EMBEDDED C

FINAL REPORT

SMART CAR PARKING SYSTEM WITH ELECTRIC VEHICLE DETECTION

PROMOTING ECO - FRIENDLY

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ABSTRACT

Our project focuses on implementing a smarter parking solution designed to revolutionize urban parking environments. By leveraging advanced technology, our system offers efficiency, convenience, and sustainability. Key features include the detection of available parking slots, seamless integration for electric vehicles, and automated control of entry and exit barriers.

Utilizing sensor technology, our smart car parking system continuously monitors parking spaces, providing real-time updates on available slots. Additionally, it accommodates electric vehicles through specialized sensors, ensuring seamless integration and efficient utilization of resources.

Furthermore, the system controls entry and exit barriers, streamlining the flow of vehicles and enhancing overall management. Through automated processes, it optimizes parking operations, reducing congestion and improving accessibility.

Moreover, our solution incorporates features for pricing and duration calculation, providing transparency and convenience for both drivers and parking operators. By displaying relevant information, such as parking duration and associated fees, it enhances the overall user experience and facilitates efficient parking management.

In summary, our smarter parking solution offers a comprehensive approach to address the challenges of urban parking. By combining detection capabilities, electric vehicle accommodation, and automated control systems, we aim to create a sustainable and user-friendly parking environment for urban communities.

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INTRODUCTION

In the throbbing arteries of modern cities, the search for parking spaces has evolved into a daunting task, exacerbated by the ever-growing influx of vehicles. The advent of electric cars has further complicated this urban puzzle, demanding innovative solutions to address the evolving needs of urban mobility.

In response to this pressing challenge, our project emerges as a beacon of innovation, seamlessly melding advanced sensor technology with automated control systems to revolutionize the landscape of urban parking. By harnessing the power of real-time data and intelligent automation, our smart car parking system endeavors to reshape the parking experience, offering a trifecta of efficiency, convenience, and sustainability.

At its core, our solution is designed to detect available parking slots with precision, orchestrate seamless entry and exit maneuvers through controlled barriers, and seamlessly integrate the burgeoning fleet of electric vehicles into the urban parking ecosystem. Through a symphony of sensors and automation, our system not only optimizes parking utilization but also paves the way for a greener, more sustainable urban future.

In this report, we delve into the intricacies of our smart parking system, exploring its functionalities, technological underpinnings, and the myriad benefits it bestows upon both drivers and parking operators. From its ability to seamlessly accommodate electric vehicles to its intuitive pricing and payment mechanisms, our project stands poised to redefine the paradigm of urban parking management, ushering in a new era of efficiency and convenience.

PLATFORM USED

- Arduino IDE
- Language - Cpp

LITERATURE REVIEW I

by Mathias Gabriel Diaz Ogás ,Ramon Fabregat and Silvana Aciar

The burgeoning urban landscape, compounded by the surge in vehicular traffic, has propelled the vehicle routing problem (VRP) to the forefront of intelligent transport systems (ITS). As cities grapple with congestion and parking scarcity, the integration of smart parking systems (SPS) has emerged as a pivotal solution. Leveraging a gamut of technologies including sensors and algorithms, SPS endeavors to streamline parking search and alleviate urban gridlock.

In the realm of scholarly discourse, a plethora of studies from 2012 to 2019 have scrutinized SPS and vehicle detection techniques (VDT), shedding light on their manifold applications and challenges. These investigations encompass a diverse array of SPS typologies and VDT methodologies, ranging from sensor-based systems to sophisticated machine learning algorithms. Despite this breadth of inquiry, existing literature reviews have often overlooked a comprehensive analysis of SPS classifications, VDT modalities, and algorithmic implementations.

Against this backdrop, our paper undertakes a systematic review of 274 publications spanning the aforementioned period, synthesizing insights to unravel the intricate tapestry of SPS and VDT. By delineating the evolutionary trajectories of SPS development and elucidating the nuances of VDT mechanisms, our study aims to chart a course for future research endeavors in the realm of smart parking systems and allied technologies.

