

SpareGo: An Intelligent Hyperlocal Framework for Spare-Part Discovery, Inventory Management, Delivery, and Emergency Technical Services

Mohammed Ihthisham S.
UG Scholar
Department of Information technology
Sathyabama Institute of Science and Technology
Chennai India

Sunjay Madan A.
UG Scholar
Department of Information technology
Sathyabama Institute of Science and Technology
Chennai, India

Purushothaman S.
UG Scholar
Department of Information technology
Sathyabama Institute of Science and Technology
Chennai, India

K. Sundara Velrani
Associate Professor
Department of Information technology
Sathyabama Institute of Science and Technology
Chennai India

Mohamed Anas M. A.
UG Scholar
Department of Information technology
Sathyabama Institute of Science and Technology
Chennai India

Mohamed Hakkem S.
UG Scholar
Department of Information technology
Sathyabama Institute of Science and Technology
Chennai India

Abstract—The availability of spare parts and batteries is an important requirement for automobile users, machinery operators, workshops, and small businesses. However, customers often spend considerable time searching for the correct part, identifying nearby suppliers, and contacting mechanics or technicians. SpareGo is proposed as a quick e-commerce and service platform designed to simplify this process. The system provides a unified interface for purchasing automobile spare parts, machinery spare parts, and batteries from nearby registered shops and suppliers. It also provides access to nearby mechanics, battery shop owners, and machinery technicians based on the customer's location. The platform combines product search, location-based supplier discovery, service assistance, order management, and fast delivery into a single system. The proposed solution aims to reduce search time, improve access to local suppliers, and provide a convenient digital purchasing experience for customers.

Keywords—Spare parts, battery delivery, e-commerce, location-based services, automobile service, machinery service, local suppliers, quick delivery, customer interface, online marketplace.

I. INTRODUCTION

Spare parts and batteries are essential for maintaining automobiles, industrial machinery, agricultural equipment, and other mechanical systems. In many situations, customers need a particular component immediately because a vehicle or

machine may remain unusable until the required part is obtained. Traditional methods often require customers to contact multiple shops, physically visit stores, or depend on personal references to locate the required product.

The rapid growth of digital commerce and location-based services provides an opportunity to improve this process. SpareGo is designed as a specialized online platform that connects customers with spare-part suppliers, battery shops, mechanics, and machinery technicians.

The system focuses on three major areas: quick product discovery, connection with nearby service providers, and faster delivery. Customers can search for products, compare available suppliers, place orders, identify nearby shops, and request assistance when required. By integrating these services into a single customer interface, SpareGo aims to provide a practical solution for time-sensitive spare-part requirements.

A. Overview

SpareGo is a hyperlocal e-commerce and service platform designed to provide quick and convenient access to automobile spare parts, machinery spare parts, and batteries. The system connects customers with nearby shops, mechanics, machinery technicians, battery service providers, and delivery partners through a single digital platform.

The primary objective of SpareGo is to reduce the time and effort required to identify, purchase, and receive spare parts during normal requirements as well as emergency situations. Instead of visiting multiple shops or contacting different service providers, customers can search for required products, identify nearby shops, check availability, place orders, and obtain technical assistance through the platform.

The system follows a location-based approach in which customer requirements are matched with nearby shops and service providers. It also supports multiple shops, allowing customers to compare available products based on factors such as availability, price, distance, and estimated delivery time. In addition, AI-assisted product discovery and image-based spare-part identification can be incorporated to simplify the identification of unfamiliar components.

SpareGo is designed as a scalable platform that can integrate product management, inventory management, order processing, delivery tracking, emergency assistance, and service-provider management. The platform can therefore serve as a unified digital ecosystem for spare-part purchasing and technical assistance.

In traditional spare-part purchasing, customers generally depend on local shops, telephone calls, personal contacts, or physical visits to identify and purchase the required component. This process becomes more difficult when a specific spare part is unavailable at the first shop visited or when a vehicle or machine experiences an unexpected breakdown.

During emergency situations, customers may also need to separately search for a mechanic, machinery technician, or battery service provider. Since these services are usually fragmented across different providers, identifying an available service provider nearby can be time-consuming.

