Robotic Applications in Garment Manufacturing: Revival of Garment Industry

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Abstract

Robotic process automation is a software technology that makes it easy to build, deploy and manage software robots that emulate human's actions interacting with digital systems and software. Physical robots may be used in automation, but many robots are not created for automation. Robots are used to automate some physical tasks, such as in garment manufacturing. However, many types of automation have nothing to do with physical robots. Artificially intelligent robots are the bridge between robotics and Artificial Intelligence (AI). These are robots that are controlled by AI programs. Most robots are not artificially intelligent. Up until quite recently, all industrial robots could only be programmed to carry out a repetitive series of movements which do not require artificial intelligence. However, non-intelligent robots are quite limited in their functionality. The applications of robots in fashionable garment manufacturing have seen tremendous infusion of technology in the manufacturing plants. The robots are effectively used in Fabric Inspection, fabric spreading, fabric segregation, cut piece assembly, garment pressing and garment packaging. This present paper deals with an indepth and extensive applications of Robots in apparel manufacturing.

Keywords: *Artificial Intelligence, Fabric segregation, Physical robots, Robotic process automation, Software robots*

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1. Introduction

Automation and robotics are the two terms that are often used interchangeably. Automation is the term pertaining to all the process based on using mechanical processes, computerized software and additional engineered machinery to accomplish those tasks that are usually performed by human workforce. Automation has many levels, ranging from the entirely mechanical to the wholly virtual and also, from very simple designs to the mind-bogglingly complex configurations.

The Robotics is the term related to the process of designing, developing and applying robots to execute plentiful tasks. In addition, Industrial automation relates to the processes of automatising various physical processes using shop-floor robots and their dedicated controllers. On the other hand, Software automation is the extensive use of software to perform the tasks performed by computers. There are abundant categories of software automation as test automation, robotic process automation, intelligent automation, and many others. Robotics engineering refers to the design and development of robots by incorporating software, hardware, sensors and other devices, for quality inspection, assembly, packaging, handling etc [1].

1.1 Robotics as an integral part of automation

The processes that utilize the application and combination of mechanics, electronics and computer based systems to operate and control the apparel manufacturing systems and their support systems is termed as AUTOMATION. It's the use of mechanical systems, control systems and web based technologies to implement suitable control on the apparel production. A robot is the technological advancement concerned with the accomplishment of a dedicated process with the use of structured commands may be combined with automatic feedback control systems to ensure the proper execution of the process. The broad areas of application of automation encompass manufacturing departments and manufacturing support systems. The typical areas to be covered in the automation of manufacturing departments of a garment industry are 3D Body scanning,

Automation in fabric & trim inspection, fabric spreading, fabric cutting, garment sewing, fusing, moulding, welding, garment pressing & packaging, workflow systems, Robots, Programmable Logic Controllers, Automated Geared Vehicles, Art work processes and Computer Integrated Manufacturing (CIM) [2].

On the other hand, the computerization of manufacturing systems is about the reduction of human participation to only supervisory control and elimination of the clerical/manual work carried out by the human assistance especially in the product designing, planning, assisting and product control and process control. The various segments affected by automation in this are MRP (Material Requirement Planning), Lean manufacturing, Agile manufacturing, MRP II (Management Resource Planning), JIT (Just In time), Inventory Management & Handling, MIS (Management Information System), CAPP (Computer Aided Process Planning) and ERP (Enterprise Resource Planning) [3].

Robots are able to fit into the genre of flexible automation due to its unmatchable capabilities of reprogramming, ease of changeovers, efficient and error-free task accomplishment.

