DEPARTMENT OF COMMUNICATIONS ENGINEERING
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Development of a Microcontroller Controlled Smart Parking Lot Management System

Yahaya Mari
Department of Communications
Ahmadu Bello University
Zaria, Nigeria
mariyahaya12@gmail.com

Abdoulie Tekanyi
Department of Communications
Ahmadu Bello University
Zaria, Nigeria
amtekanyi@abu.edu.ng

Tanko Aquila
Department of Communications
Ahmadu Bello University
Zaria, Nigeria
tankoaquila@gmail.com

Musa Mamman
Department of Communications
Ahmadu Bello University
Zaria, Nigeria
musamamman@yahoo.com

***Abstract*—Smart parking lots exist but they are mostly constructed as commercial ventures and as such are complicated and expensive. They normally include ticketing system which may require infrastructure for cashless payments and some form of surveillance systems to ensure patrons do not evade payment of the parking charges. Such system are not suitable for free parking lots. Our developed system is a standalone parking lot system that could be implemented anywhere smart parking lot system is required to manage a free parking lot. This was achieved by using an ATmega328 microcontroller, a servo motor to control the barricade, and infrared proximity sensor to sense the presence of cars. The barricade, display, and control modules were installed at the frontage of the parking lot. A single barricade system is used to control access into and out of the parking lot to keep cost down. The display system is mounted above the entry point for proper visibility to the cars entering the parking lot. The system is cost effective, easy to develop, and could be used on any existing manual-operated car parking lot. The model was demonstrated on a prototype board with good result of the set objectives. That is, the system was able to count the number of cars that have used the facility over a period of time, show the number of cars that are currently occupying the facility, show the number of slot(s) that is/are available, and prevent cars from entry when all spaces are occupied.**

Keywords—Smart parking lot, Infra-red Proximity Sensor, Barricade, ATmega 328P Microcontroller

I. INTRODUCTION

Parking lot is an area assigned for parking. Normally, marks are made on the ground with white or yellow lines that are square. Parking lots are commonly near shops, bars, restaurants, schools, shops, and other facilities like public places like offices, business centres, or sporting arenas.

Managing a car park is very difficult in a busy area. Most especially, if the numbers of the cars are more than available spaces of the parking lot and when cars are parked all over the place without considering who leaves first. This project is an attempt to take care of such anomaly by designing a system that can resolve the problems.

There are different type of car parks which maybe traditional (single level) car park or multilevel car park. The most common type is the traditional. This research work is an attempt to resolve the problems associated with the single level parking lot. The developed system is cost effective since there is no person employed to manage the parking lot.

Anderson et al. [1] Produced a real time Car Parking System using Mobile cloud computing (MCC) and vehicular networking (VN) which is called Integrated Communication-Computing platforms (ICCP). The system solves challenges such as improper parking, traffic congestion, insecurity of vehicles etc. This system is complex and expensive and cannot easily be implemented. In contrast, this research work is less expensive, simple, and easier to develop, deploy, and maintain.

Chowdhury et al. [2] produced an Automated Parking System and Unauthorized Parking Detector to solve the rapid growth of vehicle traffic and unauthorized parking. The system uses RFID and Infrared sensor to detect cars that are authorized. If unauthorized, it sends SMS via a GSM module to the relevant authority. The system fails to stop entry of vehicles into the parking lot when the parking spaces are exhausted. This research work would prevent vehicles from entering the parking lot once all the lots are occupied.

Owayjan et al. [3] introduced Parking Management System using Mobile Application (PMSMA) which addressed parking problems in malls. The system was made up of custom made proximity sensor used to detect the presence of a car, an Arduino microcontroller to process data and Ethernet shield is use to broadcast availability of space to various phones that has the mobile application designed for this purpose. The project work is not applicable to and cannot be enjoyed by phone users who do not have the application on their phones. This research work does not

need an app to work, all required information are displayed on the display [8] at the entrance of the parking lot.

II. METHODOLOGY

The research work has both hardware and software components. The methodology adopted is described in the following steps:

1) Assembling of electronic components on project board (breadboard).

a) Assembly of components is done on project veroboard.

2) Programming the microcontroller by;

a) Writing a program in Arduino IDE (C++ programmer).

b) Loading a program on the ATmega328P microcontroller through a Universal Serial Bus (USB) cable.

3) Testing the circuit by;

a) Using multi meter to check for continuity and open circuit of the constructed circuit.

b) Powering the system with a 5Vdc supply to check if the loaded program on the microcontroller is giving the desired and intended result.

4) Implementation on a prototype by;

a) Setting up the system on a plywood board.

b) Providing barricade at the entrance to control entry using a servo motor.

c) Mounting the display to show relevant messages on available spaces and number of cars in parking lot.

d) Mounting a proximity sensor at the entrance to activate open the barrier for entry.

e) Mounting a proximity sensor at the exit to activate open the barrier for a car to pull out.

f) Mounting a proximity sensor at each slot to sense the presence/absence of a car.

B. Hardware

The hardware components of this research work are made up of Arduino Uno board with ATmega328P microprocessor, infrared proximity sensor.