The lack of real-time inventory information and integrated service discovery creates a significant gap between customers, spare-part retailers, service providers, and delivery personnel. SpareGo is proposed to address this gap by bringing these stakeholders together within a single platform.

B. Existing Method and Limitations

Currently, customers generally obtain automobile spare parts, machinery components, and batteries through traditional local shops, telephone communication, online marketplaces, or personal contacts. When a vehicle or machine breaks down, customers may need to visit multiple shops or contact different mechanics to find the required part or service provider.

The existing process can generally be represented as:

**Customer Requirement → Search/Call Local Shops →
Check Availability → Compare Price → Purchase →
Arrange Delivery/Collection → Find Mechanic if
Required**

Some online platforms provide spare-part purchasing facilities, while local shops primarily depend on physical customers, telephone communication, and manually maintained inventory. However, these approaches are often separated rather than being part of a single integrated platform.

The major limitations of existing methods are as follows:

- 1) Difficulty in finding nearby spare parts: Customers may have to contact several shops to determine where a particular part is available.
- 2) Lack of real-time inventory information: Traditional shops generally do not provide customers with live information about stock availability.
- 3) Time-consuming purchasing process: Visiting multiple stores or making repeated phone calls increases the time required to obtain a spare part.
- 4) Limited emergency support: During vehicle breakdowns or battery failures, customers may struggle to quickly locate an available mechanic or battery service provider.
- 5) Fragmented service providers: Spare-part shops, mechanics, machinery technicians, and battery providers usually operate independently.
- 6) Difficulty comparing alternatives: Customers may find it difficult to compare price, availability, distance, and estimated delivery time across different local shops.
- 7) Limited digital presence for local shops: Small and medium-sized spare-part retailers may not have an effective digital platform for reaching nearby customers.
- 8) Manual inventory management: Stock information may be maintained manually, increasing the possibility of outdated availability information.
- 9) Limited intelligent product identification: Customers who do not know the exact name or model of a spare part may have difficulty identifying the required component.
- 10) Lack of integrated tracking: Traditional purchasing methods generally do not provide centralized real-time order and delivery tracking.

C. Main Contributions

The proposed SpareGo system addresses the limitations of conventional spare-part purchasing and service discovery by integrating multiple functions into a unified platform. The main contributions of the proposed system are:

- 1) Hyperlocal Spare-Part Marketplace: Provides customers with access to automobile spare parts, machinery spare parts, and batteries from nearby participating shops.
- 2) Multi-Shop Inventory Management: Allows multiple shops to maintain product information, prices, and stock availability within the platform.
- 3) Location-Based Product Discovery: Uses the customer's location to identify suitable nearby shops and available products.
- 4) Fast Local Delivery: Connects orders with delivery partners to support quick delivery of required spare parts and batteries.
- 5) Integrated Mechanic and Technician Services: Enables customers to locate nearby automobile mechanics and machinery technicians based on location and service availability.
- 6) Emergency Battery Assistance: Provides access to nearby battery shops and service providers for battery delivery, replacement, and emergency assistance.

- 7) AI-Assisted Product Discovery: OpenAI-based assistance can help customers describe their requirements and identify relevant products.
- 8) Image-Based Spare-Part Identification: Google Cloud Vision API can assist in analyzing an uploaded image of a spare part and supporting product identification.
- 9) Real-Time Order and Service Tracking: WebSocket-based communication can provide live updates regarding order and delivery status.
- 10) Scalable and Secure Architecture: The system is designed using modern web technologies and a modular backend architecture that can be extended for multi-city deployment.

The key contribution of SpareGo is the integration of spare-part discovery, multi-shop inventory, location-based services, quick delivery, and technical assistance into a unified platform rather than treating these services as separate systems.

