



COMPUTER INTEGRATED MANUFACTURING TRAINER



Configuration: DL CIM-CS

DL CIM-C

CIM (computer integrated manufacturing) is a manufacturing method, in which the entire production process is controlled by computer. This manufacturing method includes transversal applications in several didactic areas such as automation, pneumatics, electronics, mechatronics and process control.

De Lorenzo has developed station-based training systems, which allow the student to view a specific manufacturing process of an industrial production line. The trainer is a closed-loop control system based on PLC that exchanges information collected from sensors.

The version **DL CIM-C** integrates Conveyor belt, Linear Transfer unit, Pick and Place unit, six stations rotary table, drilling module, uploading arm, weighing module and palletizer.

TRAINING OBJECTIVES

DL CIM-C focuses on the study of the integration of the industrial sensors in process inspection as a support for manufacturing processing line. The trainer integrates the typical actuators (electric, pneumatic) into process executions. The performances of the actuators influence the quality of industrial automation functions. Together with the sensors, they ensure and multiply the value of manufacturing processes.

To study the components substations functionalities: linear transfer unit, horizontal transfer unit, pick and place unit, six stations rotary table, drilling module, uploading arm, weighing module and palletizer.

Ideal for 4 students to work simultaneously.

Vocational and technical schools.

And applicable to courses in:

- **Automation**
- **Electronics**
- **Mechatronics**
- **Electro pneumatics**
- **Process Control**

TECHNICAL SPECIFICATIONS

Power supply: single phase by the mains.
 Total power: 450W, 2A fuse on socket for overload and short circuit protections.

PLC included features:

- SIEMENS PLC S7-1200 series, CPU 1214C
- Expansion module SM1223 DI16/DO16

Models including HMI and SCADA software is also available:

- **DL CIM-CS_7INCH** with 7 inch HMI
- **DL CIM-CS_10INCH** with 10 inch HMI

The CIM system is also available with an open terminal block instead of the PLC. This version allows the connection of an external controller through the 2mm terminals. For the correct operation of the system, it is recommended to use a PLC with similar or improved characteristics (INPUT/OUTPUT) as the ones provided with our standard versions (see previous notes). Order code: **DL CIM-CT**

HIGHLIGHTS

The trainer is a real application of industrial sensors and actuators, programmable logic control (PLC), and dedicated information and computer technologies (ICT-s).

All training topics are designed for CIM applications understanding. The sensors are a support for inspections and manipulation, the actuators run process and the PLC monitors and controls manufacturing algorithms adjusting the processes variables.

It is the basic study of Flexible Manufacturing Systems, with benefits in increasing the machines utilization, reducing the manufacturing leading time, and ensuring high flexibility scheduling.

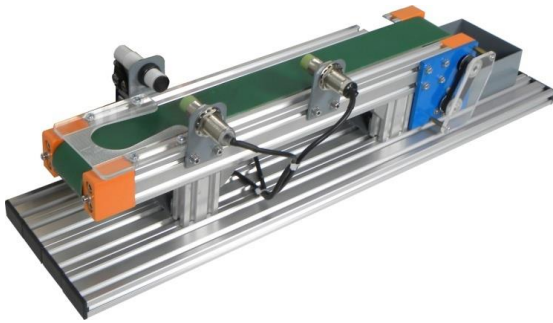
The following table shows the details of all the options available with ordering code.

