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CPAC OtoStudio

Computerized Programmable Automation Controller

GOOGOL TECHNOLOGY (HK) LIMITED

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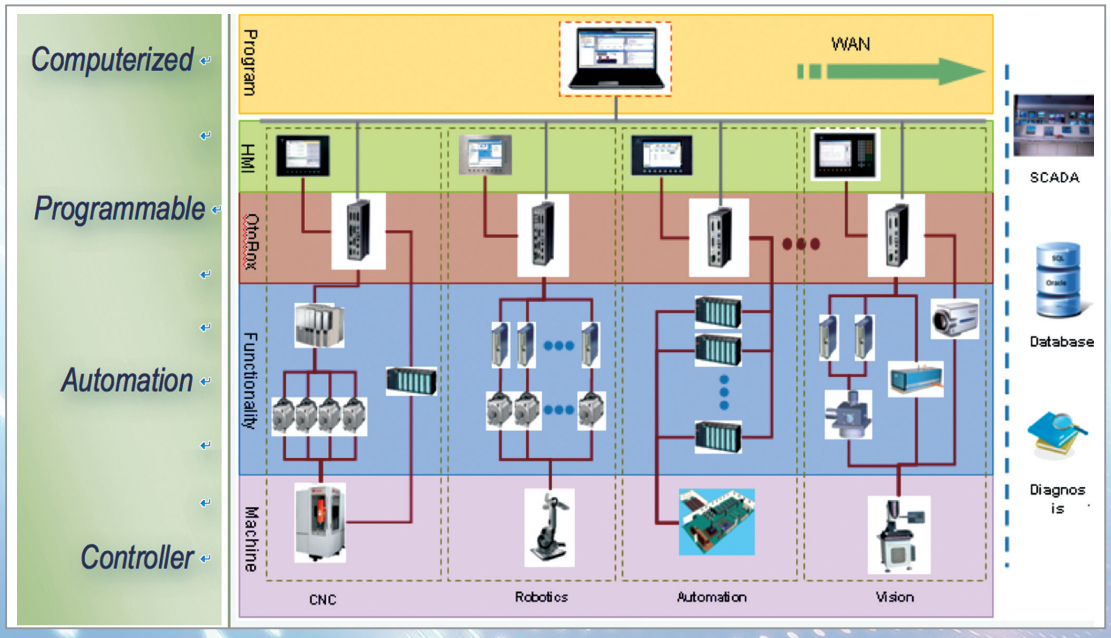
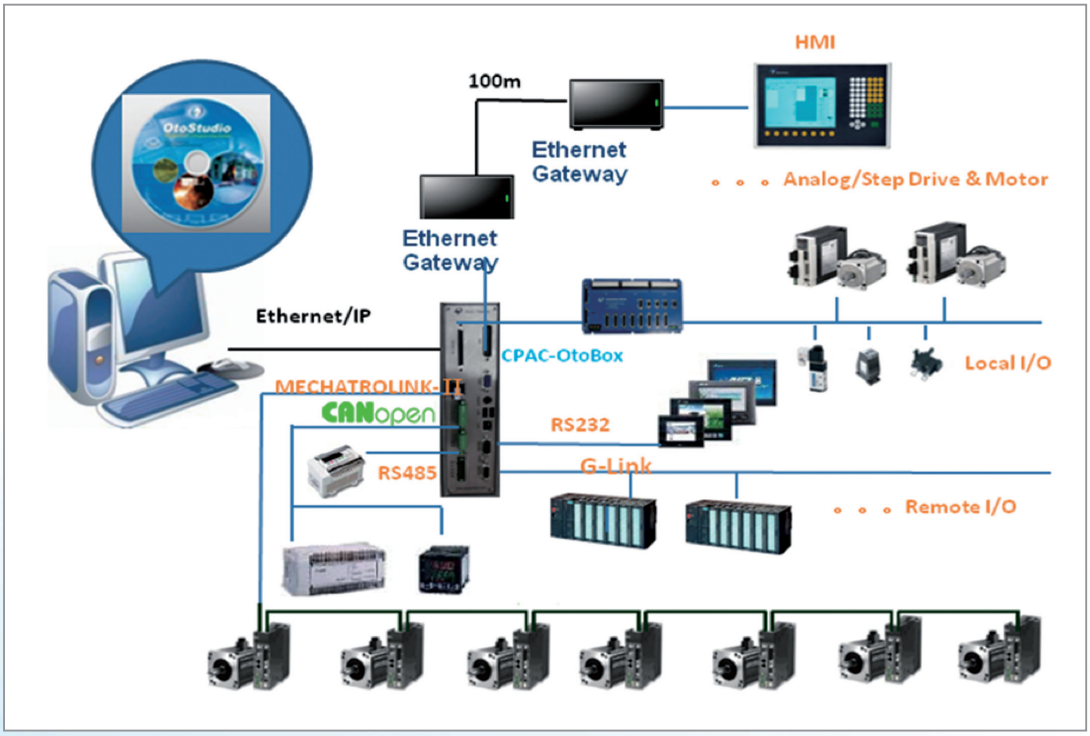