D. Organisation of the Paper

The remainder of this paper is organized as follows. Section II presents the literature survey and reviews existing approaches related to spare-part management, e-commerce platforms, location-based services, delivery systems, and AI-assisted product identification. Section III discusses the existing system and its limitations in purchasing spare parts and accessing technical services. Section IV presents the proposed SpareGo system and explains its overall functionality and stakeholder interactions. Section V describes the system architecture and the interaction between the frontend, backend, database, external services, and real-time communication components. Section VI explains the major system modules, including customer management, product and inventory management, shop management, order processing, delivery, mechanic and technician services, battery services, notifications, and administration. Section VII describes the technologies and implementation approaches used in the development of SpareGo. Section VIII presents the results and discussion of the proposed system and explains how it addresses the identified limitations. Section IX discusses the future scope and possible enhancements, including predictive inventory management, AI-based recommendations, predictive maintenance, IoT integration, augmented reality, route optimization, and multi-city expansion. Finally, Section X concludes the paper by summarizing the proposed system, its major contributions, and its potential as an integrated platform for spare-part purchasing, delivery, and technical assistance.

II. LITERATURE SURVEY

Research related to SpareGo covers several areas, including spare-parts inventory management, demand forecasting, location-based services, last-mile delivery, predictive maintenance, and artificial intelligence-based part identification.

Hu et al. presented a comprehensive review of spare-parts inventory management and discussed inventory policies, demand patterns, supply-chain structures, and data-driven approaches for improving spare-parts availability. Bacchetti

and Saccani examined spare-parts classification and demand forecasting and highlighted the challenges associated with intermittent demand, large product varieties, and the need for high service levels. These studies emphasize the importance of accurate inventory information and effective demand-management strategies.

Location-based services are also relevant to SpareGo. Mathkour proposed a GPS-based dynamic service locator that helps users identify geographically nearby service providers. Such approaches demonstrate the usefulness of location information for connecting customers with nearby resources. SpareGo extends this concept by considering product availability, service availability, distance, and delivery requirements when identifying suitable shops and service providers.

Last-mile delivery is another important research area. Existing studies have examined the challenges of e-commerce delivery, routing, delivery time, and customer-oriented logistics. These findings are particularly relevant to SpareGo because spare parts and batteries may be required urgently during vehicle or machinery failures.

Predictive maintenance research has also explored the relationship between equipment failures, maintenance requirements, and spare-parts inventory. Shokri et al. investigated the integration of predictive maintenance with spare-parts inventory management and highlighted its potential to improve supply-chain performance. This provides a foundation for future SpareGo features such as predictive inventory and proactive spare-part recommendations.

Artificial intelligence and computer vision provide another important research direction. Recent studies have investigated AI-based automobile spare-part classification and image-processing techniques for identifying components. Research on optical character recognition has also explored the identification of printed part numbers on automotive components. These approaches support the possibility of allowing SpareGo users to upload an image of an unknown component and obtain assistance in identifying the relevant product.

Although existing research provides solutions for individual problems such as inventory management, location-based services, delivery, predictive maintenance, and part identification, these capabilities are generally addressed separately. Therefore, a research gap exists for an integrated hyperlocal platform that combines local spare-part inventory, product discovery, delivery, technical assistance, and AI-based identification.

SpareGo addresses this gap by integrating multi-shop inventory management, location-based product discovery, delivery services, mechanic and technician matching, battery assistance, and AI-supported product identification within a single platform.

III. PROBLEM STATEMENT

Finding automobile spare parts, machinery components, and batteries quickly is often difficult, particularly during vehicle breakdowns, machinery failures, and battery emergencies. Customers commonly depend on physical shop visits, tele-

phone calls, personal contacts, or separate online platforms to identify the required component and determine its availability.

A major limitation of existing methods is the lack of real-time, location-specific inventory information. Customers may need to contact multiple shops to determine whether a particular part is available and may have difficulty comparing price, distance, and delivery time. The process becomes more challenging when customers do not know the exact name or part number of the required component.

Technical assistance is also fragmented. Customers may need to separately search for mechanics, machinery technicians, or battery service providers. Similarly, local spare-part shops may have limited digital visibility, preventing their available inventory from being efficiently connected with nearby customers.

Existing systems also provide limited integration between spare-part purchasing, local inventory, emergency services, and delivery. Conventional text-based searches may further create difficulties when customers cannot identify an unfamiliar spare part.