LITERATURE REVIEW II

by Debarati Pal , Himanshu Kumar , Kavita Joshi , Dr. Neelu Nagpal

The current decade has witnessed a surge in Electric Vehicle (EV) adoption, offering a sustainable and eco-friendly alternative to traditional LPG and diesel cars. As EVs gain popularity for their CO2 reduction benefits and reliance on alternative energy sources, the demand for charging infrastructure has escalated. Simultaneously, the challenge of parking remains a persistent issue in urban environments. Addressing this dual need, our project focuses on developing a "Smart Parking and Green Charging system for EVs."

Nowadays, Electric Vehicles (EVs) are a focal point in discussions surrounding sustainable transportation solutions. However, a notable drawback of EVs lies in their limited cruising range, necessitating frequent recharging. Moreover, the exponential growth in population exacerbates traffic congestion, underscoring the urgency for alternative solutions. In this context, electricity emerges as a viable option, with EVs serving as a prime example.

Recognizing the symbiotic relationship between EVs and charging infrastructure, our project endeavors to seamlessly integrate both aspects into a unified system. Leveraging IoT technology, we aim to streamline the charging process by coupling it with parking, thereby optimizing efficiency. Central to our approach is the utilization of solar panels for green charging, aligning with principles of sustainability and renewable energy. Through these endeavors, we strive to contribute to the paradigm shift towards greener transportation solutions.

LITERATURE REVIEW III

Yanfeng Geng, Student Member, IEEE, and Christos G. Cassandras, Fellow, IEEE

The urgent need to alleviate urban traffic congestion, primarily caused by drivers searching for parking spaces, serves as the driving force behind our proposed novel "smart parking" system. Studies indicate that approximately 30% of downtown traffic congestion results from this parking search, with drivers spending an average of 7.8 minutes on the hunt. Not only does this waste time and fuel, but it also exacerbates congestion for others, leading to significant environmental impacts. Despite extensive research on parking behaviors and efficiency improvement, traditional parking guidance systems have shown limited success in reducing overall travel time and vehicle emissions.

In response to this pressing issue, our system offers a groundbreaking approach by assigning and reserving optimal parking spaces based on the driver's cost function, which combines factors like proximity to the destination and parking cost. Utilizing mixed-integer linear programming (MILP) at each decision point defined in a time-driven sequence, our system ensures an optimal allocation based on real-time state information. This allocation is continuously updated at subsequent decision points, guaranteeing no resource reservation conflicts and ensuring that no driver is assigned a space with a cost function higher than their current value.

While traditional parking guidance systems have struggled to address the complexities of urban parking, our proposed "smart parking" system offers a promising solution. By leveraging advanced optimization techniques and real-time data processing, our system has the potential to streamline the parking process, minimize traffic congestion, and enhance overall urban mobility.

LITERATURE REVIEW IV

Baratam. M Kumar Gandhi and M. Kameswara Rao*

Present day's car parking has become a major issue in urban areas with lack of parking facilities and increased amount of vehicles, due to this drivers who are searching for parking space they were roaming around the city in peak hours. This causes traffic, waste of time and money. Methods: To solve those problems, this prototype is developed using sensor circuit, RFID and IoT. RFID used here to detect the car details, IR sensor is used to find the presence of the car and all details are accessed from remotely through IoT. Findings: This system helps user to find parking space availability with the help of Internet of Things (IoT) technology by providing parking free space information. The IoT maintains the database of the parked vehicles through a shared server. So drivers can book the slots in advance and the parking information updated in server. In addition to the parking, theft management will be done i.e. a theft vehicle came for parking then the number plate is checked with theft list in the database, if it is in theft list then a message is sent to the police. Applications/ Improvements: This prototype developed for the parking system with less human interaction, increases flexibility and security. This system is employable in airports and multiplexes parking.

PROBLEM STATEMENT

Existing parking management systems face challenges in efficiently integrating electric vehicle (EV) charging infrastructure, leading to suboptimal resource utilization and limited accessibility for EV owners. Additionally, the absence of EV differentiation and dynamic pricing mechanisms hampers sustainable transportation initiatives. Furthermore, the lack of print duration for each slot in the current system contributes to inefficient space allocation. Therefore, there is an urgent need for an advanced parking system that incorporates features such as color sensor integration for EV identification, dynamic pricing, and duration printing to optimize resource allocation and incentivize sustainable mobility choices, thereby fostering smart and sustainable urban development.

