The A to Z of the SANMOTION C

Nobuo Arakawa

1. Introduction

Did you know that the “C” of the “SANMOTION C” stands for “Controller”? One could perhaps visualize the product from the series name however, in fact, this product is not very well known. In light of this, this report aims to introduce the “SANMOTION C” in a straightforward way.

2. SANMOTION C Positioning

There are two types of controllers; the PC-based controller, which uses a PC (personal computer) as a platform, and the stand-alone controller, which uses the original architecture of each company as a platform. Sanyo Denki’s “SANMOTION C” falls into the latter category as a stand-alone controller.

Table 1 categorizes the existing controllers.

Table 1: Controller categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Controller type</th>
<th>Development language</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC-based</td>
<td>Software</td>
<td>C language, C++ language</td>
<td>Semiconductor manufacturing equipment, inspection equipment, mounters, food processing machines, medical equipment, packaging machines</td>
</tr>
<tr>
<td></td>
<td>Bus connection board (PCI Express/PCI, ISA, VME, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand-alone</td>
<td>CNC (Computer Numerical Control)</td>
<td>G language</td>
<td>Machine tools, injection molding machines, metal processing machines</td>
</tr>
<tr>
<td></td>
<td>PLC (Programmable Logic Controller)</td>
<td>Ladder diagram</td>
<td>General industrial machinery, food processing machines, medical equipment, packaging machines</td>
</tr>
<tr>
<td></td>
<td>Robot Controller</td>
<td>Original language</td>
<td>Articulated, scalar, parallel link, etc.</td>
</tr>
<tr>
<td></td>
<td>Integrated controller (PLC + motion)</td>
<td>SFC language, C language PLC open language (IEC61131-3)</td>
<td>General industrial machinery, metal processing machines, food processing machines, medical equipment, packaging machines</td>
</tr>
<tr>
<td></td>
<td>SANMOTION C (PLC + motion + robot)</td>
<td>PLC open language (IEC61131-3) original robot language</td>
<td>General industrial machinery, metal processing machines, coil winding machines, food processing machines, medical equipment, packaging machines, various robots</td>
</tr>
</tbody>
</table>

PC-based controllers feature excellent expandability and flexibility. Typical applications include equipment which requires computer calculations and data processing (for example mounters and medical equipment which requires image processing) and semiconductor manufacturing equipment for which process control is principle.

Meanwhile, the merits of stand-alone controllers are reliability and sustainability, allowing the same product to supply power for a prolonged period of time. Stand-alone controllers are often used in applications which focus on performance, such as machine tools, processing machines and molding machines.

The “SANMOTION C” has incorporated the strengths of both PC-based and stand-alone controllers. Moreover, it has widened its application scope with the addition of kinematics for various robots.

Figure 1 shows the positioning of the “SANMOTION C”.

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3. SANMOTION C Configuration

3.1 Software configuration

Figure 2 shows the software configuration of the “SANMOTION C”.

Operating systems (OS) adopt the highly-reliable VxWorks as a real-time operating system (RTOS).

Using this RTOS, in addition to execution of system control software, robot control, PLC/motion control software can be executed at the upper server on the same level.

This software, including RTOS, is sold installed in a compact flash memory as basic software. Moreover, the “SANMOTION C” has a software configuration with flexibility and expandability so that robot control and PLC/motion control can be installed separately depending on the necessary functions of the equipment.

At the uppermost level, there is an application layer, which executes the application software created by the user using Studio-RC or Studio-MC, which are development support software for robot control and PLC/motion control.

3.2 Hardware configuration

Figure 3 shows the hardware configuration of the “SANMOTION C”.

The “SANMOTION C” is configured from a CPU module and peripheral modules.

(1) CPU module: DIN rail mounting
   <1> CPU operating clock: Available in two types, 600 MHz and 1.1 GHz.
   <2> Ethernet, CAN, RS485, EtherCAT serial buses are standardly equipped.
   <3> 2 ch of USB memory

(2) Peripheral modules: Used by connecting with the parallel bus from the CPU module side. Up to 12 modules can be connected.

The following six types of modules are available.
   <1> Digital input/output module
       16 ch input/16 ch output (sink/source)
       32 ch input/32 ch output (sink/source)
   <2> Analog input/output module
       4 ch input/4 ch output, 12 bit resolution
   <3> Encoder input module
       2 ch input, 2 ch latch input, max 250 KHz
   <4> Bus link module
       CAN interface (125 KHz to 1 MHz)
   <5> Interface module
       2ch-RS232C, 2ch-RS485/422
   <6> Field bus module
       Sanyo Denki local motion bus (GA1060)

Peripheral modules consider flexibility and expandability so that the right one can be selected for the equipment’s requirements.
4. Development Languages

4.1 PLC open languages

The “SANMOTION C” uses the open international standard languages (IEC61131-3). This international standard consists of six language types and program developers can select the language they are familiar with or the one suitable for the system when developing equipment application programs.

Figure 4 shows images of the six program languages.

1> IL language: Instruction list
A text language resembling mnemonics

2> LD language: Ladder diagrams
A graphic language enabling visualization of relay wiring. A programming language popular for conventional PLCs.

3> ST language: Structured text
A structured text language resembling Pascal and BASIC.

4> SFC language: Sequential function chart
A graphical programming language able to express the change in status of lines, etc. as it includes process advancement programs which control sequence processing.

5> FBD language: Function block diagram
Possesses both input parameters and output parameters, dividing control (processing) combining multiple functions into components and simplifying as a single command. A graphic language for engineers familiar with DCS (Distributed Control System) in the instrumentation field.

