مجلة جامعة الملكة أروى العلمية المحكمة

QUEEN ARWA UNIVERSITY JOURNAL

Practical PLC Applications

التطبيقات العملية لانظمة التحكم المبرمجة

د. رعد حمدان ظاهر

وزارة التعليم العالي والبحث العلمي - بغداد - العراق

Dr.Raad.H.Thaher

Ministry of Higher Education and Scientific Research-Baghdad-Iraq

ISSN: *2226-5759* ***ISSN Online:*** *2959-3050* ***DOI:*** *10.58963/qausrj.v1i5.13*

Website: *qau.edu.ye*

Abstract

The programmable logic control systems are required for most industrial applications due to its fast response time and it has less troubleshooting . In this paper we use the PLC system to carry out three different process Drilling process, and transferring process using PLC model S7-300 and the lift control using PLC model S7-200. The flow chart of each system was presented and they are carried out practically without any error. Suggestion for future work was indicated.

الملخص

تعتبر انظمة التحكم المبرمجة من الاجهزة الشائعة الاستخدام في العمليات الصناعية بسبب استجابتها السريعة وخصائصها الاخرى التي تميزها عن الاجهزة الاخرى. وقد تم في هذا البحث شرح ووصف اجهزة التحكم المبرمجة اضافة الى تنفيذ ثلاثة انظمة عملية باستخدام انظمة التحكم المبرمجة وهي:

عملية التثقيب وعملية التحويل والمصعد الكهربائي

ونلاحظ من خلال تنفيذ البرامج الخاصة بهذه العمليات ان اي خطأ يؤدي الى عدم عمل اي نظام وهذا يؤشر لنا مدى دقة هذه الاجهزة كما ان عملية تصحيح الخطأ او الصيانة أسهل نسبيا من الاجهزة الاخرى..

1.Introduction [1]

Programmable logic control or PLC is the most commonly used industrial automation technique in the word .It is universally applied for factory automation, process control and manufacturing. Programmable logic control is originated from the creation of computerized versions of relay control systems used to control manufacturing and chemical process systems. The programming is done using a special technique called ladder logic, which allows sequences of logical actions to be set up, interlinked and timed. A standard task in logic control is batch control and sequencing in a process system. The PLC was invented in response to the needs of the American automotive industry. Before the PLC control, sequencing, and safety interlock logic for manufacturing automobiles and trucks was accomplished using relays, timers and dedicated closed loop controllers. The process for updating such facilities for the yearly model change-over was very time consuming and expensive, as the relay systems needed to be rewired by skilled electricians. Now one PLC can easily run many machines and the process of correcting errors in PLC is extremely short and cost effective. Also we can have thousands of contact timer and counters in a single PLC.

2. PLC Structure

Typically any PLC consist of the processor, memory,power supply unit , input/output interface, and the programming device as shown in figure(1).The processor unit or the central processing unit (CPU) is the unit that contain the microprocessor and interprets the input signals and carries out the control actions according to the program stored in its memory, communicating the decisions as action signals to the outputs. The function of the power supply unit is to convert the main a.c voltage to a low d.c voltage (5v) necessary for the processor and circuits in the input and output modules. The programming device is used to enter the program required into the memory of the processor. The program is developed in the device and transferred to the memory unit of the PLC. The program is stored in the memory unit and used for control actions to be exercised by the microprocessor. The input and output units are where the processor receives information from external devices and communicates information to external device. The basic internal architecture of PLC is shown in figure (2).It consist of the central processing unit (CPU) containing the system microprocessor, memory, and input/output circuitry. The CPU controls and processes all operations within the PLC. It is supplied with a clock with a frequency, typically, between 1 and 8 MHZ. This frequency determines the operating speed of the PLC and provides the timing and synchronization for all elements in the system. The information within the PLC is carried by means of digital signals. The internal paths along which digital signals flow are called buses. A bus, physically, is a number of conductors along which electrical signals can flow. It might be tracks on a printed circuit board or wires in a ribbon cable. The CPU uses the data bus for sending data between the elements, the address bus send the addresses of locations for accessing stored data and the control bus for signals related to internal control actions. The system bus is used for communications between input/output ports and input/output unit.

3. PLC Operation

A PLC works by continually scanning a program. The scan cycle consist of three important steps as shown in figure (3) and all the others are checking the system and updating the current internal counter and timer values. The first step include checking the input status by looking at each input if it is on or off with the help of input sensors. The second step executes the program one instruction at a time. The third step (final step) includes the updating of the output status. After the third step the PLC goes back to step one and repeats the steps continuously. One scan time is defined as the time it takes to execute the three steps above.

4. Logic Sensors

The function of the sensor is to allow the PLC to detect the state of a process. Logical sensors can only detect a state that is either true or false. The most common physical phenomena that can be detected by PLC sensors are:

1. Inductive proximity: where there is a metal object near by.
2. Capacitive proximity: where there is a dielectric object near by.
3. Optical presence: an object breaking or reflecting a light beam.
4. Mechanical contact: an object touching a switch.

They are available in many forms from multiple vendors, such as, Allen Bradely, Omron….etc.Each sensor has specific interface requirement.

5. PLC Programming

Programs for microprocessor based systems have to be loaded into them in machine code, this being a sequence of binary code numbers to represent the program instructions. However, assembly language based on the use of mnemonics can be used, e.g LD is used to load the data that followed the LD. The assembler is used to translate the mnemonics into machine code.

The function of all programming languages is to allow the user to communicate with the programmable controller via a programming device. Ladder diagrams, Instruction lists, Function Blocks, and sequential function chart are the most common types of languages encountered in programmable controller system design.

