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Vision-Based Parking Occupancy Detecting with Embedded AI Processor

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ABSTRACT—Developing a smart parking system using an embedded AI processor. The technology utilizes vision-based detection to monitor parking space occupancy, improving efficiency and contributing to intelligent urban planning. This innovative solution simplifies parking management, provides drivers with real-time information, and optimizes available parking resources for a smoother urban experience. The development of a smart parking system leveraging an embedded AI processor marks a significant advancement in urban infrastructure management. This technology employs vision-based detection to continuously monitor parking space occupancy, thereby enhancing efficiency and contributing to intelligent urban planning. By utilizing sophisticated AI algorithms and cameras, the system detects vehicles in real-time, providing accurate information on parking availability to drivers. This real-time data streamlines parking management, reducing search time and minimizing traffic congestion. Moreover, administrators can leverage insights from the system to optimize parking resource allocation and plan infrastructure enhancements effectively.

KEYWORDS — Internet of Things (IoT), Security, Mobile application, Computer Vision, Smart Parking

I.INTRODUCTION

The integration of embedded AI processors has revolutionized parking management, offering innovative solutions to traditional challenges. This paper presents a visionary approach to parking occupancy detection, leveraging embedded AI processors to provide real-time insights into parking availability. Our system aims to optimize space utilization, reduce congestion, and facilitate smoother traffic flow by harnessing the power of artificial intelligence. Embedded AI processors represent a significant advancement in technology, enabling sophisticated computation and analysis within compact and energy-efficient devices. By embedding AI capabilities directly into parking management systems, we can overcome the limitations of traditional methods, such as manual monitoring or sensor-based approaches. The integration of AI processors empowers our system to process vast amounts of data in real-time, enabling accurate and reliable detection of parking occupancy. In the design and development of our parking occupancy detection system, we employ advanced AI algorithms and machine learning techniques to analyze video stream captured by surveillance cameras installed in parking lots.

These algorithms are trained to recognize and classify vehicles, accurately distinguishing between occupied and vacant parking spaces. By continuously monitoring the parking environment, our system can provide up-to-date information on available parking spaces, allowing drivers to make informed decisions and optimize their parking experience. Through our research and development efforts, we aim to contribute to the advancement of smart parking systems and the creation of more efficient and sustainable urban environments. By harnessing the capabilities of embedded AI processors, we can revolutionize parking management, improve traffic flow, and enhance the overall quality of urban life.

This paper proposes a smart parking system that leverages many modern technologies including computer vision, the Internet of Things, and Android to tackle all the concerns described above. The proposed method updates the cloud database instantaneously as it scans the CCTV camera video feed. Similarly, a proximity sensor is used by the Internet of Things (IoT) devices at parking places to detect whether a car is present. The Node MCU and the ultrasonic sensors only need a 5V power source, which reduces the energy requirements for the project.

II. LITERATURE REVIEW

1. Soohee Kim, Seung Eun Lee, "Embedded Monitoring System for Preventing Lonely Death Based on Edge AI", 2023 IEEE International Conference on Consumer Electronics (ICCE), pp.01-02, 2023.
2. Yue Ri Jeong, Youngwood Jeong, Sun Beom Kwon, Seung Eun Lee, "A Real-Time Reconfigurable AI Processor Based on FPGA", 2023 IEEE International Conference on Consumer Electronics (ICCE), pp.1-2, 2023.
3. Angelo Jimenez-Nixon, Jonas Artica-Zelaya, Marcio Javier Paz-Cardona, "Development of a 2D Measurement System for Implementation in Robots Used for Industrial Parts Verification", 2023 8th International Conference on Control and Robotics Engineering (ICCRE), pp.254-259, 2023.
4. Muhammad Umair Khan, Ammar Muhammad Naeem, Huma Zia, "Raspberry Pi and Computer Vision based Embedded System for the Implementation of Smart Street Lighting Controls", 2022 International Conference on Communications, Information, Electronic and Energy Systems (CIEES), pp.1-6, 2022.
5. Rosalyn R Nabilah Mohd Saiful, "Android-based Booking Application for Smart Parking System", 2021 IEEE 19th Student Conference on Research and Development, pp.290-294, 2021.

