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ROBOTICS: A HI-TECH REVOLUTION IN APPAREL MANUFACTURING & TECHNOLOGY

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ABSTRACT

For many years, the application of automation has resulted in significant benefits to industrial world. High levels of consistency and precision in work pieces and high levels of repeatability and accuracy in manufacturing equipment have been required. Economic Justification can be shown only for large quantities of production. To achieve this, we need adaptive manipulation systems having some Artificial Intelligence. Keeping the concept in mind, an employee in 1970s of the Japanese Yasukawa Company developed a mechatronic system named industrial robots. Today mechatronics is often to be synonymous with robotics. Since computer plays a key role in robotics, the word robot has a specific meaning and it has an emphasis in industry specially related to textiles.

1. INTRODUCTION

Robots are being preferred in the fashion industry for tailoring and stitching clothes because robots are easier to program, more efficient, less troublesome and work at almost zero error rate.

Standard measurements have been established and the job of cutting the fabric has been handed over to machines. The fabric is fed into the machines and is cut in appropriate pieces. This is then handed over to the stitching department. Once this process is completed, the parts of the entire dress have to be stitched together and finishing touches have to be made where required. If there is scope of something going wrong, it is during the stitching and finishing process because this is where manual labor is involved.

Use of robots in stitching improves efficiency and accuracy. However, it also raises costs. The cost of building robots designed for this task and maintaining it can be very expensive. On the other hand, textile companies make use of cheap labor available in Asian countries like China, India, vietnam etc for stitching. The labor works for very low wages as the company simply has to comply with minimum wage rate of the foreign country.

There are instances where products that have been stitched for just $1 are sold for $100 in American markets. Needless to say, this offers a huge profit margin for the company. However, there is growing realization that this approach is unethical and should not be encouraged. The main criticism is that the textile companies spend more on their advertising campaigns than on paying the most important component of the labor force.

With robots taking up this job, even this employment avenue for citizens of developing countries is coming to an end. On the other hand, the fashion industry looks forward to creating more designs in an automated manner without any difficulty.

The need for advanced automation in textile manufacturing exists because of increased international competition. One area of manufacturing affected by this competition is apparel assembly. The current manufacture of textile goods from cloth requires skilled manual operators. The application of flexible automation, such as industrial robots and machine vision, to the textile industry has not progressed compared to other industries [I]. Robot/vision systems have the promise to enhance some operations associated with fabric assembly.

Most industrial robots are used in simple, repetitive tasks such as packaging and are capable of manipulating rigid, not flexible, material. The integration of robots with machine vision is still chiefly in the experimental stage. Industrial robots are generally located in well structured manufacturing environments. Fabric assembly involves complex, loosely structured operations in which human vision and manual dexterity are essential. The utilization of robot/vision systems in fabric assembly has not advanced because of task complexity, high initial costs, and technological limitations.

1.1 Classification of Industrial Robots

Industrial Robots may be categorized by their geometries or by their capabilities. The degree of flexibility of control like most other capabilities of robots is directly related to the sophistication of the software within the controlling computer.

It is classified into three categories-

I. Mechanical Stop Control Robots
II. Servo Controlled Robots
III. Continuous Path Control Robots

(i) Mechanical Stop Control Robots

Here an actuator moves a joint until the joint runs up against a mechanical stop. Programming of such robots is typically done with a screw driver although some flexibility may be built in by using several selectable stops on each axis.

A Typical example is the older programmable sewing machine where the motor slowly rotates the complex cam into the machine and the eccentricity of the cam displaced the needle the appropriate amount.

(ii) Servo Controlled Robots

It is a point to point programming in which the actuator may be controlled in such a way that it can stop at any point along its path. It is commonly used in industrial environments in which the working volume is relatively empty and in which the co-ordination with external moving objects such as conveyors is not required.

(iii) Continuous Path Control Robots

Here the robot may be required to interact continuously with its environment in more complex work environment. Some typical examples are welding, spray painting and performing operations along a moving conveyor.

1.2 Components of a Robot System

It can be explained either from a physical point of view or from system point of view. It is important to note that the same physical component may perform many different information processing operations. Likewise, two physically separate components may perform identical information operations.

(a) Actuator - A robot system contains six actuators. Since six are required for full control of position and orientation.

(b) Sensor- To give information regarding the position and possibility, the velocity of the actuator, to control on it.

