Automatic Car Parking and Controlling System Using Programmable Logic Controller (PLC)

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Abstract— Well-organized vehicle parking can assist drivers gratifying by protecting car energy as well as time consuming. In this paper, the automation process of an automatic car parking system is designed using a fully functional ladder logic based LOGO!12/24 RC, which is a small programmable logic controller (PLC). Infrared sensor (IR) electronic sensors were installed at the entrance and departure gates to sense the car those are waiting for either entry or exit. After that it gives the input signals to PLC to count the number of vehicles entering and leaving the park respectively. The developed system automatically can monitor and restrict the vehicles inside the parking space. The number of cars available in the park will be the difference of the number of vehicles entering and the number of vehicles leaving. When a car approaches to the entry gate, PLC will decide whether any space is available or not. If no space is available, the PLC will then send signal to entry gate to keep the gate closed and turn on the indication "Car Park Full". If there is space in the park, the entry gate will open to allow the car to enter the park. Similarly, at the time of exit, the PLC will send signal to the exit gate to open and allow the car to leave the park after paid the parking payment. All these activities make the car parking system completely automatic. The development of this system is cost effective and useful to make solutions to car parking space problems in city areas.

Keywords— Automate car parking, Sensor, PLC, Hardware, Software

I. INTRODUCTION

Currently, automatic parking system is one of the major issues in a parking lot due to increase of personal vehicles, shortage of space and to avoid any roadblock. Parking lot is one of the key installations found in most major cities [1]. Parking is an acquired skill many drivers struggle with because of many reasons; for example the traffic jam, the small spots reserved for parking, and poor driving skills [2]. In most of the workplaces, there are small lands or spaces compare to number of vehicles to park their vehicles in the specific places. As a result, it is irritating and wasting the time if someone does not manage to park the car for a long time searching. However, this poor car park management system can be minimized if the user able to know the exact availability of parking space before entering into the car parking lot. Over the past few years a number of research works have done on car parking system. For example, Alfatihi et al., presents an innovative intelligent parking system for car parking guidance and car damage notification [2]. Then Choeychuen et al., developed a method to estimate the map of parking lot for automatic system of available parking space detection which can help drivers to find the parking space efficiently [3]. A wireless mobile-based car parking system using low cost SMS service was proposed by Soh Chun et al. [4]. Likewise, some other researches also done for this automatic parking purpose [5-7]

However, in our project we have developed the parking system which is as follows: driver can see the availability automatically and if the car parking lot is full, the user can find another parking area or can do

alternative (leave or wait for empty place). This automatic parking aims to ensure collision-free motion within the available space and to enhance the comfort and safety of driving in constrained environments. The rest of the paper is organized as follows. In section II the methodology of the system is provided. Section III presents its design discussion and in section V a conclusion of the paper is given.

II. METHODS

A. System Design

Figure 1 present the system design which consists of Programmable Logic Controller (PLC LOGO! 12/24 RC), LADSIM (Ladder logic simulator), LED display, DC motor and IR sensors. Here, PLC acted as the brain of this system because it controlled all the operations with the external devices.