5.1 Ladder Diagrams

Avery commonly used method for programming PLCs is based on the use of ladder diagrams (writing a program is equivalent to drawing a switching circuit).The ladder diagram consists of two vertical lines representing the power rails. Circuits are connected as horizontal lines, the rungs of the ladder, between these two verticals. Figure (4) shows the scanning of the ladder program taking into account the following:

1. The vertical lines of the diagram represent the power rails between which circuits are connected.
2. Each rung on the ladder defines one operation in control process.
3. A ladder diagram is read from left to right and from to bottom.
4. Each rung must start with an input or inputs and must end with at least one output.
5. Electrical devices are shown in their normal condition.
6. The inputs and outputs must all identified by their addresses.

Figure (5) shows the standard symbols used for input and output devices. Figure (6) shows the ladder diagram which represents a motor, as an example, controlled by two keys, the first key for the start and the second for stop, in addition to two lamps. The first lamp indicates to the power supplied upon the motor, and the second lamp indicates when there is no power supplied to the motor. Another programming method can be achieved using instruction list. For this mnemonic codes are used, each code correspond a ladder element. The codes differ from manufacturer to manufacturer. Table (1) shows some of the codes used by manufacturers, and the proposed standard for instructions. Figure (7) shows a sample of a ladder diagram and its equivalent function block diagram.

IEC 1131-3	Mitsubishi	OMRON	Siemens	Telemecanique	Sprecher+ Schuh	Description
LD	LD	LD	A	L	STR	Start a rung with an open contact
LDN	LDI	LD NOT	AN	LN	STR NOT	Start a rung with a closed contact
AND	AND	AND	A	A	AND	A series element with an open contact
ANDN	ANI	ANDNOT	AN	AN	ND NOT	A series element with a closed contact
O	OR	OR	O	O	OR	A parallel element with an open contact
ORN	ORI	OR NOT	ON	ON	OR NOT	parallel element with a closed contact
ST	OUT	OUT	=	=	OUT	An output

Table (1)
Instruction code mAnemonics

6. Practical Applications of PLC

In this section we shall describe three different PLC based practical applications

6.1 The Transfer process

In this process the work piece is transferred upon three lines. It is carried out as follows

a-The gripper is in its upper position and it is switched off.

b-The gripper is stationary at initial sensor.

When the push button is pressed the process will start , first the gripper will take the piece from the first line and transfer it to the next line where act a certain process for the work piece (e.g drilling, painting,..etc), after that the work piece will be taken to the last line and finally the gripper goes back to its initial state and waiting for a certain time to repeat the process again. The system can be stopped by pressing the stop button. The practical system is shown in figure (8) and its flow chart is shown in figure (9).The function block diagram consist of about (23) ladder networks.

6.2 The Drilling Process

In this application the work piece can be drilled if it has proper dimensions. The process of drilling will start and going down. After that the drill will go back to its upper position and stop working and waiting a certain time (depending on the settings) to repeat the process. the system can be stopped by pressing the stop button. The practical system is shown in figure (10) and its flow chart is shown in figure (11).the system consist of (12) ladder networks.

6.3 PLC Based Lift Control

The lift is composed of a cabin with automatic door that move itself inside the- three floor lift- shaft, the floors are also provided with an automatic door. The plan e also includes a winch with electromagnetic brake and several push buttons in the cabin and on the floors. The process begins when

a-The cabin is at the first floor.

b-Both floor and cabin doors are closed.

When any person presses the push button, both floor and cabin doors will open and it will close after a certain period. After the person select the floor ,the cabin will go to that floor .When the person leave the cabin ,the cabin will stay in that floor until another call. The system is provided with alarm button used to indicate to any malfunction or error condition in the system by giving a sound signal showing that there is a person inside the cabin. The ALT button immediately stops the cabin in any location and at any time, canceling all reservations of the cabin. The system can return manually to its initial state at any time by pressing the reset button. The practical system is shown in figure (12) and its flow chart is shown in figure (13).The system consist of about (13) ladder networks for only 3-floor lift system and we expect that the ladder networks will be increased for any modification in the number of floors (i.e more than three floors).

7. Conclusion

The PLC system was described .Three PLC based practical systems were tested ,it was shown that any error in the programming of the PLC will cause no operation for any system, therefore the error is not allowed, most PLC systems are provided with automatic fault indicator so that the error or any fault can be corrected in a short time. Now most industrial processes use PLC system due to its fast response and carry out many processes in a short time in addition it is now considered as a versatile industrial system. As a suggestion for work one can modify the lift system for more than three floors.

References:

1-W.Bolton,"Programmable Logic Controllers',Newens,3rd edition 2003.
2-www.plc.net
3-www.cs.pdx.edu
4-www.pledev.com
5-www.arabelectronic.com
6-www.plcopen.org
7-www.eng.odu.edu
8-www.control-systems-principles.co.uk
9-www.jlab.org
10-www.racoman.com
11-www.rs.com

