Developing Programmable Logic Controller for Rotary Car Parking System

Saylee S. Begampure[1] Vaibhav V. Phale[2] Shubham S. Yadav[3] Aniket A. Wadekar[4]
[1,2,3,4]Department of Electronics & Telecommunication Engineering
[1,2,3,4]RMD Sinhgad School of Engineering, Pune, India

Abstract— A programmable logic controller (PLC) or programmable controller is an industrial electronic computer which is developed and used for process of manufacturing, such as assembly lines, or robotic devices, or any activity that requires super reliable control and utility of programming and prosecutes fault finding and solving [1]. They were first developed in the automobile industry to provide flexible, ruggedized and easily programmable controllers to replace hard-wired relays, timers and sequencers. Since then they have been widely adopted as high-reliability automation controllers suitable for harsh environments. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result [1].

Key words: PLC, Controller, Car Pallet Parking

I. INTRODUCTION

PLC is a Programmable Controller which is used to achieve Domestic or small scale Industrial applications. PLC is nothing but the Input Output Board with the controller. Assembling all this inputs and outputs properly with Controller gives you a plc.

In our Project we have used ATmega328p controller as a CPU of a developed PLC. Our PLC has input and output board. PLC has 8 inputs and 8 outputs.

II. LITERATURE SURVEY

There are many PLCs available in market but this is the First PLC which has been developed. This PLC is very cost efficient compared to others and very flexible. All the inputs outputs of the available PLC's are dedicated but as compared to them this PLC gives you the freedom to map them according to your need. Where other PLC's lacks in communication ports this PLC gives you Communication access through two ports.

III. BLOCK DIAGRAM

Figure 1. shows block diagram of Control 328p PLC. It consists of Input Module, Central Processing Unit, Output Module, Power Supply, and Status Indicator.

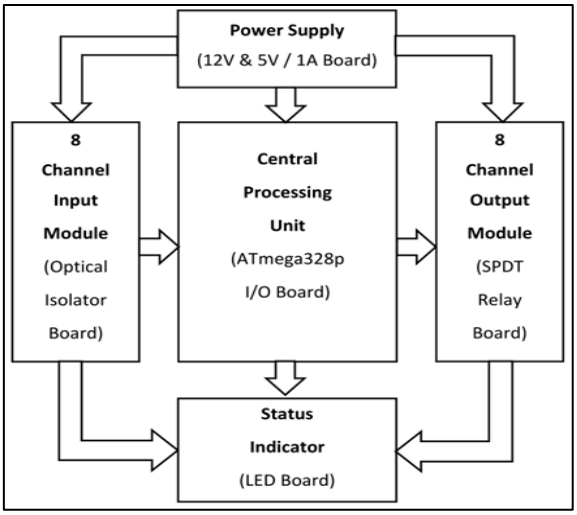

Fig. 1: Block Diagram of PLC

Input Module is nothing but 8 channel op to isolator board. It provides optical isolation between Input Devices such as sensor, transducer, switches etc. to Central Processing Unit. For this purpose, PC817 op to isolator is used. PC817 has High isolation voltage between input and output up to 5kV. Pull – downed output of opt– isolator is provided to Central Processing Unit.

Central Processing Unit is ATmega328p input and output board. ATmega328p is ATMEL AVR 8 – bit microcontroller. It has 8 inputs in which, 6 inputs are Analog /Digital and remaining 2 inputs are Interrupt /Digital, and 8 outputs in which, 4 outputs are PWM/Digital and remaining 4 outputs are Digital only. Central Processing Unit has IS Pheader which provides SPI and Serial (TTL) interface for programming's well as communication, andDB9 Port which provides Serial (RS232) interface for communication only.

Output Module is 8 channel SPDT relay board which has 250V, 7A (Max) rating. The outputs of Central Processing Unit are provided to relay board. Relays are driven by ULN2803 Driver. The main purpose of Output Module is to provide isolation between Central Processing Unit and Output Devices such as AC mains motor, lamps etc.

Power Supply has 12VAC/12VDC, 2A (Max) input. And has 12VDC, 1A (for Output Module) and 5VDC, 1A output (for Central Processing Unit, and Input Module). Conversion of 12VDC to 5VDC is done by LM7805 Voltage Regular which has 1A (Max) current output.