EXISTING SYSTEM

In the existing system, the primary component used for parking slot detection is the IR sensor. These sensors are strategically placed in each parking slot to detect the presence of cars. When a car enters or exits a slot, the IR sensor detects the change in infrared radiation and sends a signal to update the LCD displays, indicating the availability status of the parking slot. The LCD displays provide real-time information to drivers, allowing them to identify vacant parking spaces easily.

Additionally, a servo motor is employed to control the barrier at the entry/exit points of the parking area. The servo motor receives signals from the IR sensors, allowing it to either raise or lower the barrier based on the presence or absence of vehicles in the parking area. This mechanism helps in managing entry and exit into the parking facility efficiently, ensuring smooth traffic flow.

Challenges Faced in Existing System

- **Limited Functionality:** The existing system relies solely on IR sensors for detecting the presence of vehicles in parking slots. While effective for basic detection, IR sensors may have limitations in accurately identifying certain types of vehicles or distinguishing between different vehicle types, such as electric vehicles.

- **Lack of Differentiation:** Without the ability to differentiate between regular vehicles and electric vehicles, the existing system cannot provide tailored services or accommodate the specific needs of EV owners, such as access to charging stations.

- **Manual Monitoring:** The system requires manual monitoring and management to ensure accurate updates on the availability of parking slots. This manual intervention increases the risk of errors and delays in providing real-time information to drivers.

- **Limited User Experience:** Due to the lack of advanced features such as EV detection and differentiated pricing, the existing system may offer a limited user experience, leading to inefficiencies in parking management and customer satisfaction.

- **Scalability Issues:** Scaling the existing system to accommodate future growth or evolving parking requirements may pose challenges, as it may not have the flexibility or adaptability to integrate new functionalities seamlessly.
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PROPOSED SYSTEM

To enhance the functionality and efficiency of the parking system, several additional features are proposed in the project. One significant enhancement is the integration of a color sensor to identify electric vehicles (EVs). This sensor can distinguish between regular vehicles and EVs based on their color or specific markings. Once an EV is detected, the system guides it to specific parking slots equipped with charging stations, ensuring that EV owners have convenient access to charging facilities.

Furthermore, the proposed system incorporates duration and price calculations based on the time a car occupies a parking slot. Different pricing rates are applied for regular vehicles and electric vehicles, reflecting the varying costs associated with parking and charging. This feature not only promotes efficient space utilization but also incentivizes the use of electric vehicles, contributing to sustainability efforts.

Overall, the proposed system builds upon the foundation of the existing system by introducing innovative features such as color sensor integration and differentiated pricing for EVs. These enhancements aim to provide a comprehensive solution for smart parking management, catering to the evolving needs of urban environments and promoting sustainable transportation practices.

F L O W

GATE

IR (Open)

IR (Close)

Colour Sensor

PARKING

IR (S1)

IR (S2)

IR (S3)

IR (S4)

MAIN LCD (Parking Status)

LCD (S1)

