MWES MANUFACTURING AUTOMATION

Whitepaper

The Force/Torque System: In Depth Robotic Capabilities

The Future of Automation

Perception of touch can enhance the robot's performance.

The KUKA.ForceTorqueControl is one of KUKA's Hub Technologies. These are packages of hardware and software that enhance the ability of KUKA robots to perform specific applications.

In the case of the Force/Torque package, it gives the robot a way to "feel" the work it is doing. This is useful in applications where the perception of touch (force) can enhance the robot's performance to perform sensitive applications.

Robots without a sense of "touch" are just repeating pre-programed moves, point to point to point. Robots can perform these moves very precisely, but what if you to us a robot in an application where the robot's path must change due to variations in parts, tooling wear, changes in part location? Here, a sense of touch would be beneficial.

Humans use their sense of touch in a variety of ways every day. You feel when you are placing a key into a keyhole, you feel where the light switch is in a dark room, and you feel how hard you are pressing a pencil onto a piece of paper. For a robot without force/torque control these applications would be difficult. A keyhole is not always exactly aligned with the key; a light switch may be at different heights or locations; a pencil may be sharp, dull, or even broken.

In some applications a human uses their touch skills with great ability. Assembly application where parts must be aligned together is one example. There are many applications where multiple parts must be aligned precisely together. Humans can easily do these tasks because they can feel and adjust to the variations in parts to allow assembly. Robots, which can only make repetitive moves, cannot achieve this without a sense of touch.

The Force/Torque package adds both hardware and software to allow the robot to make minuet path adjustments. The combination allows robots to adjust its path and orientation to perform the required application.

The Hardware Used

The hardware portion of this system uses an ATI force/torque sensor. This sensor measures force seen by the tool or part at the end of the robot arm. It measures this force in the X, Y and Z directions. It also measures if any twisting occurs along each axis. This twisting action is torque; which is measured along the X, Y and Z axis. Forces and torques are rarely measured in only one direction but in a combination of directions. Therefore, the sensor measures three forces and three torques.

In the ATI sensor, these force/torque values are measured and converted to digital values, which are communicated to the KUKA Robot Controller via a digital interface. These values are measured every 4 or 12 milliseconds (user selectable). This is done utilizing the KUKA RSI (Robot Sensor Interface) system, which can bring in data from many sources at a very high speed, all while the robot is in motion.

The forces and torque values are used by the KUKA.ForceTorqueControl application software. This software runs in the KUKA robot controller to make minuet adjustments to a pre-programmed path. These adjustments use specific algorithms to optimize the process you want to perform. This algorithm is selectable by the robot programmer.

In a buffing/polishing application, the requirement is to touch a surface and apply a constant force in one direction. Here you are actually moving the robot such that it sees a force value in the specific direction desired. If certain forces are not desired, the software can adjust the robot's position to compensate.

Another application requires that a part is inserted into a hole, and the fit is extremely tight. In this application you would be trying to minimize forces experienced by the robot in the part insertion direction by adjusting the path of the robot in the other two directions. High torque values experienced can help determine if the insertion angle is correct (an angle adjustment is necessary). The side loading forces can indicate if there is a misalignment of the parts (a location adjustment is necessary). All of this adjustment is done as part of the application software and various parameters can be used to customize the solution to your application.

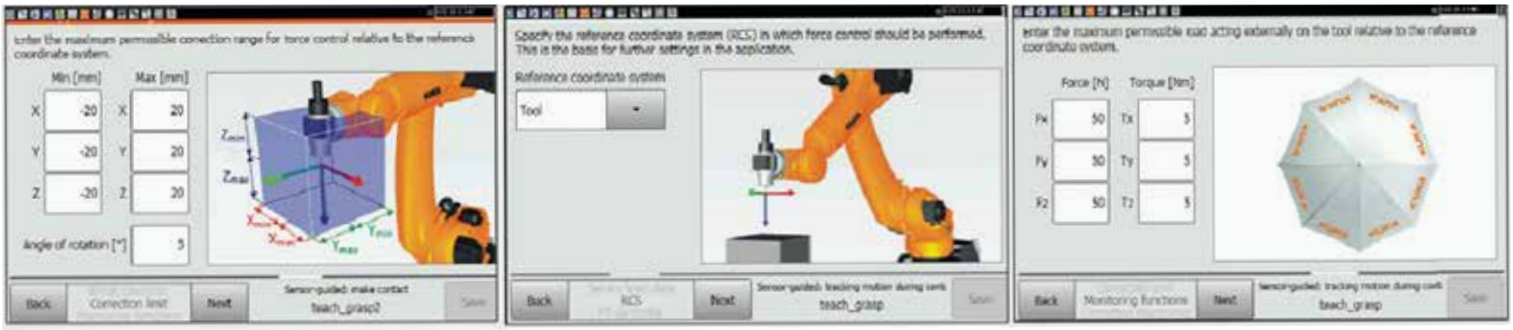
A graph of the forces and torques that is generated by the Force/Torque Software

Streaming Data and Feedback

With the KUKA robot, real time force/torque monitoring is available. As the specific force/torque application is run, a graph of all the specific forces and torques experienced by the sensor are graphed on screen. This can be useful for troubleshooting an application. The process can be “tuned” and results can be seen in real time.

In addition, thru the RSI interface software, these real time forces can be recorded for future playback or even sent to a remote computer system for data collection and analysis in real time.

If forces experienced by the sensor are of spec, the system can determine and alarm for this condition.



Snapshots for setting up a Force/Torque application on the teach pendant

Process Evaluation

To determine if force/torque control would work with your application, it would be useful to develop the application in stages. A proof of concept project could be used to determine the feasibility of using force/torque control in your application. If the results meet end-user satisfaction, this could be developed into a process which would be incorporated into the customers factory.

Force/Torque Applications

Precision part alignment such as: valves into valve heads, spool valve spools inserted into a valve sleeve, shaft alignment when assembling shafts into a bearing housing (gearbox, motor assembly), precision grinding/buffing (castings), product testing (checking force needed to operate device (pass/fail).

About Midwest Engineering Systems

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