Undergraduate Conference on Intelligent Computing and Systems (UCICS 2025)
26-27 February, 2025; Varendra University, Rajshahi, Bangladesh

IoT-Based Cost-Effective Smart Car Parking System for Middle-Income Countries

SHAHADAT HOSEN
Dept. of EEE
Varendra university
shahadatrskb@gmail.com

MD. TUSHAR IMRAN
Dept. of EEE
Varendra university
md.tushar3108imran@ gmail.com

MOST. UMMAY KULSUM
Dept. of EEE
Varendra university
srabonehaque@gmail.com

RABEYA KHATUN
Dept. of EEE
Varendra university
rabeyakhatun13579@gmail.com

Abstract- In recent times, the automatic car parking system is gaining popularity. Every smart city needs this concept to save car driver's time and decrease the complexity of parking. This project proposes an automatic, cost-effective car parking system for middle-income countries. In this project, an Arduino board is used as a processing and main circuit board connected to all types of necessary devices, and an ESP-32 board is used as a communication board to add IoT features. Every necessary data shows on LCD, Web application, android app, and all data stored in the computer as an Excel sheet. This project is mainly developed for middle-level garages and middle-income countries. So very high-level devices and complex programming languages are not used.

Keywords- IoT, Middle -Income, LCD, Web Application, ESP-32

I. INTRODUCTION

IoT-based smart car parking systems are becoming a trending project. Many researchers are working on this system. IoT stands for the Internet of Things. An IoT-based car parking system is an automatic system where humans are not required to maintain and account for a parking area. All systems can be monitored using an Android app and web dashboard through the Internet.

In a conventional garage, one or more human is needed to handle cars in the parking area. It is time-consuming and hard to keep accurate records. On the other hand, drivers and car owners cannot easily find which garage is empty to park their car. As a result, they are found empty garages to park their car by visiting one after another garage. In the modern world, already AI-based very advanced car parking systems exist to solve these problems. However, these systems are not a cost-effective solution to implement in a small garage. So, a complete system is needed to solve this problem. This paper aims to develop a complete IoT-based advanced cost-effective car parking system for small or medium garages. In this project, Arduino Uno, ESP-32, and RFID are used in that very cheap microcontroller and there are no expensive modules used in this project. Arduino Uno is a very cheap microcontroller.

II. LITERATURE REVIEW

From 2015 to 2024, at least 10 papers are studied on smart car parking systems. From these papers, huge research gaps were found. In [1] paper, Avirup Khanna and their team proposed a system to make an IoT-based car parking system by using mathematical functions. In this system, they just proposed it but they didn't make it practically. This is also costly to make. They also use high-level devices like Raspberry PI which was not a cost-effective solution. In this paper, a system is proposed where no Raspberry Pi is used. Arduino UNO is used as a processing device and ESP-32 is used as a communication device.

In the [2] paper, Mohan p. Takri and their research team proposed an IoT-based smart car parking system using RFID. Their proposed system was cost-effective and easy to use. But ESP12 is an old model device and it has not enough features. Their proposed system was excellent but there was no system developed for offline. Without the Internet, this system is not working properly. In this project, Excel software is used to collect and record data in offline, and an update communication module ESP-32 is used.

In the [3] paper, they proposed a smart car parking system with an automatic billing process. Their system was updated and cost-effective. This is also used for middle-income countries. But they used the E-WALLET system which not everyone is used to. In this project, not only E-WALLET is not used but also a manual payment system is used.

In the [4] paper, they proposed a system where they used maximum integer linear programming. This programming concept was very hard to execute. But in this project, simple Arduino coding is used.

In the [5] paper, they used RF wake-up sensors, motion detector wake-up sensors, and positioning sensing are used for the real-time update. This is not a cost-effective solution. In this project, a simple IR sensor is used to detect cars.

From these limitations, a completely new system is needed. As a result, this paper aims to develop a complete IoT-based advanced cost-effective car parking system for small or medium garages.

III. PROPOSED SYSTEM ARCHITECTURE

The proposed architecture is shown in Figure: 1 [6]. The proposed system can be divided into two parts. In the first part, the Arduino Uno is used as a main controlling and processing unit that connects RFID, LCD, and IR modules array. The IR modules are used to detect objects by using infrared. Here used five IR modules. Four IR modules are used to detect whether car parking slots are empty or full and another IR module is used to detect whether the car has left the garage. Arduino Uno is also connected with a computer to send the data to an Excel sheet the second part is the communication and door-controlling part. In the second part is used a ESP-32 as a communication unit which is connected to a door control servo motor. Every second, ESP-32 is getting data from the Arduino that which slot is empty and whether the cars waiting for entry are registered or unregistered cars. The door servo motor is used to control the door to enter or exit the car. The ESP-32 sends the data to the Blynk server to display the necessary data on the Android app and website.