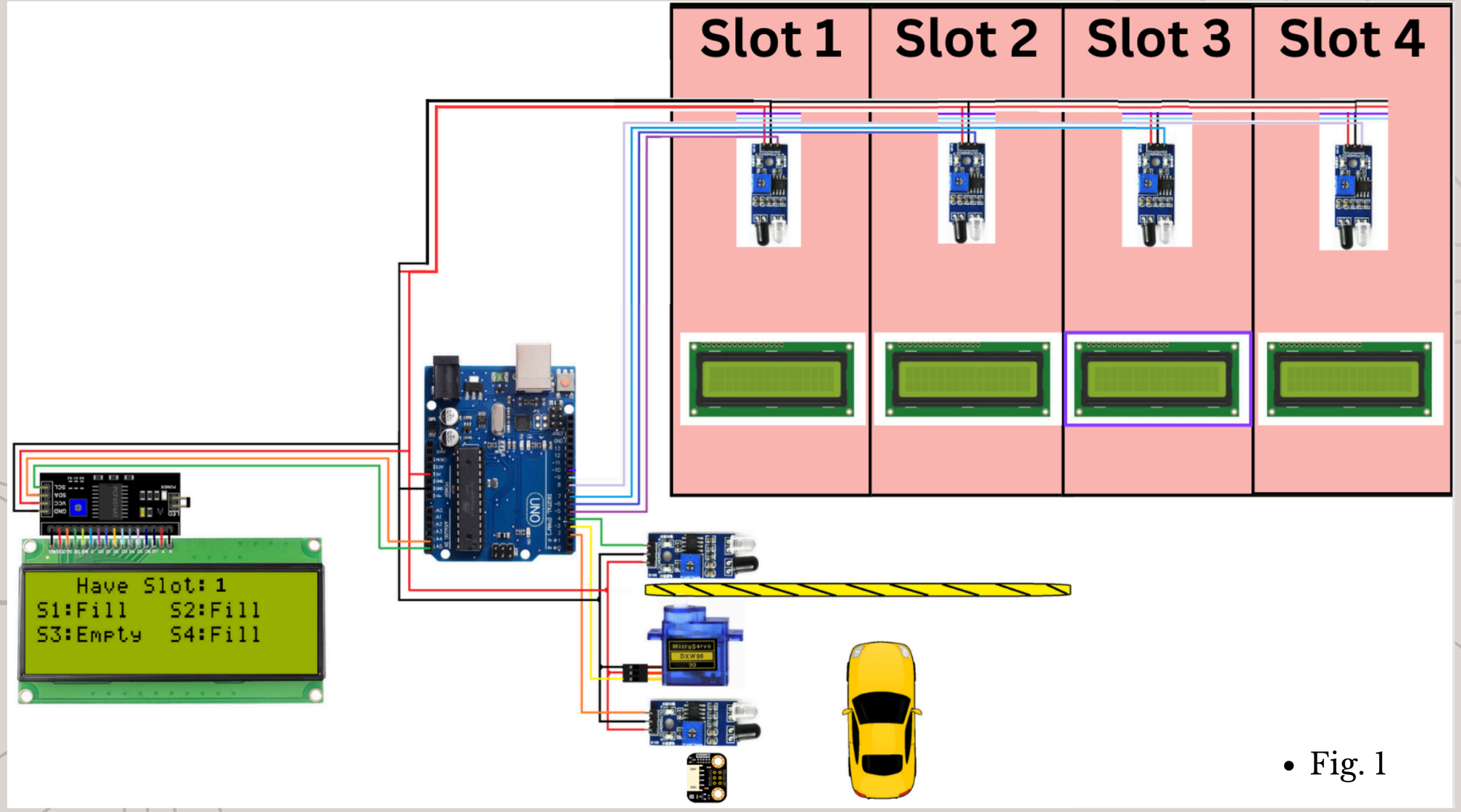
LCD (S2)

LCD (S3)

LCD (S4)

LCD (E V)