6> CFC language: Continuous function chart
A process flow chart used in DCS, etc. Controls by joining function block parameters with a line on editor. A graphic language which uses a re-locatable area as the address area and the user does not need to be conscious of anything other than the device name.

By using standardized development language, the developed program can be comprehended by anyone, thus improving the capitalization of software.

4.2 Robot language

Sanyo Denki has prepared an original language to program robot operations. This has made it possible to easily change from the teaching pendant to an operation program onsite. Table 2 gives a list of robot commands.

<table>
<thead>
<tr>
<th>Movement</th>
<th>IL language</th>
<th>ST language</th>
<th>FBD language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-to-point movement</td>
<td>PTP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear interpolation movement</td>
<td>Lin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circular movement</td>
<td>Circ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance-specified PTP action</td>
<td>PTPRel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distance-specified linear interpolation action</td>
<td>LinRel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robot stop</td>
<td>StopRobot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wait until main-run has reached a certain position</td>
<td>WaitTillFinished</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delays program execution as long as possible</td>
<td>WaitJustInTime</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homing of an axis</td>
<td>RefRobotAxis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homing of an axis (asynchronous)</td>
<td>RefRobotAxisAsync</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wait until homing is completed</td>
<td>WaitRefFinished</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Slow Control</th>
<th>Move Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subroutine call</td>
<td>CALL</td>
</tr>
<tr>
<td>Pending command</td>
<td>WAIT</td>
</tr>
<tr>
<td>Branch command</td>
<td>IF_THEN_END_IF</td>
</tr>
<tr>
<td>Conditional judgment 1</td>
<td>ELSE</td>
</tr>
<tr>
<td>Conditional judgment 2</td>
<td>ELSEF_THEN</td>
</tr>
<tr>
<td>Repetition control</td>
<td>WHILE DO_END WHILE</td>
</tr>
<tr>
<td>Repetition control</td>
<td>LOOP DO END LOOP</td>
</tr>
<tr>
<td>Program start</td>
<td>RUN</td>
</tr>
<tr>
<td>Program unload</td>
<td>KILL</td>
</tr>
<tr>
<td>Program return</td>
<td>RETURN</td>
</tr>
<tr>
<td>Label setting</td>
<td>LABEL</td>
</tr>
<tr>
<td>Unconditional jump</td>
<td>GOTO</td>
</tr>
<tr>
<td>Conditional jump</td>
<td>IF_GOTO</td>
</tr>
</tbody>
</table>

Table 2: List of robot commands
5. Interfaces and Uses

Figure 5 shows the interfaces and uses.
Controllers must control equipment. Not only is the motor controlled, but also various sensors, monitor display and other controllers. As such, the “SANMOTION C” is connected to several types of interfaces to control various control devices.

(1) Ethernet connection
   <1> Image processing unit: Confirms the position and shape of the target.
   <2> PLC: Simultaneously controls equipment.
   <3> Teaching pendant: Operates various robot.
   <4> PC: Monitors equipment parameters.

(2) RS485/422, RS232C connection
   <1> Touch panel display: Starts, monitors, etc.
   equipment as HMI (Human Machine Interface).

(3) CAN (Controller Area Network)
   <1> Remote I/O: Controls equipment proximity sensors, contacts, lights, etc.

(4) Analog connection
   <1> Hydraulic control unit: Controls pumps, etc.
   <2> Temperature adjustor: Controls equipment temperature.
   <3> Temperature measurement (thermocoupler): Measures temperature

(5) Encoder connection
   <1> Manual pulse generator: For JOG operations.
   <2> Incremental encoder: Commands the equipment’s master position.

(6) EtherCAT connection
   <1> Servo amplifier: Operates the equipment freely.

6. Example of Application

6.1 Chip mounter

Figures 6 and 7 show the system configuration of a chip mounter.

Specifications
<1> X axis: linear motor 2 axes
   Head collision prevention operation.
<2> Y axis: Ball-screw drive 1 axis
   Synchronized control with the X axis.
<3> Z axis: 2 heads (8 axes linear motor/1 head)
   Make the positioning time 5 ms or less.
<4> θ axis: 2 heads (2 axes belt pulley drive/1 head)
<5> 4 ch camera recognition
   Recognizes parts ON the FLY.
<6> DI/DO: Each 32 ch
   Also controls remote I/O board of RS422 communication.

Machine performance
Mounted at 40,000 CPH.

Fig. 5: Interfaces and uses

Fig. 6: Chip mounter

Fig. 7: Chip mounter system configuration
6.2 Parallel link robot

Figure 8 shows the configuration of a tracking system using a parallel link robot.

Specifications
<1> Controls 3 axes parallel link robot + rotation 1 axis
<2> Belt drive as the additional axis
<3> Operating range: $300$ mm
<4> Recognizes the products being transferred through the use of a camera and picks products at high speed using a parallel link robot.

Tracking characteristic
Achieved air picking at 100 times/minute.

Fig. 8: Configuration of a parallel link robot tracking system

The two examples introduced above were achieved with Sanyo Denki’s support. We wish to continue supporting customers and together aim for further value creation.

7. Conclusion

This report, as the A to Z of the “SANMOTION C”, has described the positioning and configuration of the production from the series name origin and discussed application development languages, connection with peripheral devices and roles so that readers may better understand how the “SANMOTION C” is related to equipment development. Lastly, we introduced examples of application to explain how the “SANMOTION C” is applied.

Sanyo Denki hopes that this introduction helps our customers to better understand the “SANMOTION C” and provide various useful equipment development proposals.

We will continue to enhance our interfaces and strengthen our networking controllers in order to offer the optimal controllers for automation requirements.

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Joined Sanyo Denki in 1982.
Servo Systems Division, 2nd Design Dept.
Worked on the development and design of controllers.