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Design and analysis of parking guidance system for underground intelligent stereo garage in downtown business district

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Abstract—**The basses of the intelligent measurement and control system used in underground stereo garage at the downtown business district were investigated. Firstly, the principal constituents for vehicle storage and the intelligent supervision systems were explored, the scheme involves the warehousing guidance, access mode and transmission system. Secondly, the modules of overrun detection and the parking place detection in the vehicle guidance system were successfully designed. Thirdly, three-dimensional information of the storage vehicle (i.e., length, width and height) and the position of the vehicle was collected by employing semiconductor lasers and peripheral circuits. STC89C52 Single-chip Microcomputer was adopted to improve the signal acquisition and control the voice prompt and light guide information and their output. Based on this information, the coding, debugging and testing of the control program were completed. The research of the parking vehicle storage intelligent guidance control at the downtown business district reduced the garage control cost, to a certain extent, and improved the cost-effective, which has an important significance for popularization and application of stereo garage.**

Keywords-Intelligent stereo garage; Semiconductor laser; Parking guide; Overrun detection

I. INTRODUCTION

As a means of transportation, automobiles have been widely used with sales rising rapidly year by year. Various brands and models of cars around us and affect our daily life. More and more people believe that intelligent stereo garage is an effective method to alleviate the problem of difficult parking especially in the downtown area [1]. The safety of inbound, storage, outbound becomes the crucial factor of people eventually accept stereo garage parking [2].

At present, intelligent stereo garage is still in its infant stage in the domestic inland cities[3]. It is of significant practical importance to develop intelligent stereo garage control systems that are low cost and easy to implement.

In the present paper, putting the downtown business district as the background, we designed the intelligent control system of the underground intelligent stereo garage for guiding vehicle into the specified location automatically using single-chip microcomputer technology, voice alarm technology, laser sensor and its peripheral circuit. Car overrun detection and car parking position detection improved the stereo garage storage intelligent guidance and the safety of vehicles and personnel.

II. MEASUREMENT AND CONTROL SCHEME AND PRINCIPLE

Stereo garage is a kind of intelligent logistics transportation system, it is a collection of mechanical, electronic, hydraulic, optical, magnetic control, computer technology and so forth[4]. Its main detection and control system can be divided into warehousing guidance, automatic access mode and transmission etc.

Warehousing guidance: When a car entered the garage entrance, the detection devices detect the sizes of the body, and send the detection signal into STC89C52 Single-chip Microcomputer (SCM). If the measured length, width and height exceed the set value, SCM controls system alarm and sends a stop signal to computer; other devices stop action, prompts vehicle out of the garage. For those of appropriate size, parking position detection module detects the position of the vehicle, guides the vehicle into the specified location through the voice prompt system and the guide light The voice prompt OK, guide lights positioning OK, said the vehicle parking in place, then computer sends a clear signal.

Access mode: In downtown business district where traffic is heavy, there are frequent vehicles in and out of garage even crossing occurs. In order to avoid an empty car carrying board during successive car parking and leaving, the system selects the more efficient fork comb type access mode. The system structure is simple with less transmission components, low maintenance and high operating efficiency.

Here, the fork comb type refers to the parking space that

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has a fixed fork comb, the elevator has a moving fork comb. Fixed fork comb structure and moving fork comb structure is just the opposite, i.e., one's comb teeth corresponding to the other's space. After the elevator arrived at the designated floor, equipment moving fork traversing in place, through the mutual movement of the comb park a car or take a car. Vehicle access is through the relative motion about the fixed comb and the moving comb, so the design have to allow enough space motion for the moving comb to move up and down. One side comb fixed fork as shown in Fig. 1.

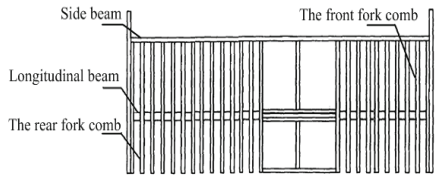

Figure 1. One side comb fixed fork

Transmission device: Transmission device is divided into chain transmission and wire rope transmission. Chain transmission is simple and reliable, easy maintenance, low cost, but the impact is relatively high with limited lifting height [5]. Attention needs to be paid to the chain bites. Wire rope driver for unrestricted chassis can increase the height of the garage, cost is lower, but requires additional wire rope bucket and brake disc, which increases the time and cost of installation and debugging [6]. The wire rope hoisting method was chosen owning to the cost of land and installation.