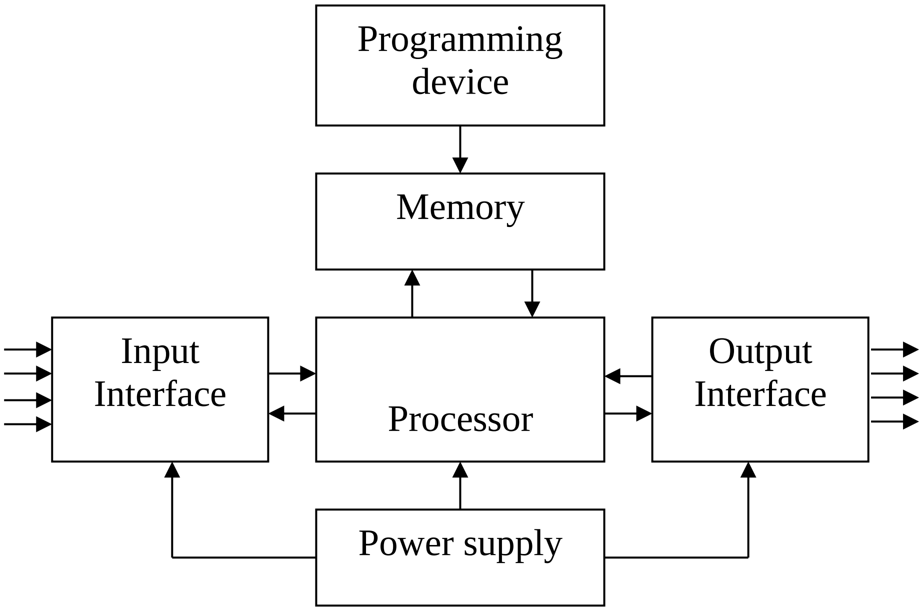


Figure (1)
PLC structure

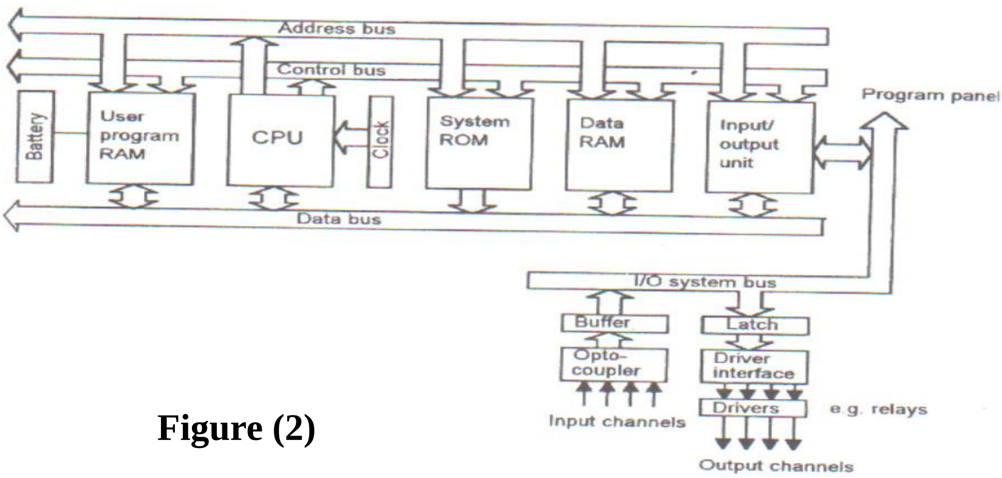


Figure (2)