	TERMINAL BLOCK	PLC SIMENS	TOUCH PANEL 7INCH	TOUCH PANEL 10INCH	SCADA SOFTWARE
DL CIM-CT	✓				
DL CIM-C_1200		✓			
DL CIM-CS_7INCH		✓	✓		✓
DL CIM-CS_10INCH		✓		✓	✓

Note: A compressor is needed (no less than 0.6Mpa). Module suggested: **DL 8110SLZ**



SUBSTATIONS DETAILS



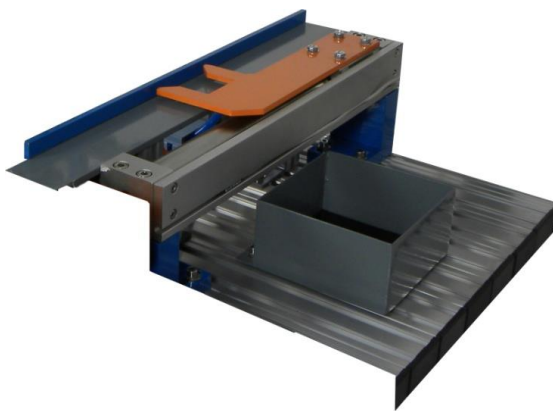
CONVEYER UNIT

This is a miniature model of a real time industrial conveyor system, driven by a DC motor.

The operation of the conveyor is limited to single direction according to the usage.

The conveyor belt rolls over two pulleys fixed on either end. The pulleys roll freely and maintain a free movement for the belt.

- Length: 480 mm.
- Width: 50 mm.

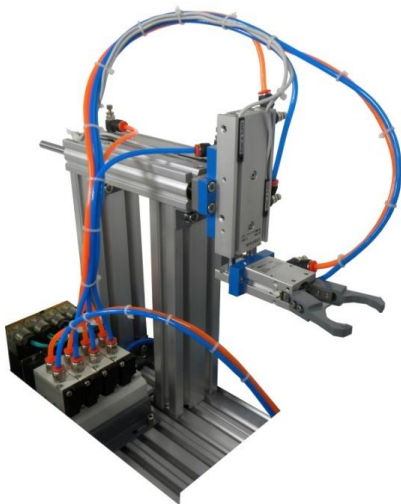


LINEAR TRANSFER UNIT

The Linear Transfer Unit is an electro-pneumatic controlled linear actuator. Magnetic switches are fixed to sense the retracted and extended position of the transfer unit.

It transfers materials from the conveyor with the help of a pneumatically operated rod less double acting cylinder.

- Cylinder: Pneumatic rod less (20 mm diameter, stroke length 200 mm).
- Travel length: 200 mm.



PICK AND PLACE UNIT

It is a totally electro-pneumatic control system. There are three main parts in this unit:

- a vertical arm (double acting cylinder),
- a horizontal arm (double acting cylinder), and
- an angular gripper (double acting angular gripper for holding work pieces).

Magnetic switches are fixed to sense the retracted and extended position of the vertical and horizontal arms; so, the Pick & Place Unit transfers the material from the Linear Transfer Unit end to the next Unit with the help of the vertical arm, the horizontal arm, and the angular gripper.

- Vertical travel: 50 mm.
- Horizontal travel: 125 mm.
- Load Capacity: 0.5Kg.



CONTROL SYSTEMS: SIEMENS AND ALLEN BRADLEY PLCs

There are programmable controllers that combine high performance and ease of use.

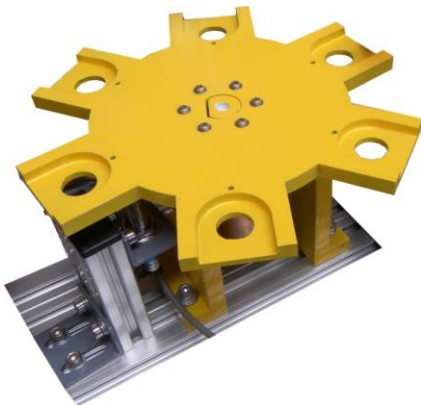
Their main advantages are:

- the flexibility, as they can be reprogrammed,
- the possibility of their use in environments with severe working conditions,
- the reliability and safety, and
- the possibility of processing both digital and analogue signals.

With this controller integrated into the system, the students can perform experiments commonly used in the industrial automation environment.

It includes 30 digital inputs, 26 digital outputs and 2 analogue inputs.