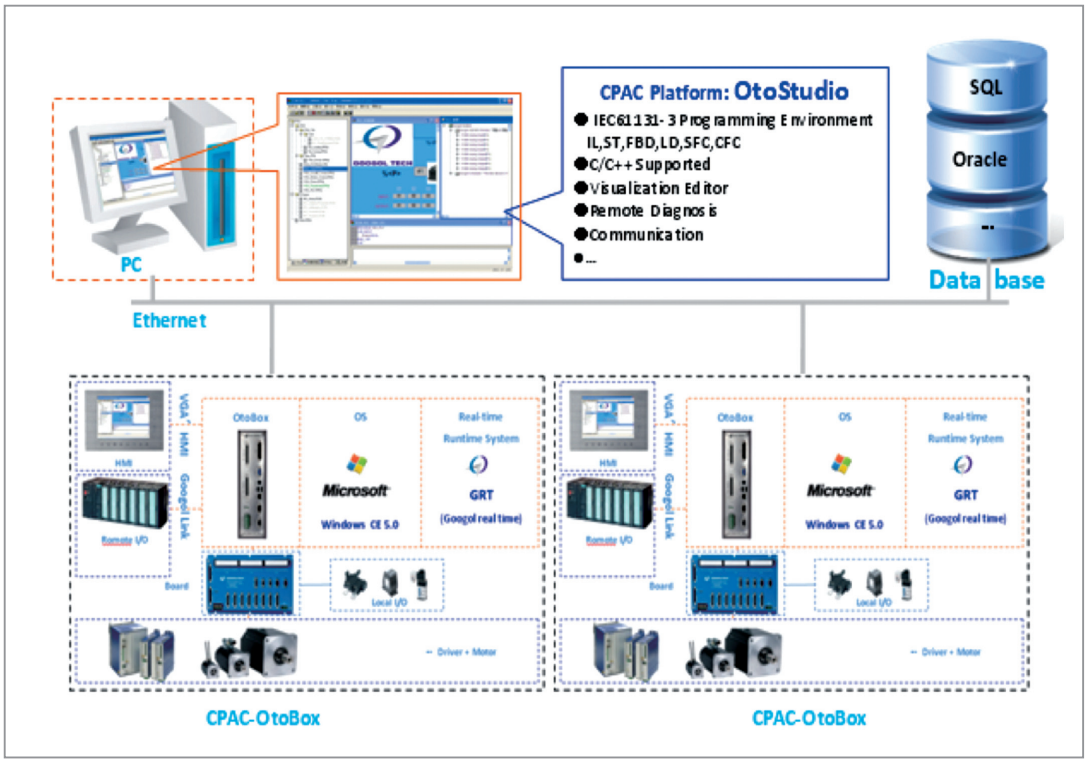
1. INTRODUCTION

Computerized Programmable Automation Controller (CPAC) developed by Googol Technology is a highly integrated development platform specialized for machine control system and factory automation. It consists of both hardware and software portions. The hardware part includes industrial PC, multi-axes motion controller, PLC, on-site networks and HMI technology. The software part includes a powerful program development tool named OtoStudio which is IEC61131-3 compatible programming environment with many extra functions.



CPAC System Diagram

Based on the long time practices and experience in industry by many customers and experts, the CPAC has been designed to meet the standards of industrial PC (JB/T 8384-1996) and PLC (GB/T 15969.2-1995), EMC and States safety criteria and CE certificates, etc. Equipped with high speed real-time motion control function, open software and hardware architecture, plentiful combination of HMI, the CPAC can provide users a powerful and low cost development platform and overall solution with independent intellectual property advanced equipment and automatic production line.



In comparison with the traditional control system, CPAC shows the advantages as below:

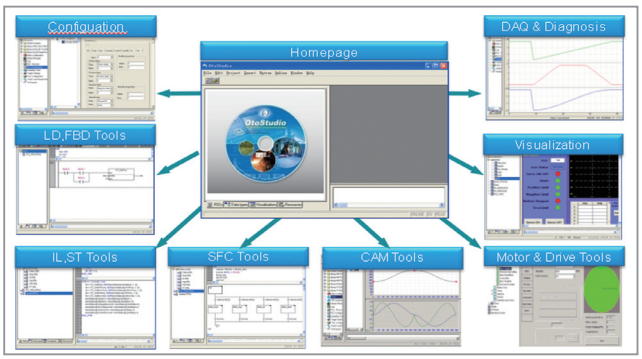
- **Powerful Functionality:** Motion Control, PLC and HMI all in one structure, flexible to configure the hardware and software development platform. It not only retains the openness, flexibility, scalability, high-speed computing and large storage capacity of Googol's existing motion controllers, but also has reliability of traditional PLC systems, simple programming and easy for maintenance features.
- **Applicability:** Multi-language for programing based on IEC 61131-3.
- **Reliability:** Multi-task & real-time control; high stability and reliability hardware
- **Efficiency:** Reusable design allows users to shorten the development cycle, hence more focus to their application solution.
- **Safety:** Fast DAQ & Encryption, including Online data acquisition, tracking the data curve and variables changes anytime and anywhere; and encryption for Source code, Licensing and Hardware Binding
- **Low cost:** CPAC features a highly integrated control system, with lower cost and better performance comparing to a decentralized control system.

Googoltech's CPAC technology has been successfully applied to many industrial areas such as open CNCs, package printing, industrial robots, metal processing and other industries. Its openness and good development platform of efficient, powerful, encryption and strong scalability characteristics has been well recognized by customers in many industrial areas.

2. SOFTWARE DEVELOPMENT PLATFORM

2.1 OtoStudio

The CPAC standard development platform named OtoStudio is a powerful software development tool. It support IEC61131 industrial standard and 6 commonly used programming languages, including Instruction List (IL), Function Block Board (FBD), Continuous Function Chart (CFC), Ladder Diagram (LD), Structure Text (ST), and Sequential Function Chart (SFC). It is also compatible with high level C or C++ languages. Other functions of CPAC such as hardware configuration, DAQ/ Diagnosis, Technical modules, application samples such as CNC, printing machines and robotics.



CPAC OtoStudio Software

OtoStudio is a programming tool that adopts IEC61131-3 standard industrial controller and PLC module. The application samples in the function database can be accumulated by overlapped uses of the modular programming manner, and therefore uses can program in higher efficiency and less mistake.

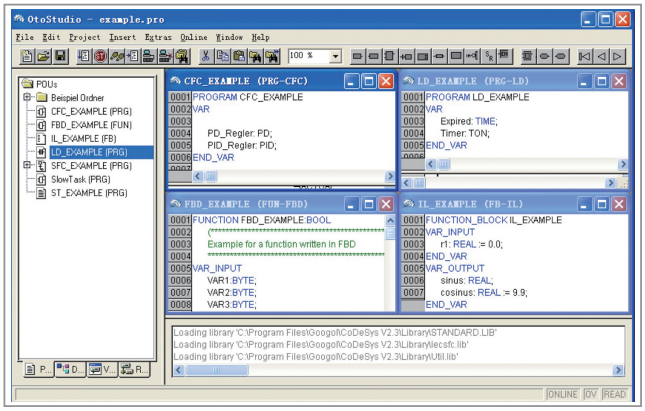
Equipped with control program editor and emulator debugger, OtoStudio is a comprehensive development kit for software programming and debugging, providing an easy-to-use tool for a powerful programming language to realize various control solutions as well as Offline simulation debugging tools to users.

2.2 Functions Blocks of OtoStudio

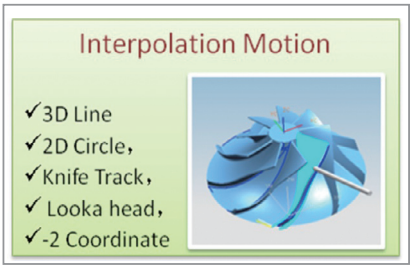
- Motion control function: Motion control function modules such as point-to-point continuous, synchronized are provided. Thus many types of motions such as PTP, JOG, PT/PVT, Electronic Gear Motion (GEAR), Electronic CAM Motion, Electronic follow (FOLLOW), Interpolation containing 3D Line, 2D Circle, Knife Track, Look-ahead, 2 coordinate, and PLCopen can be achieved.
- PLC function: Configuration of local IO and remote IO, debugging and testing functions; convenient to connect local or distance digital I/O modules, relay modules, analog I/O modules.
- HMI functions: A plentiful HMI configuration tool is provided, convenient for developing various customized MHI.
- OPC Server: convenient for connecting various outsource communication

2.3 Characteristics

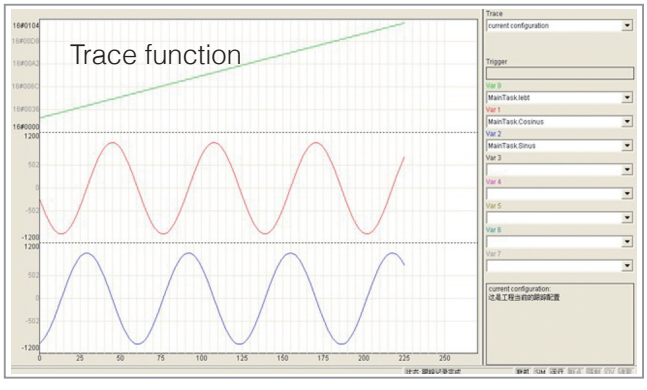
- Provide 6 programming languages that support IEC61131-3 standard, which contains Instruction List (IL), Function Block Board (FBD), Continuous Function Chart (CFC), Ladder Diagram (LD), Structure Text (ST), and Sequential Function Chart (SFC).



