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Car parking management system

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Abstract:

In the contemporary world, a prevalent challenge we confront is the rapid growth of the global population. This demographic expansion has given rise to several consequential problems, including the proliferation of automobiles on our roadways. The surge in vehicle numbers has led to congested traffic conditions and a scarcity of available parking spots, consequently fostering the problem of unauthorized parking. This unauthorized parking, in turn, poses a significant threat to the security of vehicles. In this area of high automobile traffic, the main issue arises when there is no management in the parking of automobiles. Due to this, there are high chances of accidents. To accomplish this task, we implemented a car parking system which is really very reliable and decreases the chance of risk in parking the vehicles. We proposed a car parking system which will calculate the empty slots available in the given parking place. Here, we have taken an ideal case of having 32 slots available in the parking place. We implemented and synthesized the project on the XILINX VIVADO platform using Verilog HDL. Hardware prototyping is done on Nexys a7 FPGA board.

1. Introduction

According to data from a study conducted by Ford, as cited in Reference [1], it was found that 27% of Filipino drivers experience stress when attempting parallel parking, even when a free parking space is available. Additionally, 53% of Thai drivers find reverse parking to be a stressful task, particularly in tight parking spaces. Nevertheless, it's important to note that parking challenges remain a significant issue, especially in densely populated and compact urban areas.

A parking assistance system is designed to augment drivers' parking capabilities, focusing on improving both safety and efficiency. Multiple technologies are accessible for the implementation of parking assistance, facilitating parking in various settings, including car parks and roadside locations. These technologies encompass autonomous path planning for vehicles in confined spaces [2], advanced driving assistance systems tailored for electric vehicles [3], semi-autonomous parking assistance systems [4], and dedicated parking assistance applications [6].

Xilinx VIVADO serves as a software design tool, as documented in Reference [11], intended for co-design systems. To fully harness the potential of this tool, there is a requirement for a more comprehensive methodology that supports C/C++ based design and optimization, the development of IP sub-systems, and the seamless integration of accelerated systems. Enabling designers to operate at a higher level of abstraction would greatly facilitate the reuse of designs. Numerous features within the tool present opportunities for enhancement by both engineers and developers, encompassing the acceleration of implementation, verification processes, and the facilitation of high-level design tasks.

2. Background work

Multiple technologies exist for the execution of driver-assist systems. One of these technologies involves a combined approximation approach for path planning in confined spaces, as detailed in Reference [2]. This approach consists of two components: a global planner responsible for generating an initial path, and a local planner tasked with realizing the initial path in a feasible manner.

In Reference [3], the paper discusses the automation of neighborhood electric vehicles utilizing an embedded distributed architecture, primarily designed for advanced driving assistance systems. In terms of hardware architecture, this system consists of two distinct layers of embedded processing systems. The lower-level system is responsible for overseeing all electric signals, while the upper-level system is responsible for executing the driver-assist functionalities.

In Reference [6], the authors introduce a novel park-assistance application that relies on a multiagent virtual environment. This application takes into account trajectory evaluation, which plays a crucial role in making decisions for guiding the vehicle.

Furthermore, in Reference [9], the authors describe a parking system operated by Raspberry Pi, utilizing in-vehicle monitoring to provide a top-view image of the external environment using fish-eye cameras. This system enables the driver to have a comprehensive view around the vehicle, promoting both comfort and safety during parking maneuvers.

Furthermore, in Reference [7], the authors have introduced a lane parking detection and tracking system. This system employs GPS for car positioning and navigation and utilizes a miniature self-driving car operating on Raspberry Pi for this purpose.

In their study referenced in [8], the authors emphasize enhancing drivers' parking skills, particularly in the context of reverse parking and steering timing. To aid drivers in this endeavor, they suggest a method involving auditory assistance, where the driver can follow guidance provided by a target trajectory during reverse parking. They propose a semi-autonomous parking assistance system [4] whose design components are rooted in kinematic vehicle models.

