ABB MultiMove functionality heralds a new era in robot applications

The technology step made by ABB Automation in the development of its fifth generation robot controller, the modular IRC5, is as big as any made since the launch of its first generation S1 in 1974 alongside the IRB6, the world's first electric drive robot. And, of the advances made with the IRC5 it is perhaps the introduction of MultiMove that will have the biggest impact in terms of applications and customer benefits.

MultiMove is a function embedded into the IRC5 software that allows up to four robots together with work positioners or other devices, to work in cooperation including fully coordinated operation. This advanced functionality has been made possible by the processing power and modularity of the IRC5 control module that is capable of calculating the paths of up to 36 servo axes.

However, such power is not at the expense of cost as the modular concept of the IRC5 delivers a lean solution. Only one control module is required whether it is a single or a multiple robot cell and expansion only requires the addition of a drive module for each robot up to the maximum four. Also, the number of I/Os and communication links are significantly reduced compared to the more common multiple controller solution.

The principle of MultiMove is an expansion of that used in coordinating a robot with a work positioner but, now more than one robot can be coordinated with another robot or other device. The work handling device, which can be a robot or work positioner, controls the work object and all the other devices are coordinated to move relative to the work object when it moves. It is achieved by defining the object coordinate systems of each of the coordinating devices as fixed to the work object held in the handling device, so that when the work object moves the other devices move in coordination.

Even though MultiMove is a complex function to implement and requires large processing power particularly in the path planning and the synchronisation of all the drive motors of each robot, its realisation has been made simple. Experience from customers given early exposure to MultiMove has indicated that anyone familiar with programming an ABB robot particularly when coordinated with additional axes such as a work positioner, will have little difficulty in creating MultiMove applications.

A key to the easy implementation of MultiMove is that each robot and additional device in the cell has its own program, which may be written and edited in the ABB RAPID robot programming language. Each program may be viewed and executed totally or partly independent of each other using either the Windows style FlexPendant graphical teach unit, which has been developed as an integral part of the IRC5 controller, or a PC. This concept of program separation in the MultiMove function is unique to ABB.

MultiMove is totally flexible through the ability to switch between coordinated and independent operation of the robots in the cell. For instance, all the devices may

operate totally independent of each other for all the time; or they may be synchronised at certain points in their cycles – semi-coordinated movement; or they may work totally coordinated with fully synchronised sequences and movements. Further, the robots may operate in groups with two or three coordinated, while at the same time the other one or two in the cell work independently.

In semi-coordinated operation the robots in the cell work on the same stationary object that requires some time synchronisation of the sequence of operations but not any coordinated movements. For instance, a positioner moves the work object while the robots are stationary, but the robots only work on the object while it is stationary. This is semi-coordinated movement, which requires synchronisation to 'advise' the positioner when the work can be moved, and when the robots can process the work.

An example would be two robots welding the same workpiece in different areas and on two different sides. The positioner first moves the work to present its upper side while the robots wait. Then the robots perform their welds while the positioner waits. Next, the positioner indexes the work to present its lower side to the waiting robots. Finally, the robots perform their welds on the lower side.

In fully coordinated movement, several robots operate on the same moving work object. So, the positioner or robot holding the work and the robots operating on that work, move in synchronism. Therefore, the coordinated robots must start and stop their movements at the same time and must execute the same number of move instructions simultaneously.

An example of fully coordinated movement is a spot welding task in which the work is continually moved along an arc by one robot during which two spots are applied by a weld gun held by another robot coordinated to the handling robot. A single instruction in the work handling robot's program would be sufficient to move it from the start to the finish of its movement along the arc. However, because the welding robot applies two spots in different spatial positions and, therefore, requires two instructions in its program, the handling robot must also have two instructions. So, the arc movement must be accomplished using two move instructions, one to a midpoint and another to the end of the arc, which are executed in synchronism with the two move instructions in the welding robot program.

Another feature of MultiMove is the ability to jog multiple robots fully coordinated using the joystick on the FlexPendant. During "coordinated jogging" the relative positions of all the devices are maintained constant and exactly the same as during the full speed execution. At any point, any of the devices may be switched to an independent jog so that their relative position may be adjusted and then switched back again for the coordinated jogging to continue. This is a powerful tool in fine tuning MultiMove programs and is unique to ABB.

Recovery from a production stop due to equipment or process failure is a potential problem due to the complexity of the choreography in MultiMove operations. Not only has the robot at 'fault' to avoid work and tooling but also has to communicate with its coordinated 'partners' during the retraction to a safe position as well as the recovery back to the last position. The problem is eased with the IRC5 controller through its path recording functionality, which is activated for every robot in a

MultiMove operation. Knowledge of the path leading to the error point enables the ‘fault’ robot to retract in synchronism with the coordinated robots, to the safe point identified in its RAPID error recovery routine. The same path data will similarly be used after recovery, to return all the coordinated robots to the program positions at which the error occurred.

Some errors may not need recovery to a position but merely a retry. An example is arc welding when an arc failure occurs. In this case an arc re-strike is likely to be requested rather than a retraction. In such a situation, “retry” will be specified in the RAPID error recovery routine, but again in MultiMove all devices need to be coordinated during the retry.

To make it easier to recover from errors in such as arc welding, ABB has developed a new “asynchronously raised error” function in RAPID. For instance in the above example, it is most likely that the arc failure will occur along the programmed path after the instruction has been executed but before the robot has completed the movement to the end of the path. In this case, it is necessary that the error recovery routine is executed at the point of the arc failure and not at the completion of the instruction. The asynchronously raised error function allows this to occur in MultiMove as well as in single robot routines.

Shorter lead times, increased productivity and improved quality are just some of the generalised potential benefits of multiple robot operation with the new IRC5 controller. Even in totally independent operation of the robots in a cell, time and costs will be reduced due to the efficient internal communications and minimal handshaking of the single controller. When some degree of synchronisation is introduced, waiting times may be minimised leading to further reductions in cycle times.

Better product quality is a high potential benefit of MultiMove such as two or more robots working together in order to balance the load on the workpiece. An example is simultaneous arc welding to eliminate the risk of distortion due to uneven shrinkage on cooling. Another is to use two or more robots to handle delicate or flimsy workpieces that may flex or bend under their own weight.

It is also possible to expand the ‘part-on’ concept with MultiMove by coordinating a workpiece handling robot with one or more process robots, helping to simplify and reduce tooling and fixturing. It can also reduce cycle time as the time to place the workpiece in the fixture has been eliminated and the process robots may be able to start their operations as soon as the part is picked. And, the 6-axis robot has more dexterity in manipulating the workpiece compared with a rigid fixture or even a servo controlled positioner. This could mean, for instance, that the process robots are able to access all areas of the work, allowing the operation to be completed in one handling with no intermediate stops for reorienting the work, so-called one-stop or ‘one hit’ processing.

Another advantage of coordinating a work handling robot with two or more processing robots is the higher relative speeds attainable, for instance, between the weld torch and the workpiece, leading to possibly better quality welds and/or shorter cycle times. A further benefit is in lifting heavy loads. It may be less costly to employ

two smaller robots to lift the load rather than a larger one, or the load may be heavier than the capacity of even the largest robot but not of two robots working in coordination.

The unique functionality that MultiMove brings to the whole ABB robot range sets new standards in robot technology and opens up a range of applications previously impractical or uneconomic. Its development has been backed-up by the knowledge gained from the previous four generations of ABB robot controllers and aided by the expertise generated from over 100,000 ABB robots installed worldwide. MultiMove further strengthens ABB's lead in advanced robot systems.

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For more information about IRC5 and MultiMove: www.abb.com/robotcontroller