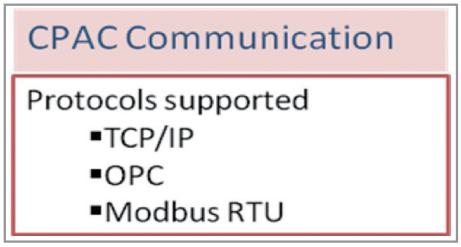
- Operates in many task-based methods, such as cyclic task, freewheeling task and event triggered task, etc. Based on the requirement, users can create the task priority list thought the task function, easy to program and maintain.



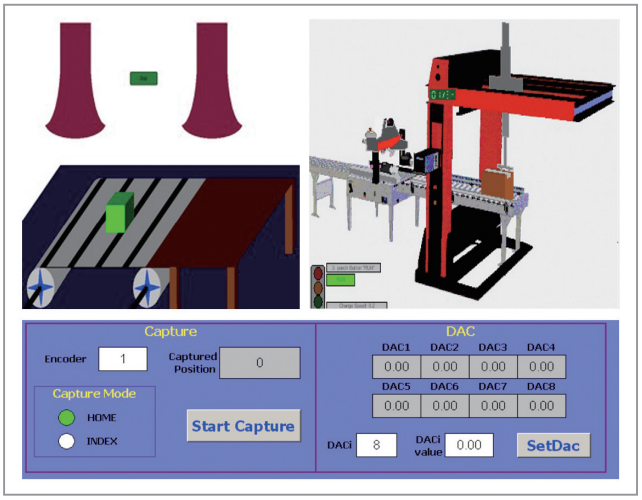
- Debug function: OtoStudio supports online debugging as well as Simulation debugging.
- Online support provides users efficient assistances.
- Inheritability which allows the programed modules to be packed transplanted and reapplied.



- Privacy encryption: OtoStudio provides the encryption function such as source code turn on encryption, amendment encryption, library encryption, cash receiving encryption, hardware bonding encryption to protect uses IP right.
- Remote diagnose function: System integrators can access the target machine via Ethernet, and process online programming, debugging, operating and maintaining etc.
- Simulation function
- Equipment protection function. Watch dog can be set up for each of the task.
- Automatic initializations function for multiple axes and remote IO modules.



In order to meet the requirement of many industrial applications, OtoStudio also provides many kinds of function modules such as CNC module (G-code analysis module, Compiling module, execution module, display module and editor module), Cross Cut module, and different types of robotics module for customer chose.

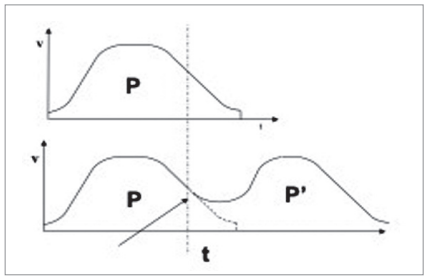


Graphic visualization

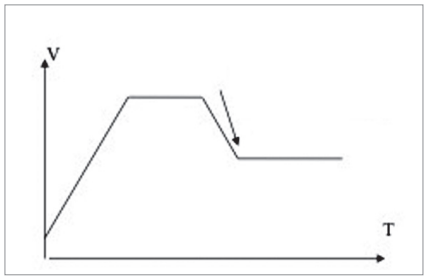
2.4 Application Function Modules

Motion Control Function

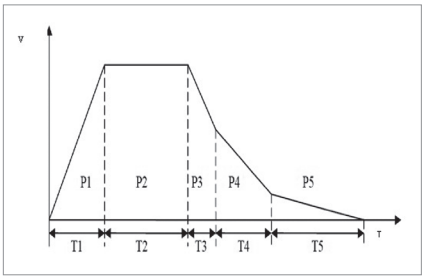
PTP: Symmetrical or non-symmetrical T curve and S curve	JOG mode: Online change the target velocity
PT/ PVT motion	Continuous motion: Linear Interpolation, circular Interpolation
Electric Gear Motion (GEAR)	Electric CAN Motion (CAM)
Offline running	Motion combination and compensation



