

Ultra-Heavy Payloads

Multiple Robot Arms and Gantry Arms Cooperate to Handle Ultra-Heavy Payloads



While the strongest ultra-heavy six-axis robot can handle up to 2300 kg, gantry robots and collaborative lift robot cells can handle payloads several times that weight.



Industries

Automotive, Transportation, Shipping, Distribution, Durable Goods, General Manufacturing



Processes

When it comes to ultra-heavy payloads, the options range from single robots to gantry robots, cooperative robots and combinations thereof.



Key Data

- Current ultra-heavy-payload robots can handle up to 2300 kg.
- Gantry robots can handle payloads up to several thousand kilograms.
- New controllers are making cooperative multi-robot installations possible for coordinated lifts of ultra-heavy loads.
- Tracks can handle ultra-heavy robots and their payloads while extending the work envelope.

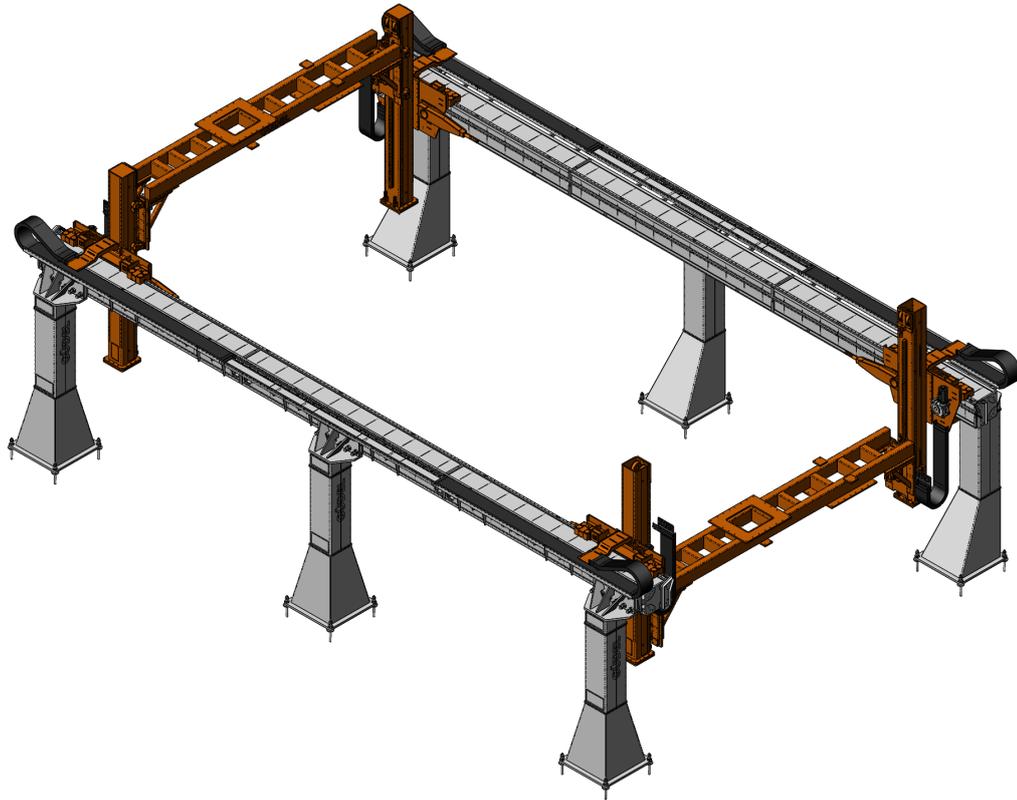


Figure 1

A dual-arm gantry system with a redundant set of gantry arm pairs. The fixture to carry the part is not shown but would be mounted to the crossbeam pictured.



Multiple robot arms and gantry arms cooperate to handle ultra-heavy payloads

Demand for industrial automation continues to rise for a diverse range of tasks. This includes reducing the number of large loads moved with manual cranes. More companies are asking robotic systems integrators to automate large-load material handling projects. In response, robot manufacturers are bringing ultra-heavy-payload robots to market. But what happens when the payloads and travel distances exceed the capabilities of ultra-heavy-payload robots? This white paper presents another approach to large-load material handling: the use of multiple gantry arms or multiple robot arms on linear tracks.

