Simulation and offline programming of Motoman robot systems
Perfect planning without hocus-pocus

Virtual simulation of robot-based systems and processes provides crucial advantages not only in planning, but also in the commissioning and operation of such systems. In particular, costly errors can be reliably excluded and resources used more efficiently. The prerequisite is software solutions which cater for the technical parameters of robotics as well as the specific requirements of the system environment. One example is the MotoSim EG VRC (Enhanced Graphic – Virtual Robot Control) software developed by YASKAWA specifically for the simulation and offline programming of Motoman robot systems.

Even today, the planning and implementation of new robot-based manufacturing processes in some companies is as follows: First of all the new process is subjected to a lengthy process of testing, e.g. in the form of welding tests. This calls for the repeated reprogramming of robots and other plant components such as positioners, torches and tracks. Once the desired result has been achieved, the system is retooled. Meanwhile, it is not available for actual production. Nor can unforeseen errors and disruptions be excluded during and after the start of operations.

There are very good reasons why simulation programmes are winning increasing recognition. They enable the virtual configuration and inspection of manufacturing processes in a dynamic 3D environment. The desired standards of quality, resources, costs and deadlines are reliably guaranteed. Capacity utilization and cycle times are optimised by
simulation. Possible problems in the product design can be recognized in
the forefront and eliminated prior to the actual start of production.

The use of simulation and offline programming is of particular interest in
medium-sized production plants with frequent product changes, such as
sheet metal forming or coating applications. This applies to plant engineers
as well as users: in addition to planning, plant engineers and system
integrators can use them to completely pre-programme cells. Installation at
the customer’s premises is correspondingly simpler and faster. Users can
significantly shorten their set-up times by simulation and offline
programming. All processes can be developed parallel to production.
Because the jig is checked in advance for accessibility, etc., only minor
corrections. – if at all – are required later.

**MotoSim offline programming system**

YASKAWA developed the MotoSim software package, an offline
programming system with 3D simulation, specifically for planning Motoman
robot systems. The controller function is integrated from the start. What is
special about it is that MotoSim uses the same kinematic model as the
robot control unit. The user interface of the teach pendant (TP) is thus
mapped 1:1 by software for robot programming on the PC. Even the
programming language (Inform) is the same. This greatly facilitates the
work of the operator. Downtimes are minimized and productivity increased.

All Motoman control generations are supported by MotoSim EG, from type
ERC to the latest FS100 and DX200 control units. Besides simple
programmability, MotoSim facilitates planning with a comprehensive library
of Motoman products. In other words: the library not only includes all robot
models of various generations, it also offers accessories such as
positioners and tracks. YASKAWA’s 3D data models can be downloaded
from its homepage. This service is already included in the software licence,
as are enhancements with new robot models.

The MotoSim EG is a simpler version for pure simulation. Per-track
calculation using CAD enables fast estimation. On the other hand, the full
version MotoSim EG VRC (Enhanced Graphic – Virtual Robot Control) is fully programmable offline and configured for multi-robot solutions. The full version supports robot generations NX100, DX100, DX200 and FS100.

Comprehensive range of functions

With a multitude of functions MotoSim guarantees the highest standards in planning:

- **Range and accessibility analyses** – MotoSim enables the fast set-up and analysis of system layouts. The integrated 3D Hoops Graphic Engine ensures high-quality graphic display. Import filters for ASIC, IGES, STeP, ProE, Catia, Solidworks, Parasolid and Inventor permit the problem-free import of customized CAD models. The internal model editor additionally enables the creation of CAD models. Key dimensions can be taken directly. The user interface features convenient tools, e.g. collision control and user-defined 3D views.

- **Cycle time analysis** – as a native manufacturer’s tool, MotoSim guarantees a high degree of accuracy of the measured cycle times. Optimum cycle times can be obtained by alignment of the system layout, robot track and, where applicable, the robot type used.

- **Offline programming** – movement programs are created in MotoSim and can be transmitted directly to the real robot control. On CAD models direct track points are inserted on the workpiece by a simple mouse click. For example in coating applications, the robot track is automatically calculated as a polygon based on the CAD data of the component.

- **Sample cells** – MotoSim contains a large number of sample cells. These serve, among other things, to demonstrate more complex system configurations.

- **Job transfer module** – enables jobs to be transferred between different manipulator types. This may be necessary, for example, when robot programmes are to be transferred from an old to a new manipulator type or when production is to be moved from one manipulator type to another.
• MotoSim Viewer function – MotoSim simulations can be exported as a web application, AVI files or vPDF. This means that finished simulations can be played in a browser or PDF viewer without the need for MotoSim to be installed. This permits the simple transmission of ready simulations, e.g. to customers or partners.