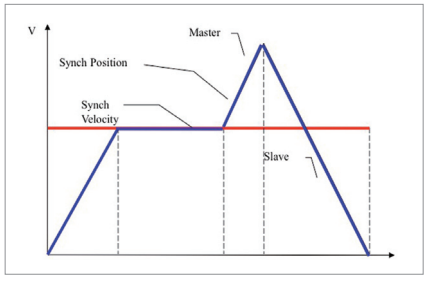
PTP Motion



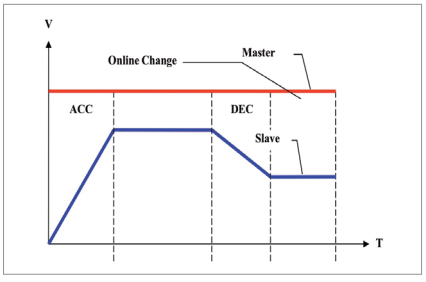
JOG Motion



PT/PVT motion

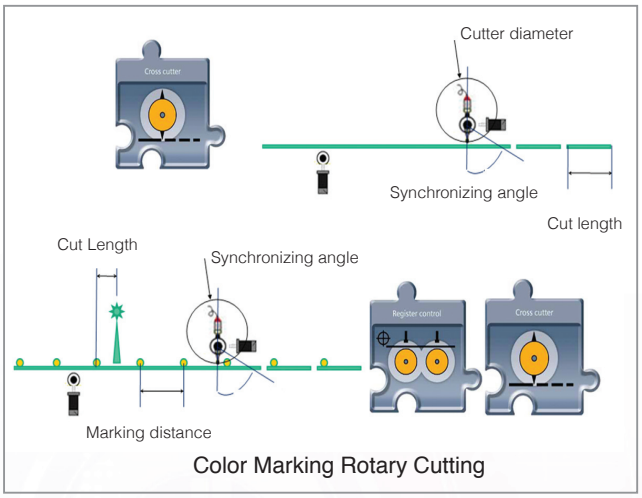


Electric CAM Motion

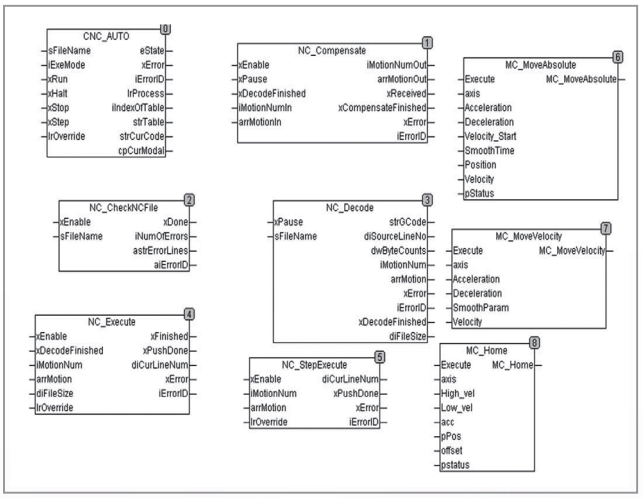


Electric GEAR Motion

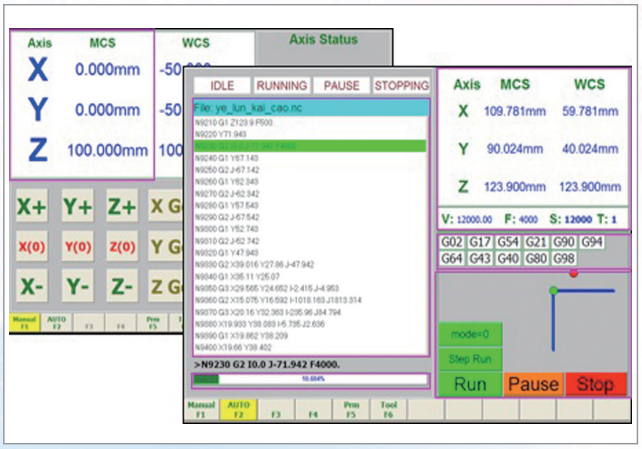
Cross Cut Module



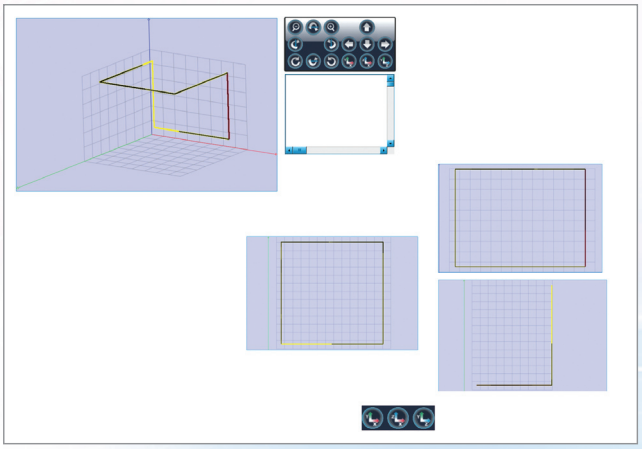
OpenCNC Functions Module



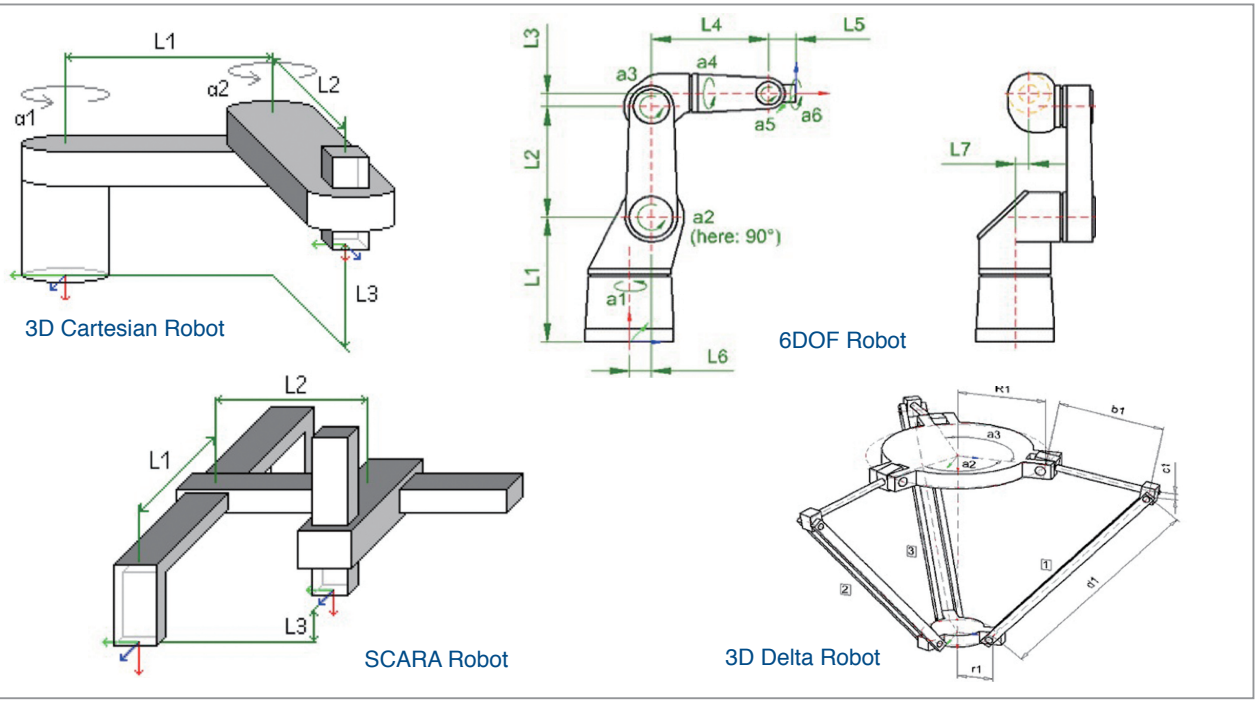
CNC HMI Control Module



CNC 3D and Text Editor Modules



Modules for Different Robots



2.5 Model Selection Guide

CPAC program software

Model No.	Name	Description
CPAC-OtoStudio-Std	Standard version	• IEC61131-3 program module • IO & field bus module • Distance debug & diagnose module • Visualized program module • Multi axes synchronized motion module (PT, GEAR, Interpolation)
CPAC-OtoSudio-Base	Basic version	• IEC61131-3 program module • IO & field bus module • Distance debug & diagnose module • Visualized program module
CPAC-OtoSudio-Test	Test version	• IEC61131-3 program module • IO & field bus module • Visualized program module

Note: PC configuration requirements for OtoStudio Software:

- Windows 2000/NT/XP, or 32bit Vista/Win7 OS
- CPU 600MHz or above;
- 256MB or above
- Hard disk 100MB or above

3. HARDWARE PLATFORM

CPAC-OtoBox hardware structure is highly integrated with industrial PC, PLC, multi-axes motion controller and HMI (PC+PLC+HMI+MC). Each module can be used in standalone or in combination.