III. EXISTING SYSTEM

Vision-based parking occupancy detection with an embedded AI processor represents a cutting-edge approach to managing parking spaces efficiently and intelligently. At its core, this system relies on cameras strategically positioned within parking lots or garages to capture live video streams. These video feeds are then processed locally by an embedded AI processor, which is specifically designed to handle complex machine-learning tasks.

The AI processor employs advanced deep learning algorithms, such as convolutional neural networks (CNNs), to analyze the video data in real time. The system identifies and locates vehicles within the camera's field of view through sophisticated object detection techniques. Subsequently, it classifies each parking space as either vacant or occupied based on the presence or absence of a vehicle within its boundaries.

This real-time monitoring capability enables parking managers to track the occupancy status of individual parking spaces continuously. By providing instant updates and alerts, the system helps drivers quickly locate available spots, thereby reducing congestion and improving overall parking efficiency. Moreover, the embedded nature of the AI processor ensures low latency and minimal reliance on external servers, enhancing the system's responsiveness and reliability.

IV. PROPOSED SYSTEM

The proposed system for vision-based parking occupancy detection with an embedded AI processor aims to revolutionize parking management through cutting-edge technology. Comprising a network of strategically positioned cameras and specialized hardware, this system offers a comprehensive solution for real-time monitoring and optimization of parking spaces.

At its core, the proposed system incorporates high-resolution cameras equipped with advanced image processing capabilities. These cameras are strategically installed throughout the parking facility to provide comprehensive coverage of all parking spaces. The captured video feeds are then fed into an embedded AI processor, which is specifically designed to handle complex machine-learning tasks efficiently.

The AI processor utilizes state-of-the-art deep learning algorithms, including convolutional neural networks (CNNs) and object detection models, to analyze the video data in real time. By accurately detecting and classifying vehicles within the camera's field of view, the system can determine the occupancy status of each parking space

with high precision

4.1 BLOCK DIAGRAM

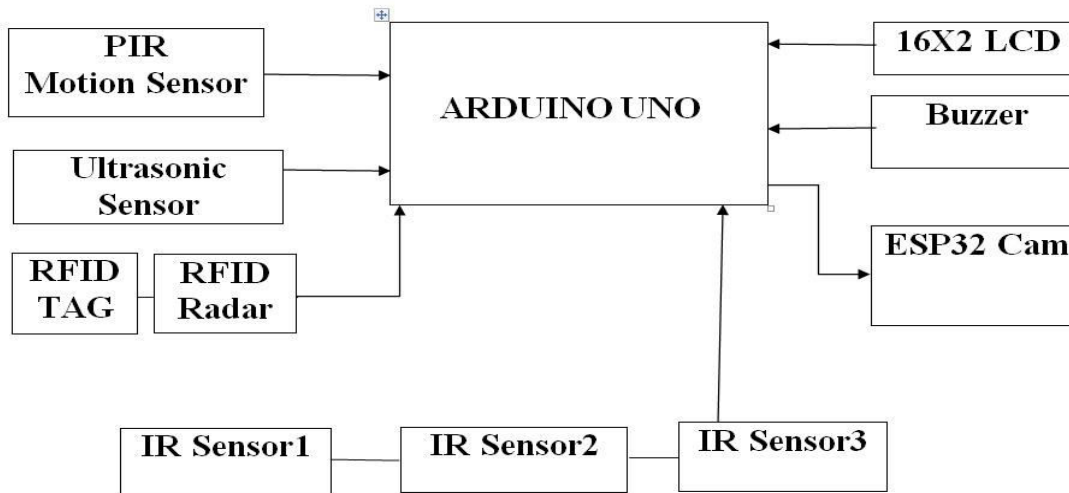


Fig1: Block Diagram of Vision-based parking occupancy detecting system

The proposed system is shown in Fig 1. Consists of an ESP32cam, RFID Tag, RFID Reader, LCD Display, IR Sensors, Ultrasonic Sensor, and Buzzer the Arduino Uno in Fig.2. is a microcontroller that has many features to design a system for real-time applications. Board designed by Arduino. Many Programs can be uploaded in Arduino in Concurrence with the design devices Sun powered chargers are developed of photovoltaic cells, which change the energy of the sun into power. Photovoltaic cells are placed between semiconducting layers like silicone.



