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"Green Park: An Arduino-Based Smart Parking System for Sustainable Urban Mobility"

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Abstract - *The number of cars on the road is rising as a result of the world's population growth and the congested cities. One of the main challenges in cities is parking management. Research on the design of parking systems has been conducted in the past. On the other hand, smart parking systems continue to be in demand and are grabbing the attention of researchers as a possible improvement to satisfy contemporary demands. To enhance the global security system, it is essential to keep an eye on and control vehicle access in parking lots owned by the public and private sectors. Therefore, the purpose of this research is to design and build a smart parking system using Arduino and sensor technology.*

The developed system may prevent illegal cars from entering parking lots while controlling the entry of permitted vehicles. At the moment, smart parking or parking guidance systems only convey the information to drivers after receiving it from deployed sensor networks about available parking spots. IR sensors, an LCD display, a servo motor, and an Arduino UNO will all be used. When a car enters or exits a parking lot, infrared sensors send a signal to an Arduino, which displays the number of available parking spots on an LCD. With such a system, we can determine whether parking spaces are available even before we approach the parking lot, and we may utilize this strategy to save time, gasoline, and pollution.

Keywords: Arduino, IRSensor, Servo Motor, Smart Parking.

1. INTRODUCTION:

In order to address many of the issues that are readily apparent and to reduce urban congestion, smart cities require more innovative and efficient technologies. One of the most annoying problems for drivers is finding a parking space. Especially in public spaces like shopping centers, five-star hotels, and movie theaters. Drivers waste time and gasoline looking for a place to park their automobiles, even inside the park. While looking for a parking space, this will harm the driver's feelings and pollute the environment. We develop and construct a smart parking system in this study that successfully tackles these problems.

A smart parking system is made with an Arduino Uno. In a new city, the gadget helps the motorist find parking by using infrared sensors installed in the parking spaces to identify unoccupied spaces. Neither a payment system nor a parking space-finding guiding technology are included in the system. The smart vehicle parking program aims to simplify and streamline parking. This initiative gives drivers accurate information on parking spot availability, allowing them to park their cars with the least amount of lost time.

1.1 Issues with the Traditional car Parking system:

In the past, the majority of locations around our nation used manual or traditional automobile parking systems. However, as several studies have shown, this method is riddled with issues. Listed below are a few of them:

1) We see a traffic bottleneck in front of the hospital, where a parking area is designated for the hospital but adjacent utilities' cars are parked there as well. Traffic delays are also caused by the parking guard stopping every car and collecting payments.

2) Finding the right parking space is challenging and time-consuming, which wastes time and gasoline. Additionally,
3) The other issue with manual parking is human security; anybody may access the space and there is a risk of snatching, robbery, or grabbing.
4) A additional guard is needed for the full operation of a manual parking system, which raises the cost. Mubashirin, M., & Mahmud, S. (2017).

Figure 1: Heavy urban traffic congestion caused by unorganized roadside parking and high vehicle density in a metropolitan area.

2. LITERATURE SURVEY

The primary goal of research on smart parking systems, especially those utilizing Arduino technology, is to solve the increasing problems related to urban parking. By minimizing fuel use, optimizing resource allocation, and offering users

convenient parking options, these systems hope to support the growth of smart cities.

In 2013, Yanfeng Geng and Christos G. Cassandras presented the idea of reservations and optimal resource allocation in smart parking systems. Their goal was to create and put into place a system that minimizes parking issues in cities by allocating resources and reservations as efficiently as possible. They hoped to aid in the creation of smart cities by doing this. The significance of effective parking management using cutting-edge technologies was highlighted in this paper.

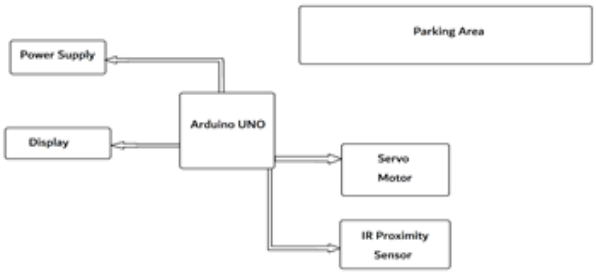
A. K. Hilal (2014) shed light on how intelligent parking management systems are really put into practice. The goal was to show how these technologies may be used practically in an educational setting, proving their efficacy in actual situations. The study highlighted how smart parking solutions might affect day-to-day operations, especially at educational institutions.