Therefore, the main problem addressed by SpareGo is the lack of a unified, location-aware platform that connects customers with nearby spare-part shops, service providers, and delivery partners while providing product availability and technical assistance.

SpareGo addresses this problem by providing a hyperlocal platform for automobile spare parts, machinery spare parts, and batteries. The system integrates multi-shop inventory, location-based product discovery, quick delivery, mechanic and technician services, battery assistance, real-time order tracking, and AI-assisted product identification.

The major objectives of the proposed system are to:

- 1) Reduce the time required to find suitable spare parts and batteries.
- 2) Provide location-based access to nearby shops and service providers.
- 3) Improve visibility of product availability and shop-level inventory.
- 4) Connect customers with mechanics, technicians, and battery service providers.
- 5) Support faster local delivery and real-time order tracking.
- 6) Assist users in identifying unfamiliar spare parts using AI and image-based methods.

IV. PROPOSED SYSTEM

The proposed SpareGo system is a hyperlocal digital platform designed to connect customers with nearby spare-part shops, battery providers, mechanics, machinery technicians, and delivery partners through a single application. The system addresses the limitations of conventional spare-part purchasing by integrating location-based product discovery, multi-shop inventory management, ordering, quick delivery, emergency assistance, and AI-assisted product identification.

Customers can search for automobile spare parts, machinery spare parts, and batteries using product names, categories,

vehicle or machine information, or images. The system identifies suitable nearby shops based on product availability and customer location. Customers can compare available products and place orders through the platform. In emergency situations, the system also enables customers to locate nearby mechanics, machinery technicians, and battery service providers.

The proposed system consists of customer management, shop management, product management, inventory management, order management, delivery management, service-provider management, AI assistance, location services, notification, and administration modules. The backend manages the core business logic and maintains transactional information, while external services can be integrated for mapping, artificial intelligence, computer vision, payments, and notifications.

The overall workflow of SpareGo can be represented as:

Customer Requirement → Product/Service Search → Location Detection → Availability Check → Matching → Selection → Order/Service Request → Confirmation → Delivery/Service Assignment → Tracking → Completion

A. Proposed Algorithm

The proposed system uses a hyperlocal matching algorithm to identify suitable products, shops, and service providers according to customer requirements and location.

B. Matching Score

To rank suitable shops and service providers, SpareGo can use a weighted matching score:

$$Score = w_a A + w_d D + w_p P + w_t T + w_r R \quad (1)$$

where A represents availability, D represents proximity, P represents price, T represents estimated delivery or service time, and R represents provider rating. The parameters w_a , w_d , w_p , w_t , and w_r represent configurable weights.

For emergency requirements, greater importance can be assigned to availability, proximity, and response time. For normal purchases, price, rating, and delivery time can also be considered during ranking.

The algorithm enables SpareGo to provide customers with relevant local options instead of simply displaying all available products. It also establishes a foundation for integrating future features such as predictive inventory management, intelligent recommendations, route optimization, and predictive maintenance.

V. SYSTEM ARCHITECTURE

The SpareGo system follows a modular and scalable architecture designed to support multiple users, services, product transactions, and real-time operations. The architecture consists of four major layers: the Presentation Layer, Application Layer, Data Layer, and External Services Layer. These layers communicate through well-defined interfaces, allowing individual components to be developed, maintained, and scaled independently.

TABLE I
 HYPERLOCAL SPAREGO MATCHING ALGORITHM

Step	Process	Description
1	Input Requirement	Receive product or service requirement from the customer.
2	Identify Requirement	Determine product category, part, battery, or required service.
3	Capture Location	Obtain the customer's current or selected location.
4	Database Search	Search registered shops, products, inventory, and service providers.
5	Availability Check	Filter results according to stock and provider availability.
6	Distance Calculation	Calculate geographical distance between customer and providers.
7	Generate Matches	Consider availability, distance, price, delivery time, and rating.
8	Rank Results	Rank suitable options according to the matching criteria.
9	Selection	Customer selects the required product or service provider.
10	Reservation	Reserve available inventory for product orders.
11	Create Request	Create an order or service request.
12	Confirmation	Process payment and confirm the transaction where applicable.
13	Assignment	Assign a suitable delivery partner or service provider.
14	Tracking	Provide real-time order or service status updates.
15	Completion	Complete delivery/service and update relevant records.
16	Feedback	Collect customer ratings and reviews.

