

New Tracking Technology Enables Robots to Carry Out New Tasks on Composite Parts and its Molds

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ABSTRACT

Composites are becoming a common material for aero structures; that means new manufacturing processes with new problems and new challenges have to be solved.

Our engineering team (EiNA) has recently developed and patented a new end effector for Robots that is able to track any kind of surface (even if the surface is moving, swinging, bending....which usually happens when working with big composite parts.) and carry out the required task.

This new feature has enabled robots to automate manual tasks that hadn't been automated yet like sanding, cleaning, polishing, applying solvents, applying release and cleaning agents not only on aero structures but also on its molds.

The solution is based on a set of sensors, a postprocessor which runs a software and a mechanical compensation gadget. As a result, we can keep all the parameters of a process fully under control even if the part we are working on is not stable and it moves swings and bends.

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INTRODUCTION

The aerospace market is one of the largest and arguably the most important to the composites industry. Commercial aircraft, military craft, helicopters make substantial use of composites,

It means the manufacturing processes are quickly changing, and new tools are necessary. New processes require new automations, and EiNA decided to invest resources and time to solve some of those new tasks.

THE CHALLENGE

Aero structures are parts with special features which make them special in terms of handling. They easily swing, vibrate, bend or move. And even if they are supported with nests or they hang from a crane they bend because of their own weight, which means theoretical CAD geometry does not match the real form of the parts.

On the other side EiNA had a broad experience on automations where there are either CNC like systems or anthropomorphic robots, which have a very high repeatability (0,05mm in the case of the robots and a

hundred of mm in the case of CNC) and a reasonably good accuracy. Nevertheless such figures are useless if the part behaves as big composite parts do; the exactly location of the part is unknown, and the simple action of whatever tool on the surface will modify the position of the surface or would make the part move.

THE SOLUTION

There are only two possible solutions, either the part is forced to come back to a known position and form with the help of complex fixtures like riveting machines among others do, or a tool, able to adapt itself to whatever movement or deviation of the part, and follow up the evolution of the surface is necessary.

EiNA has chosen the second solution, proposing a head intended for being coupled to a robot and which is capable of continuously controlling the position of the tool, adapting it with respect to the working surface, allowing operation on that entire surface in suitable conditions to obtain an efficient work, without the need of establishing a specific programming of the surface.

The solution has 2 main components, hardware and software. As for Hardware:

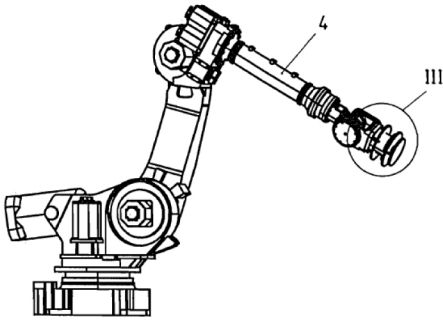


Fig. 2.

The head comprises a plate (1) which is attached by means of a complex force sensor (2) to a support (3) for the coupling to a robotic arm (4).

The plate has a ball joint or similar system (5) in the center on which the tool (6) is attached. It enables the tool to vary its position up to an inclination of 15 degrees or even more, and adapt its position to the surface.

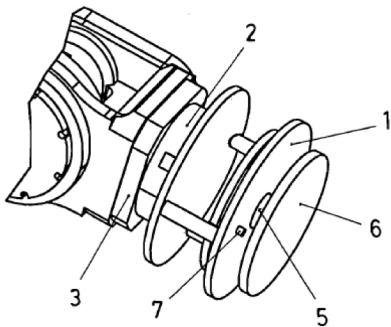


Fig. 3.

Distance sensors (among others) which control the position of the tool from different points with respect to the mentioned plate (1) are also located in the plate (1).

Thus when the tool is supported on a working surface, force sensors (2) control the force on the support, generating information that is applied to control and reprogram the trajectories or the robotic arm (4), modifying the thrusting force thereof so that the supporting force of the tool on the surface is maintained under control.

In addition, the distance sensors (7) control the position of the tool, generating in turn the necessary information that is also applied to control the robotic arm (4), which based on given information modifies its positioning so that the head is maintained perpendicular (or with the selected angle) with respect to the surface.

The same concept of control also applies for tools (8) that not have any physical contact with the surface, such as a laser, a thermographic camera, etc..... as shown in [figure 4](#).

In this case the tool (8) not contacting the working surface is arranged on the support (3) coupling with the robotic arm (4). Distance sensors (9) on that support (3) control the position of the different points with respect to the corresponding working surface (10). The information is used to modify the robot's trajectories, so the tool strikes with the right angle on the surface (10).

As for Software, EiNA has developed a post-processing system that is able to process the info given by the sensors, and compare the information with 2 kind of database within milliseconds:

- The system compares with the CAD file of the surface.
- The system compares with the information received from the sensors on similar situations in the past.
- The system compares the current trajectories of the robot with the trajectories of the robot the last time the same surface was performed.

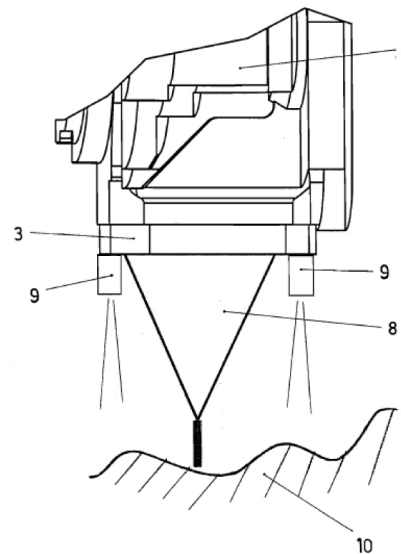


Fig. 4.

As a result, the head does not only keep the position and the applied pressure, it is also able to foreseen failures and detects unexpected features of the surfaces.

Technology has been worldwide patented. US 13/055569

NO HYSTERESIS

Even if EiNA has developed a quick response software, the response of the system is not immediate. Electronic response time, sensor time and robot response time have to be added and taken into account.

Our test have shown the head deviates its position with regard to the surface till 2,5 degrees in the worst scenario