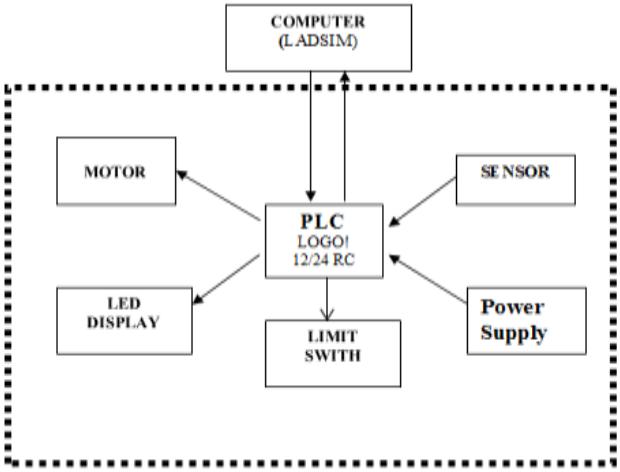

Fig. 1. Architecture of the System

B. Hardware Equipment

To develop the system following hardware equipment were used, 1) programmable logic controller was used as a black box with a number of inputs from, and a number of outputs to, the outside world. It can make decisions easier, store data, convert codes, do timing cycles, and do simple arithmetic analysis. Siemens LOGO! PLC was used in this project which has a fully functional ladder logic design. PLC simulation software program that incorporates the basic functions used in PLC ladder programming. LOGO! Includes a visual editing environment for graphical programming. A simple 'drag and drop' method is used to add functions to the ladder rung, and comments can be added to each rung for documentation purposes. LOGO! functions include inputs, outputs, timers, counters, flags and shift registers. An interactive debugger is included allowing the program to be fully tested before being used to control a specific application, 2) sensor: photoelectric sensors (IR) were used for non-contact detection of targets at a distance regardless of material. It emits invisible infra-red or visible red light to detect the presence of a car. The target is detected when it breaks a beam of light to activate the sensor output, 3) motor: two DC motors were used to open and close the barrier for entry and exit of the cars, 4) an electromechanical limit switch applied **for** breaking the electrical path for interrupting the current flow, 5) in this project, a special type of regulated DC power supply was designed which has two types of output voltage (12V and 24V), and 6) light-emitting diodes (LED display) were used to display the status of the parking system. It indicates whether the parking space is available or not.

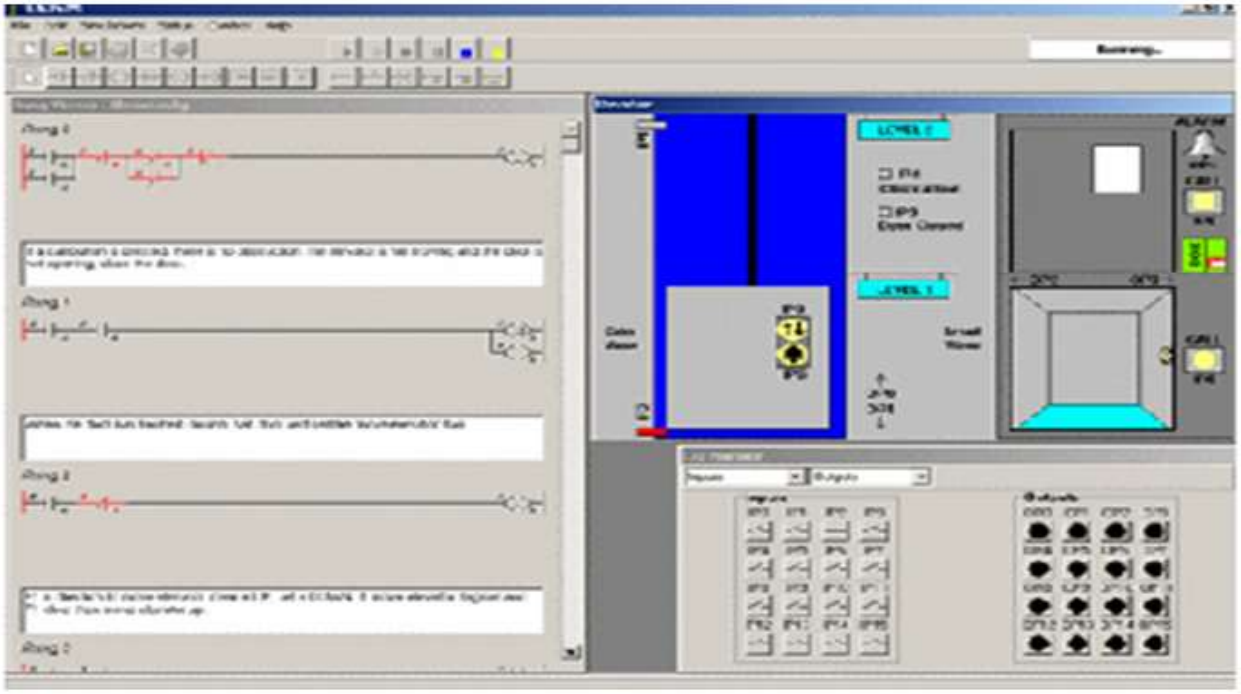

Fig. 2. LADSIM Ladder Logic Simulator for PLC programming

C. *Software Design*

The software design of this system was developed based on the following two logics, 1) motor opens the entry gate when a car is at the entry barrier and the car parking space is not full. A timer starts to count the number of vehicles (with increment) when the entry gate is opened. Then, automatically the entry gate becomes close when the time is over. Finally LED indicates the "Full" signal, if the counter is at maximum level, and 2) the motor opens the exit gate when a car is at the exit barrier. The timer starts to count the number of vehicles (with decrement) when the exit gate is open. Then the exit gate becomes close when the time is over. Finally, the LED indicates "Empty" symbol when the counter is at minimum. Figure 2 shows the LADSIM Ladder Logic Simulator which was used to design the above mentioned two logics by ladder diagram for PLC programming. Also, Figure 3 and Figure 4 depict the full system installation and running condition.