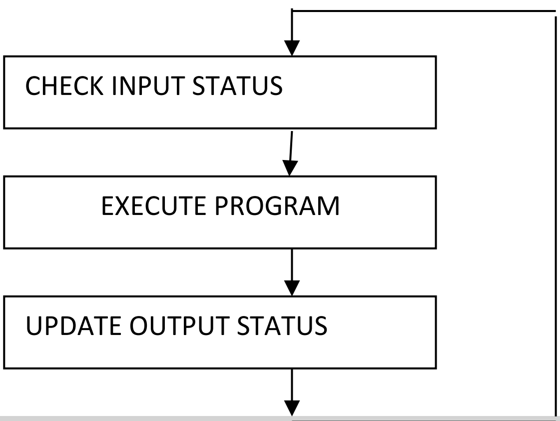


Figure (3)
PLC operation

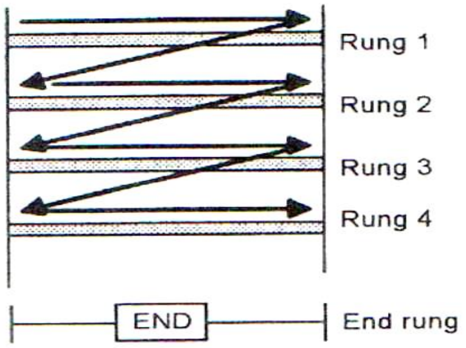


Figure (4)
Scanning the ladder program

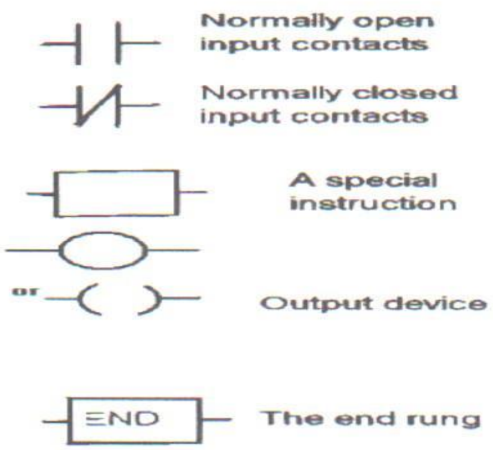


Figure (5)
Basic symbols

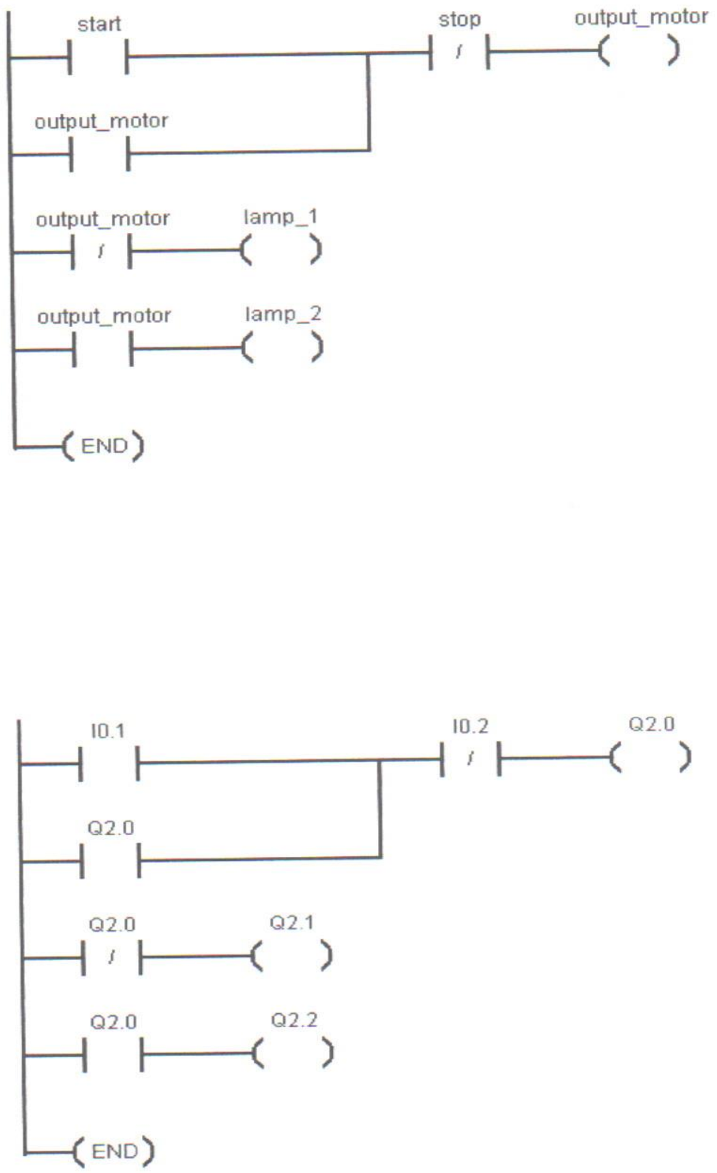