III. IMPLEMENTATION OF WAREHOUSING GUIDE SYSTEM HARDWARE

Warehousing guide system is divided into two phases: namely, the overrun detection and the parking place detection. Overrun detection gets vehicle length, width, height parameters by sensors, ensure that the vehicle size meet the requirements of the specification limits. SCM receives the detection signal. Upon failing an inspection, the sound and light alarm system issue warning signals, and inform the master control system, stop the follow-up actions. if both tests are passed, the vehicle will be allowed to enter the storage followed by subsequent operations. Parking position detection uses laser sensors to detect vehicles in the garage entrance, SCM according to the received signal, through the light signal and voice prompting module, guide the vehicle to the designated location. Fig. 2 is a diagram of this system.

Overrun detection and the parking place detection are based on photoelectric testing way. That is use the car body to keep out of the light, by the synchronization loop gating circuit, thereby detecting signal with or without. Multiple groups of transmitting and receiving devices judge whether the vehicle overrun or determine the vehicle location. It adopts the LD semiconductor laser diode as light emission signal, since the laser has the advantages of good coherence, strong direction,

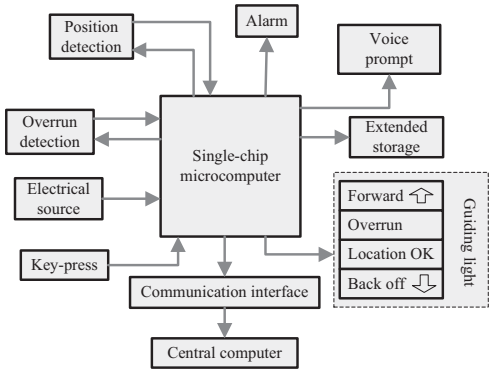

Figure 2. The system block diagram

small divergence angle, high brightness, easy modulation. Laser emission is mainly composed of a laser modulation, driving circuit and LD semiconductor laser diode, etc. Laser modulation tube is equivalent to an integrated circuit, which has a phase-locked loop circuit, automatic gain control. After sending the specific frequency oscillation wave, amplified by a chip, laser tube lights. Japan's sanyo red light semiconductor laser diode DL-3147-3147 are selected as laser transmitter. Laser receiver is mainly composed of receiving circuit, amplifying circuit, demodulation circuit, drive circuit, executive circuit, etc.. Laser receiving device receives a wave length of 500 nm ~ 500 nm, 160 KHZ to 200 KHZ frequency, duty cycle modulation between 20 ~ 30%. The output of a digital voltage signal through the capacitor filtering, are sent to SCM after processing. SCM determines vehicle information through the received signal, and control the voice prompt and guiding lights. The laser emission and laser receiver consist of laser sensor. Laser emission circuit is shown in Fig. 3.

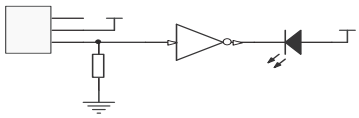

Figure 3. Laser emission circuit

A. *Vehicles Overrun Detection*

The laser sensor measures the vehicle size, to ensure that the stored vehicle does not exceed the garage specification limits. This module consists of 5 pairs of laser sensors to detect vehicle length, width and height. Two pairs of sensors installed on both sides of the warehouse walls at a certain height. Two pairs of sensors (C1 and C2) detect the vehicle length; Two pairs of sensors (D1 and D2) detect the vehicle width; sensor E detects the vehicle height. The detection circuit is shown in Fig. 4. When receiving the laser, the receiver, with low norm, outputs a high level signal.