In the next expansion stage MotoSim will be fully implemented as an online solution. The marriage between software and robot control, as well as back-ups and communication with the system control, can then be safely and conveniently implemented by Ethernet connection. As a further innovation, it will be possible to integrate separate control units (SPSn) into the simulation. For example, cycle times for presses and other random processes will also be simulated.

**Practical example: RIKA Blechkomponenten GmbH**

Convinced of these benefits, RIKA Blechkomponenten GmbH with headquarters in Micheldorf, Upper Austria, has also been using MotoSim EG VRC successfully for the simulation and offline programming of Motoman robot systems. The privately run enterprise with 115 employees manufactures complex sheet metal and construction parts, primarily of aluminium, stainless steel and sheet steel. The company places an emphasis on state-of-the-art technologies and equipment such as laser cutting machines, CNC-controlled stamping and nibbling machines, automatic bending machines and CNC-controlled mechanical press brakes – and on YASKAWA robot welding units.

In the operation of robot cells, simulation and offline programming with MotoSim provide a valuable service, as welding technology expert Lukas Kaltenbrunner of RIKA explains: “Without simulation we would hardly be able to cope with the high workload in contract manufacturing. Simulation enables us to maximise the capacity of our systems. While one workpiece is being welded, the other is being prepared virtually. Then the programme is transferred to the robot and we can continue with the next workpiece.”
Conclusion
Simulation and offline programming of robot-based automated tasks offers major advantages in terms of quality, resources, costs and deadlines. Capacity utilization and cycle times can likewise be optimized. YASKAWA developed the MotoSim software packet specifically for planning Motoman robot systems. It employs the same kinematic model as the robot control and thus simplifies operation. Under the licensing model, free 3D data models for all robots, positioners, torches, tracks, etc. are available for downloading from the homepage. With these arguments, RIKA Blechkomponenten GmbH of Austria has been championing the MotoSim EG VRC for many years.

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Captions:
The use of simulation and offline programming is of particular interest to medium-sized manufacturing companies with frequent product changes, e.g. in sheet metal forming. (Source: YASKAWA)
MotoSim enables fast assembly and analysis of system layouts. The integrated 3D Hoops Graphic Engine guarantees a high-quality graphic display. (Source/Screenshot: YASKAWA)

RIKA Blechkomponenten GmbH with headquarters in Micheldorf, Upper Austria, uses MotoSim EG VRC successfully for the simulation and offline programming of Motoman robot systems. (Source: RIKA Blechkomponenten GmbH)
For sheet metal forming the company focuses on state-of-the-art technologies and equipment such as YASKAWA robot welding units.
(Source: RIKA Blechkomponenten GmbH)

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About YASKAWA:

With an annual sales volume of more than 360 billion Yen, YASKAWA is a world-leading manufacturer of servo drives (Sigma Series), inverter drives (such as the A1000), and Motoman industrial robots. Founded in 1915 in Japan, the company’s philosophy has been based on the principle of highest quality for 100 years, making YASKAWA a global leader.

The wide range of YASKAWA’s business activities covers drives (inverters), motion control (AC servo motors and drives, machine control), robotics (industrial robots and robotics systems), systems engineering (medium voltage inverters, generators, converters), and information technology (software-based products). VIPA GmbH in Herzogenaurach, which specialises in visualisation and process automation, has also been a part of YASKAWA since 2012. Furthermore, YASKAWA acquired The Switch Engineering Cooperation, which does business in the wind turbine sector, in October 2014. This makes YASKAWA one of the few global companies able to supply components and solutions for almost all industries from a single source.

Extensive investments in research and development have yielded numerous inventions, patents and innovations. These technological aspirations have enabled the Drives & Motion and Robotics divisions to achieve a leading market position in various industries including manufacturing systems and plant engineering (packaging machines, pumps/compressors, textile machines, digital printing machines, cranes and hoisting gear, equipment for semiconductor and electronics production, machines for producing and processing wood, glass, metal and stone) as well as lift, automotive, assembly and handling technology.

Today, YASKAWA Europe GmbH, based in Eschborn near Frankfurt, operates three divisions – Drives & Motion (drives and control technology), Robotics (industrial robots) and VIPA (automation and control technology) – and services the markets of Europe, Africa, the Middle East and the region of the former Soviet Union.

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