The architecture supports different stakeholders, including customers, spare-part shop owners, mechanics, machinery technicians, battery service providers, delivery partners, and administrators. Customers can access the platform through web or mobile interfaces, while shops and service providers can use dedicated portals to manage products, inventory, orders, availability, and service requests.

A. Architecture Overview

The overall architecture of SpareGo is illustrated in Fig. 1. The presentation layer provides responsive web and mobile interfaces. The application layer contains the core business logic and is implemented using Spring Boot. The data layer manages persistent and temporary information using PostgreSQL and Redis. External services provide additional capabilities such as maps, artificial intelligence, image recognition, payment processing, and notifications.

B. Presentation Layer

The presentation layer provides the user interface for all stakeholders of the SpareGo platform. Customers can access the system through responsive web and mobile applications to search for spare parts, compare available products, place orders, request technical assistance, and track deliveries.

Shop owners can use a web portal to manage products, prices, inventory, and incoming orders. Mechanics, machinery technicians, and battery service providers can manage their availability and respond to service requests. Delivery partners can use a mobile interface to receive delivery assignments and update delivery status. Administrators can access a dedicated portal for managing users, shops, products, services, transactions, and system operations.

C. Application Layer

The application layer contains the core business logic of SpareGo and is implemented using Java and Spring Boot. It follows a modular architecture in which different business functions are separated into independent modules.

The major modules include user management, product and inventory management, shop management, order management, delivery management, service-provider management, AI and image recognition, location services, notification services, and administration.

The application layer validates incoming requests, applies business rules, communicates with the database, and interacts with external services. Security mechanisms such as authentication, authorization, role-based access control, input validation, and secure API communication can be implemented at this layer.

D. Product and Inventory Management

The product and inventory module maintains information about automobile spare parts, machinery spare parts, and batteries. Each shop can maintain its own product availability, price, and stock quantity.

When a customer searches for a product, the system checks available inventory and identifies shops that can fulfill the requirement. Inventory reservation can be performed during order processing to reduce the possibility of overselling when multiple customers attempt to purchase the same product.

E. Order and Delivery Management

The order management module handles the complete order lifecycle, beginning with cart creation and ending with successful delivery. The system can maintain states such as:

PENDING → CONFIRMED → PACKING →
 READY_FOR_PICKUP → OUT_FOR_DELIVERY →
 DELIVERED

For cancelled transactions, appropriate cancellation and refund states can also be maintained.

The delivery module identifies suitable delivery partners based on factors such as location, availability, and workload. Real-time status updates can be provided to customers during the delivery process.

F. Service Provider Management

SpareGo provides an integrated mechanism for discovering automobile mechanics, machinery technicians, and battery service providers. Service providers can maintain their service