1.1 History of Robotic Technology Evolution & Developments

The robot history is the amalgamation of fiction and real time technological advancements. The first modern automation was invented in the year of 1810 by a German artist Friedrich Kauffman. The initial prototype of this robot looked like a soldier equipped with automatic bellows to blow a trumpet. “Robot” term came from the Czech literature that meant “forced labor.” They looked like humans but instead of metal, chemical batter was used to produce them. In the 1950s, George Devol designed a revolutionary “Unimate”, a robotic arm device that transported die castings in a General Motors plant in New Jersey in 1961. In addition to it, by mid-1950s, the German firm “Kuka” developed an automated welding line for appliances as well as a multi-spot-welding line for Volkswagen. After this, by 1970s, Stanford University designed the “Standard Arm” to be used for small part assembly for the incorporation of touch and pressure feedbacks. In 1973, Kuka had introduced the six-axis robotic arm, which became an industry standard after its commercialization [4].

At the same time fully electrical systems based robots began to emerge in the Industrial arena. By 1970s, many new endeavors were tried for Robots as a microprocessor-controlled robot, increased ability to handle higher payloads (ability to lift high weights), a sensor-based welding robot, development of the SCARA arm and PUMA robot for small parts assembly, hand on trials of basic robot programming languages & Speeds and capacities were also worked upon tremendously. In 1990s, first packaging robot was innovated with pure robot controls and synchronizations. The onset of 21st century had completely revolutionalized the robot technology with the invention of a handheld teach pendant, robot multi axial synchronization, Automated geared vehicles, Collaborative Robots (COBOTS) and Autonomous Mobile Robots (AMR) by 2010. The progression of the Robotic developments is depicted in Figure 1

Figure 1 - Evolution and development of Robots from the infant stage to the modern forms

1.3 Robotic applications in the garment manufacturing processes

The requirements of the Robots for the Garment Industry are entirely different from those required by the other hard core manufacturing plants due to the complexities involved in the assembly and handling of textile materials in raising the garments. The major challenges implicated in the infusion of the Robots in the garment manufacturing include the use of extremely limpy, unstable and delicate raw materials as fabrics, threads and notions; high speed processes; minuscule labor intensive processes; huge diversity and variability in the raw materials in each lot and requirement of human intelligence and intervention in all the processes to some extent.

These challenges posed by the garment Industry had deferred the use Robots in this specific segment of production Industry. But with the advent of Science, Engineering and Technology, even the Garment Industry hasn't remained unscathed for the Robotics [5].

The design of Robots for the garment manufacturing has always required different class of manipulators and its subparts, control systems and driving mechanisms to suit the requirements of the variable garment making steps just as movable platform based manipulators are always preferred for the material transfer within a department; use of combined pneumatic and hydraulic drives for assembly of garments; variety of sensors as touch, tactile and vision systems are the most common preference for fabric spreading, cut fabric segregation and seaming of cut parts; special designs and materials for grippers & end effectors based on the clamp, pinch, pins, vacuum, air jet blow principles are devised to suit the raw material variables as Materials type, Weight per unit area, Thickness, Wettability, Stiffness, Hairiness, Permeability, Friction, Elasticity and the ability to keep an electric charge [6].

2. Robots in Fabric Spreading

In this area, Robots are used for the identification of the fabric defects, shade matching of different plies, adjustment of ply tension during the spreading process. This is made possible by employing different types of touch, tactile and vision sensors to the manipulators. The major challenges posed by this process line to the use of Robot is that these programmed machines are not able to distinguish various fabric weaves and patterns or other types of fabric details during ply matching as shown in Figure 2.