3.1 Motion Controllers

CPAC-Otobox series motion controllers well developed by Googoltech consist of both industrial PC functions and motion control functions in-one-architecture. The highly integrated architecture shows advantages as below:

- Perfect integration of industrial PC and motion controller, less cost, less space, more reliable.
- Adopting low power consumption CPU, no fun need, no noise, and no vibration.
- 600MB-1.3GB,>256MBmemory, for high level OS, such as Win 2000, and XP.
- Three processors: CPU+DSP+FPGA, DSP for motion control, and FPGA for I/O processing.
- Equipped with VGA, USB, Ethernet, key board and mouse interfaces, flexible to use.
- HMI (LVDS, USB, PS/2) expansion interface.
- I/O expansion interface, convenient to connect distant I/O thought Googollink, and Siemens 300 series computable.

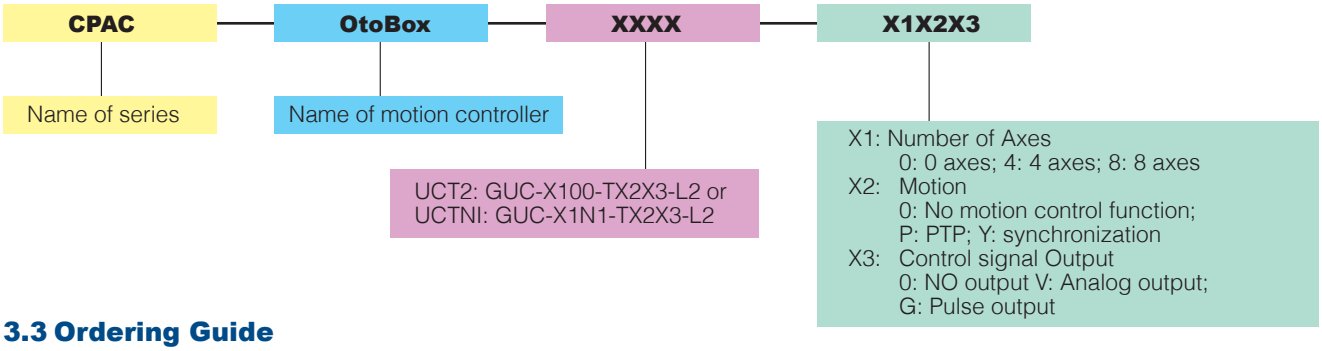
In addition, it also comes with greater thermal reliability, significantly boosting the shelf life of the systems and affording greater value and mileage for the customers.

Technical Specifications:

Embedded PC	• CPU: 600MHz，1GHz，1.6GHz • RAM: 512M,1G,2G • Display : VGA HMI (LVDS, USB, PS/2, RS-232) • Hard drive (selectable): DOM:1G, 2G, 4G , harddisk:80G, 120G • USB2.0 X 2 • Keyboard & Mouse: PS/2 X 1 • RS232 X 1 • Network: RTL8139, 10M/100M • Operation System: WinCE (Recommend 1G DOM)
Motion Control	Motors control • Pulse output, Max frequency: 1MHZ • Analog Output (TPV mode only): -10V to +10V, accuracy: 16bit • Encoder feedback, Max frequency: 8MHZ • Home &Index hardware capture • Limit sensor for Positive, Negative &Servo alarm Motion control functions • NON-Symmetry T-Curve, S-Curve motion planning • JOG mode • PT/PVT motion planning • E-Gear • Follow (E-CAM) • Linear interpolation and circular interpolation mode • Look ahead function • Hand wheel • Digital Filter: PID +Kvff+ Kaff • Configurable IO
Field Bus	• Mechatrolink II/Mechatrolink III/Realtime Express/CAN/Rs485
I/O	• 16 digital inputs/ 16 digital outputs
I/O extension	• Digital IO module, AD/DA module
Working Environment	• Temperature: 0~55℃ • Humidity: 5%~90%
Power	• +18V to +36V, Icc=3A Min
Dimension (GUC)	• 296mmx160mm × 75mm
Dimension (Terminal board)	• 292mmx165mmx42mm

3.2 Model Definition:

Part number description:



3.3 Ordering Guide

※ CPAC Package Configuration List:
User must select applicable type according to your requirements.

Model	Component	Model Number	Quantity
CPAC-OtoBox-UCT2-8PV	Motion controller	GUC-800-TPV-M01-L2-CPAC	1
	Terminal board	GT2-800-ACC2-V	1
	Cable	ACC3-T1-068015/30	2
	OS	WINCE 5.0(core)	1
	Real time software	CPAC-GRT-V2.1	1
	DOM	GUC-F1G	1
CPAC-OtoBox-UCT2-8PG	Motion controller	GUC-800-TPG-M01-L2-CPAC	1
	Terminal board	GT2-800-ACC2-G	1
	Cable	ACC3-T1-068015/30	2
	OS	WINCE 5.0(core)	1
	Real time software	CPAC-GRT-V2.1	1
	DOM	GUC-F1G	1
CPAC-OtoBox-UCT2-4PV	Motion controller	GUC-400-TPV-M01-L2-CPAC	1
	Terminal board	GT2-400-ACC2-V	1
	cable	ACC3-T1-068015/30	1
	O.S	WINCE 5.0(core)	1
	Real time software	CPAC-GRT-V2.1	1
	DOM	GUC-F1G	1
CPAC-OtoBox-UCT2-4PG	Motion controller	GUC-400-TPG-M01-L2-CPAC	1
	Terminal board	GT2-400-ACC2-G	1
	cable	ACC3-T1-068015/30	1
	O.S	WINCE 5.0(core)	1
	Real time software	CPAC-GRT-V2.1	1
	DOM	GUC-F1G	1
CPAC- OtoBox-UCT2-000 NOTE: Without Motion control function and local IO (Only PLC function)	Motion controller	GUC-400-TPG-M01-L2-CPAC	1
	O.S	WINCE 5.0(core)	1
	Real time software	CPAC-GRT-V2.1	1
	DOM	GUC-F1G	1

※ Necessary Components:

Name	Model number	Descriptions
Motion controller	GUC-800-TPV-M01-L2-CPAC	8 Axes, PTP, Analog & pulse output
	GUC-800-TPG-M01-L2-CPAC	8 Axes, PTP, pulse output
	GUC-400-TPV-M01-L2-CPAC	4 Axes, PTP, Analog & pulse output
	GUC-400-TPG-M01-L2-CPAC	4 Axes, PTP, pulse output
Terminal board	GT2-800-ACC2-V	For 8 axes analog output motion controller
	GT2-800-ACC2-G	For 8 axes pulse output motion controller
	GT2-400-ACC2-V	For 4 axes analog output motion controller
	GT2-400-ACC2-G	For 4 axes pulse output motion controller
cable	ACC3-T1-068015	1.5m
	ACC3-T1-068030	3m

※ Optional Components:

(I) IO modules

CPAC-300 series connect to motion controller as IO slave based on Googol-link 300 filed bus.

