Smart Garage

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ABSTRACT

The Smart Garage System using IoT Technology aims at providing improved security, convenience, and efficiency in the service centers of contemporary vehicles. In traditional service centers, the majority of the tasks such as vehicle tracking, customer identification, and service updates are performed manually. Such traditional practices are generally considered to be time-consuming and are likely to cause various types of errors and delays in the provision of service. In some cases, the absence of proper verification procedures can cause the wrong customer to receive the wrong vehicle, which can create serious security issues.

In order to avoid the aforementioned problems and challenges, the proposed Smart Garage System uses the benefits of IoT Technology and automation to create a more intelligent service center environment. Once a vehicle enters the service center, smart cameras and sensors detect the important details of the customer and the vehicle.Upon entry of the vehicle to the service center, it recognizes all the relevant information regarding the customer and vehicle using smart camera technology. It utilizes facial recognition technology to identify the customer and records all this information in a database.

Throughout the process of servicing the vehicle, all information is recorded digitally and in real-time, facilitating easier service operations for the staff and vehicle information for the customer. Upon delivery of the vehicle, it utilizes facial recognition technology to identify the customer before delivering the vehicle.

1.INTRODUCTION:

With the rapid evolution of technology, the Internet of Things (IoT) has emerged as a significant factor in the development of traditional systems into smart systems and automated systems. In the automobile service sector, the majority of the garage activities are performed manually, including the tracking of vehicles, customer verification, service notifications, and delivery notifications. Such traditional systems are more likely to cause inefficiencies and are more prone to security risks due to the lack of proper security measures and the potential for human error.

In the last few years, the requirement for smart systems has been on the rise to improve the efficiency of the garage while maintaining proper safety and customer satisfaction levels. The idea of a smart garage has emerged as a potential solution to the challenges and inefficiencies of traditional garage systems. Using the facilities of the Internet of Things (IoT) and automation systems, the entire garage can be monitored and controlled with the help of sensors and cameras.

2.LITERATURESURVEY:

Sahayadhas et al. (2012) [1]
In this research, various driver monitoring and

sensor detection systems are reviewed, and the importance of real-time monitoring in such safety applications is emphasized. The research proves that using multiple sensors increases reliability, but also adds complexity and cost to the system**.**

Gubbi et al. (2013) [2]
The research provides a detailed overview of various IoT architectures and its applications in smart environments. However, security and privacy are major problems faced by IoT-based smart environments.

Abtahi et al. (2014) [3]
The research proposes a smart camera-based vision monitoring system for detecting human behavior. The research proves its effectiveness in a real-time environment, but its accuracy also depends on lighting conditions and environmental changes.

Amato et al. (2016) [4]
The research proposes a deep learning-based approach for face recognition using convolutional neural networks (CNN). The system has a high accuracy rate in recognizing individuals under different conditions. However, the system demands a lot of computational resources and data, and hence it is not suitable for developing low-cost embedded systems.

Anand et al. (2025) [5]
The research discusses an IoT-based smart parking system integrated with facial recognition technology using OpenCV and ESP32. The system can authenticate users in real-time, allowing the gate to open automatically, thus eliminating the need to open the gate manually. The system, however, may experience challenges in different lighting conditions, which need proper training data.

3.PROBLEM STATEMENT:

In most vehicle service garage environments, the handling of vehicles, verification of customers, and updating of services are done in traditional ways, which are not only inefficient but also prone to human errors, security risks, and the lack of proper security checks. As a result, problems such as delays in the processing of services, mismanagement of vehicle information, and unauthorized vehicle delivery can be experienced.For instance, the current solutions involving the use of RFID cards are not effective, considering the fact that the cards can be misplaced, shared, or misused, while the traditional verification processes are not only unreliable but also inefficient. Moreover, the current solutions do not allow the garage to provide real-time tracking and communication of services to the customers, which can affect the level of satisfaction.In addition, most current garage solutions do not incorporate the use of advanced technologies, including IoT, automation, and facial recognition, in a unified platform, which can lead to the inefficient handling of workflow, delays in the provision of services, and security risks.

4.PROPOSED SYSTEM:

The idea of the Smart Garage System is to develop an IoT-based automated garage management system to provide better security, efficiency, and convenience to the customers. The Smart Garage System will incorporate IoT sensors, facial recognition technology, cloud storage, and automated control systems to develop an intelligent garage management system.

When the vehicle enters the garage, IoT-based cameras and sensors will capture the customer's facial details along with the vehicle details. These details will be processed and saved in the centralized database. The entire process will be maintained digitally, reducing manual intervention and the possibility of errors.

During the servicing process, the system will update the status of the servicing in real time. This will enable the garage staff to manage the servicing process more efficiently, along with keeping the customer informed about the servicing status and delivery time through notifications.

5.METHODOLOGY:

The proposed Smart Garage System will be an IoT-based automated system.

a. Data Collection

The customer data and vehicle data will be collected once the vehicle enters the garage. The data will be in the form of a data set, including customer data, vehicle data, and images captured through cameras. The data will be stored in a centralized database.

b. Face Detection

The face of the customer will be captured through a camera, and the features will be detected through image processing.

c. Feature Extraction

The features will be extracted from the face detected in step b, using algorithms. The features will be the locations of the eyes, nose, and mouth, which will help identify the unique identity of the customer.

d. Face Recognition (Authentication)

The features detected will be compared with data stored in the database using a machine learning algorithm. If there is a match, the customer will be authenticated; if not, access will be denied.

e. Automated Access Control & Notification System

Once the customer has been authenticated, the garage door will be opened, allowing entry or exit of the vehicle. After the process, the door will be closed automatically. The customer will be notified about the process through notifications.