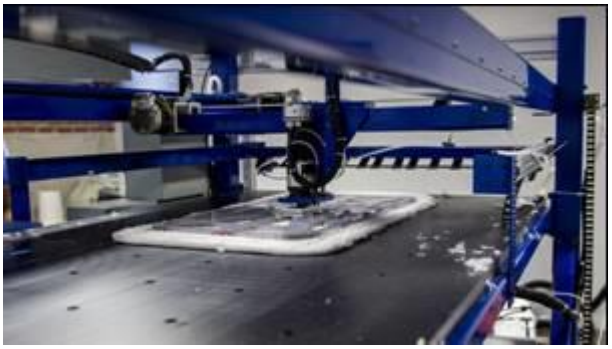

Figure 2 - Spreading process with the interface of Robots

3. Robots in Fabric Cutting

Robots are used with two main perspectives in the garment cutting room. In the first scenario, the robotic arm is equipped with the cutting aids as drills at the position of its manipulator grippers. This will eliminate the need of manual drills for the cutting room. In the second perspective, the Robotic arms are interfaced with the cutting tables to sort the cut pieces from each other as front, back, sleeves, pockets, collars etc. either bundling cum ticketing or for UPS production lines to be transferred to the next production processes as can be seen in Figure 3. In this, the exact position of each cut part and its suitable picking points should be programmed along with other details as decisions have to be taken on what is to be picked and where is it required to be delivered. Highly sophisticated tactile sensors are required to accomplish this task. The clamp and pinch type of mechanical grippers can be chosen with the two sided attraction and of handling and mechanical gripping principles. Clamp grippers are successful in fabric ply picking and also ply separation [7, 8].

Figure 3 - Fabric cutting with the specialist robotic arms

4. Robots in Garment Assembly

The most complicated automation and robotics are used in sewing section of the garment industry. This is due to the reason that sewing process employs very small and yet complex tasks for garment assembly. Also, the variety of tasks, machine settings according to the raw materials and raw material composition further makes the integration of Robots more challenging. There are numerous approaches in which robots are used in the garment assembly.

In the first approach, Robots are used in **material handling** between the sewing processes. In the second approach, **Sewing robots** as "***SEWBOTS***"– Robotic sewing- It is the advanced technology that is based on the combination of machine vision systems and pneumatic robot drive systems to maneuver the fabric compositions upto and from the needle with greater speed and accuracy than humans can achieve. It is commercially applicable in the automated production of different types of floor coverings as bath mats, carpets, rugs, automotive textiles, medical textiles, bath towels and several categories of 3D composites. The fabric compositions are fed by soaking them in highly diluted liquid polymers solutions to turn them into thermoplastic hard composites that robots can easily handle. The sewing machine assembles the stiffened compositions of fabrics to produce a neatly seamed product. After sewing the fabrics, the polymers are washed off with running water without the need of detergents (Figure 4). Sewbots suffers from a few limitations as fabrics like wool or leather can't be easily used with this technology as they can lose some of their properties while getting wet [7, 9].

In another approach, stitching robots are equipped with the sewing zones to assemble the preformed composites for automotives, as earlier flat sewing techniques are not suitable for these preformed 3D auxiliary automotive parts due to their large dimensions. In this interface, the workpiece is fastened on to the fixation devices and the stitching heads are carried along the seamline of the resting workpiece. One side stitching is only performed in this mainly with single thread chain stitches. Other approaches of robots include the integration of robots with already existing sewing units.