Interface Module: CPAC-IOET300 series		
Power supply		
CPAC-300-307-1BA00	voltage output: 24V DC	current:2.5A
CPAC-300-307-1EA00	voltage output: 24V DC	current output:5A
CPAC-300-307-1KA00	voltage output: 24V DC	current:10A
Digital input modules		
CPAC-300-321-1BH02	16 inputs, 24V DC	floating
CPAC-300-321-1BH50	16 inputs, 24V DC	resourcing
CPAC-300-321-1BL00	32 inputs, 24V DC	floating
Digital output modules		
CPAC-300-322-1BF01	8 outputs, 24V DC	floating
CPAC-300-322-1BH01	16 outputs, 24V DC	floating
CPAC-300-322-1BL00	32 outputs, 24V DC	floating
Relay Digital outputs modules		
CPAC-300-322-1HF01	8 relay outputs,	floating
CPAC-300-322-1HH01	16 relay outputs,	floating
CPAC-300-322-1HH50	16 relay outputs,	dry contact
Analog input modules		
CPAC-300-331-7KF02	8 inputs 12bit	current/voltage/resistance/thermocouple
CPAC-300-331-1KF01	8 inputs 13bit	current/voltage/resistance/thermocouple
Analog output modules		
CPAC-300-332-5HD01	4 outputs 12bit	current/voltage
DIN RAIL	CPAC-300-390-1AB60	160mm
	CPAC-300-390-1AD20	320mm
	CPAC-300-390-1AE80	480mm
	CPAC-300-390-1AF30	530mm
	CPAC-300-390-1AJ30	830mm
Front connector	CPAC-300-392-1AJ00	20-way
	CPAC-300-392-1AM00	40-way
Googollink cable	CPAC-cable-0015	

Name	Digital Input Module		
Model	CPAC-300-321-1BH02	CPAC-300-321-1BH50	CPAC-300-321-1BL00
Function	Connection with switch.		
Number of inputs	16	16 resourcing input	32
Input voltage	24V DC		
For “0” signal	0-5V	15-30V	0-5V
For “1” signal	15-30V	0-5V	15-30V

Name	Power Supply Module		
Model	CPAC-300-307-1BA00	CPAC-300-307-1EA00	CPAC-300-307-1KA00
Function	Protection against short circuit, overload and overheat, used as load power supply.		
Input voltage	100-240V AC	120-230V AC	120-230V AC
Frequency	50/60Hz		
Input current	1.5A MAX	2.1A / 1.2A	4.1A / 2.1A
Voltage output	24V DC ±3%		
Current output	2.5A	5A	10A

Name	Interface Module
Model	CPAC-IOET300
Function	CPAC-300 module can be used as Googollink300 slave
Input voltage	12~24V
Current voltage	1A Max(V-in = 15V)
Output voltage	4.75~5.25V
Output current	3A Max
Transmission distance	500m Max

Name	Digital Input Module	
Model	CPAC-300-321-1FF01	CPAC-300-321-1FH00
Function	Connection with switch.	
Number of inputs	8	16
Input voltage	120/230V AC	
For “0” signal	0-40V	0-40V
For “1” signal	79-264V	79-264V

Name	Digital Output Module		
Model	CPAC-300-322-1BF01	CPAC-300-322-1BH01	CPAC-300-322-1BL00
Function	Connection with solenoid valves, contractors, and small power motors within the permissible data.		
Number of outputs	8	16	32
Input voltage	24V DC		
Out voltage	L+ -0.8V	L+ -0.8V	L+ -0.8V
Max. output current	2A	1A	1A
Mini. Output current	5mA		

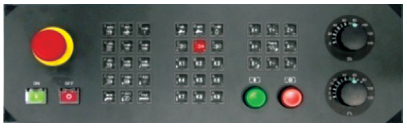
Name	Relay Output Module		
Model	CPAC-300-322-1HF01	CPAC-300-322-1HH01	CPAC-300-322-1HH50
Function	Connection with solenoid valves, contractors, and small power motors within the permissible data.		
No. of outputs	8 relay	16 relay	16 relay
Input Voltage	24-230V AC 24-120V DC	24-230V AC 24-120V DC	24-230V AC 24-120V DC
Switching frequency	resistive, 2Hz inductive, 0.5Hz	resistive, 1Hz inductive, 0.5Hz	resistive, 1Hz inductive, 0.5Hz

Name	Analog Input Module	
Model	CPAC-300-331-7KF02	CPAC-300-331-1KF01
Function	Connection with voltage and current sensors, thermocouples, resistors.	
Number of input	8	8
Used in resistance measurement	4	4
Input voltage L+	24V DC	
Input range Voltage	± 80mV, ± 250mV, ± 500mV ± 1V(10MΩ) ± 2.5V, ± 5V, ± 10V,1-5V(100KΩ)	± 50mV, ± 500mV, ± 1V(10MΩ) ± 5V, ± 10V,0-10V 1-5V(100KΩ)
Current	± 3.2mA, ± 10mA, ± 20mA 0-20mA, 4-20mA(50Ω)	± 20mA,0-20mA, 4-20mA (100Ω)
Resolution	9/12/12/14bit(400/60/50/10Hz)	13bit(60/50Hz)

Name	Analog Output Module
Model	CPAC-300-332-5HD01
Function	Connection with analog actuator
Number of output	4
Voltage input L+	24V DC
Out range	
Voltage	± 10V, 1-5V, 0-10V
Current	0-20mA, 4-20mA, ± 20 mA
Resolution	11+signbit (± 10V, ± 20 mA) 12bit (1-5V, 0-10V, 0-20 mA, 4-20 mA)

(II) HMI

Standard HMIs and customized HMI are provided for customer choses.



ACC6-PN5-T12-K61

12 inch touch screen

LCD Type	12 inch true colors TFT
Resolution	800×600
Total Dimension	483mm×320mm
Interface	VGA, RS232, HMI (LVDS, USB, PS/2, serial port)
Keyboard	61
Power supply	DC 24V

GTC-DP-01A

12 inch HMI & Control Panel

LCD Type	12 inch true colors TFT
Resolution	640×480
Touch function	NO
Total Dimension	483mm×310mm×62mm
Interface	HMI (LVDS, USB, PS/2, Rs232)
Keyboard	EXT IO
Power supply	61
Ingress protection	DC24V IP65

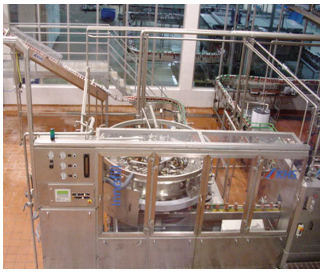
GTC-DP-01B

10 inch HMI & Control Panel

LCD Type	10 inch true colors TFT
Resolution	800×600
Touch function	NO
Total Dimension	236mm×174mm
Interface	HMI (LVDS, USB, PS/2, Rs232),
Keyboard	EXT IO
Power supply	61
Ingress protection	DC24V IP65

4. APPLICATION SAMPLES AND SOLUTIONS

Googol Technology is devoted to provide industrial automation equipment control system development platform products, solutions and services to our clients. Our products include motion controllers, human machine interfaces, remote I/O modules and automation software. They not only can be used as independent components but also can be integrated into an intact control system. They are widely used in electronics, medical, semiconductor, packing, printing, survey, plastic, metallurgy, textile, clothing, CNC, robots and other types of industrial equipment automation control fields.