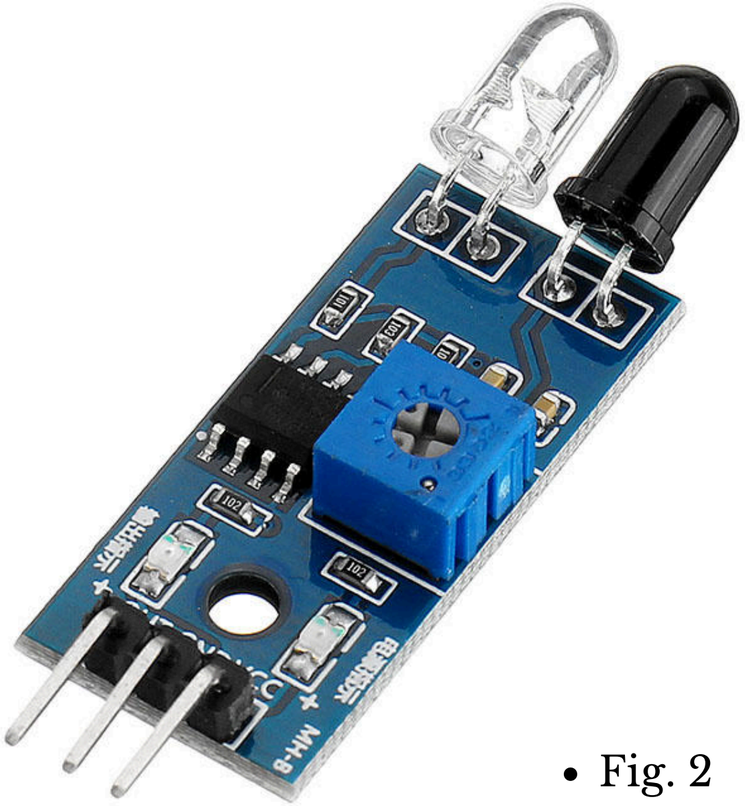
SCHEMATIC DIAGRAM



- Fig. 1

HARDWARE COMPONENTS

- **IR Sensors:** These sensors are used for detecting the presence of cars in each parking slot. They help the system determine whether a slot is occupied or vacant.



- Fig. 2

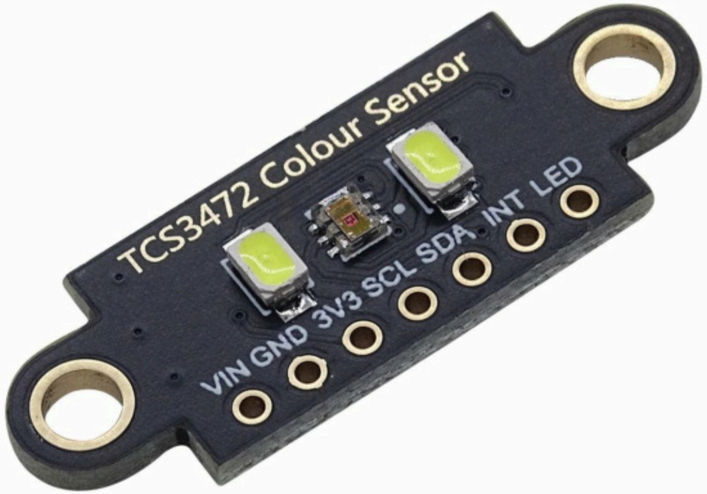
HARDWARE COMPONENTS

- **Servo Motor:** The servo motor is used to control the entry and exit barriers of the parking system. It opens and closes the barriers to allow or restrict the entry and exit of vehicles.

- Fig. 3

HARDWARE COMPONENTS

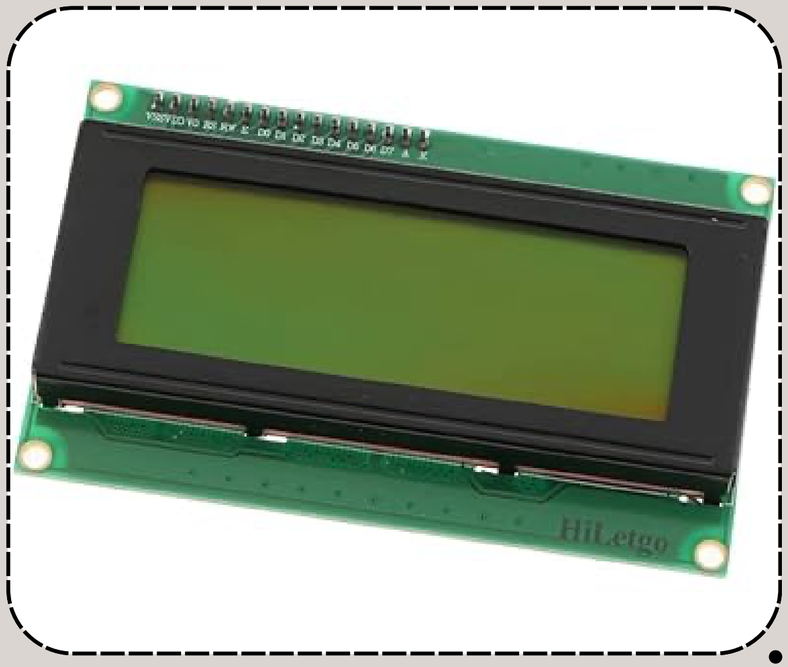
- **Colour Sensor (TCS34725):** This sensor is utilized to identify electric vehicles. It measures the color of the vehicle at the entrance and determines whether it is an electric vehicle based on predefined criteria.