Fig.3 System under installation

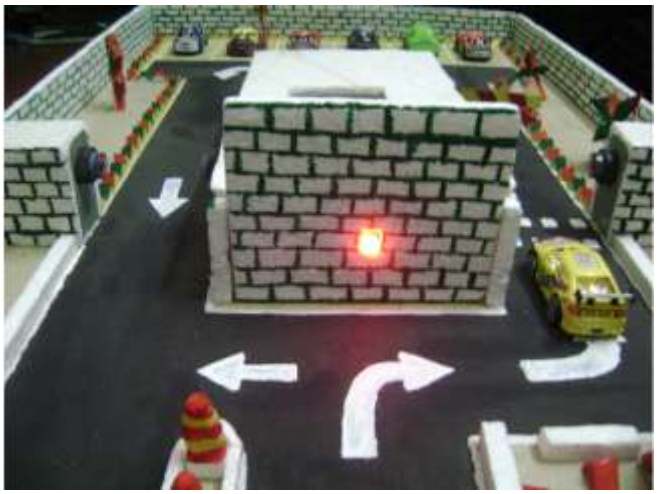

Fig. 4. System under running

III. Results and Discussion

Automatic system plays an increasingly important role in the global economy and in daily experience. Engineers strive to combine automated devices with mathematical and organizational tools to create complex systems for a rapidly expanding range of applications and human activities. Automation, industrial automation or numerical control is the use of control systems such as computers to control industrial machinery and processes, replacing human operators. In the scope of industrialization, it is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the physical requirements of work, automation greatly reduces the need for human sensory and mental requirements as well.

There are two types of car parking systems: traditional and automated. In the long term, automated car parking systems are likely to be more cost effective when compared to traditional parking garages. Automatic multi-story automated car park systems are less expensive per parking slot, since they tend to require less building volume and less ground area than a conventional facility with the same capacity. Both automated car parking systems and automated parking garage systems reduce pollution - cars are not running or circling around while drivers look for parking spaces.

Automatic multi-stored car parking system is very good substitute for car parking area. Since in modern world, where space has become a very big problem and in the era of miniaturization it's become a very crucial necessity to avoid the wastage of space in modern, big companies and apartments etc. In space where more than 100 cars need to be parked, it's a very difficult task to do and also to reduce the wastage of area, this system can be used. This Automatic Car Parking enables the parking of vehicles-floor after floor and thus reducing the space used. Here any number of cars can be park according to requirement. This makes the system modernized and evens a space-saving one.

Specialized hardened computers, referred to as programmable logic controllers (*PLC*s), are frequently used to synchronize the flow of inputs from (physical) sensors and events with the flow of outputs to actuators and events. This leads to precisely controlled actions that permit a tight control of almost any industrial process.

Human-machine interfaces (HMI) or computer human interfaces (CHI), formerly known as man-machine interfaces, are usually employed to communicate with PLCs and other computers, such as entering and monitoring temperatures or pressures for further automated control or emergency response. Service personnel who monitor and control these interfaces are often referred to as stationary engineers.

IV. Conclusion

There are several advantages of employing a car park system for urban planners, business owners and vehicle drivers. They offer convenience for vehicle users and efficient usage of space for urban-based companies. Automated car park systems save time, money, space and simplify the often tedious task of parking. As urban centers' population continues to grow, residential and business complex owners continue to look for new ways to handle large numbers of vehicles that need to be parked. It seems highly likely that automated and semi-automated car parking systems and parking garages will become an integral part of many existing and future business and residential buildings. The advantages offered by these advanced car parking systems will undoubtedly contribute to their growth in urban and suburban complexes in the coming decades.

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