CPAC SOLUTION IN PACKAGING INDUSTRY

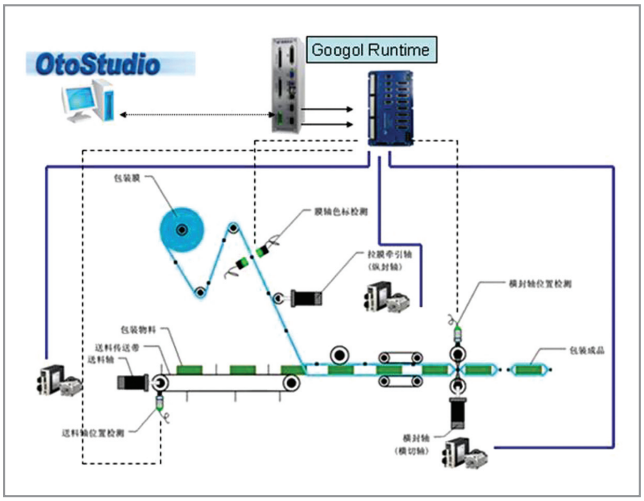
System Overview

Food, medicine, beverage, tobacco and other industries will need product packaging, packaging equipment. There are many types of packaging equipment, such as filling machines, sealing machines, wrapping machines etc. Generally speaking, packaging equipment is one that requires multiple-axis precise synchronized control and multiple I/O control.

System Principle

Packaging equipment is made up of control system, servos mechanism, machine tool body etc. Its control system consists of HMI, motion control function module, logic control function module. The HMI realizes the human machine interaction, the motion control functions module makes precise synchronous control of every axis possible, the logic functions module realizes loading and unloading, sensor signals control etc.

System Diagram:



System Configuration

By below a real life example of a three servo pillow packaging machine using Googoltech's CPAC, one can better understand the application of Googoltech's CPAC in packaging industry as well as other applications:

- Controller: CPAC-OtoBox-UCT2-4PV
- HMI: ACC6-PN5-T12-K8
- Local I/Os
- OtoStudio: the software development platform of pillow packaging machine.
- Servo mechanism: AC servo drive + AC servo motor

System Evaluation

Googoltech's CPAC is simple yet efficient development platform to shorten the development cycle of products, reduce system development and production cost. The integration of the system enhances the system stability, the use of E-CAM functions increase the packaging preciseness. The realization of remote diagnosis functions helps to cut the maintenance cost. The packaging speed can reach 200 packs per minutes and the packaging error is less than 1mm.

CPAC SOLUTION IN METAL CUTTING PROCESS

System Overview

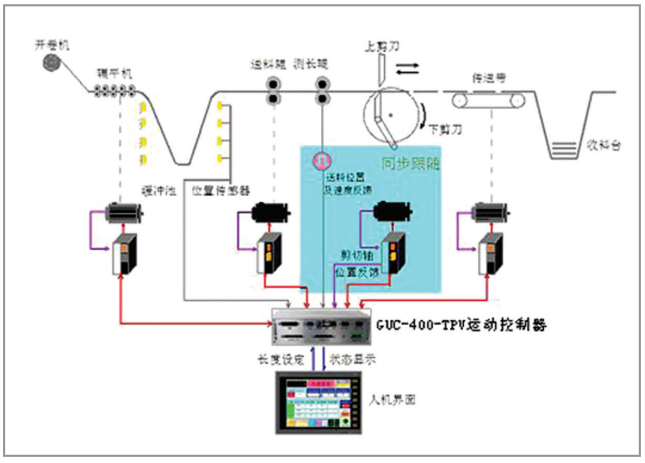
Flying shear, rolling shear and flying saw control system are important types of equipment for synchronized shearing of stripes, plates and pipes. They are widely used in processing of steel, aluminum and carton paper.

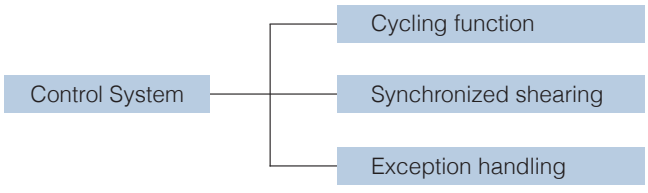
System Principle

The main function block of flying shear, rolling shear and flying saw control system are briefly explained as follows:

- Cycling function block:
- To manage the production process, including jogging, homing and rest of shearing axis, processing of production activation, acceleration, deceleration, stop and other operating signals.
- Synchronized shearing function block:
- Planning of shearing axis motions according to production requirements and encoder feedbacks.
- Exception handling function block:
- Handling of alarms in production process, motion error and encoder exception to ensure the safety of the machine.

System Diagram:





Control system the main function block

System Configuration

- Controller: CPAC-OtoBox-UCT2-4PV
- HMI: ACC6-PN5-T12-K8
- OtoStudio - Software developing platform of the flying shearing control system.
- Servo mechanism: HP AC servo drive + HP permanent magnet synchronous AC servo motor

System Evaluation

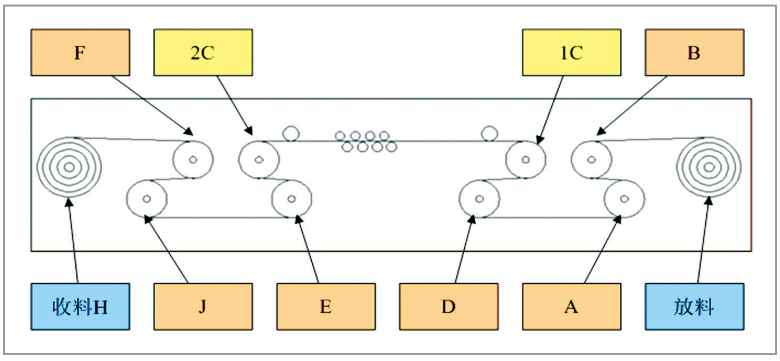
Synchronized following among different axes is fulfilled precisely via Googoltech's high performance motion controller. Reasonable motion planning curves ensure that synchronized following of acceleration, deceleration and high speed production process between shears and speed of production line, precision is thus raised and smooth cuts result. Friendly human machine interface makes operating convenient. The maximum shearing speed of the system can reach 300m/min. (shearing error $< \pm 0.3$mm). This proves that Googoltech's CPAC shearing system possesses high performance and reliability.