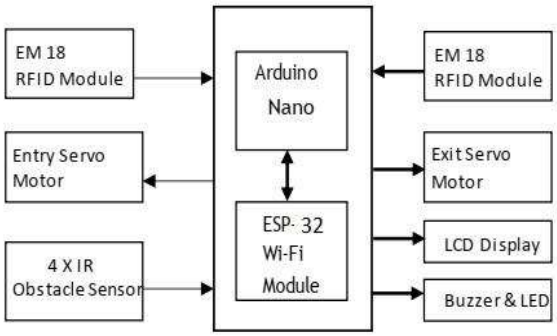


Figure 1: Proposed System Block Diagram

IV. CALCULATION METHOD AND CIRCUIT DIAGRAM

a) Calculation Formula:

Parking slots are defined as, $S1, S2 \ldots \ldots S_n$
Car entering or existing is defined as, $flag1$ & $flag2$
Total parking slot, $total$= S1+S2……S_n
Available slot, $slot = slot - total$
[6]

b) Circuit Connection:

The circuit diagram is shown in Figure 2. This circuit diagram is designed by using proteus. Here describes the connection of this circuit diagram.

- IR sensor modules are connected with Arduino Digital Pins.
- 20*4 LCD connected with I2C and I2C connected with Arduino SCK and SDK pin
- ESP-32 is connected with Arduino A0 and A1 pins
- The servo motor is connected to ESP-32
- Arduino Connected to a computer by using a serial cable

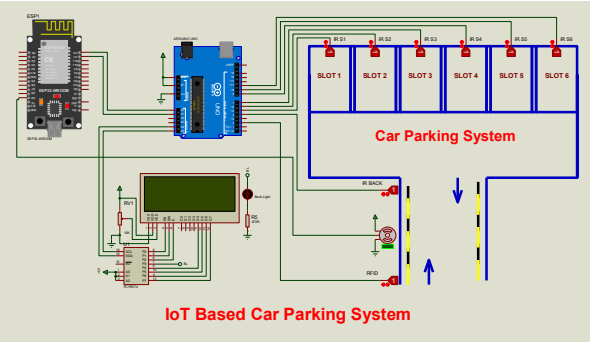


Figure 2: Circuit Diagram

V. CONTROL SYSTEM & WORKING PRINCIPLE

If the car is registered, the door is opened. First IR sensor detects whether the car successfully entered or not. If the car enters and parks in a slot, the display shows the

slot is full. Similarly, LCD shows the slot status. All data is sent on the Blynk server. All systems are monitored by the Blynk app. At the same time, this data is practically seen in an Excel file.

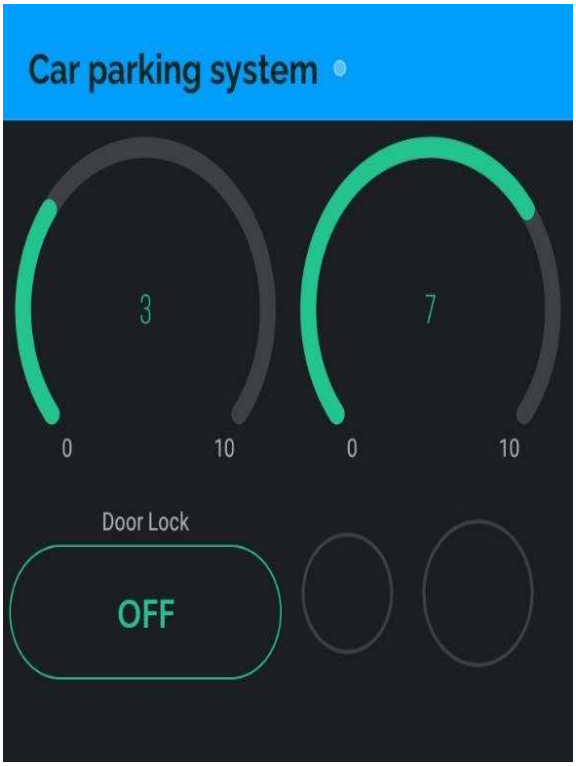


Figure 3: Android App

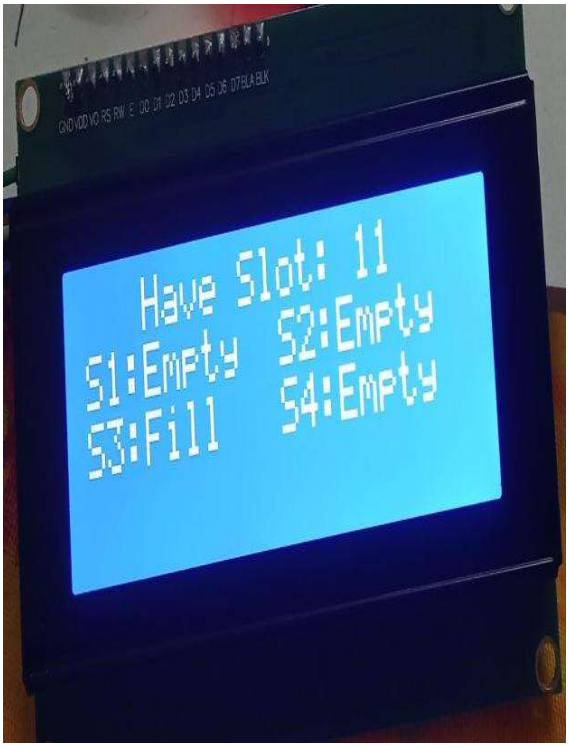
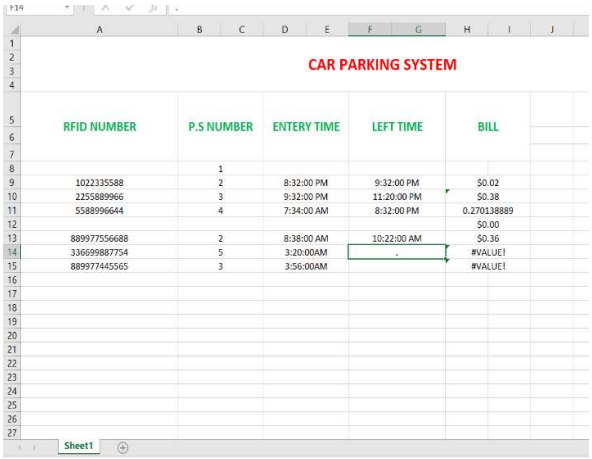