3. Motivation and Goals:

1) Minimize traffic jams brought on by an unorganized parking system.
2) Make the most of the parking spots available.
3) To conserve gasoline and cut down on damaging carbon emissions.
4) Improve car safety and car owners' safety.
5) Time-saving.

Many benefits will undoubtedly result from resolving this issue or simply making an effort to lessen it, such as reducing drivers' stress and irritation, saving time and fuel, and lowering gas emissions, which will lessen the negative impacts of pollution levels. The current figures make it clear that a significant amount of gasoline is spent when looking for a parking place.

4. Block Diagram of proposed system:



5. Working of System:

An automated, cost-effective, and efficient method of managing parking in the current era is provided by the Arduino-based smart parking system. The system incorporates a 16x2 LCD module for real-time status display, a servo motor mechanism for automated gate control, and infrared (IR) sensors for vehicle detection. In order to govern vehicle entrance and slot occupancy, the Arduino microcontroller serves as the central processing unit. It does this by continually monitoring sensor inputs and carrying out preprogrammed control logic.

The IR sensor recognizes the presence of a car approaching the parking entry and sends a signal to the microcontroller. After confirming slot availability, the system turns on the servo motor to either permit or prohibit admission. Individual slot sensors simultaneously track the number of occupied slots and dynamically update the number of vacant slots. The LCD display provides real-time information to users, thereby reducing confusion and unnecessary vehicle movement within the parking area.

The suggested solution greatly reduces the need for human interaction by automating slot monitoring, gate operation, and vehicle identification. Additionally, it cuts down on the amount of time spent looking for parking spots, which lowers vehicle emissions and fuel usage. As a result, the system helps to improve urban mobility and traffic flow, which makes it a workable and scalable option for smart city infrastructure.

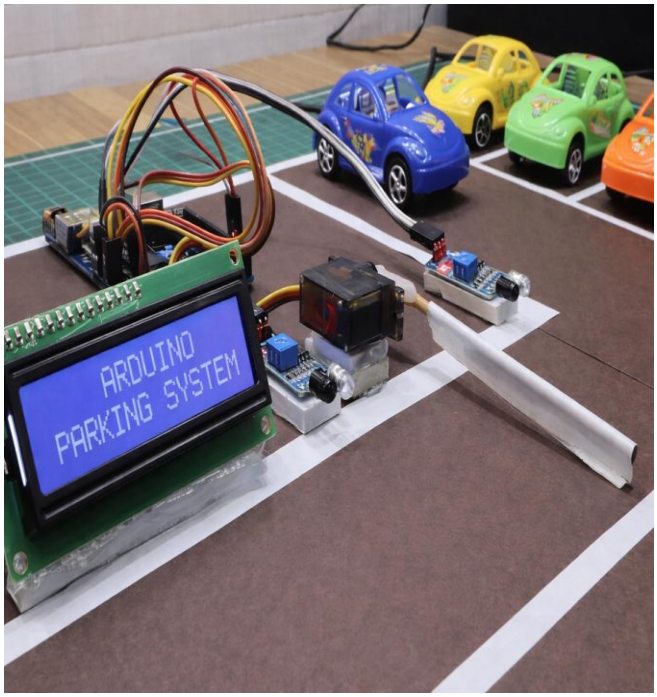


Figure:**2** Prototype Model of Arduino-Based Smart Parking System

6. Result:

The smart parking technology makes parking administration easier by efficiently detecting and managing parking spots. During real-world testing, the system consistently identifies the presence of cars at entry and exit points using infrared (IR) sensors. It also controls the entrance and exit gates, allowing or denying vehicle access based on parking space availability.

By continuously updating an LCD display, the system provides customers with real-time information on parking space availability. When a car arrives, the system instantaneously modifies to reflect the drop-in available slots; when a car leaves, it reflects the increase in availability.