CPAC SOLUTION IN METAL STRETCHING PROCESS

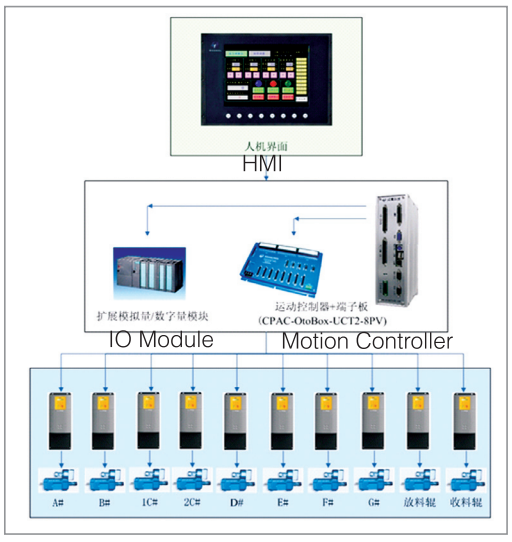
System Overview

The stretching-bending rectifier is an apparatus for rectifying metal sheets, its main purpose is for eliminating the surface wave edge, wave shape, buckling, and minor camber; it can also improve mechanical properties of the strips.

System Principle



System Diagram:



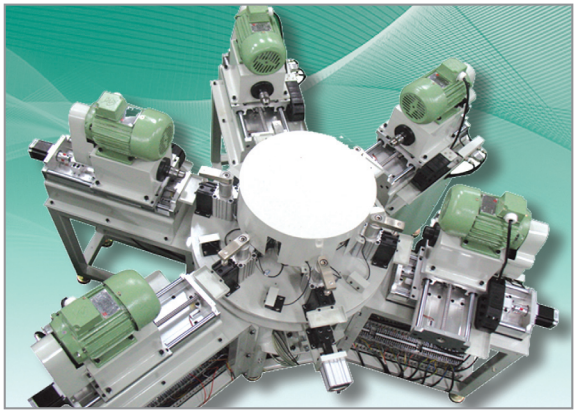
As shown in the above diagram, the transmission system that the rectifier needs to control includes feeding roller, import tension roller group, export roller group, and receiving roller. The import tension roller group includes four driving rollers (A, B 1C and D) while the export tension roller group includes four driving rollers (2C, E, J and F). All the driving rollers are driven by high power DC motors.

System Configuration

- Controller: CPAC-OtoBox-UCT2-8PV
- HMI: ACC6-PN5-T12-K8
- Local I/Os and remote I/O modules
- OtoStudio development software
- Servo system: High-power DC servo drive + High-power DC servo motor

System Evaluation

The maximum processing speed of the system can reach 100m/min while the percentage elongation is 0.1~0.3%. It shows that the control system based on CPAC has excellent performance and high reliability.



CPAC SOLUTION IN CNC MODULAR MACHINE TOOL

System Overview

The modular machine tool as well as the modular machine tool automatic line is specialized and high efficient automatic processing equipment. It is widely used in the field for production of cars, tractors, and internal combustion engines.

System Principle

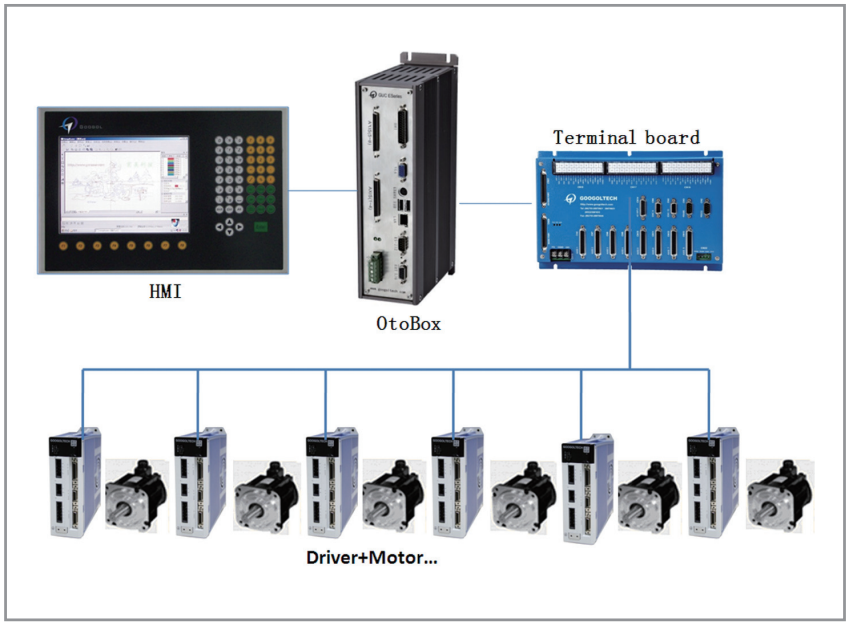
Modular machine tools consist of control system, electric operating system and mechanical body. This type of equipment consists of many stations. Each station is controlled independently.

6 work station machine tool

System Configuration

- Controller: CPAC-OtoBox-UCT2-8PV
- HMI: ACC6-PN5-T12-K61
- Local and remote I/Os
- OtoStudio development software

System Diagram:



CPAC SOLUTION IN 6 DOF INDUSTRIAL ROBOT

System Overview

The applications of 6DOF industrial robot include fields of automatic transport, assembling, welding, and spraying painting, etc. Googoltech's 6DOF robotic arm showcases the motion control technology, advanced design, and education idea. Not only does it satisfy the need of industrial site, it is also the ideal target of motion planning and programming design for educational and research institutes.

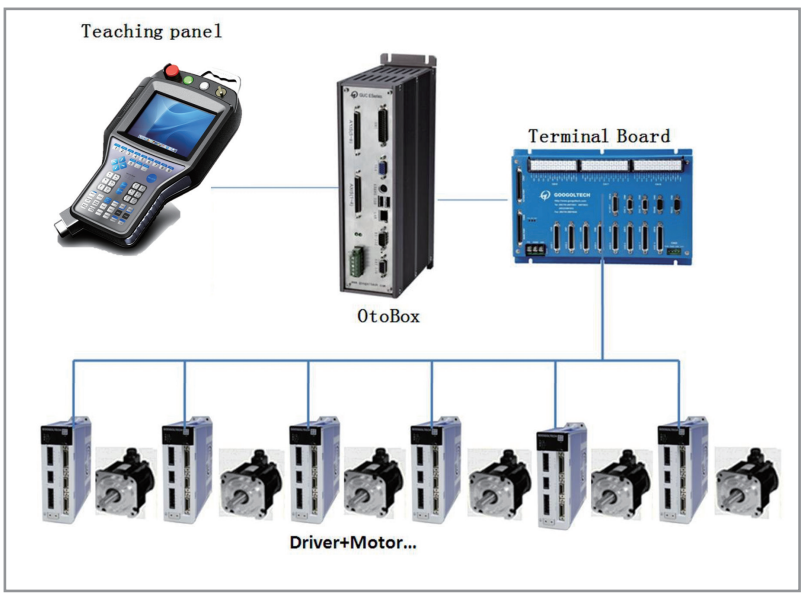
System Principle

- The open architecture robotic control system is built on high performance 8-axis embedded automation controller;
- Based on open, re-configurable OtoStudio platform, real-time precise control of robotic arm is thus ensured;
- Hand-held operation teaching panel is equipped for better manipulability.

System Configuration

- Controller: CPAC-OtoBox-UCT2-8PV
- HMI: GRP1000
- Local I/Os
- OtoStudio development software

System Diagram:



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