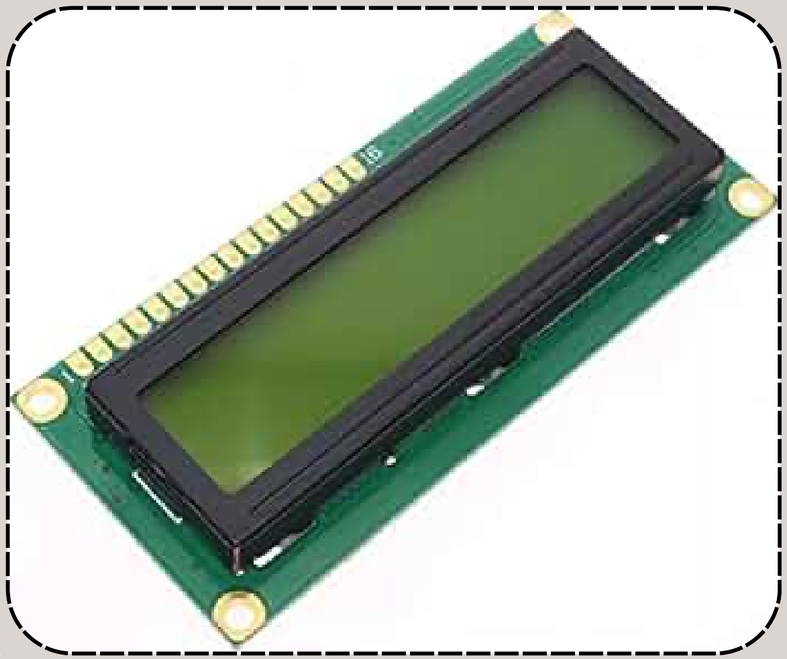
- Fig. 4

HARDWARE COMPONENTS

- **LCD Displays:** Multiple LCD displays are used to provide real-time information to users. They display the status of parking slots, duration of parking, pricing information, and messages related to electric vehicle detection.



20x4



16x2

- Fig. 5

EXPLANATION

Module I

- **IR Sensor Integration:**
  - The system is equipped with infrared (IR) sensors strategically placed within each parking slot to detect the presence of vehicles. These sensors continuously monitor the occupancy status of the slots, sending real-time data to the central processing unit of the parking management system. By leveraging IR technology, the system ensures accurate and reliable detection of parked vehicles, enabling precise monitoring of parking slot occupancy.

EXPLANATION

Module II

- **LCD Display Updates:**
    - Upon detecting a vehicle in a parking slot, the system promptly updates the corresponding LCD display unit. These displays, positioned at strategic locations throughout the parking area, provide visual feedback to drivers, indicating the availability or occupancy status of individual parking slots in real time. This feature enables drivers to quickly identify vacant parking spaces, thereby streamlining the parking process and minimizing unnecessary traffic congestion within the parking facility.

EXPLANATION

Module III

- **Servo Motor-Controlled Barrier:**

  - A servo motor is integrated into the entry/exit barrier mechanism of the parking facility. The servo motor receives signals from the IR sensors positioned at the entry and exit points, allowing the barrier to dynamically respond to the presence or absence of vehicles. When a vehicle approaches the entry point, the barrier automatically lifts, granting access to the parking area. Conversely, when the exit point is approached, the barrier lowers, restricting unauthorized vehicles from exiting the premises. This servo motor-controlled barrier mechanism enhances security and facilitates smooth vehicular movement within the parking facility.

EXPLANATION

Module IV

- **Colour Sensor for EV Identification:**
    - A colour sensor is employed to distinguish electric vehicles (EVs) from conventional vehicles based on their unique color or specific markings. Upon detecting an EV, the color sensor communicates this information to the parking management system, triggering specialized guidance for EVs to designated parking slots equipped with charging stations. This innovative feature ensures that EV owners have convenient access to charging facilities, thereby promoting the adoption of electric vehicles and supporting sustainable transportation initiatives.

EXPLANATION

Module V

- **Duration and Price Calculations:**
    - The system incorporates sophisticated algorithms for duration and price calculations, which are based on the duration of time a car occupies a parking slot. Different pricing rates are applied for regular vehicles and electric vehicles, reflecting the varying costs associated with parking and charging. By accurately tracking the duration of parking sessions, the system provides transparent and fair pricing for users, promoting efficient space utilization and incentivizing the use of electric vehicles.