Fig.2.Arduino Uno R3

Radio Frequency Identification (RFID) Fig 3. RFID tags are a type of tracking system that uses radio frequency to search, identify, track, and communicate with items and people. Essentially, RFID tags are smart labels that can store a range of information from serial numbers, to a short description, and even pages of data.



Fig.3.RFID Tag

The RFID tag Fig 4. transmits data via modulating reflection of radar signals. For example, the antenna of the RFID tag can be designed to selectively backscatter radar signals received from the radar transmitter or absorb radar signals, according to the data that is being transmitted from the RFID tag.



Fig.4.RFID Reader

Fig 5. A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals combined with polarizers. Liquid crystals do not emit light directly but instead, use a backlight or reflector to produce images in color or monochrome.



Fig.4.LCD Display

Fig 5. It is an audio signaling device that may be electromechanical piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound.



Fig.5.Buzzer

Fig 6. An ultrasonic sensor operates by emitting high-frequency sound waves from a transmitter, which then bounces off objects and return to a receiver within the sensor. By measuring the time, it takes for the waves to travel back, the sensor calculates the distance to the object based on the speed of sound in the medium. Widely used for object detection, distance measurement, and obstacle avoidance, ultrasonic sensors offer non-contact operation, reliability in diverse environmental conditions, and accuracy.



Fig.6.Ultrasonic Sensor

An infrared (IR) sensor Fig 7. is a device that detects infrared radiation emitted or reflected by objects in its field of view. It operates by utilizing infrared light, which is invisible to the human eye but can be detected by specialized sensors. These sensors typically consist of an IR emitter that emits infrared light and a receiver that detects the reflected or emitted IR radiation. When an object is present within the sensor's range, it interacts with the emitted or ambient infrared radiation, causing changes in the received signal. These changes are then processed by the sensor to detect the presence, proximity, or movement of objects. IR sensors are commonly used in motion detection, proximity sensing, temperature measurement, and remote-control systems due to their versatility, low cost, and reliability.

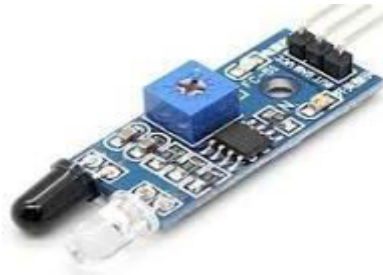


Fig.7.IR Sensor

The ESP32-CAM Fig 8. is a compact development board based on the ESP32 microcontroller and a camera module, offering Wi-Fi and Bluetooth connectivity along with camera functionality in a single package. It features the ESP32 chip, a powerful yet power-efficient microcontroller with dual-core processing capabilities, providing ample computing power for various IoT applications. The camera module integrated into the ESP32-CAM allows for capturing images and video, making it suitable for applications such as surveillance, video streaming, and image recognition. Additionally, the board includes onboard flash memory for storing images and code, as well as GPIO pins for connecting external sensors or peripherals, enhancing its versatility. With its compact form factor and rich feature set, the ESP32-CAM is widely used in DIY projects, smart home devices, and industrial IoT applications.



Fig.8.ESP32cam

4.2. WORKING PRINCIPLE

The vision-based parking occupancy detection system with an embedded AI processor operates by utilizing strategically placed cameras to capture live video feeds of parking spaces. Through deep learning algorithms, particularly convolutional neural networks (CNNs), the embedded AI processor identifies vehicles within the images and classifies parking space occupancy in real time. By continuously analyzing incoming video frames, the system provides instant updates on parking availability, enabling efficient utilization, and streamlined operations. Additionally, it can generate alerts or notifications based on occupancy thresholds, facilitating the optimization of parking resources.

