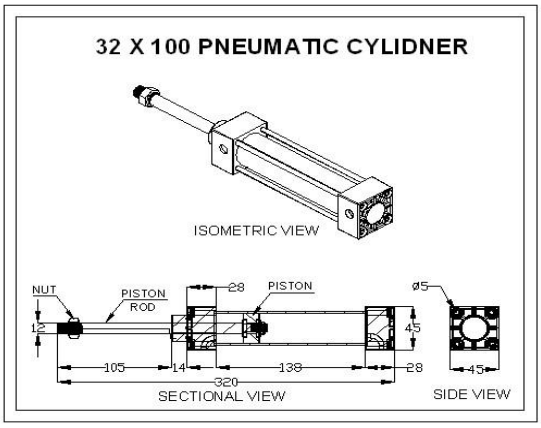

Fig. 12 32x100 Pneumatic cylinder

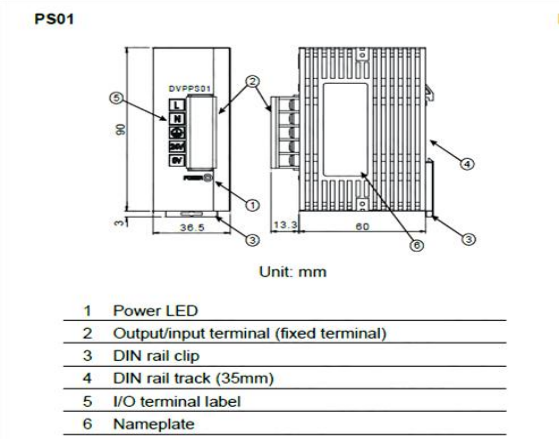

Fig. 13 Profile and Outline

VII. CONCLUSION

Everyone is happy to wear a colorful designed dress but no one is interested to see the workers who are working hardly to provide colorful dresses with great designs. This "Semiautomatic Hoisery Printing Machine" intends to make the labors to work efficiently without any pain and makes them to work comfortably. Thus, it increases the production rate without any skilled labors.

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AUTHORS PROFILE

Ananthi K is working as Assistant Professor in Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil nadu. She completed her BE in Electrical and Electronics Engineering from EGS Pillay Engineering College, Nagapattinam, ME in Embedded System Technologies from Anna University of Technology Coimbatore, MBA in Humar Resource Management from Bharathiyar University, Coimbatore and pursuing her PhD in Power quality improvement in Anna University. Her area of interest includes Power quality imporvement, Renewable Energy, and Embedded systems. She is having 9 years of acadmic Experience. She guided many projects for UG students. She published many papers in National and International Conferences and Journals.

Priyadharshini R is working as Assistant Professor in Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil nadu. She completed her BE in Instrumentation and Control Engineering from Mookambigai College of Engineering, Trichy , M.Tech in Process control and Instrumentation from Sastra University, Thanjavur. She involved in many projects and published a patent. She published number of papers in National and International urnals.

Indirapriyadharshini J is working as Assistant Professor in Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil nadu. She completed here BE in Electronics and Instrumentation Engineeirng from Tamilnadu College of Engineering, Coimbatore, ME in Applied Electronics from Anna University of Technology, Coimbatore. She is currently pursuing her PhD in Anna University. She guided many students for doing projects and participated in many Hackathons. She published papers in National and Inernational Conferences and Journals.

Arun Kumar P M is working as Assistant Professor in Department of Mechatronics Engineering, Sri Krishna College of Engineering and Technology, Coimbatore, Tamil nadu. He completed his Bachelors degree in Mechatronics discipline and Masters degree in Engineering design discipline in Kongu Engineering college . His area of interest are Automation, and Fluid power.

Jaipraba V completed her Bachelor Degree in Mechatronics Engineering at Sri Krishna College of Engineering and Technology, Coimbatore, Tamilnadu. She involved in many industrial projects and published papers in International Conferences. Her area of interest includes Design and manufacturing.