It can be programmed through the integrated Ethernet port with TIA portal software.



SIX STATIONS ROTARY TABLE

A Six Stations Rotary Table (also known as Rotary Indexer Supplier) consists of a horizontal circular worktable, on which the work piece is placed to be processed.

The worktable is indexed to present each work piece to each work head to accomplish the sequence of machining operations.

The control and driver use electrical energy.



DRILLING MODULE

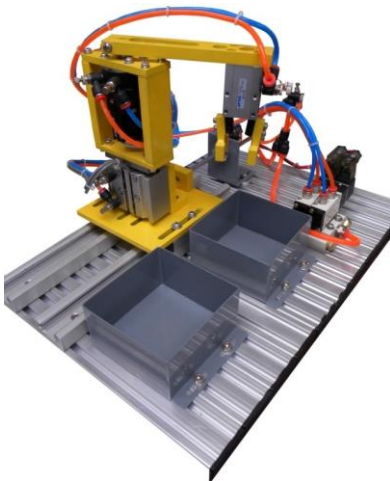
The module simulates the function of drilling the work piece. The PLC tells the vertically double acting flat cylinder to position the drilling device near the work piece and to start the drilling device.

The Drilling module is pneumatically operated with several main characteristics:

- Speed: 22000 RPM
- Compressed air flow: 4 CFM (Cubic Feet per minute)
- Work pressure: $0.5 \div 0.8$ Mpa
- Connection Port: $\frac{1}{4}$ inch

Lifting cylinder: 16 mm diameter & Stroke length 60mm

Fixed cylinder: 10 mm diameter & Stroke length 10mm.

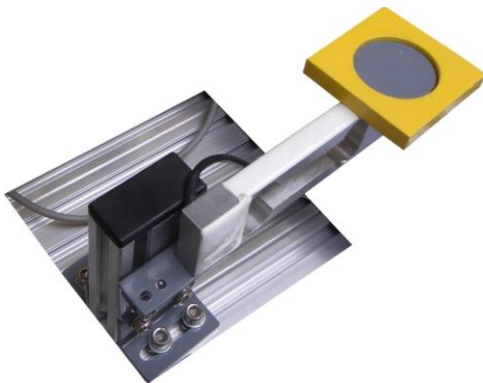


UPLOADING ARM

The uploading arm or horizontal Pick & Place Unit is an electro-pneumatic system in which the movement is controlled by a linear and rotary actuator. This system works as a miniature pick and place robot with a limited path application.

The uploading arm is used to transfer the components or work pieces from one workstation to the other. It is pneumatically operated with main characteristics:

- Slide table drive cylinder: 10 mm diameter & stroke length 200 mm
- Lifting cylinder: 16 mm diameter & stroke length 20 mm
- Rotary cylinder: $0 \div 180^\circ$
- Load Capacity: 0.5 kg.



WEIGHING MODULE

The weighing module consists of two elements: the load cell and the interface circuit. The load cell generates a variable resistance value related to the weight of the object that is placed over it.

The interface circuit receives processes and sends this value to the analogue input of the PLC, which determines the correspondent weight of the work piece placed over the load cell.

The measuring principle: balance beam-single point weighing with:

- Rated load: $0 \div 1$ kg
- Output: $0 \div 10V$.



VISION SYSTEM

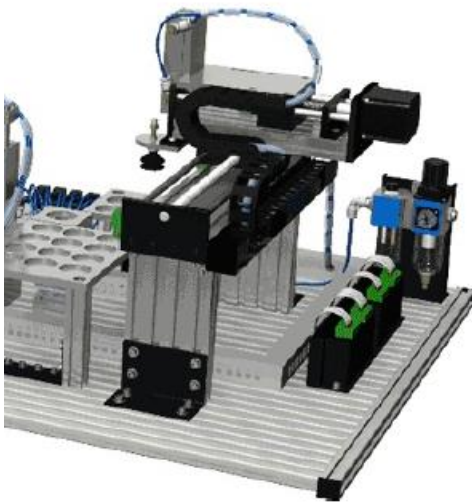
The vision system is a compact visual sensing equipment, which is used for quality control inspections in automated production lines. The vision system serves under the class of visual sensing methods. It basically analyses an image obtained by a video camera, displays it, and reports its characteristics to the system controller.

