

Sky's the limit Automation keys efficient production



Robots are helping German researchers to keep production prices of carbon fiber reinforced plastics down.

The materials used to make modern-day aircraft consist of more than 50 percent carbon fiber reinforced plastics (CFRP), primarily because these materials are extremely strong and lightweight. This is a growing trend due to the ever-increasing demand for lighter aircraft, but it is quite costly. "The production and assembly of components still involves a high amount of manual labor and is therefore very expensive," says Dr. Dirk

Niermann, head of the Fraunhofer Project Group Joining and Assembly FFM at the large-scale research center CFK Nord in Stade, Germany.

He and his staff hope to change this with their research. Fraunhofer FFM is one of the main tenants of the approximately 8000-square meter research hall. Since 2010 the researchers have been working together with partners from industry and science, as well as with experts from the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, on a forward-looking solution that will enable users in the aviation industry to handle big CFRP parts with a higher degree of automation in the future.

Manufacturing automation

“Automation is common in the aviation industry but so far mainly specialized machinery has been used, designed for a specific operation on a specific component,” says Niermann. As these machines are generally heavy, expensive and not very flexible, the need for low-cost, versatile solutions in the form of modules, which can be quickly configured, is great. The aim of the research in the CFK Nord is therefore to provide universal automation technology available at short notice that can be quickly converted to deal with other components and assembly situations; a technology that is capable of executing tasks previously carried out successively and simultaneously.

Robots are an important element in this development and are already in use elsewhere, such as the automotive industry. In this sector the necessary processes are accurately determined and set down to a fraction of a millimeter. “However, this solution cannot be directly transferred to the aviation industry,” says Niermann, “because aircraft components have much larger dimensions and vary in their geometry from each other.” Therefore, it is not necessarily crucial that a robot continuously repeats high precision movements for the processing of large CFRP components. Rather, positioning accuracy must be significantly improved. It is a challenging task, as the robot controller is only notified of the exact tool path during the running process. Therefore, one of the most important approaches of the researchers is the automatic adaptation of robotic processes to various component geometries and positions. “On the one hand, we require a detection accuracy of the component dimensions of a few hundreds of a millimeter,” says Nierman. “On the other hand, the robot controller must be able to set the appropriate angle for the five, six or seven axes of each robot from ever-varying dimensions and to compensate for accuracy-mitigating factors.”

At Fraunhofer FFM, an ABB IRB 6660 operation processing cell is on the job. The robust robot has been specifically designed for difficult, high-performance applications and symbolizes high precision and reliability. ABB’s Force Control Technology is a significant contributing factor, too. The force created during milling is recorded using a 6D force and torque

sensor and regulated by adjusting the feed rate accordingly, to ensure a consistent product quality. Quality is a decisive criterion for the processing of large CFRP components; for example, the window hatches of a body part are cut out at the end of the process chain, where the components already have a high economic value. Milling has distinct advantages over other processing methods, such as sawing, because it allows for higher contour flexibility.

To achieve good processing results, however, the precise measurements of large components up to 20 meters long need to be determined. This can be done quickly and accurately using a laser. The measured data is transferred to the robot controller and then converted into commands for the individual positions of the robot axes. Using the systems and applications developed in Stade it will be possible to implement a practical processing line of large CFRP components in the medium term. In the long term, the researchers want to develop online process monitoring and optimization to improve the efficiency of the work processes. ABB will continue to offer its support to help shape these developments.

Software benefits

- Processing of delicate components with a powerful and space-saving industrial robot
- Flexible motion control in real time using Integrated Force Control
- Force Control allows component machining using pre-defined forces or moments

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