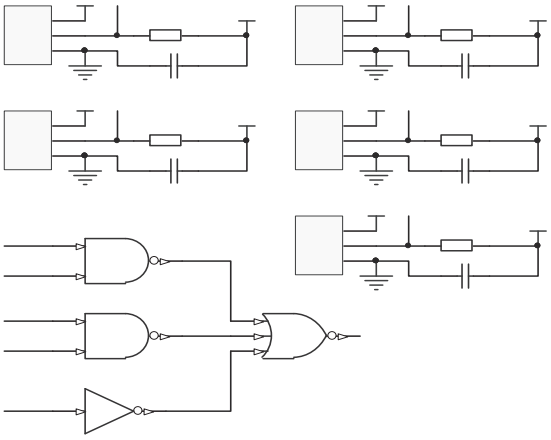

Figure 4. Overrun detection and SCM interface circuit

Position detection and overrun detection laser sensor layout as shown in Fig. 5. When a car arrives, SCM controls the laser sensors. If P2.0 is low, said vehicle overrun. According to the received signal, SCM controls the guiding lights, the buzzer and the voice prompt system.

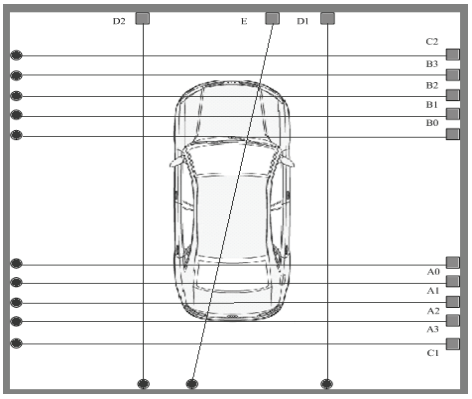

Figure 5. The laser sensor layout

B. *Parking Position Detection*

The combination of guide light and voice prompt in the garage entrance guides the driver to park the vehicle to a specified location under the control of the SCM. SCM according to the received signal to judge vehicle location, and simultaneous voice prompt and guiding light vehicle forward, backward or positioning is OK. Only when the vehicle parked in the specified location which was judged based on the signals received by the laser receiver , the OK light will be on and the voice prompt location OK. Eight laser sensors were installed horizontally on both side walls of the garage entrance at proper height, divided into two groups. According to the direction of vehicle, laser receivers are numbered as A3~A0 and B0~B3. The A3~A0 forms a four bit binary code A, A3 is high, A0 is low, the B3~B0 forms a four bit binary code B, B3 is high, B0 is low. Putting A and B into 74LS85 four bit digital comparator, the outputs are respectively connected with the single-chip I/O ports, as shown in Fig. 6.

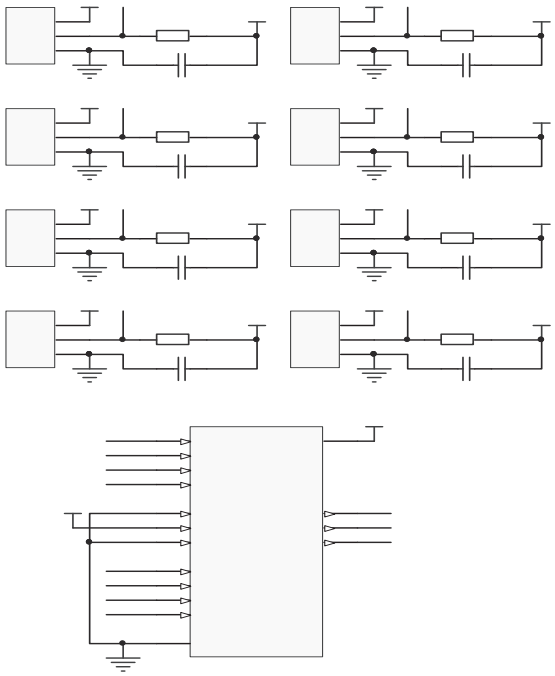

Figure 6. Position detection and SCM interface circuit

SCM determines whether a vehicle is parked at the specified location by assessing the I/O port data, then sends a signal to the indicator lamp and the voice prompt system. 74LS85 is a positive logic chip, a high voltage represents "1", a low voltage represents"0". If P2.3 is high, i.e., A<B, it means that the vehicle parked behind the specified position, then the "forward" lamp shines, and voice prompted vehicle forward; if P2.2 is high, i.e., A=B, means that the vehicle parked in the right position, the "OK" lamp shines, and voice prompted vehicle location OK; if P2.1 is high, i.e., A>B, means that the vehicle parked in front of the specified position, the "back " lamp shines, and voice prompted vehicle back. After confirming vehicle in place, SCM requests to other systems, the comb fork moves and sends vehicle to the allocated parking spaces to store.