Ultra-Heavy-Payload Robots

The heaviest-lifting six-axis standard robot model available today is the FANUC M-2000iA/2300, which is capable of carrying a 2300 kg load. Other standard ultra-heavy-payload robots on the market include the Kawasaki MG15HL (1500 kg

payload), KUKA KR 1000 Titan (1000 kg payload), Yaskawa Motoman MPL800 II (800 kg payload), NACHI SC700 (700 kg payload) and ABB IRB 8700 (630 kg payload). While the payload capacity for these ultra-heavy robots is significant – the average automobile weighs 1800 kg – it's still less than many ultra-heavy material handling application requirements today.

Gantry Robots Maximize Payload Power

Gantry robots offer another option for automating ultra-heavy-payload material handling. These linear-motion rack-and-pinion-driven Cartesian devices are typically capable of two- to four-axis motion. Two-axis gantries can lift and lower vertically and transfer along a single axis. Three-axis gantries can lift, transfer and rotate the part lifted. Four-axis gantries can lift, traverse an area bidirectionally and rotate the part lifted. Available from a variety of manufacturers, standard gantry



A FANUC M-2000 series robot handles a Chevrolet Corvette.

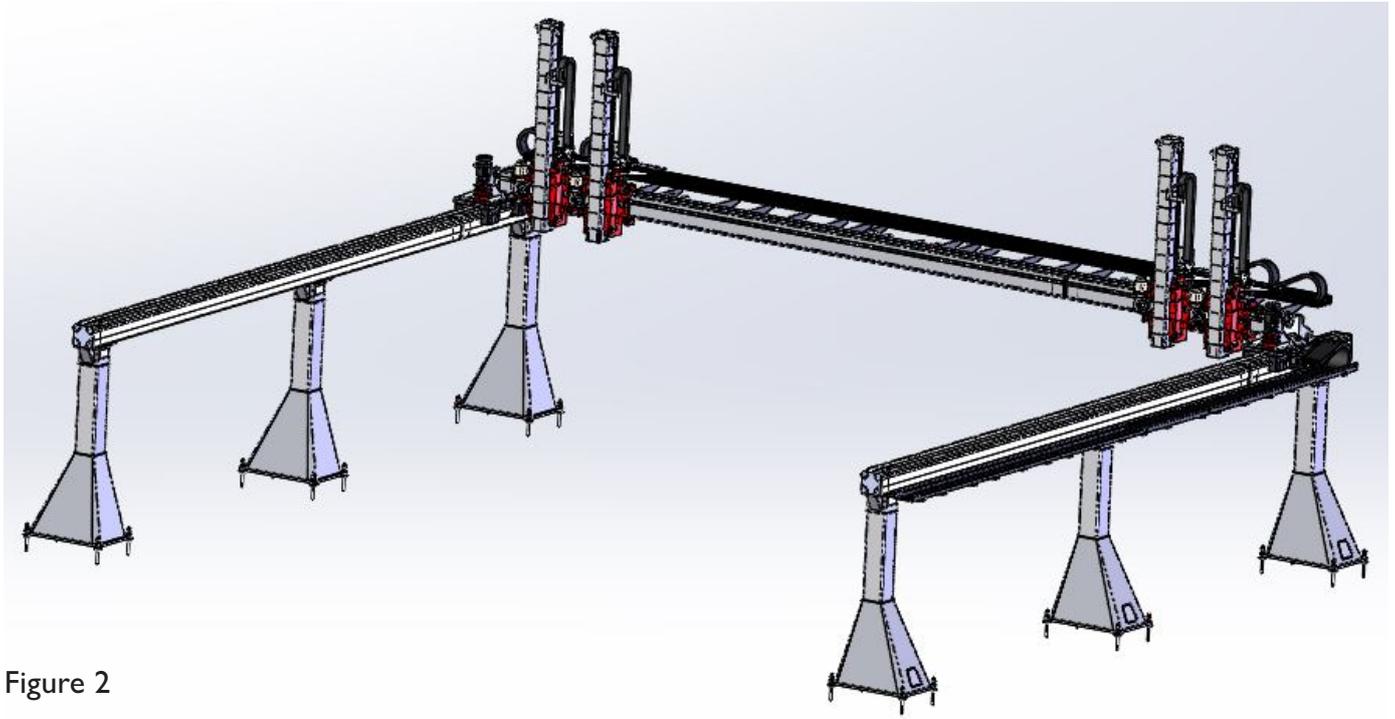


Figure 2

A dual-arm gantry handles long, heavy products.

robots offer payload capabilities ranging from very light (several kilograms) to ultra-heavy (several thousand kilograms).