Status Indicator has 18 LEDs gives status of 8 inputs (Green LEDs), 8 outputs (Red LEDs), power supply (Blue LED), and Central Processing Unit RESET (White LED).

IV. HARDWARE

A. PLC Components

1) AT mega328p Microcontroller

The Atmel® picoPower® ATmega328/P is a low-power CMOS 8-bit microcontroller based on the AVR® enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328/Pachieves throughputs close to 1MIPS per MHz. This empowers system designed to optimize the device for power consumption versus processing speed [2].

2) MAX232

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply TIA/EIA-232-F voltage levels from a single 5V supply. Each receiver converts TIA/EIA-232-F inputs to 5V TTL/CMOS levels. These receivers have a typical threshold of 1.3V, a typical hysteresis of 0.5V, and can accept ±30V inputs. Each driver converts TTL/CMOS input levels into TIA/EIA-232-F levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library[3].

3) PC817

PC817X Seriescontains an IRED optically coupled to a photo transistor. It is packaged in a 4pin DIP, available in wide-lead spacing option and SMT gullwing lead form option. Input-output isolation voltage (rms) is 5.0kV.Collector-emitter voltage is 80V (V_{CEO}: 35V) and CTR is 50% to 600% at input current of 5mA [4].

4) ULN2803

The ULN2803A device is a 50V, 500mA Darlington transistor array. The device consists of eight NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of each Darlington pair is 500mA. The Darlington pairs may be connected in parallel for higher current capability.

Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED and gas discharge), line drivers, and logic buffers. The ULN2803A device has a 2.7kΩ series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices [5].

5) W10G

W10G is Glass Passivated Single-Phase Bridge Rectifier. It has Maximum average forward rectified current of 1.5A and Maximum repetitive peak reverse voltage of 1000V.

6) LM7805

The LM7805 series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents [6].

B. PLC & Microcontroller Pin Mapping

Each terminal of PLC is directly or indirectly connected to the ATmega328p microcontroller. Here, term indirectly means terminals are connected via Input or Output Modules which provides isolation to ATmega328p microcontroller.

Programming port pins of PLC is also connected to microcontroller. PLC having 10 – pin ISP header as a Programming Port. The user can also use Programming Port for Communication purpose using SPI and/or Serial (TTL) interface.

Following Table No. 1, 2, 3 shows the Pin Mapping of Input Module Terminals, Output Module Terminals, and Programming Port respectively. Figure 2. shows ISP Header Pin-out.

1) Input Terminals

Sr. No	PLC Input Terminal	Controller Pin
1	XI0	PC0/ADC0
2	XI1	PC1/ADC1
3	XI2	PC2/ADC2
4	XI3	PC3/ADC3
5	XI4	PC4/ADC4
6	XI5	PC5/ADC5
7	XI6	PD2/INT0
8	XI7	PD3/INT1

Table 1: Input Terminal - Pin Mapping

2) Output Terminals

Sr. No	PLC Output Terminal	Controller Pin
1	YQ0	PD4
2	YQ1	PD5/OC0B
3	YQ2	PD6/OC0A
4	YQ3	PD7
5	YQ4	PB0
6	YQ5	PB1/OC1A
7	YQ6	PB3/OC2A
8	YQ7	PB4

Table 2: Output Terminal - Pin Mapping

3) Programming Port

Sr. No	ISP Header Terminal	Controller Pin
1	1	PB3/MOSI
2	2	VCC
3	3	GND
4	4	PD0/RXD
5	5	PC6/RESET
6	6	PD1/TXD
7	7	PB5/SCK
8	8	GND
9	9	PB4/MISO
10	10	GND

Table 3: Programming Port -Pin Mapping

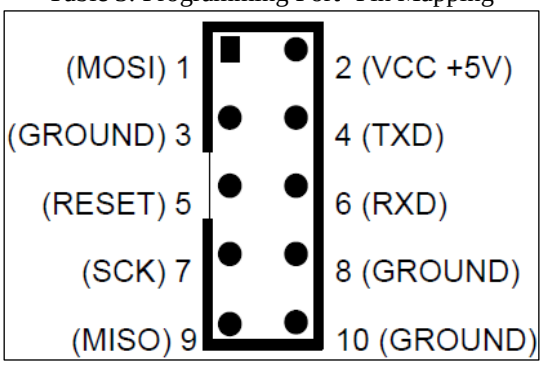

Fig. 2: 10 - Pin ISP Header Pin-out

V. SOFTWARE

Software support for the system is given through the LD micro Software [7].This is the open source software which can be used publically. The code for this PLC is done on Ladder Logic and the generated hex file is downloaded on the controller. All the pin assignments for any application can be done using this software only.