Figure (6)
Ladder diagram

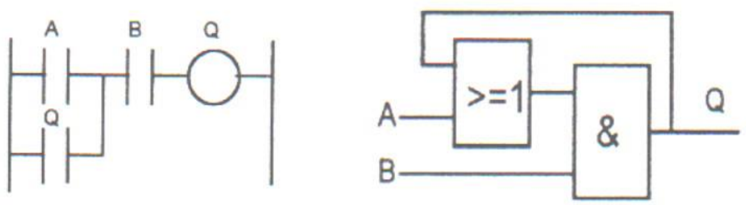


Figure (7)
Ladder diagram and its equivalent function block diagram

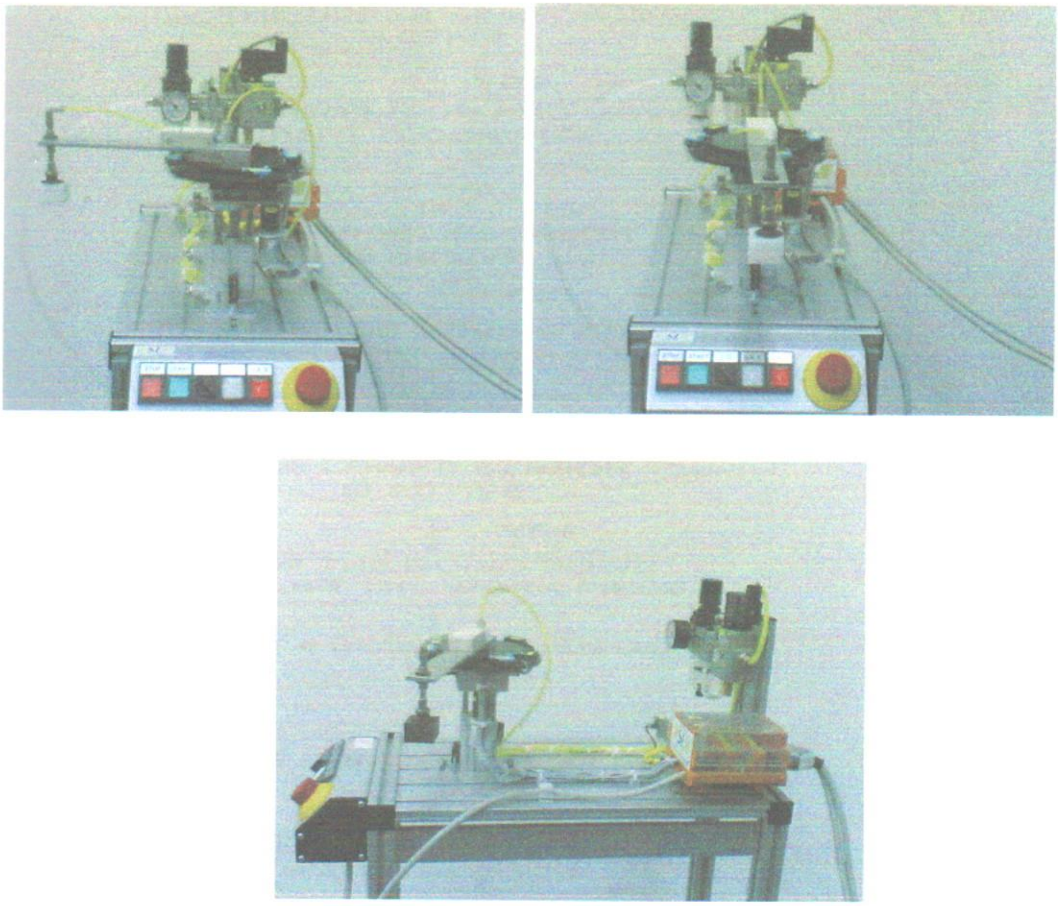
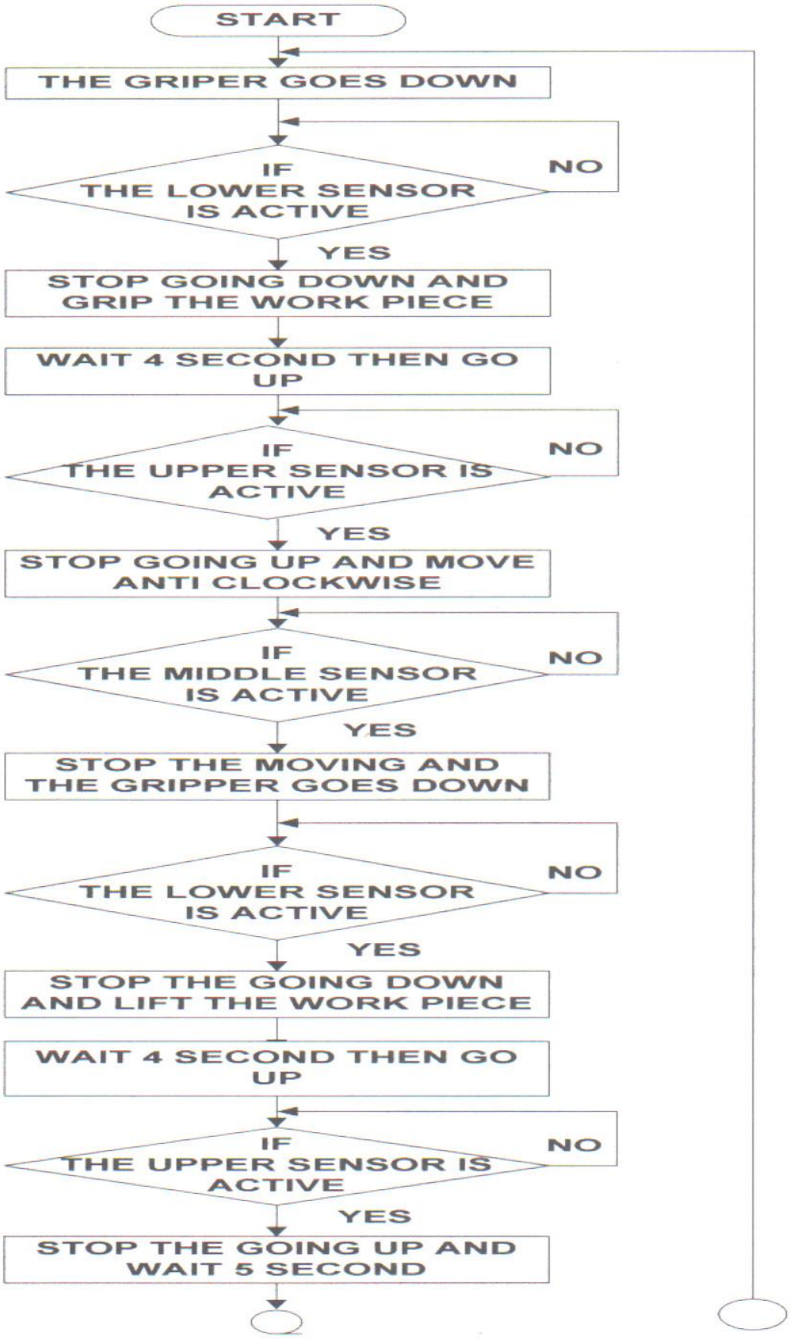