Camera parameters:

- set distance (L): 100 to 800 mm.
- detecting range (H): 10 to 60 mm.
- built in lens: focus f13.47.
- sensor component: 1/4-inch CMOS.
- shutter: electronic shutter,
- time: 1/1.000 to 1/4.000.
- power supply voltage: 12 Vdc.
- current consumption: 500mA.

Visual process module parameters:

- output parameters: relay output, 30Vdc, 3A, none offset voltage.
- teaching area size: mode (PTRN), brightness (BRGT).
- sensor area: 660mm x 660 mm.
- resolution ratio: 1280*720.
- output signal:
 - (1) DN- Identify finished.
 - (2) ERR- error output.
 - (3) B0-B3: recognition result output (binary type coding method).
- output signal EN: start recognition.
- sensor head interface: 100M internet access (TCP/IP) interface.
- image display: H.264 compress 720P.



STACKER CRANE - PALLETIZER

Stacker crane - also called palletizer; it is used for palletizing (placing) the work piece in a particular order. Our XY palletizer is a stepper motor-controlled unit. The motor controls the movement and the position of the axis of the Palletizer. For work piece handling, a suction cup is provided which is controlled using a double acting flat cylinder that will extend & retract to pick up or dispense the work piece.

The driver adopts AC servo driver current loop for subdivided control, motor low speed running stable, almost no shake and noise. Suit for various CNC mechanical, robotic, cash-counting machine industries.

Its main parameters are:

- Input voltage: 24-50Vdc signal voltage power supply.
- Phase current: it can be adjusted between 1.3 and 4.5A.
- Running method: 1/2, 1/4, 1/8, 1/16, 1/32, 1/64, 1/128, 1/256 steps.
- 1/5, 1/10, 1/25, 1/50, 1/125, 1/250 steps.
- Protecting method: overheat, overpressure, overcurrent protection.
- Input method: single/dual pulse input compatible.
- Suitable motor: 85mm, 57mm and two-phase stepper motor with current less than 4.5A.

The technical parameters of the crane are:

- X axis and Y axis: trip all is 200mm.
- vertical lifting cylinder: diameter is 12mm, travel is 60mm.
- four inductive approach switches: use to detecting X axis and Y axis limit position.
- operating pressure: 0.6MPa.
- I/O point: 6 input and 6 output



CIM



Available only for the following models:

DL CIM-CS_7INCH

DL CIM-CS_10INCH



Available only for the following models:

DL CIM-CS_7INCH

DL CIM-CS_10INCH

HUMAN MACHINE INTERFACE (HMI)

It is a computer based DCS and power automation monitoring system, which has a wide application area and can be used for data acquisition, supervisory and process controls, and it is the most widely used in power systems.

With this unit added to the system, the students can perform experiments commonly used in the industrial automation environment.

It has a high resolution and includes I/O interfaces such as Serial interface and Ethernet 10/100 base-T.

it is available in 7-inch or 10-inch

Supervisory Control And Data Acquisition (SCADA) software

The system is supplied with **Supervisory Control And Data Acquisition (SCADA)** software and already installed in the HMI unit.

It occupies an important position in remote control systems and can monitor and control on-site operating equipment to achieve functions such as data acquisition, equipment control, measurement, parameter adjustment, and various signal alarms. It interfaces with the CIM's PLC.



EXPERIMENTS DESCRIPTION

On the inspection area (a), the capacitive sensor detects metals, the inductive sensor distinguishes the difference between metals and plastic, and the photoelectric switch detects reflexivity of the object for correct positioning.