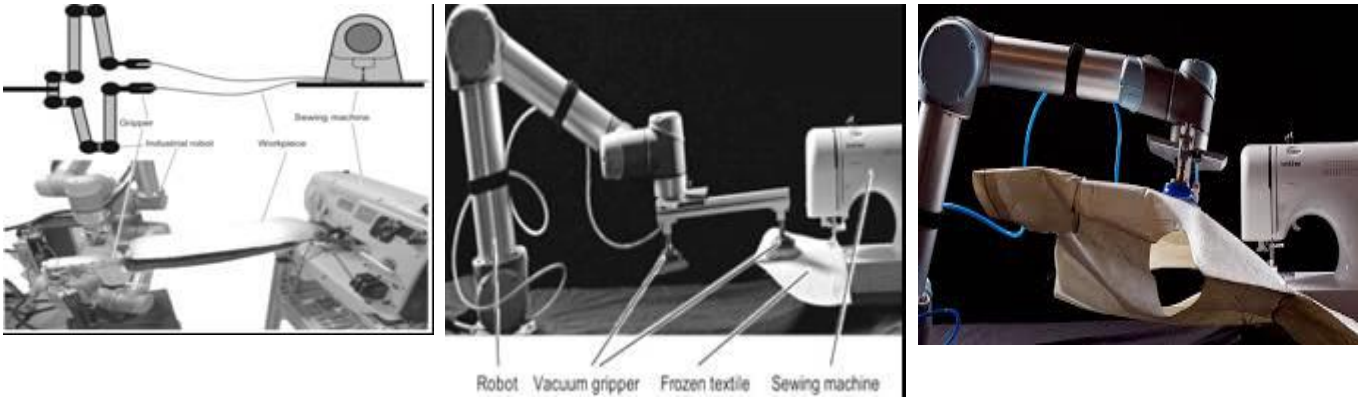

Figure 4 - Garment Assembly by employing Sewbots

5. Robots in Garment Packaging

In addition to manufacturing, machining and assembly; robots can be used for garment packaging, cartoon sorting and order picking. Variable types of grippers and gripping principles are employed for the robots to order pick and package the ready garments as per the packaging materials. Clamp type of grippers is the best choice for the garment packaging robots interlaced with the packaging workstations for garment sorting, picking them at the correct positions by using two attachment points with the options of changing the distance between them to handle wide range of textile materials as shown in Figure 5. In addition to it, specially designed Pinch grippers are also used to pinch the textile materials using soft tipped fingers while packaging. The design of this gripper has followed the engineering design principles with low cost, non-destructive, minimum DOF and cycle time [10].

Figure 5 - Garment folding and Packaging by dedicated Robotic arms

The leading manufacturers of robotic assemblies providing solutions to the garment industries include Siemens Technology in association with Sewbo Inc., Bluewater Defense and University of California at Berkeley; Interface Technologies, Hickey Freeman; Yaskawa Electric Corporation (Japan); Universal Robots (Japan); Universal Robots (Japan) and Midea Group (Kuka of Germany).

6. Conclusion

The applications and success of robots in the garment industry was long awaited till 21st century. In the current scenario, most of the segments of the garment industry have been able to employ the robot technology to the pinnacle of success. But the newer face of the Industry have brought many provocations as it has led to unrest among people due to the reduced requirement of the labour, thus leading to increased unemployment, need of only literate and technology compliant workforce, massive initial capital and maintenance investment, lacking creativity and many more. Yet the changing implications of automation and robots in the current fashionable garment industry will surely give innovative horizons to the manufacturers, designers and consumers as well.

References

[1] https://www.themanufacturer.com/articles/robotic-process-automation-rpa-for-manufacturing/

[2] Gries T and Lutz V, "Application of robotics in garment manufacturing", Automation in Garment Manufacturing, The Textile Institute Book Series, 2018, 179-197

[3] https://govisetech.com/automation-the-future-of-fashion-industry/

[4] Wilson M, Implementation of ROBOT SYSTEMS- An introduction to robotics, automation, and successful systems integration in manufacturing, Elsevier, 2015

[5] Malik T and Parmar S, "Application of Robotics in Textiles", https://www.fibre2fashion.com/industry-article/6590/application-of-robotics-in-textiles, Sep 2012

[6] Koustoumpardis P and Aspragathos N A, "A Review of Gripping Devices for Fabric Handling", International Conference on Intelligent Manipulation and Grasping, July 2004, 229-233

[7] Jindal H and Kaur S, "Robotics and Automation in Textile Industry", International Journal of Scientific Research in Science, Engineering and Technology, 8, 3, 2021, 40-45

[8] Michelini R. C and Razzoli R. P, "Robotics in clothes manufacture", International Journal of Mechanical Engineering and Applications, 1, 1, 2013, 17-27

[9] Srikrishnan M R, Parthiban M and Viju S, "Robotics: A Hi-Tech revolution in Apparel Manufacturing & Technology, International Journal of Textile and Fashion Technology, 1, 1, 2011, 11-20

[10] Kiron M I, "Automation and Robotics in Apparel Industry", https://textilelearner.net/automation-and-robotics-in-apparel-industry/