Figure (8)
The transfer process


START
THE GRIPER GOES DOWN
IF THE LOWER SENSOR IS ACTIVE
NO
YES
STOP GOING DOWN AND GRIP THE WORK PIECE
WAIT 4 SECOND THEN GO UP
IF THE UPPER SENSOR IS ACTIVE
NO
YES
STOP GOING UP AND MOVE ANTI CLOCKWISE
IF THE MIDDLE SENSOR IS ACTIVE
NO
YES
STOP THE MOVING AND THE GRIPPER GOES DOWN
IF THE LOWER SENSOR IS ACTIVE
NO
YES
STOP THE GOING DOWN AND LIFT THE WORK PIECE
WAIT 4 SECOND THEN GO UP
IF THE UPPER SENSOR IS ACTIVE
NO
YES
STOP THE GOING UP AND WAIT 5 SECOND

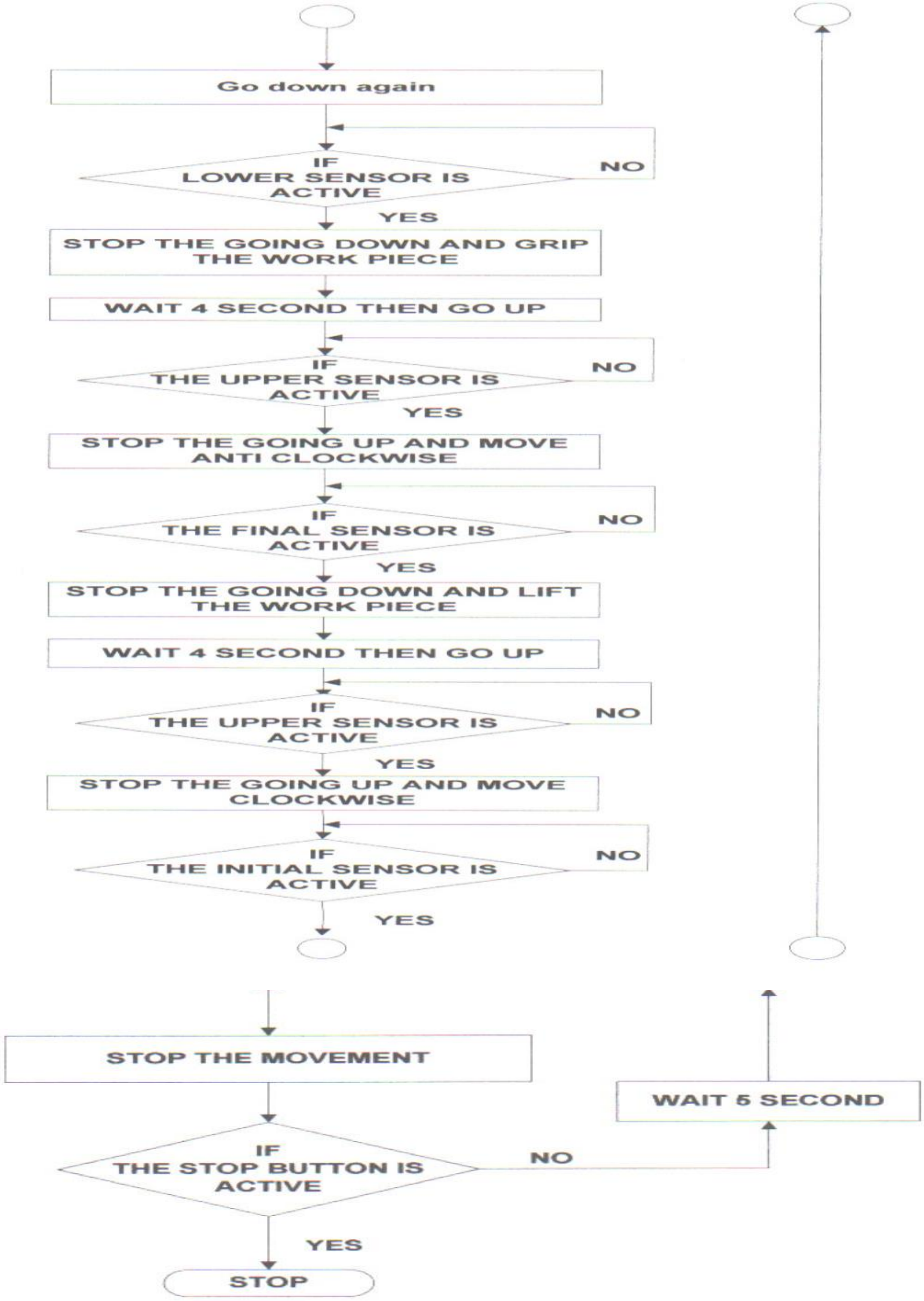


Figure (9)
The flow chart of the transfer process

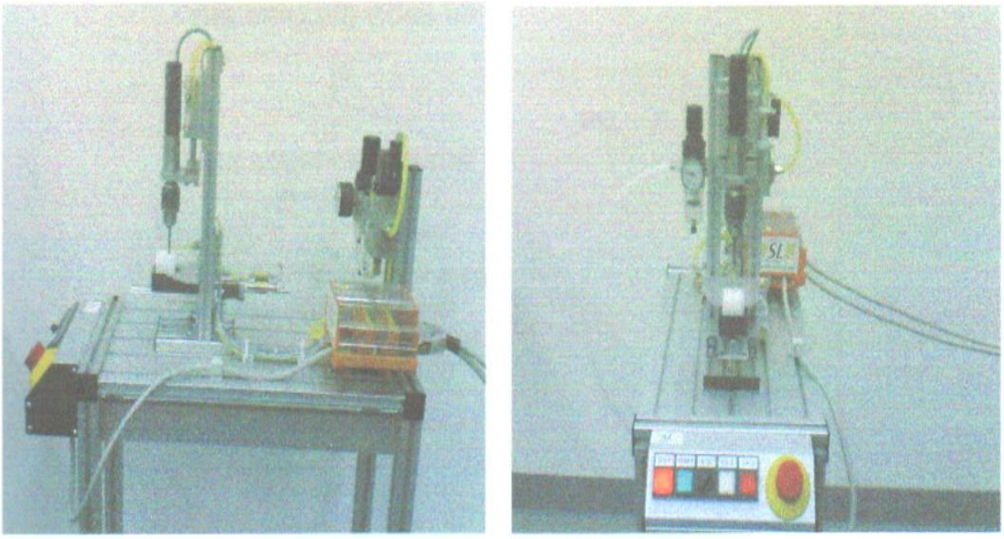


Figure (10)
The drilling process

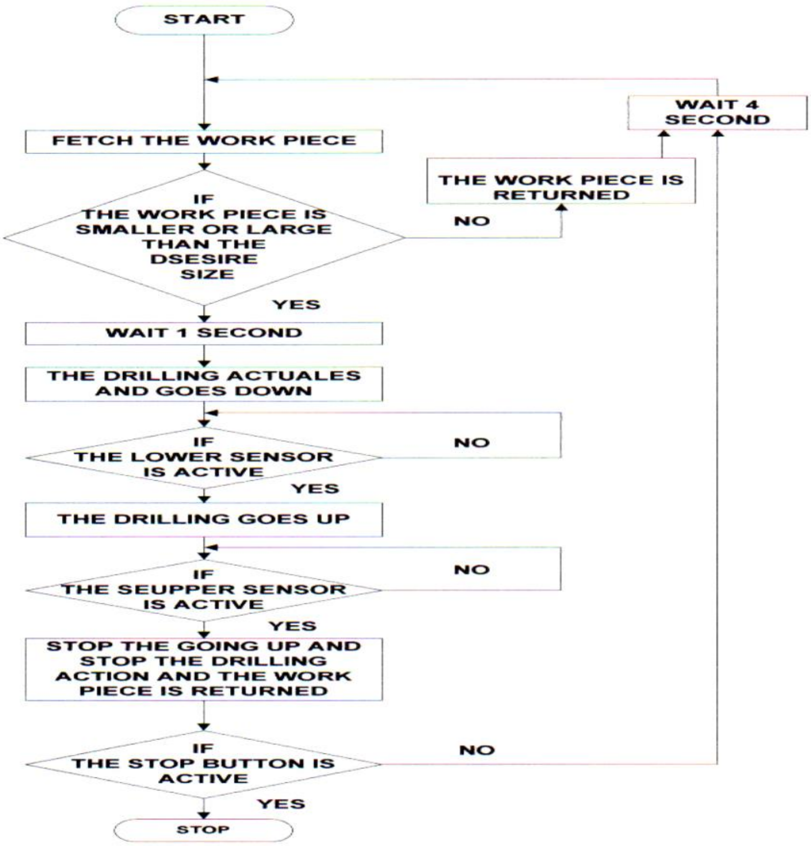


Figure (11)
The flow chart of the drilling process

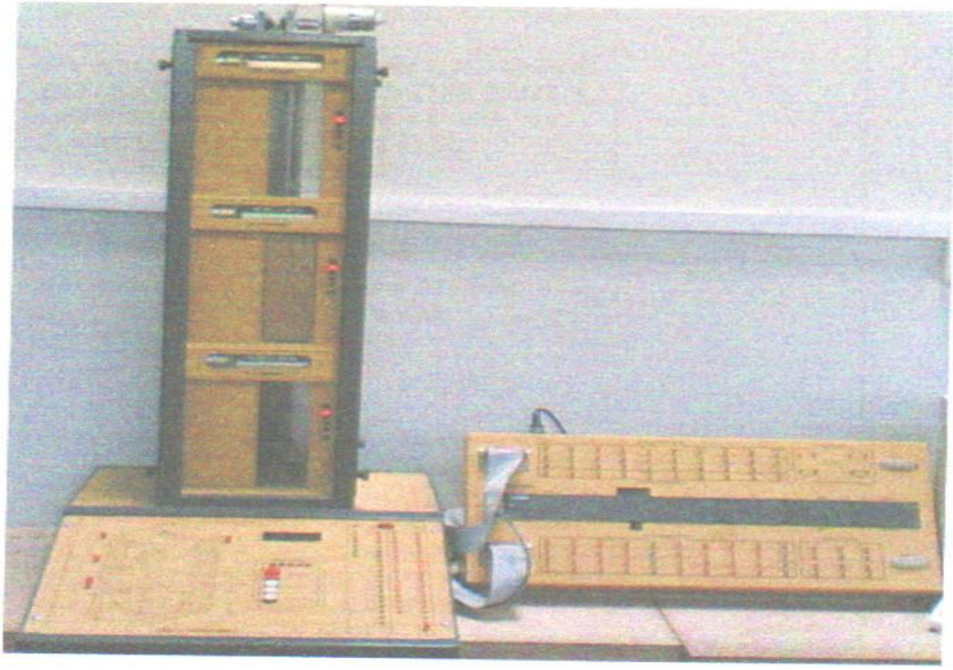
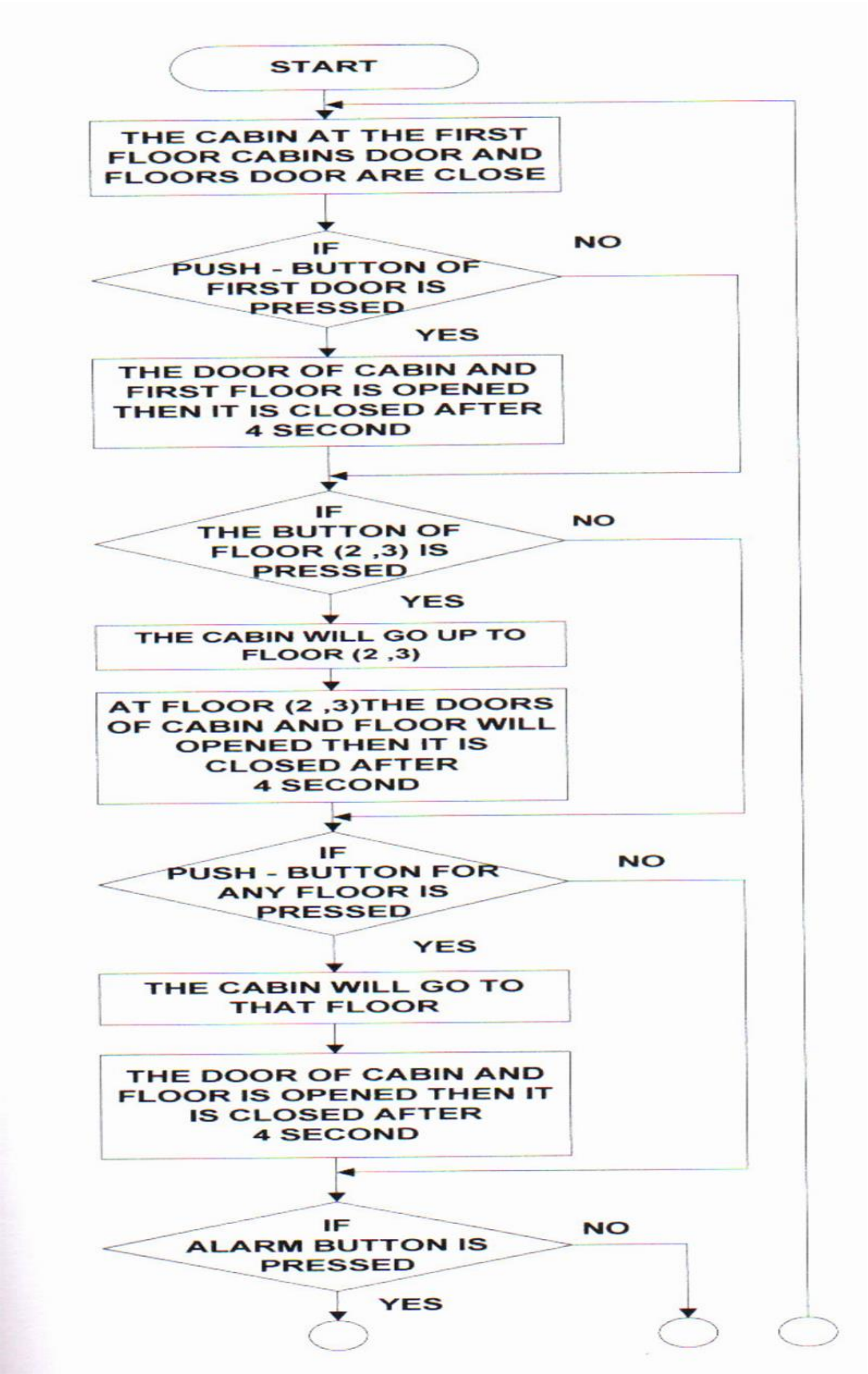