Tracks Add Reach, Coordination Options

Linear floor or overhead tracks can be added to the motion group of most six-axis robot products on the market today, allowing for fully coordinated seven-axis motion. For example, Güdel recently released the TMF-6, a seventh-axis TrackMotion Floor track motion that can carry a FANUC M-2000 series robot and its load. Güdel also offers TMF modules for all brands and models of robots at every payload capacity.

Using two robots together can double the payload capacity of the materials handling system. Robot control and communication advances make it possible for two robots to act as a master-slave pair with mirrored motions. These technologies enable dual-arm robot heavy-load handling. Stationary robots mounted side by side that split the payload for material handling applications will have a limited range of motion, or work envelope. However, by using two robots on parallel linear floor tracks, designers extend that range of motion, increasing the

system's work envelope and allowing for the transfer of heavier parts.

Cooperating Gantry Robots for Maximum Payload

Two key enabling technologies for large-load handling with a pair of gantry arms are improved motion-control technology and large permanent magnet servo motors. Today's motion-control capabilities include the ability to synchronize servo motors to coordinate multi-axis motion. This makes it possible to have multiple six-axis robots or linear two- to four-axis gantry arms in contact with the load and to move that load with synchronized and coordinated motion.

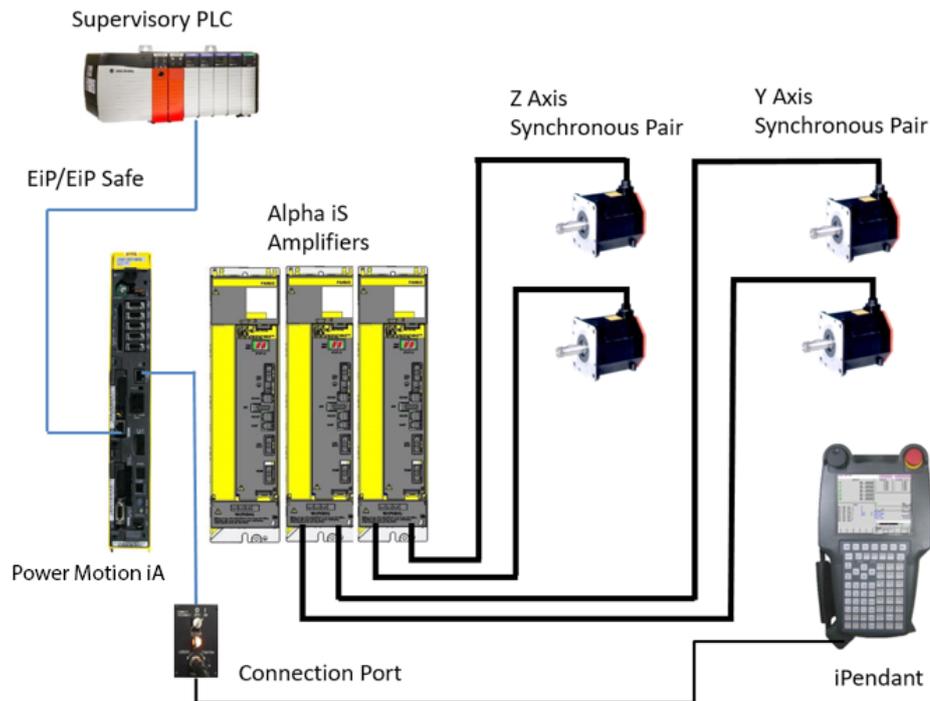
Large permanent magnet servo motors cost-effectively drive gantry rack-and-pinion drive trains capable of carrying heavy loads. Using multiple gantry arms in contact with a part splits the large payload between devices. Gantry robots operating these multiple-arm configurations with synchronized motion results in gantry arms that cooperate.

State-of-the-art integrated control systems such as the FANUC Power Motion i-MODEL A can control large permanent



Güdel ZP-7 two-axis linear gantry.

- ZP-7 linear gantry offers a max payload of 31,250 N in the Y and Z axes
- Ultra-heavy payloads don't sacrifice speed with the ZP-7, with rates ranging from 150 m/minute under high dynamic payload to 60 m/min for heavy payloads.
- ZP-7 offers repeatability of +/- 0.02 mm.



FANUC's Power Motion i-MODEL A is a powerful motion and CNC controller for simple and complex general motion applications. The multi-process motion controller and integrated PLC, coupled with FANUC servo motors, make it an ideal solution for the comprehensive line of Güdel linear and area gantry systems.

magnet servo motors. Dual motors can be used on a dual-input gearbox employing torque tandem control technology. Two separate gearboxes with individual motors can be operated with synchronous control technology. A dual-input gearbox with dual motors works with a combination of torque tandem and synchronous control technologies. Two reasonably sized motors working together doubles the torque and inertia available while keeping the motors cost-effective. This gives a wide range of choices for configuring an ultra-heavy-load rack-and-pinion-driven system.