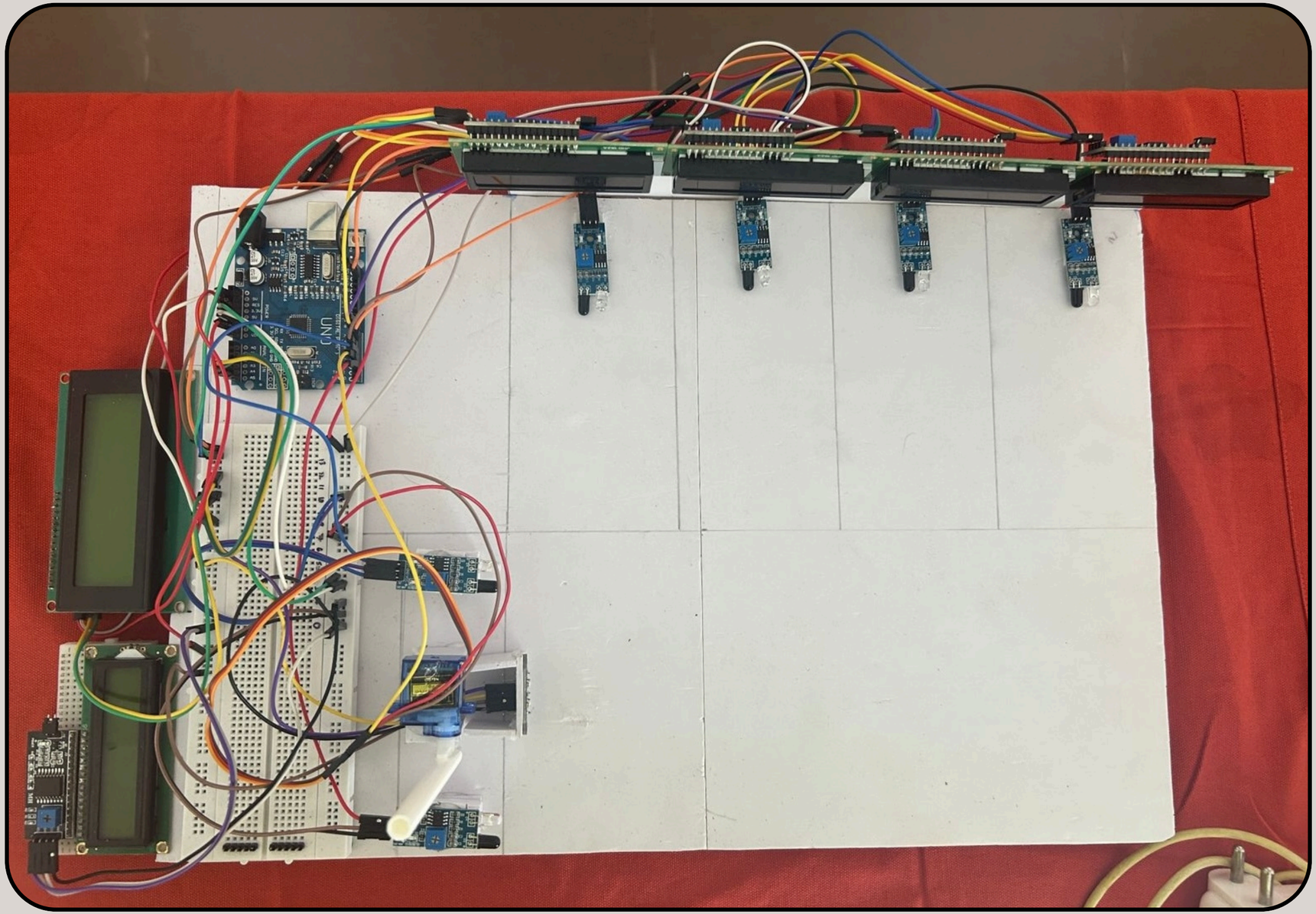
EXPLANATION

Module VI

- **Real-time Monitoring and Management:**

  - Collectively, these features enable the system to provide comprehensive real-time monitoring and management of parking slots within the facility. By continuously updating occupancy status, facilitating entry/exit control, and efficiently managing EV parking spaces, the system optimizes the utilization of parking resources while enhancing the overall user experience for both drivers and parking facility operators. This holistic approach to parking management fosters sustainability, convenience, and efficiency in urban mobility solutions.