Additionally, leveraging machine vision technology, they introduce an approach [5] that detects the nearest point between the vehicle and obstacles. This approach involves fitting the automobile's tail with a polygon model, enabling it to provide crucial information for safe parking.

Reference [10] introduces an embedded system design for a voice-controlled car parking prototype. The primary objective of this research is to prioritize safety, especially in situations where the driver's visibility around the car is limited. To address these safety concerns, the authors propose the utilization of an embedded system designed for voice-controlled car parking.

Through experimentation, they obtained results by comparing the original voice commands to those received via a Bluetooth device, revealing average amplitudes of approximately 45 kHz and 50 kHz. This system design has the potential to be implemented in future car prototypes, further enhancing safety and convenience.

3. High-level proposed system

In the real world, individuals engage in numerous tasks while striving for efficiency and productivity. To make the most effective use of our resources, it's essential to take prudent measures to minimize time wastage in unproductive areas, such as the often-frustrating task of finding parking for vehicles. This paper aims to propose a solution for optimizing time spent on parking, with a focus on enhancing security measures. This solution can be seamlessly integrated with other public utilities, offering a multifaceted approach to addressing this issue.

The outputs of the top module are [6:0] seg and [3:0] and for displaying FULL and OPEN. SLOW CLOCK: The slow clock of 100 Hz frequency is generated by using an FPGA clock of 100MHz frequency. Seven seg module: This module is responsible for displaying FULL for all slots occupied and OPEN for at least one empty slot available case.

A challenge arises in the assignment of parking spaces, with the existing parking management system struggling to effectively organize and provide efficient information. To address these issues, we propose the design of a secure car parking management system. This system will be implemented on an FPGA (Field-Programmable Gate Array) to monitor parking availability and enhance vehicle security.

Lately, reconfigurable FPGA architecture has emerged as a potent means to implement digital logic. Unlike processors designed for general-purpose use and Application-Specific Integrated Circuits (ASICs), FPGA architecture strikes a balance. It offers robustness, programmability, and the capacity for reconfiguration. The beauty of FPGA-based designs lies in their adaptability through software component modifications.

Our proposed system is tailored for FPGA design, involving gate-level modeling. At its core, we have the "car_parking_system," where inputs consist of parking slots [4:0] and the system clock. This design promises to address the parking assignment challenges efficiently.