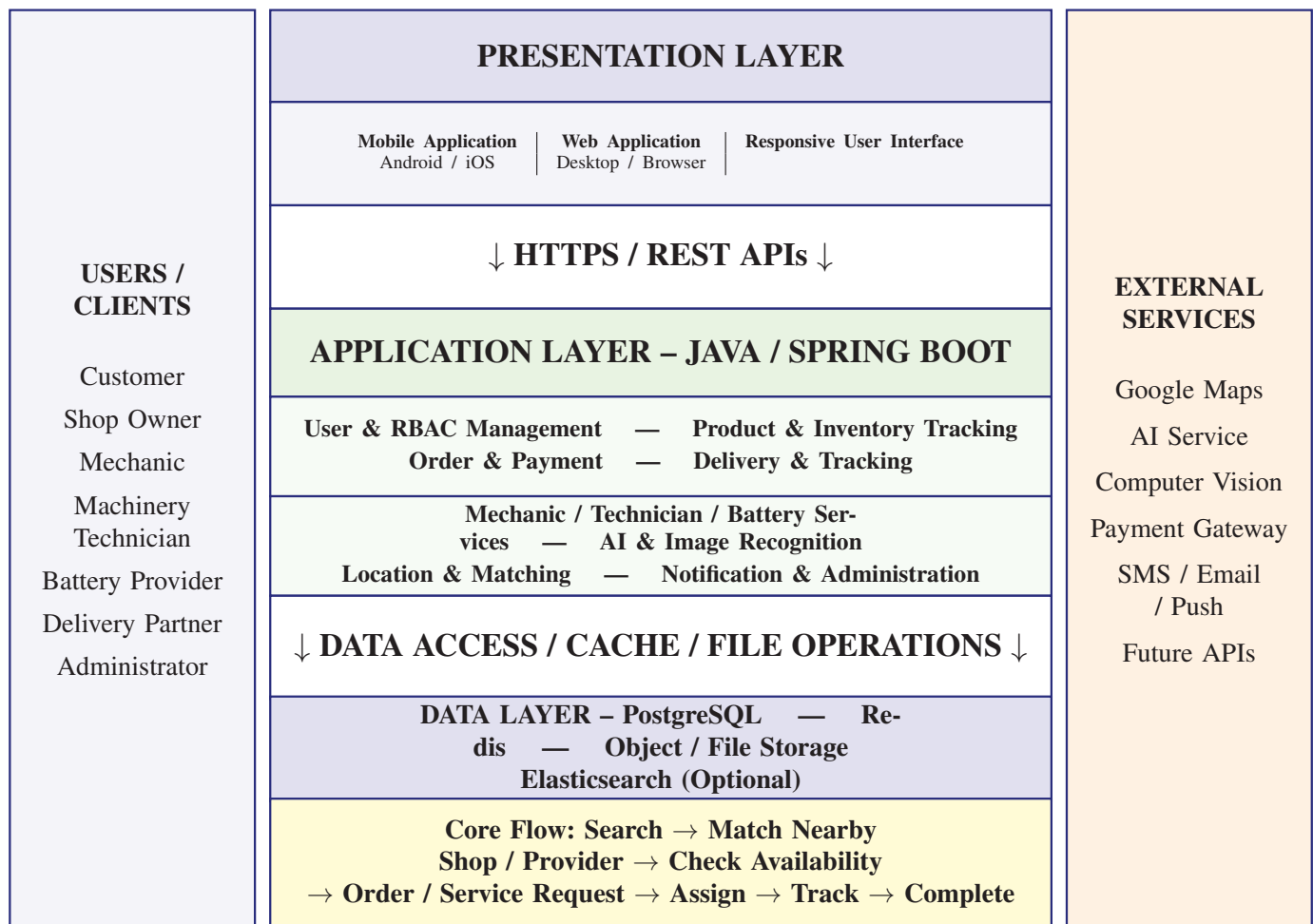


Fig. 1. System Architecture of SpareGo

categories, availability, location, and other relevant information.

When a customer submits an emergency service request, the application can identify suitable providers based on geographical proximity, service capability, availability, and workload. This allows technical assistance to be integrated with spare-part purchasing rather than treating them as independent services.

G. Data Layer

The data layer is responsible for storing and managing the information required by the SpareGo platform. PostgreSQL can be used as the primary relational database for storing users, shops, products, inventory, orders, payments, service requests, delivery information, and transaction records.

Redis can be used as a high-speed caching and temporary-data layer for frequently accessed information, session-related data, OTPs, rate limiting, nearby search results, and real-time operational information.

Images and documents submitted by users, such as spare-part images, can be stored using suitable file or object-storage

infrastructure rather than directly storing large binary files in the primary relational database.

H. External Services Layer

SpareGo can integrate external services to extend the capabilities of the platform. Mapping services such as Google Maps can support location identification, distance calculation, nearby-shop discovery, service-provider matching, and delivery tracking.

AI services can assist customers in describing their requirements and discovering relevant products. Computer vision services can be used to analyze uploaded images of spare parts and extract useful visual or textual information.

Payment gateways can be integrated to process digital transactions, while notification services can provide SMS, email, or push notifications for order, delivery, payment, and service events.

I. System Workflow

The overall operation begins when a customer submits a product or service requirement through the web or mobile

interface. The request is transferred to the Spring Boot application layer, where it is validated and processed.