6. ALGORITHM:

FACE RECOGNITION ALGORITHM:

1. FACE DETECTION:

The presence of a human face is detected using a camera.

2. FEATURE EXTRACTION:

Facial features are extracted, which are unique characteristics of a human face.

3. MATCHING PROCESS:

The features are compared with the data stored in the database.

MATCHING CONDITION:

If match score ≥ threshold, then the user is

authorized.
If match score < threshold, then the user is unauthorized.

4. THRESHOLD VALUE:

The threshold value is set to determine the

verification of the user.
If the value is high, then security is high.
If the value is low, then the recognition speed is high.

5. SYSTEM ACTION:

If the user is authorized, then the garage door will open, allowing vehicle delivery.
If the user is unauthorized, then access will be denied.

7.RESULTS:

The proposed Smart Vehicle Service Management System is an automated platform based on the Internet of Things technology, which aims to enhance the process of vehicle servicing and delivery services. The system combines software components with hardware components through an Arduino interface, which allows real-time communication with physical devices, including sensors and automated garagemachines.

The above diagram illustrates the hardware configuration of the proposed Smart Garage System, which consists of an Arduino microcontroller and other hardware components. The main hardware component of the Smart Garage System is the Arduino microcontroller, which serves as the control unit of the system. The microcontroller processes input data from the sensors and controls the output devices according to the specified logic. The Arduino microcontroller is connected to a power source via a USB cable.

The above figure represents a snapshot of the Vehicle Delivery Dashboard of the proposed Smart Garage System, which handles the secure and efficient handover of vehicles to customers.

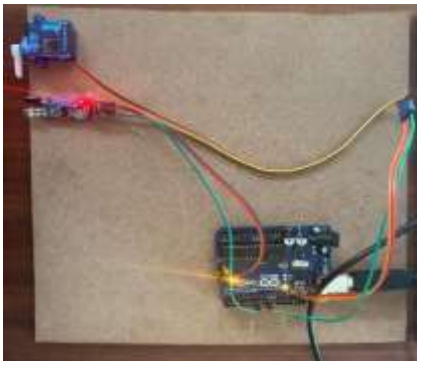
The left side of the dashboard shows a display of customer information, such as the image of the customer, name, vehicle number, and contact details. The image data also helps in verifying the identity of the customer before delivering the vehicle, thus providing security features.

The right side of the dashboard shows a detailed service bill, including all the problems identified in the vehicle along with the respective costs. The total amount is also calculated, providing transparency and hence building trust among customers.

The system also includes a delivery authentication feature, in which a code is sent to the customer, and after entering this code into the system, the vehicle is delivered to the customer. This provides security along with image identification.

The above figure depicts the Vehicle Delivery Dashboard of the proposed Smart Garage System. The module is intended to ensure safe and efficient vehicle delivery.

On the left side of the dashboard, customer information is indicated, such as the image of the customer, customer name, vehicle number, etc. Facial data have been incorporated in this module for verification of the customer before delivering the vehicle.



The above figure depicts an email-based Vehicle Delivery Code Notification system, which is an integral part of the proposed Smart Garage System. The module is intended to enhance security and ensure safe vehicle delivery to only authorized customers.

Once the vehicle servicing process is complete

and approved by the manager, a unique vehicle delivery verification code is generated. The verification code is sent to the registered customer's email address along with some crucial information like vehicle number, etc.

The vehicle delivery verification code acts as an authenticator for vehicle delivery. At the time of vehicle delivery, the customer needs to provide this verification code, which is further verified by the system. Only after verification of this vehicle delivery verification code and facial data, the vehicle is released for delivery.

8. CONCULSION:

The proposed Smart Garage System based on Internet of Things technology can be an efficient and effective means of providing security for vehicle service management. The proposed system can effectively automate various processes such as vehicle entry, service, customer verification, and vehicle delivery, thus reducing human intervention and errors.

The proposed system can effectively identify customers and prevent vehicle delivery to wrong customers through the integration of IoT technology, face recognition technology, and automation technology. Moreover, it can effectively allow customers and service staff to monitor vehicle service through data updating and storage technology.

The proposed system can effectively enhance security in vehicle service through automation technology for controlling garage doors, thus allowing only authorized persons to access vehicles. Additionally, it can effectively notify customers of various service details, thus providing an enhanced user experience.

9. FUTURE SCOPE:

The proposed Smart Garage System can be further enhanced for better performance, scalability, and security by incorporating various advanced technology solutions. One such enhancement can be made possible through the incorporation of more efficient deep learning techniques for face detection, thereby providing more accurate results under different lighting conditions and at different face angles. Another possible enhancement can be made through the incorporation of various multi-factor authentications like OTP and mobile-based verification systems.

The proposed Smart Garage System can be further extended through various enhancements like incorporating Automatic Number Plate Recognition technology, enabling face detection and vehicle detection for more reliable and efficient verification. This can be done in parallel with face detection technology, thus providing more reliable results without having to rely on a single technology for verification.

Another possible enhancement can be made possible through the incorporation of cloud computing and mobile-based solutions, enabling remote monitoring and control of vehicles. Various advanced IoT devices can be incorporated for efficient performance and edge computing for faster decision-making.

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