Figure (12)
The practical set-up of lift control


START
THE CABIN AT THE FIRST FLOOR CABINS DOOR AND FLOORS DOOR ARE CLOSE
IF PUSH - BUTTON OF FIRST DOOR IS PRESSED
NO
YES
THE DOOR OF CABIN AND FIRST FLOOR IS OPENED THEN IT IS CLOSED AFTER 4 SECOND
IF THE BUTTON OF FLOOR (2 ,3) IS PRESSED
NO
YES
THE CABIN WILL GO UP TO FLOOR (2 ,3)
AT FLOOR (2 ,3)THE DOORS OF CABIN AND FLOOR WILL OPENED THEN IT IS CLOSED AFTER 4 SECOND
IF PUSH - BUTTON FOR ANY FLOOR IS PRESSED
NO
YES
THE CABIN WILL GO TO THAT FLOOR
THE DOOR OF CABIN AND FLOOR IS OPENED THEN IT IS CLOSED AFTER 4 SECOND
IF ALARM BUTTON IS PRESSED
NO
YES

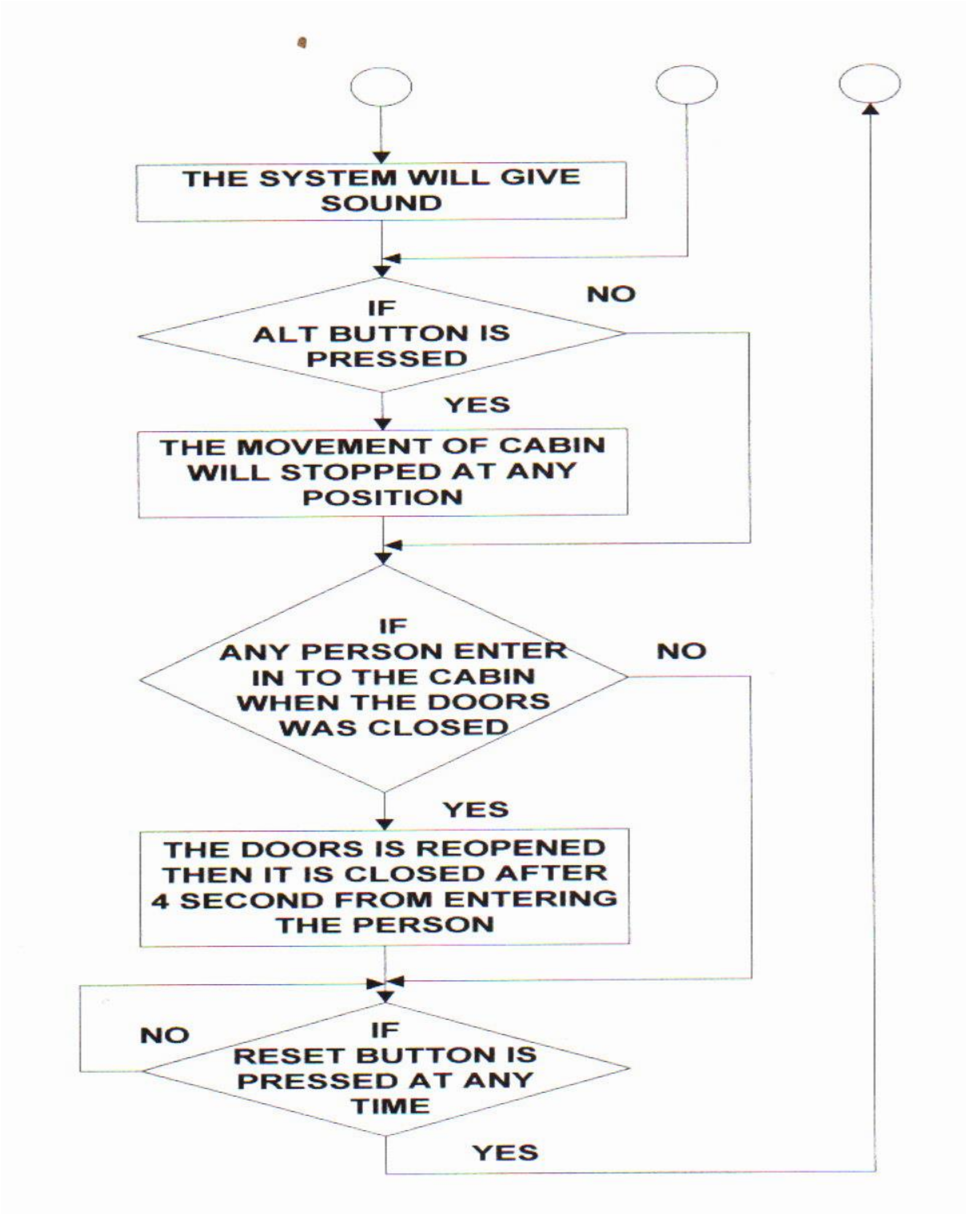


Figure (13)
The flow chart of the lift system