For a product request, the system searches the product and inventory database, identifies shops with available stock, calculates relevant location information, and presents suitable options to the customer. After the customer selects a product and confirms the order, inventory is reserved and the order is created.

For a service request, the system searches available mechanics, machinery technicians, or battery service providers and identifies suitable providers according to location, availability, service capability, and workload.

After confirmation, the appropriate delivery partner or service provider is assigned. The system then provides status updates until the order or service request is completed.

J. Scalability and Security

The modular architecture allows individual components to be improved or scaled without redesigning the complete application. The initial implementation can operate as a modular monolithic Spring Boot application. As transaction volume increases, individual modules can be separated into independent services if required.

Security can be implemented using Spring Security, JWT or OAuth-based authentication, role-based access control, password hashing, request validation, rate limiting, secure API communication, and audit logging. Sensitive credentials and API keys should be maintained using environment variables or secure secret-management systems.

The architecture also provides a foundation for future capabilities such as Elasticsearch-based advanced search, predictive inventory management, AI recommendations, predictive maintenance, IoT integration, route optimization, and multi-city deployment.

VI. TECHNOLOGY STACK

The proposed implementation uses modern web technologies to provide a scalable and responsive platform.

TABLE II
PROPOSED TECHNOLOGY STACK

Component	Technology
Frontend	React.js, HTML5, CSS3, JavaScript
Backend	Node.js and Express.js
Database	MongoDB
Authentication	JWT and secure password hashing
Maps	Google Maps Platform / Location Services
Image Recognition	Google Cloud Vision API
AI Assistance	OpenAI API
Cloud	Google Cloud Platform
Version Control	Git and GitHub
Deployment	Cloud-based deployment platform

VII. SYSTEM MODULES

The system is divided into multiple modules to simplify development and maintenance.

A. Customer Module

The customer module provides registration, login, product search, product details, cart management, order placement, payment, delivery tracking, and service-provider access.

B. Product and Inventory Module

This module manages automobile spare parts, machinery components, batteries, product descriptions, prices, stock levels, compatibility information, and supplier availability.

C. Shop Owner Module

Shop owners can register their businesses, add products, update inventory, manage prices, accept orders, and update order status.

D. Location-Based Module

The location module identifies nearby suppliers, shops, mechanics, battery dealers, and machinery technicians using location information.

E. Mechanic and Technician Module

Automobile mechanics and machinery technicians can create service profiles, define their service areas, receive requests, and communicate with customers.

F. Battery Service Module

Customers can search for nearby battery suppliers and request battery delivery, replacement, inspection, or related assistance.

G. Order and Delivery Module

This module manages cart processing, order confirmation, supplier allocation, delivery assignment, tracking, and completion status.

H. Admin Module

The administrator manages customers, suppliers, products, service providers, orders, complaints, verification, and platform-level operations.

VIII. FUTURE SCOPE

The SpareGo platform can be enhanced with several advanced features in future versions.

- AI-based spare-part recommendations.
- Image-based spare-part identification.
- Vehicle and machinery compatibility checking.
- Real-time inventory synchronization between multiple shops.
- Real-time delivery tracking.
- Predictive demand analysis for shop owners.
- Automated product recommendations.
- Voice-based product search.
- AI-powered customer support.
- Emergency roadside assistance.
- Subscription-based maintenance services.
- Digital service history for vehicles and machines.
- Expansion to multiple cities and regions.
- Integration with fleet and industrial maintenance systems.

IX. CONCLUSION

SpareGo proposes a specialized digital marketplace for quick delivery of automobile spare parts, machinery spare parts, and batteries. The system addresses the common difficulty of locating the required component and finding suitable local service providers.

By connecting customers with nearby shops, battery dealers, mechanics, and machinery technicians, the platform can reduce the time required to obtain products and technical assistance. The combination of e-commerce, location-based services, inventory management, and quick delivery provides a practical approach to modern spare-part distribution.

The proposed system can be further expanded with artificial intelligence, image recognition, predictive inventory management, and real-time logistics, making SpareGo a scalable platform for spare-part commerce and technical service delivery.

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