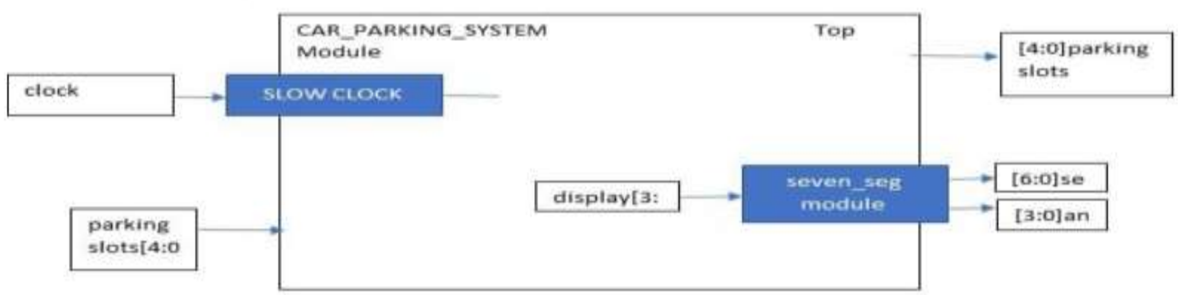

Fig. 1. Block diagram of car parking system

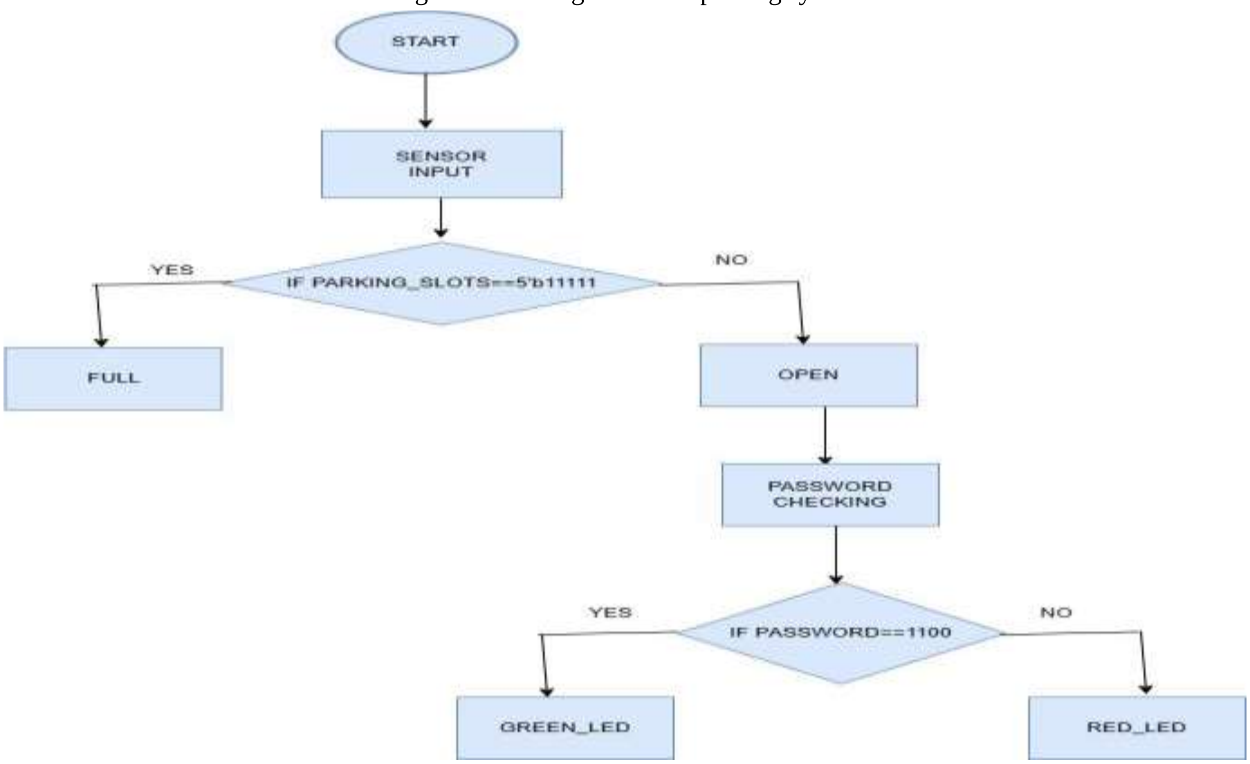

Fig. 2. Flow chart of car parking system

4. Uniqueness of proposed system

The car parking system project implemented on an FPGA (Field-Programmable Gate Array) board can offer several unique advantages and features compared to traditional parking systems. Here are some potential areas of uniqueness