(c) Computation Objects- It requires a micro-computer to perform work place analysis, servo, kinematics and dynamic operations. In addition it should perform supervisory operations such as path planning and operator interaction.

1.3 Tactile Sensing of Robots

Touch information is obtained through physical contact of the sensor with a target object. The sensor includes all the major components of a tactile sensor system.

They are-

1. Touch Surface
2. Transduction medium
3. Structure

4. Control / Interface.

1.4 Characteristics of Tactile Sensor

Mode Points to the direction of sensor response relative to the touch surface. Basic modes are normal and shear. Further meaning of mode establishes whether the response is Primary or Gray Scale. Some sensors measure the combined effects of all the forces and torques imposed on the touch surface. Information is delivered in terms of force and moment components related to the six degrees of freedom for a particular coordinate system. Such sensors can be called as Force- Torque Sensor or a Vector Sensor.

Resolution relates to several aspects of the sensor.

i. First is the spatial resolution
ii. Second is at the individual site and
iii. The Third is in the time domain

The total range depends upon the dimensions and configuration of the touch surface as well as the performance of the control and interface electronics.

1.5 Tactile Sensor Styles

The tactile sensor styles are determined by the manner in which the sensor is used and also by the sensitive fields. There are several general classes of style –

1. Gripper mounted
2. Work surface mounted
3. Large field and Small field

The large field and small field designations are two subclasses that would fit either within the gripper or work surface mounted styles. Large field sensors are likely to be work- surface mounted.

2. Robotics in Apparel Manufacturing & Technology

(i) Recent Development in the Robotic Stitching Technology

The stitching of several textile partial structures whose fiber alignment is optimized according to the stress lines in the non-impregnated state is gaining increasingly attraction in the composite industry. An additional essential part of this strategy is the direct reinforcement of the FRP components for the improvement of their mechanical characteristics by inserting reinforcement of fibers in Z-direction. Although stitching as a technology for connecting two or several individual textile parts together has been well known for a long time, the previously known stitching techniques are not efficient or cannot be applied in the majority of the cases, mostly due to the large dimensions and the three-dimensional structure of the FRP components.

To overcome stitching technique limitations the ALTIN Nähtechnik has developed a technology where stitching heads, which have been especially designed for the processing of FRP performs, are continuously carried along the seam line of a resting work piece by a robot. During stitching the work piece is fastened onto special fixation devices.The limitations of the access to the preforms due to the necessary fixtures have been overcome in the majority of the applications by the availability of one side stitching techniques. Since the work piece has to be accessed from one side only, stitching of complicated structures is no longer limited by the design or the size of the stitching machine. The possibility to mount the manipulator arm to a rail or a gantry system has also eliminated the limitations in the stitching area. Besides the conventional double lock stitch two different techniques for one side stitching are available. The two needle one side simple chain stitch head produces a double line seam; the work piece is penetrated by the stitching thread at different inserting angles.

Especially for the local reinforcement of FRP a tufting head can be used which allows to insert the stitching thread under various angles and at lowest possible thread tensions. To make optimal use of the well known advantages of NC-operated robot systems, a wide range of control features is available including an offline programming systems which aside from generating the robot program is also capable of conducting feasibility analyses and simulations.

(ii) The Stitching Robot

The robot-supported three-dimensional stitching system described here is based on the principle of a continuous relative motion between the stitching head fastened to a robotic arm and the stationary work piece held by a work piece fixation device. This system (see fig. 1) can be applied to all stitching types which are used for the processing of FRP preforms. A major advantage is that the stitching machine does not need work piece feed items known from conventional stitching machines. Thus, careful handling of the work piece is ensured and structural damage caused by the transport system can be prevented. A precondition for the continuous relative motion between the stitching head and the work piece is that the needles have no sideward movement in seam direction while they are in contact with the material to be stitched.

This is guaranteed by a mechanical differential gear, the so called transverse slide drive. The vertical upward and downward movements of needles occur concurrently to a back and forth movement in seam direction. For this purpose the moving axles of both stitching tools are integrated in a common framework. This framework is moved against the positive seam direction as long as at least one needle is in contact with the work piece. The velocity of this movement corresponds to the seam building velocity. When neither of the two stitching tools is in contact with the work piece, the transverse slide movement in seam direction takes place.