ATmega328P microprocessor

The Atmel® picoPower® ATmega328/P is an 8-bit microcontroller based on the AVR® enhanced Reduced Instruction Set Computer (RISC) architecture. It's a low-power Complementary Metal-Oxide-Semiconductor (CMOS) microcontroller that achieves throughputs close to 1 Million Instructions Per Second (MIPS) per MHz. [10].

The ATmega328/P is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits [10].

Arduino Uno Board

Arduino is an open source programmable circuit board that contains a microcontroller which is able to be programmed to sense and control objects in the physical world. By responding to sensors and inputs, the Arduino is able to interact with a large array of outputs such as LEDs, motors, and displays [11].

Infrared Proximity Sensor

The infrared proximity sensor [4][5][6] comprises mainly of an LM393 OP-amp, 10kΩ potentiometer to vary sensitive of the sensor, IR receiver and IR transmitter [9]. This module is used to sense the presence of car and also count the cars leaving the parking area

Circuit Diagram

The project circuit diagram was designed with the aid of the software called Fritzing. The diagram fig.1 shows the circuit diagram of the Smart Parking Lot Management System (SPLMS).

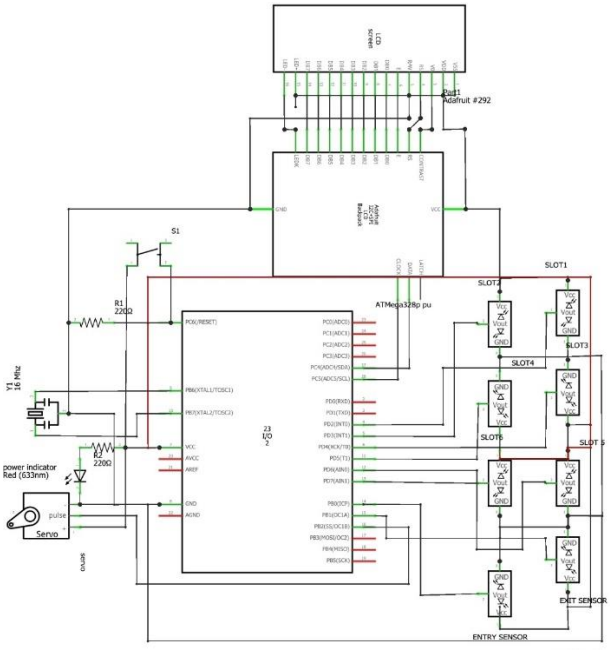

Fig. 1. Circuit Diagram of the Smart Parking Lot Management System

C. Software

The microcontroller was programmed to perform the design function. This was achieved by the use of Arduino Integrated Development Environment (IDE) to write and upload the code to the ATMega328P microcontroller through the use of Arduino ISP [7]. The IDE is a C++ programming

language that contains library that supports many different Arduino module.

III. Result and Discussions

This study is the development of a microcontroller controlled Smart Parking Lot Management System (SPLMS) which helps to control parking in a crowded parking lot in a cost-effective manner. The project is cost effective as it removes the need for an operator to man the gate. The SPLMS was able to:

1) Count the number of cars that have used the facility over a period.
2) Count the number of cars that have used the facility over a period.
3) Show the number of cars that are occupying the facility.
4) Show the number of slot(s) that is/are available.
5) Prevent cars from entering when all spaces are occupied. These are illustrated in Fig. 3 and Fig.4.

The objective function is achieved by using infrared proximity sensors, ATmega328 microcontroller and a servo motor to control the barricade. Table 4.1 shows the conditions under which the barricade opens. It opens under the following three conditions:

1) Opens for a car to enter only when at least 1 vacant slot exist as shown in Fig. 2.
2) Always opens for a car to exit the parking lot.
3) Remains close under all other conditions.

TABLE I. Barricade Status

	Vacant Lot	Car at entry	Car at exit	State of barricade
1	≥1	0	0	*Close*
2	≥1	0	1	*Open*
3	≥1	1	0	*Open*
4	≥1	1	1	*Open*
5	0	X	0	*Close*
6	0	X	1	*Open*

Legend:
0: No car sensed.
1: Car sensed.
X: Car sensed or not.
≥: At least a Car in the parking lot.

Fig. 2. Conditions for barricade to open or close.

The infrared proximity sensor detects the occupied parking lot when a car is parked in a slot. It is installed at the center of the slot in an actual parking lot. It could also sense other vehicles like motorcycles if packed directly above the sensor.

Fig. 3. Front View of the Parking Lot when it is Empty

Fig. 4. Top View of the Parking Lot when all the Parking Spaces are Occupied.

Fig. 5. Front View of the Parking Lot when all the Parking Lots are Fully Occupied.

IV. CONCLUSIONS

The developed system was successfully implemented on a board and could easily be upscaled and implemented on a conventional parking slot. This model considers a parking lot of 6 cars capacity and the only consideration for access to the parking lot is availability of a vacant slot. A single barricade is also used to control both entry and exit points due to cost considerations.

This system is set to achieve a better performance and improve effectiveness by taking out the need for an operator thereby making it cost effective.

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