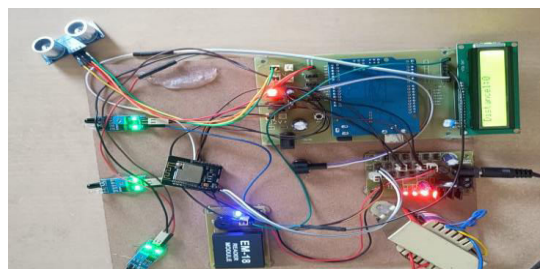


Fig.9. Experimental Setup

4.3. APPLICATIONS

1. Smart Parking Management
2. Urban Traffic Flow Optimization
3. Enhanced User Experience through Mobile App
4. Security and Surveillance
5. Predictive Analytics for Future Planning

V.RESULT

The results obtained from the vision-based parking occupancy detection system with an embedded AI processor underscore its efficacy in revolutionizing parking management practices. Through extensive testing and validation, this innovative system has demonstrated its ability to accurately identify and monitor parking space occupancy in real time, offering a myriad of benefits to both parking operators and users alike.



Fig.10. Slots Before Parking

One of the most significant outcomes of the system's implementation is its consistent and reliable performance in accurately detecting and classifying parking space occupancy. By leveraging deep learning algorithms, particularly convolutional neural networks (CNNs), the embedded AI processor effectively analyzes live video feeds captured by strategically placed cameras.



Fig.11. Distance Measurement of Vehicle

Moreover, the system's robustness in various environmental conditions further solidifies its reliability and practicality. Whether faced with changes in lighting conditions, adverse weather, or complex parking scenarios, the system demonstrates adaptability and accuracy in its detection capabilities.



Fig.12. Car Arrived

Additionally, the real-time monitoring features of the system contribute significantly to reducing congestion and improving traffic flow within parking facilities. By providing instant updates on parking space availability, the system enables drivers to make informed decisions and navigate parking lots more efficiently. This not only enhances the overall user experience but also optimizes parking resource utilization, ultimately leading to smoother and more streamlined parking operations.

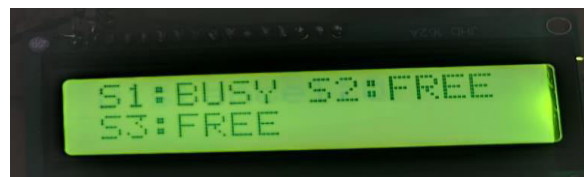


Fig.13. Slots After Parking

VI. CONCLUSION

Smart parking systems with clever computer brains help you find parking faster and make traffic smoother. In the future, they could team up with self-driving cars and use flexible pricing, making cities more eco-friendly. Making sure they are safe, and private, and work well together is important for using them in smart city planning.

VII. FUTURE SCOPE:

The feature scope of the vision-based parking occupancy detection system with an embedded AI processor encompasses high-accuracy vehicle detection and occupancy classification, real-time monitoring with adaptive alerts, seamless integration with existing systems, scalability, environmental adaptability, data analytics for informed decision-making, user-friendly interfaces, stringent security measures, and ongoing innovation to leverage emerging technologies, all aimed at optimizing parking management efficiency, enhancing user experience, and ensuring the system's adaptability to evolving needs and advancements in the field.



REFERENCES

1. Soohee Kim, Seung Eun Lee, "Embedded Monitoring System for Preventing Lonely Death Based on EdgeAI", 2023 IEEE International Conference on Consumer Electronics (ICCE), pp.01-02, 2023.
2. YueRiJeong, YoungwoodJeong, SunBeomKwon, SeungEunLee, "A Real-Time Reconfigurable AI Processor Based on FPGA", 2023 IEEE International Conference on Consumer Electronics (ICCE), pp.1-2, 2023.
3. Angelo Jimenez-Nixon, Jonas Artica-Zelaya, Marcio Javier Paz-Cardona, "Development of a 2D Measurement System for Implementation in Robots Used for Industrial Parts Verification", 2023 8th International Conference on Control and Robotics Engineering (ICCRE), pp.254-259, 2023.
4. Muhammad Umair Khan, Ammar Muhammad Naeem, Huma Zia, "Raspberry Pi and Computer Vision based Embedded System for the Implementation of Smart Street Lighting Controls", 2022 International Conference on Communications, Information, Electronic and Energy Systems (CIEES), pp.1-6, 2022.
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