Figure 4: LCD

VI. RESULT AND DISCUSSION

This project was completed successfully. Necessary data were shown in Excel table, LCD and Blynk IoT platform. In this project, empty slots were shown in LCD and Blynk app. Figure 3 shows the Android application. Where shown the necessary data like empty slot numbers, and slot status. LCD also shows the necessary data that was shown in Figure 4 and in Figure 5 shows an Excel sheet that shows the car number, parking times, car bills, etc. Data were sent in Excel file, Blynk server, and LCD successfully. As a result, the data were shown. Figure 6 shows the complete project prototype.

In figure-5 the excel sheet show the output result. Here RFID number means the registered car number and P.S means the parking slot number. The excel sheet successfully show the RFID number, Parking slot number, left and entry time and automatic generate the bill according to the time.



CAR PARKING SYSTEM

RFID NUMBER	P.S NUMBER	ENTERY TIME	LEFT TIME	BILL
	1			
1022335588	2	8:32:00 PM	9:32:00 PM	$0.02
2255889966	3	9:32:00 PM	11:20:00 PM	$0.38
5588996644	4	7:34:00 AM	8:32:00 PM	0.270138889
				$0.00
889977556688	2	8:38:00 AM	10:22:00 AM	$0.36
336699887754	5	3:20:00AM	-	#VALUE!
889977445565	3	3:56:00AM		#VALUE!

Figure 5: Excel Sheet

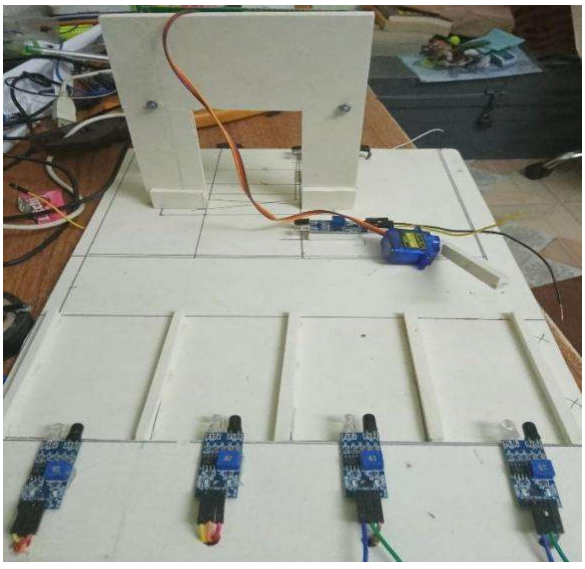


Figure 6: Complete Project

VII. CONCLUSION & FUTURE WORK

This project was working properly but it has some limitations. These limitations are:

1. No advance payment gateway.
2. IR sensors are not properly working due to sunlight. So, an alternative way is needed.

In the future, this problem will be solved. These problems are not major problems.

IoT-based SCADA system will be added to monitor properly. An advance payment system will be added. Complete personalized software and an Android app will be added.

REFERENCES

[1] R. A. Abhirup Khanna, "IoT based Smart Parking System," *IEEE,* p. 267, 2016.

[2] S. B. N. P. P. S. Mohan P. Thakre, "IOT Based Smart Vehicle Parking System Using RFID," *IEEE,* pp. 1-5, 2021.

[3] P. P. R. M. U. S. Mr. Yash Agarwal, "IoT based Smart Parking System," *IEEE,* p. 466, 2021.

[4] S. G. S. E. N. a. T. M. K. M. Ramaswamy, "IoT based Smart Parking System for large parking slots," *IEEE,* 2018.

[5] I. G. P. S. D. S. W. P. Woes, "An IoT- Based Intelligent system for real-Time Parking Monitoring and Automatic Billing," *IEEE,* pp. 622-626, 2020.

[6] r. Y. Agarwal, "IoT based Smart Parking System," *IEEE,* p. 1, 2021.

[7] "Car parking system," techatronic, 10 February 2024. [Online]. [Accessed 9 February 2024].