The system can optionally save important data in a database for later review and analysis. A user interface, such a web platform or mobile app, may let users make bookings, check parking availability, and get alerts.
All things considered, the system greatly improves the effectiveness of parking operations, cuts down on search times, and uses less fuel, giving users a better parking experience.

7. APPLICATION:

There are several useful uses for the Arduino-based smart parking system with infrared sensors:

1. **Urban Parking Management:** This method is useful for controlling parking in congested cities, making it simpler for drivers to locate open spaces fast.

2. **Commercial Establishments:** To improve customer satisfaction and lessen parking-related stress, this system can be used in shopping malls, multiplex movie theatres, and major commercial centres.

3. **Public Venues:** This technology may be used to effectively manage parking for major events at stadiums, conference centres, other event venues.

4. **Smart Cities:** As cities adopt smart technology, smart parking systems are essential for cutting down on pollution, traffic jams, and lost time looking for a place to park.

5. **Private Parking Facilities**: Private parking facilities, such as company parking lots or residential complexes, can adopt this system to optimize their parking resources.

6. **Environmental Impact**: By reducing the time spent searching for parking spots, this system indirectly contributes to lowering fuel consumption and reducing air pollution.
7. **Data Analytics**: The logged data can be analysed to understand parking patterns and optimize the allocation of parking spaces.
8. **User-Friendly Interfaces**: Integrating mobile apps or web platforms allows users to interact with the system, check parking availability, make reservations, and receive real-time notifications.

Overall, the smart parking system has broad applications in improving parking management, enhancing user experience, and contributing to more sustainable urban environments.

8. CONCLUSION

In conclusion, the smart parking system employing Arduino technology and Infrared (IR) sensors represents a significant advancement in parking management. This innovative system effectively detects and manages parking slots, ultimately improving the overall parking experience.

The system's ability to detect vehicles at entry and exit points, control gates, and provide real-time parking slot availability updates via an LCD display streamlines the process of finding parking spaces. This not only saves time for drivers but also reduces fuel consumption and environmental impact.

Additionally, the optional data logging feature provides valuable insights into parking patterns and usage, which can inform future parking infrastructure improvements.

With practical applications in urban parking management, commercial centres, public venues, smart cities, and private parking facilities, this system addresses the challenges of parking in crowded environments.

Moreover, the integration of user-friendly interfaces, such as mobile apps and web platforms, enhances user interaction and convenience. Users can effortlessly check parking availability, make reservations, and receive timely notifications.

In summary, the smart parking system offers a comprehensive solution to the persistent parking issues faced in modern urban settings. Its efficiency, environmental benefits, and user-centric features make it a promising technology for improving the quality of life in urban areas.

9. FUTURE SCOPE:

The smart parking system using Arduino and IR sensors offers a promising platform for further development and expansion. Its future scope includes:

1. Scalability: The system can be easily scaled up to accommodate larger parking facilities, making it suitable for urban areas and megacities with growing parking needs.
2. Integration with IoT: Future iterations can integrate with the Internet of Things (IoT) for enhanced connectivity, allowing users to check parking availability remotely and receive real-time updates via mobile apps or web platforms.
3. Predictive Analytics: By leveraging historical parking data, the system can predict peak parking hours, enabling better resource allocation and improved traffic management.
4. Payment Solutions: The integration of cashless payment options and digital wallets can simplify the payment process, making it more convenient for users.

5. Environmental Monitoring: The system can incorporate environmental sensors to measure air quality, temperature, and other factors, contributing to smart city initiatives.
6. Reservation Systems: Advanced reservation systems can be implemented, allowing users to book parking slots in advance, ensuring availability during peak hours.
7. Security Enhancements: The system can be augmented with advanced security features, such as license plate recognition and surveillance cameras, to enhance safety.
8. Data-Driven Decision Making: Data collected by the system can be used for data-driven decision-making in city planning and infrastructure development.
9. Mobile App Integration: Develop dedicated mobile apps that provide users with a seamless parking experience, including navigation to available slots and real-time information.
10. Global Adoption: The system's adaptable design makes it suitable for global adoption, benefiting cities worldwide by reducing traffic congestion and pollution.

As urbanization continues, the demand for efficient parking solutions will grow. The smart parking system has significant potential for further innovation and widespread implementation, contributing to more sustainable and user-friendly urban environments.

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