In the transfer area (b), electromagnetic (reed) sensors collect information regarding strokes of the horizontal rod less cylinder.

On the handling area (c), electromagnetic (reed) sensors detect correct positions of the arms during manipulations.

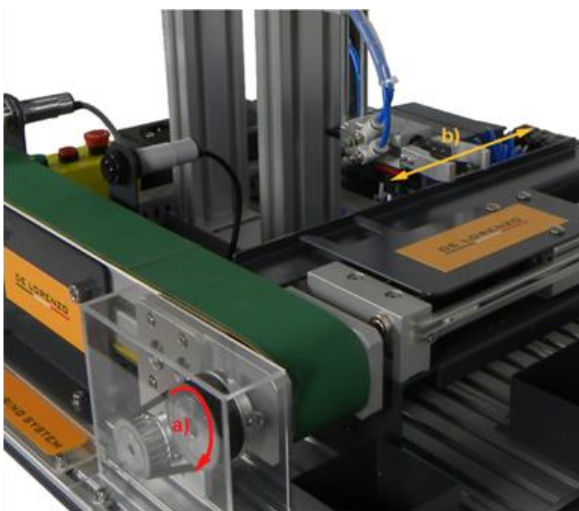
Integration of the sensors in CIM experiments:

- **Capacitive proximity switch**
- **Inductive proximity switch**
- **Photoelectric switch**
- **Electromagnetic sensors**



Integration and control of dedicated actuators experiments:

- **DC motor control**
- **Pneumatic cylinders control**



The **DL CIM-C** trainer offers an excellent possibility to study, understand, and design the most appropriate applications of a DC motor use (a). Simple, easy to control, with some proper gear, the application for belt conveyor is fast integration of this electric machine in manufacturing chain.

The pneumatic actuators, with their elasticity, offer best solutions for alternative linear displacements, and grippers. Together with its electric and pneumatic controlling accessories, and the use of PLC, these execution elements define and describe in an excellent form the mechatronics concept.

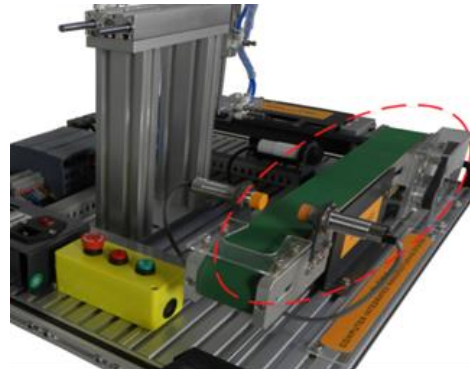
Through these experiments, the student/user can compare the possibilities of expansion for these actuators, following the main formulated functions for the manufacturing process design.



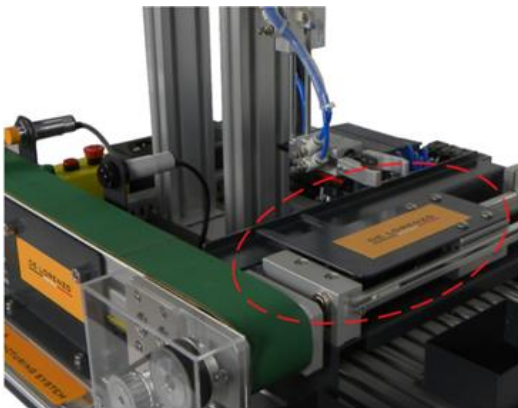
Around a PLC program, that integrates different kind of signals (detection whether has work piece, metal work piece detection, detection whether the work piece coming, START/STOP commands), it is built a linear transportation system, as manufacturing function.

Different kinds of working zones are identifiable: process controlling, inspection area, delivering point.

Substation functionality: Linear transfer unit experiment



Substation functionality: Transfer unit experiment



Around a PLC program, that integrates different kind of substation signals (linear transport cylinder stretch out detection, linear transport cylinder retract detection with upstream process signals and type of transported materials), it is built a transfer substation.