Customization: FPGA boards provide a high level of customization and flexibility. You can design and implement the car parking system according to your specific requirements, such as the number of parking spots, user interface, sensor integration, and control mechanisms. This flexibility allows you to tailor the system to your needs, making it unique compared to off-the- shelf solutions.
Real-time Processing: FPGAs are known for their ability to perform high-speed parallel. In the context of a car parking system, this means that the FPGA board can handle real-time data from various sensors, such as proximity sensors or cameras, and process them rapidly. Real-time processing enables quick decision-making, accurate detection of available parking spots, and efficient control of entry and exit gates.
Sensor Integration: FPGAs can interface with a wide range of sensors and actuators, enabling seamless integration into the car parking system. You can connect different types of sensors, such as ultrasonic sensors, infrared sensors, or even computer vision-based cameras, to accurately detect the presence or absence of vehicles in parking spots. This flexibility in sensor integration allows you to choose the most suitable and cost-effective sensors for your specific project, adding a unique touch to the system.
Low Latency and High Throughput: FPGA-based systems often exhibit low latency and high throughput due to their parallel processing capabilities. In a car parking system, low latency ensures quick response times, such as detecting a vehicle's arrival or departure and updating the parking availability status in real-time. High throughput enables the system to handle multiple sensor inputs simultaneously and process them efficiently, providing a smooth user experience and efficient parking management.
Scalability: FPGA-based car parking systems can be easily scaled up or down to accommodate various parking lot sizes. Whether you have a small parking area or a large multi-level parking structure, FPGA boards allow for flexible scalability. You can add or remove parking spots, integrate additional sensors, or expand the system's functionality as needed. This scalability feature adds uniqueness by providing a customizable solution that can adapt to different parking lot configuration.
Energy Efficiency: FPGAs are known for their efficient power consumption compared to general-purpose processors. By leveraging FPGA's power optimization techniques, the car parking system can minimize energy consumption while maintaining high-performance levels. This energy efficiency aspect can be a unique selling point, especially in applications where sustainable solutions are valued.
Overall, the car parking system implemented on an FPGA board brings together customization, real-time processing, sensor integration, low latency, high throughput, scalability, and energy efficiency. These features make it a unique solution that can be tailored to specific requirements, offering advantages not commonly found in traditional parking systems.