C. *Voice Prompt*

Voice prompt module implements automatic voice prompt function. Voice module adopts the ISD company of ISD1420 voice chip. Low power ISD1420 chip standby (0.5W), playback time is 20(s). Both sustainable playback, and can be segmented playback. The whole time can be divided into 160 sections, minimum segment: 20s/160 section =0.125(s),

without electricity for information storage. Button S1, S2, S3 mainly achieve the manual recording sound debugging of the module circuit, SCM selects playback content through the P0 port. The PLAYL foot and REC foot of ISD1420 connected to the P2.7 and P2.6 foot of SCM through the pull-up resistor respectively, so as to control the playback sound of voice prompt. Voice prompt and SCM interface circuit as is shown in Fig. 7.

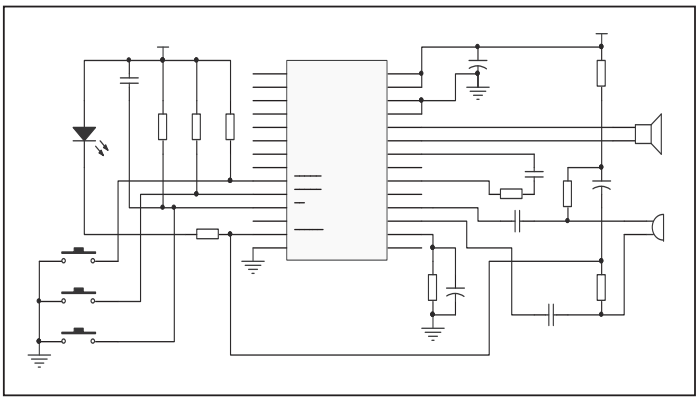

Figure 7. Voice prompt and SCM interface circuit

IV. WAREHOUSING GUIDE SYSTEM SOFTWARE IMPLEMENGTATION

Guidance system program is mainly composed of initialization, overrun detection, position detection, guide indication, voice prompt, etc. The program flow diagram is shown in Fig. 8. Initialization mainly sets up communications, interrupt, timing of initial state, etc.

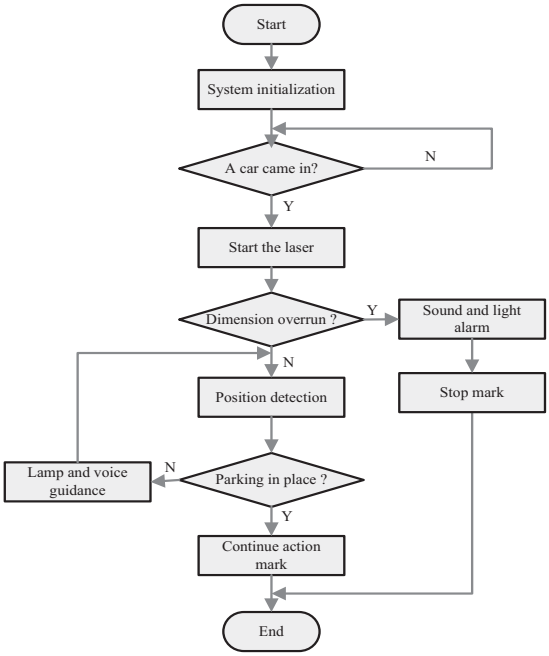

Figure 8. The program flow diagram

V. CONCLUSIONS

This research studied the intelligent control method of vehicle parking guidance system which is applicable to the three-dimensional garage at downtown business district. Intelligent parking guidance system using laser sensors determined whether the vehicle overrun and the specific location, and STC89C52 single-chip microcomputer controlled the voice prompt module and guiding light module, guided the vehicle into the specified location, realized the intelligent operation of vehicle storage guide. The system can also be used for other positioning and guiding applications. Fork type access method can effectively avoid idle stroke when keeping a car or taking a car, and improve access efficiency. Different parts of the system cooperate with each other to realize efficient, secure and intelligent access to parking garage in downtown business district.

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