VI. RESULT

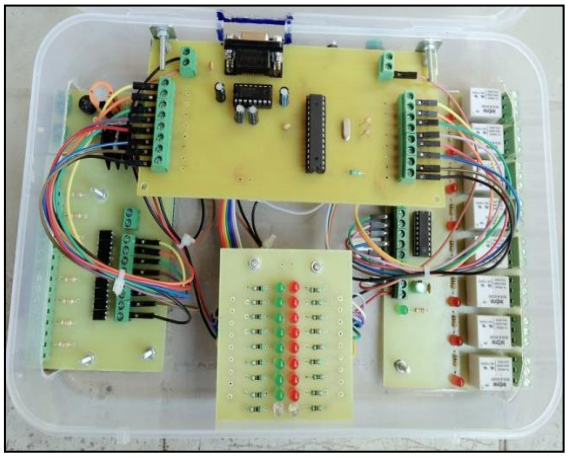

Fig. 3: Final PLC

Figure 3. Shows all the hardware implementation of input section, output section, processing unit and the indicator board. All the inputs and outputs work as specified and give's proper output as mentioned. For given inputs the particular outputs are turned on which shows reliability of the controller.

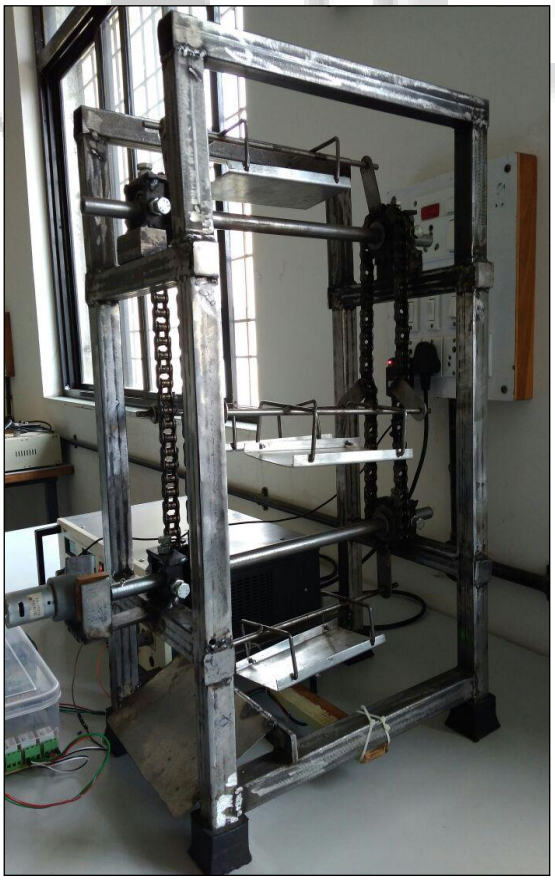

Fig. 4: Parking Structure

Figure 4. Shows the complete pictorial of Rotary Car Parking System. Where all the car pallets are controlled using this PLC.

The system works on automatic as well as manual mode. In auto mode the particular pallet comes to ground position automatically where as in manual mode it can be controlled according to need. This PLC can be stated as dedicated PLC for this Car Park System. This system is very efficient as compared to cost, area consumed and simplicity in handling.

VII. CONCLUSION

Thus Programmable Logic Controller is successfully developed. All the concepts in this system have been tested and analyzed to conclude that this is the most suitable Programmable Logic Controller for domestic and small scale industrial applications. And also the Rotary Car Parking System is tested on the same. Based on its cost and other given results we can conclude that This Programmable Logic Controller can be used efficiently for rotary car parking system.

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