Through this experiment, we understand the operations sequence and dependencies of the material transportation and handling up to the moment of materials transferring substation.

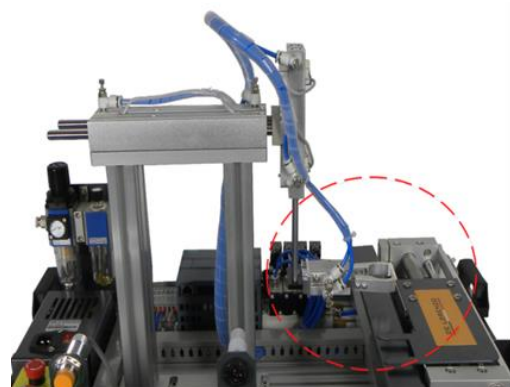
These understood and clarified handling constraints allow expanding solutions for many other classes of transported materials.

Around another PLC program, that integrates different kind of substation signals (horizontal cylinder stretch out detection, horizontal cylinder retract detection, vertical cylinder stretch out detection, vertical cylinder retract detection) with upstream process signals (related to availability of the materials), it is built this pick and place substation. The implementation and the control of the gripper is the core idea.

Through this experiment, we understand the operations sequence and dependencies of the material transportation and handling up to the moment of materials transferring substation.

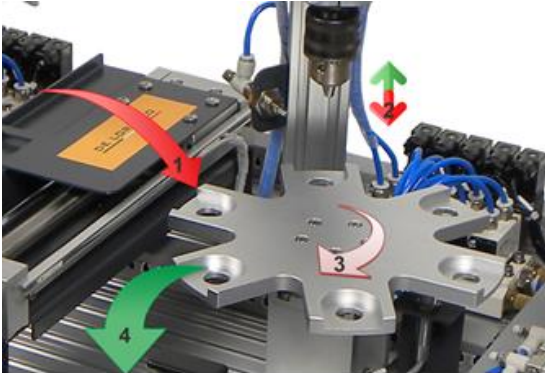
These understood and clarified handling constraints allows expanding solutions for many other classes of transported materials.

Substation functionality: Pick and place unit experiment





Six Stations Rotary Table Experiment



We study here an integrated motion system (motors, mechanical power transmission devices, encoders, sensors, and controllers). We underline the important parameters for rotary indexing tables (the needed resolution of the application, the required repeatability and accuracy, and other mechanical parameters such as acceptable levels of backlash or hysteresis).

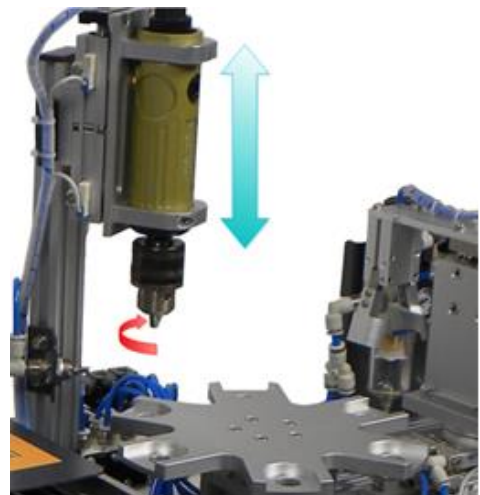
Another key parameter is the loading including torque, axial, radial, and moment loads. These can impact the type and size of the indexer used in each application - probably it is the most important element in the production chain (four major interconnected operations: 1- 4).