4.1 Simulation

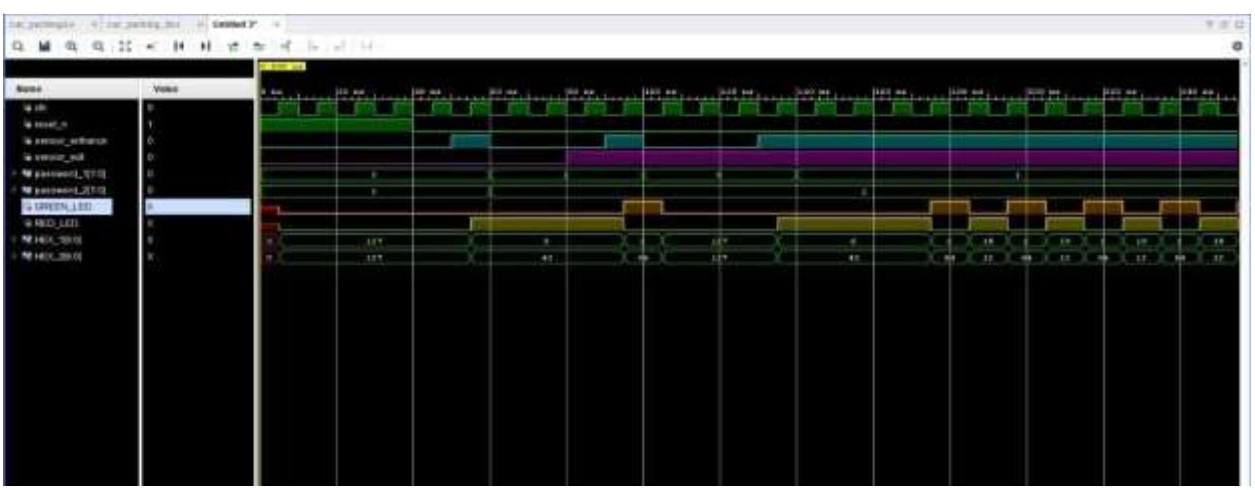

Fig. 3. Simulation of car parking system

4.2 RTL diagram

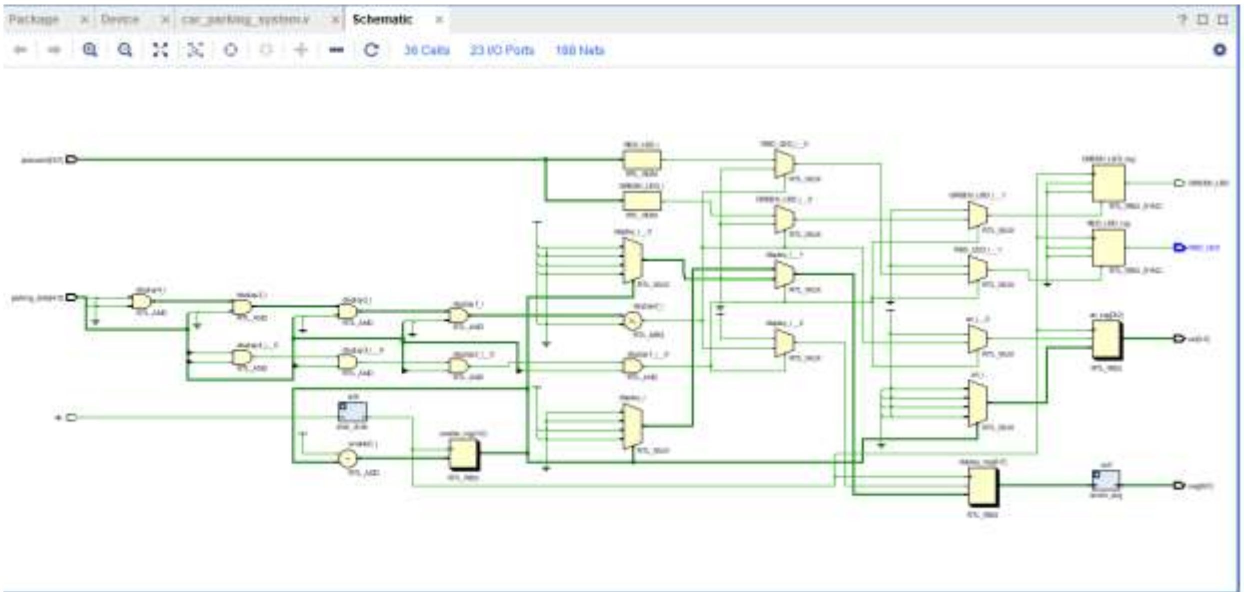

Fig. 4. RTL design for car parking system

4.3Synthesis

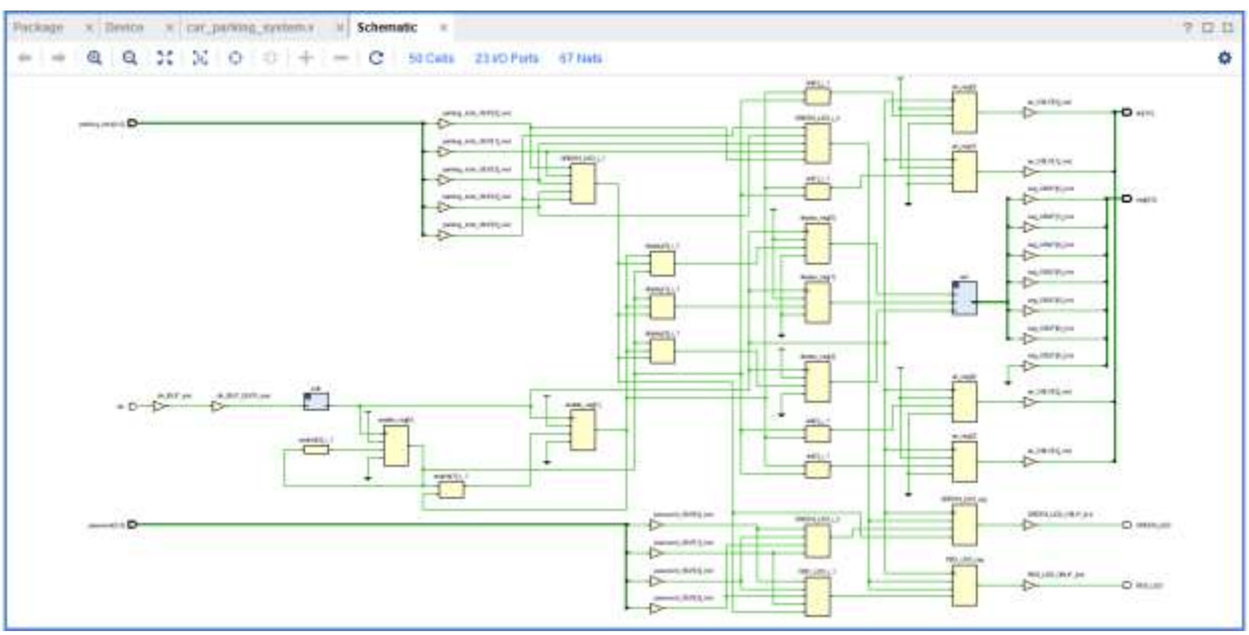

Fig.5: Synthesis for car parking system

5. Hardware prototype:

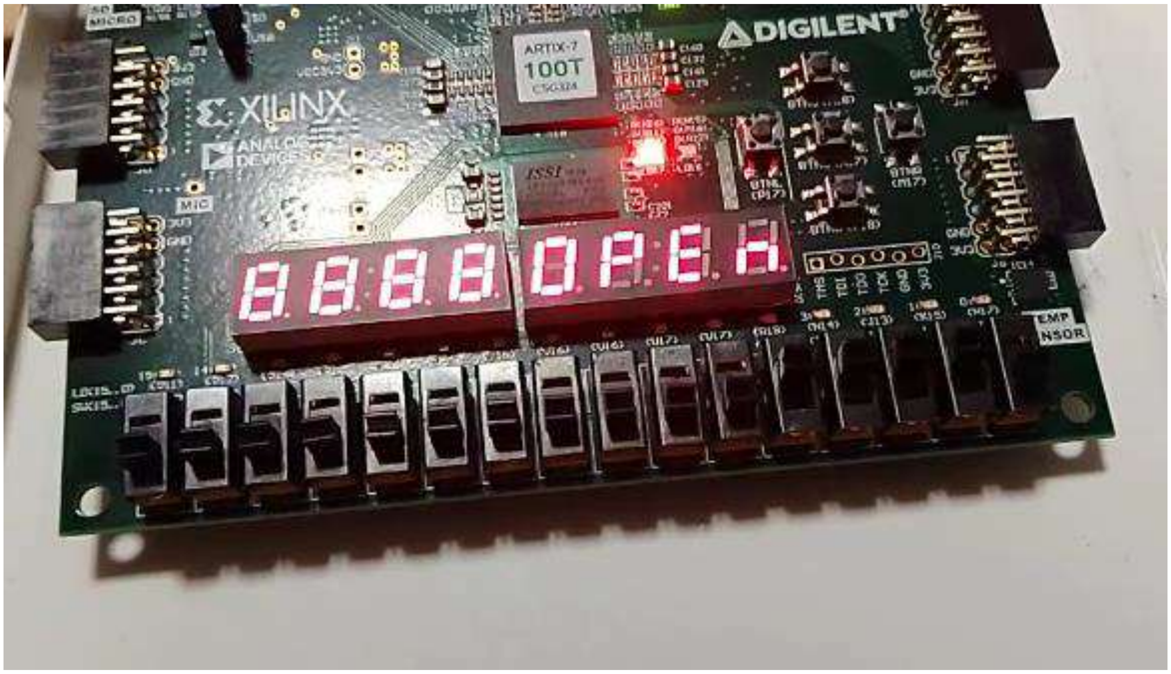

Fig.6: Hardware implementation

6. Performance metric:

When evaluating the performance metrics of a car parking system implemented using FPGA (Field-Programmable Gate Array), several factors can be considered. Here are some common performance metrics for a car parking system Occupancy Detection Accuracy: The accuracy of the occupancy detection system is crucial to ensure that the system can accurately determine the availability of parking spaces. High accuracy reduces the chances of errors and helps optimize the overall parking process.

7. Conclusion:

The goal of this paper is to develop a most effective car parking system. This is the the key impact in deciding to incorporate the FPGA method. With the support of Xilinx ISE Design Suite parking system is implemented using Verilog HDL.The car is correctly identified and parking safety will be stressed. Even the drivers can easily pick the slot.

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