Misalignment can present a significant challenge in these systems, as large mechanical systems requiring synchronized motor control can get out of position. That's why the control system must monitor the motor master-slave relationship. Diagnostic programs are also necessary to notify the user once the synchronization error reaches a predefined level. Once this out-of-bounds condition is identified, the control system must have features to enable easy realignment and resynchronization.

Multiple-Arm Gantry Robots

Multi-axis motor synchronization technology enables another method for long-stroke applications: two gantry arms on a single Y-axis longitudinal beam or two gantry arms on separate Y-axis longitudinal beams.

Güdel manufactures a two-axis motion gantry system called the ZP-7, which can lift and transfer static loads up to 3150 kg. But what if a 6000 kg load needs to be transferred? In this case, two gantry arms on separate Y-axis beams can be used to lift and transfer the shared load. This reduces the load on each arm to 3000 kg, which is feasible if the speed requirements and duty cycle are within the constraints of the system drive train and motor capabilities. Using two gantry arms also eliminates design concerns about large offset centers of gravity, offering better configurations for handling large parts. The vertical lift weight capability of these gantries can be further enhanced using custom assist devices such as counterweights or pneumatic cylinders to keep the drive motor sizes smaller and more affordable.



Güdel Multi-Axis Gantry featuring FANUC's Power Motion i-MODEL A motion controller, a powerful motion and CNC control that complements Güdel's comprehensive line of linear and area gantry systems.



ZP-7 with dual XY mechanisms to handle railcar axles.

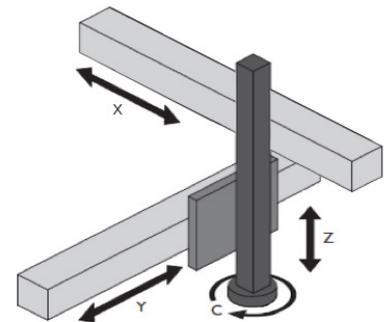
Examples engineered recently include a system that uses a pair of gantry arms to carry a 2700 kg payload of fixture and product, lifting vertically 2.3 m and then traversing 10 m. A second set of gantry arms provides total system redundancy to protect against downtime. (See Figure 1).

Additionally, Güdel offers a custom gantry module with four Z axes on a single Y beam capable of picking up and transferring a single long and heavy part, such as a pipe. The custom Y beam on this module is 16 m long, and the four Z axes can be programmed to locate to any position along that Y beam. This custom solution can lift long parts with no concerns about offset loads. (See Figure 2).

Conclusion

Manufacturers seek cost-effective methods to automate the handling of large, heavy loads while reducing reliance on manual crane operations. Today's motor and control technology makes this possible with synchronized operation of multiple lifting arms, while ultra-heavy-duty tracks and drive systems extend the work envelope – a common requirement when dealing with heavy-load material handling. Don't assume the payload capacity of a single robot or single gantry arm is the limit of what can be carried. By taking advantage of technology advances, robot and gantry system providers can cooperate for ultra-heavy material handling applications.

Author: Roberta L. Zald



Gantry robots come with a wide variety of axis options. Two-axis gantries can lift and lower vertically and transfer along a single axis. Three-axis gantries can lift, transfer and rotate the part lifted. Four-axis gantries can lift, traverse an area bidirectionally and rotate the part lifted.

About Güdel Inc.

Güdel Inc. is the US subsidiary of Güdel Group, a global manufacturer of robotic automation products, systems and services. Güdel supplies linear-motion modules, robot track motion units, gantry robots and components to OEMs, systems integrators and machine builders serving the automotive, aerospace, logistics, heavy industrial and power-generation industries. Güdel Inc. is located in Ann Arbor, Michigan, in a dedicated 45,000-square-foot facility, providing North American customers with engineering, design, production and customer service support.

Güdel Group was founded in 1954. Headquartered in Langenthal, Switzerland, today Güdel operates in more than 30 locations worldwide.

Contact

Güdel Inc.
 4881 Runway Blvd.
 Ann Arbor, Michigan
 48108 USA
 Phone: +1-734-214-0000
 Fax: +1-734-214-9000
info@us.gudel.com | gudel.com/us