A rotary indexing table can be used in many applications including manufacturing, inspection, and assembly tasks

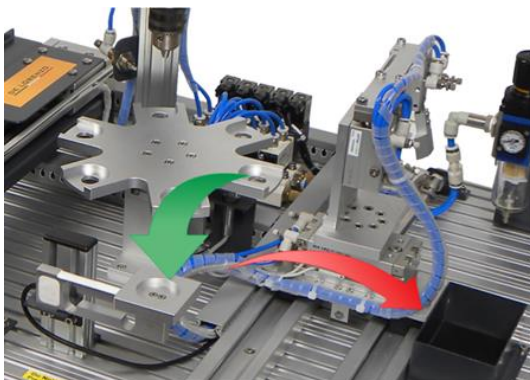
Hole drilling operation using an elastic driving system (pneumatically operated) offers the possibility to observe, understand, and design later, the main operations: connecting the air source output port of the compressor to the air source input, turning the pressure regulating valve, the drilling control, till the ending operation. It is an application and technique that utilizes high pressure to obtain a mechanical movement.

As for many other machine tools used in industrial processes, this station is equipped with standard control (manual or automated, emergency actions). At the same time, we underline some major advantages: safe, robust, powerful, long lasting, easy to maintain.

Drilling Module Experiment



Uploading Arm and Weighing Module Experiment



A simple and robust decision maker algorithm has been implemented in DL CIM-C based on the weight of the work pieces.

The uploading arm is controlled for selecting pieces of work, in a programmed operations sequence. During the experimenting time, the automation of the uploading process is tested as a concept.



Visual Inspection Module



Vision inspection systems provide image-based inspection automated for your convenience for a variety of industrial and manufacturing applications. They can measure parts, verifying parts are in the correct position, and recognizing the shape of parts. Computer software processes images captured during the process you are trying to assess to capture data, and they can be embedded into your lines to provide a constant stream of information.

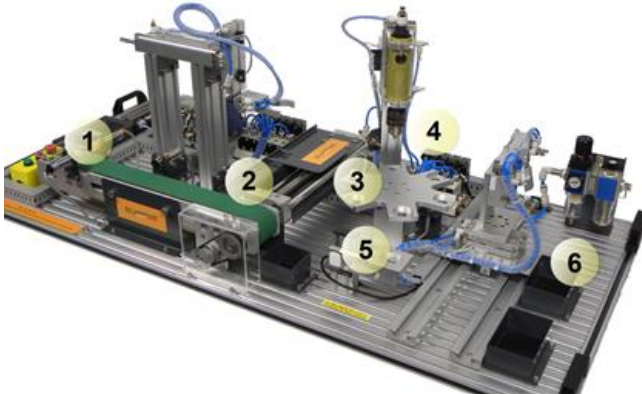
The visual inspection module has two work modes: learning mode and compare mode; learning mode is used to update the contrast images stored in the system; the compare mode is that the camera compares the store image with the shoot one, to determine that this image is similar with which picture that pre-existing in the system.

These systems can be used in any number of industries in which quality control is necessary. For example, they can assist robotic systems to obtain the positioning of parts to further automate and streamline the manufacturing process.

The data collected by a vision system can help improve efficiency in manufacturing lines, sorting, packing and other applications. In addition, the information captured by the vision system can identify problems with the manufacturing line or other function you are examining to improve efficiency, stop inefficient or ineffective processes, and identify unacceptable products.



Integration of the substations: CIM experiment



The DL CIM-C trainer offers excellent possibility to study, understand, and design the most proper applications where particular substations are implemented to work together.

The experiment is mostly focused on sequential execution of different manufacturing operations:

- 1- reception, loading and first inspection, then transporting materials according with the processes flow,
- 2- selection point according with inspection algorithms,
- 3- locating on rotary index for repetitive operations,
- 4- example of technological process (drilling machine),
- 5- selection point according with another specific criteria (weight),
- 6- output selection, palletizing, and preparation for expedition.

One time we understand the main operations of defined manufacturing system, the success of using this trainer would be the measure of expansion, or customization according to local requirements.

In actual implementation, the PLC sub-programs are working in CIM experiment, like program routines that allow easy understanding of the programming manner