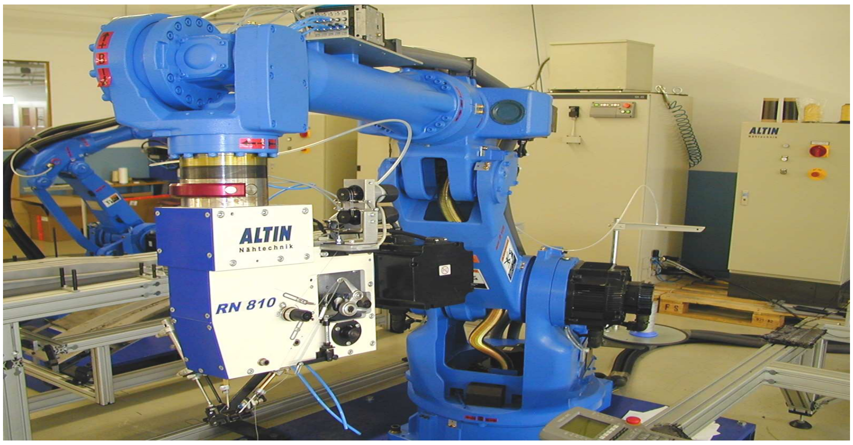

Figure 1 : Robotic Stitching System

(iii) Double lock stitch

The main aspect to be considered when stitching FRP semi-finished material is the handling of geometrically more complicated, usually three-dimensional structures with simultaneous large spatial expansion. Technically the stitching of these types of structures is difficult if conventional stitch types are applied. For instance the two thread lockstitch requires access to the work piece from both sides. A double lock stitch head and a typical application for a double lock stitch are shown in figures 2 and 3.The existing limits of the well-known stitching techniques can be overcome by a technology where access to the work piece is only necessary from one side. The ALTIN Nähtechnik has developed two separate stitching technologies, the one side stitching system, known as the OSS system and a tufting system.

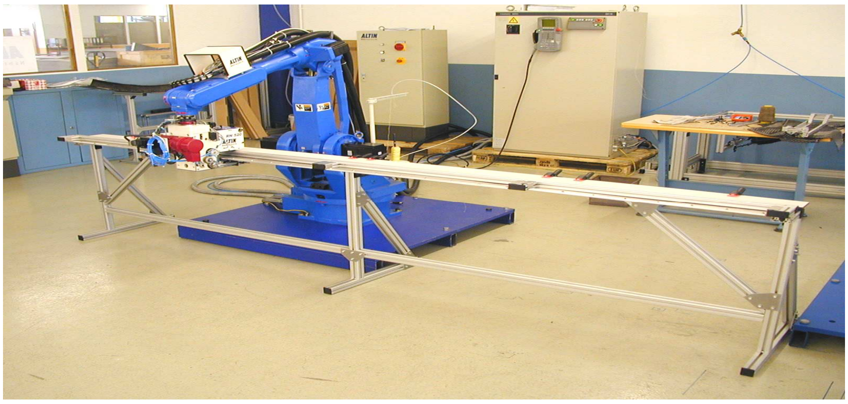

Figure 3 : Double Lock Stitch Head in Operation

The core of this system is a robot-guided special stitching head (see fig. 1). Its stitch formation mechanism is based on the principle of the simple chain stitch. This stitch is produced by two stitching tools. Both tools are manipulated from the top side of the work piece, so that it is not necessary to arrange any stitch formation element underneath the work piece. Only free space for penetration of the needles has to be taken into consideration.

The inserting angles of the stitching tools are 45° and 90°. Although the operational principle permits a variation of these angles within certain limits, these angles were determined to be optimal. The reason is that the stitching angle determines the final position of the stitching thread in the FRP structure.

3. CONCLUSION

In recent years, studies on industrial robots for manufacturing applications tend to be less and less active while most academic researchers are inclined towards non-manufacturing applications. In consequence, applications for industrial robots have not varied much from the conventional handling, assembly, welding and painting. Some researchers even consider industrial robots as mature or old-fashioned technology since they only take notice of such applications. Current industrial robots are generally used for simple repetitive tasks of low added value, which substitute for unskilled factory workers. Such robots have value only if they are less expensive and used in mass production to achieve higher speed and yield. However, mass production is not the only form of operation in manufacturing industries. There are various types of manufacturing crafts that only experienced artisans can perform. Such crafts are usually of small quantity but can create high value added products. A new market for robot technologies might develop if robotics researchers were attracted to such areas, utilizing the potentials of accumulated techniques, e.g. sensory feedback control, to achieve valuable application tasks for which even expensive intelligent robots can be worthwhile.

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