OUTPUT



CODE (Source File)

https://github.com/raghul-g1322/Parking-System-EV-Based

CODE – EXPLANATION

Module I

- **Header Files:**
  - The code includes necessary header files such as Servo.h, Wire.h, LiquidCrystal_I2C.h, and "Adafruit_TCS34725.h" to use various libraries for servo motor control, I2C communication, LCD display, and color sensor functionality respectively.

- **Global Variables:**
  - LiquidCrystal_I2C objects are declared for each LCD display.
  - Servo object myservo is declared for controlling the servo motor.
  - Definitions for IR sensor pins, RGB LED pins, and other variables are provided.

- **Gamma Correction:**
  - A gamma correction table is created to adjust the brightness levels for the RGB LED.

CODE – EXPLANATION

Module II

- **Setup Function:**
  - Serial communication is initiated at 9600 baud rate.
  - Pins are configured for input and output.
  - Servo motor is attached and set to its initial position.
  - Each LCD display is initialized and messages are displayed.
  - Color sensor is initialized.
  - Gamma correction is applied to the RGB LED pins.

CODE – EXPLANATION

Module III

- **Loop Function:**
    - Continuously reads sensor data and updates the LCD displays accordingly.
    - Checks for available parking slots and displays their status.
    - Checks for IR sensor signals to control the servo motor (opening and closing the barrier).

CODE – EXPLANATION

Module IV

- **Read_Sensor Function:**

  - Reads the status of each IR sensor to detect the presence of cars in parking slots.
  - Monitors changes in sensor readings to calculate parking duration and price for each slot.
  - Updates the respective LCD displays with duration and price information.
  - Uses the color sensor to detect the presence of electric vehicles and displays appropriate messages on an LCD.

ADVANTAGES

- **Efficient Use of Resources:** By detecting EVs, the system can optimize parking spaces, ensuring that EV charging stations are utilized effectively. This optimization helps maximize the use of available parking spots, reducing congestion and improving overall parking efficiency.

- **Convenience for EV Drivers:** EV drivers can easily locate available charging stations through the system's real-time information, reducing the time spent searching for a spot. This convenience encourages more drivers to adopt EVs, contributing to the growth of sustainable transportation.

- **Reduced Carbon Footprint:** By promoting the use of EVs through convenient access to charging infrastructure, the system helps reduce reliance on fossil fuels and lowers carbon emissions. This aligns with environmental goals and supports efforts to combat climate change.

ADVANTAGES(cntd...)

- **Real-time Information:** The system provides real-time data on the availability of EV charging stations, allowing drivers to plan their trips more efficiently. This information improves user experience, reduces wait times, and enhances overall satisfaction with the parking facility.

- **Integration with Smart Grids:** Smart Car Parking Systems can integrate with smart grids for efficient energy management. This integration allows for better utilization of renewable energy sources, such as solar or wind power, to charge EVs, further reducing the environmental impact of transportation.

- **Revenue Generation:** Parking facilities can generate revenue by offering premium services for EV charging, such as faster charging. Additionally, the system can provide valuable data to third parties for analysis and planning, creating potential revenue streams.

- **Future-proofing Infrastructure:** As EV adoption continues to grow, having a Smart Car Parking System in place to manage EV parking and charging will become increasingly important for urban planning and infrastructure development. This proactive approach helps cities and parking operators adapt to the evolving transportation landscape and meet the needs of a growing number of EV drivers.

CONCLUSION

The conclusion summarizes the key features and benefits of the smarter parking solution. It highlights the system's ability to detect available parking spots, manage entry and exit through barrier control, and accommodate electric vehicles. Additionally, it emphasizes the convenience and sustainability aspects, making parking management more efficient for urban environments. Overall, the conclusion effectively encapsulates the value proposition of the smart car parking system for both drivers and parking operators.

Thank You