GROUP 4 - RECIPE APP DOCUMENTATION

Project: Recipe Application System
Team: Group 4
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- **Team Members:** All group members who contributed to this project
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- **Testing Users:** Those who provided valuable feedback during the testing phase

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1. Introduction

1.1 Project Overview

The Recipe Application System is a comprehensive platform designed to facilitate recipe sharing, cooking guidance, and culinary community building. The system consists of three main components:

- **Mobile Application (Flutter):** User-facing mobile app for iOS and Android
- **Admin Panel (Node.js):** Web-based administrative interface
- **Backend API (Spring Boot):** RESTful API services

1.2 Project Objectives

- Create an intuitive recipe sharing platform
- Provide comprehensive cooking guidance with multimedia support
- Enable community interaction through reviews and ratings
- Offer robust administrative tools for content management
- Ensure scalable and maintainable system architecture

1.3 Project Scope

The system covers:

- User registration and authentication
- Recipe management (CRUD operations)
- Multimedia content support (images, videos)
- Category and cuisine management
- Review and rating system
- Admin dashboard and analytics
- Mobile-responsive design

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2. Problem Definition

2.1 Current Challenges

- **Scattered Recipe Sources:** Users struggle to find reliable recipes from multiple sources
- **Lack of Interactive Guidance:** Traditional cookbooks don't provide interactive cooking assistance
- **No Community Feedback:** Limited ability to share experiences and improvements
- **Poor Content Organization:** Difficulty in categorizing and searching recipes effectively
- **Mobile Accessibility:** Most recipe platforms are not optimized for mobile cooking environments

2.2 Target Users

- **Home Cooks:** Individuals looking for new recipes and cooking inspiration
- **Food Enthusiasts:** People passionate about sharing culinary experiences
- **Cooking Beginners:** Users needing step-by-step guidance
- **Professional Chefs:** Experts wanting to share knowledge
- **Content Administrators:** Staff managing platform content

2.3 Solution Approach

Develop a comprehensive mobile-first recipe platform that addresses these challenges through:

- Centralized recipe database with multimedia support
- Interactive cooking modes with timers and step-by-step guidance
- Community features for sharing and rating

- Advanced search and categorization
- Responsive design optimized for kitchen use

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3. Requirement Specification

3.1 Functional Requirements

3.1.1 User Management Functions

FR-01: User Registration

- Users can register with email and phone number
- OTP verification via email required
- Password strength validation
- Unique email constraint

FR-02: User Authentication

- Secure login with email/password
- JWT token-based session management
- Password reset functionality with OTP
- Account activation/deactivation

FR-03: Profile Management

- Update personal information
- Change password
- Upload profile picture
- View account statistics

3.1.2 Recipe Management Functions

FR-04: Recipe Creation

- Add new recipes with multimedia
- Specify ingredients with quantities
- Step-by-step cooking instructions
- Categorization by cuisine and type
- Difficulty level assignment

FR-05: Recipe Browsing

- View recipe lists with pagination
- Filter by category, cuisine, difficulty
- Search functionality with keywords
- Sort by popularity, date, rating

FR-06: Recipe Details

- Display complete recipe information

- Image gallery and video support
- Nutritional information
- Cooking time and servings
- Print-friendly format

3.1.3 Community Functions

FR-07: Review System

- Rate recipes (1-5 stars)
- Write detailed reviews
- View aggregate ratings
- Sort reviews by date/rating

FR-08: Favorites Management

- Save recipes to favorites
- Organize favorite collections
- Share favorite lists
- Quick access to saved recipes

3.1.4 Administrative Functions

FR-09: Content Management

- Admin dashboard with analytics
- Recipe approval/rejection workflow
- User account management
- Category and cuisine management

FR-10: System Configuration

- App settings management
- Advertisement configuration
- Email template management
- System monitoring tools

3.2 Non-functional Requirements

3.2.1 Performance Requirements

NFR-01: Response Time

- API responses within 2 seconds
- Mobile app launch under 3 seconds
- Image loading optimization
- Offline data caching

NFR-02: Scalability

- Support 10,000+ concurrent users

- Horizontal scaling capability
- Database performance optimization
- CDN integration for media files

3.2.2 Security Requirements

NFR-03: Data Security

- Encrypted password storage (SHA256)
- JWT token expiration management
- HTTPS/TLS encryption
- Input validation and sanitization

NFR-04: Privacy Protection

- GDPR compliance
- User data anonymization options
- Secure data deletion
- Privacy policy implementation

3.2.3 Usability Requirements

NFR-05: User Experience

- Intuitive navigation design
- Mobile-first responsive layout
- Accessibility compliance (WCAG 2.1)
- Multi-language support

NFR-06: Reliability

- 99.9% system uptime
- Automated backup procedures
- Error handling and logging
- Graceful degradation

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4. System Requirements

4.1 Server Requirements

4.1.1 Hardware Specifications

- **CPU:** Minimum 4 cores, 2.5GHz+
- **RAM:** 8GB+ for development, 16GB+ for production
- **Storage:** 100GB+ SSD with backup capability
- **Network:** Stable internet connection, 100Mbps+

4.1.2 Operating System

- **Primary:** Ubuntu 20.04 LTS or higher
- **Alternative:** CentOS 8+, Windows Server 2019+
- **Containerization:** Docker support recommended

4.2 Client Requirements

4.2.1 Mobile Devices

- **Android:** Version 6.0+ (API level 23+)
- **iOS:** Version 12.0+
- **RAM:** Minimum 2GB, Recommended 4GB+
- **Storage:** 100MB+ available space

4.2.2 Web Browsers (Admin Panel)

- **Chrome:** Version 90+
- **Firefox:** Version 88+
- **Safari:** Version 14+
- **Edge:** Version 90+

4.3 Development Environment

4.3.1 Software Requirements

- **IDE:** Visual Studio Code, IntelliJ IDEA
- **Mobile:** Android Studio, Xcode (for iOS)
- **Database:** MongoDB Compass
- **API Testing:** Postman, Thunder Client
- **Version Control:** Git

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5. Technology Stack

5.1 Frontend Technologies

Component	Technology	Version	Purpose
Mobile Framework	Flutter	3.5+	Cross-platform mobile development
Programming Language	Dart	3.5+	Flutter development language
State Management	Provider	6.1+	App state management
HTTP Client	http	1.2+	API communication
Local Storage	SharedPreferences	2.3+	Local data persistence

5.2 Backend Technologies

Component	Technology	Version	Purpose

Component	Technology	Version	Purpose
Admin Panel	Node.js	16+	Server-side JavaScript runtime
Web Framework	Express.js	4.21+	Web application framework
Template Engine	EJS	3.1+	Server-side templating
API Framework	Spring Boot	3.0+	RESTful API development
Programming Language	Java	17+	Backend development

5.3 Database & Storage

Component	Technology	Version	Purpose
Database	MongoDB	4.0+	NoSQL document database
ODM/ORM	Mongoose	8.1+	MongoDB object modeling
File Storage	Local File System	-	Media file storage
Caching	In-Memory	-	Application-level caching

5.4 Development Tools

Tool	Purpose	Version
Git	Version control	2.30+
Docker	Containerization	20.0+
Postman	API testing	Latest
MongoDB Compass	Database GUI	Latest

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6. Use Case Diagram

6.1 System Actors

6.1.1 Unregistered User

- View public recipes
- Browse categories
- Search recipes
- Register for account

6.1.2 Registered User

- All unregistered user functions
- Login/logout
- Manage profile
- Rate and review recipes

- Save favorite recipes
- Create personal recipes

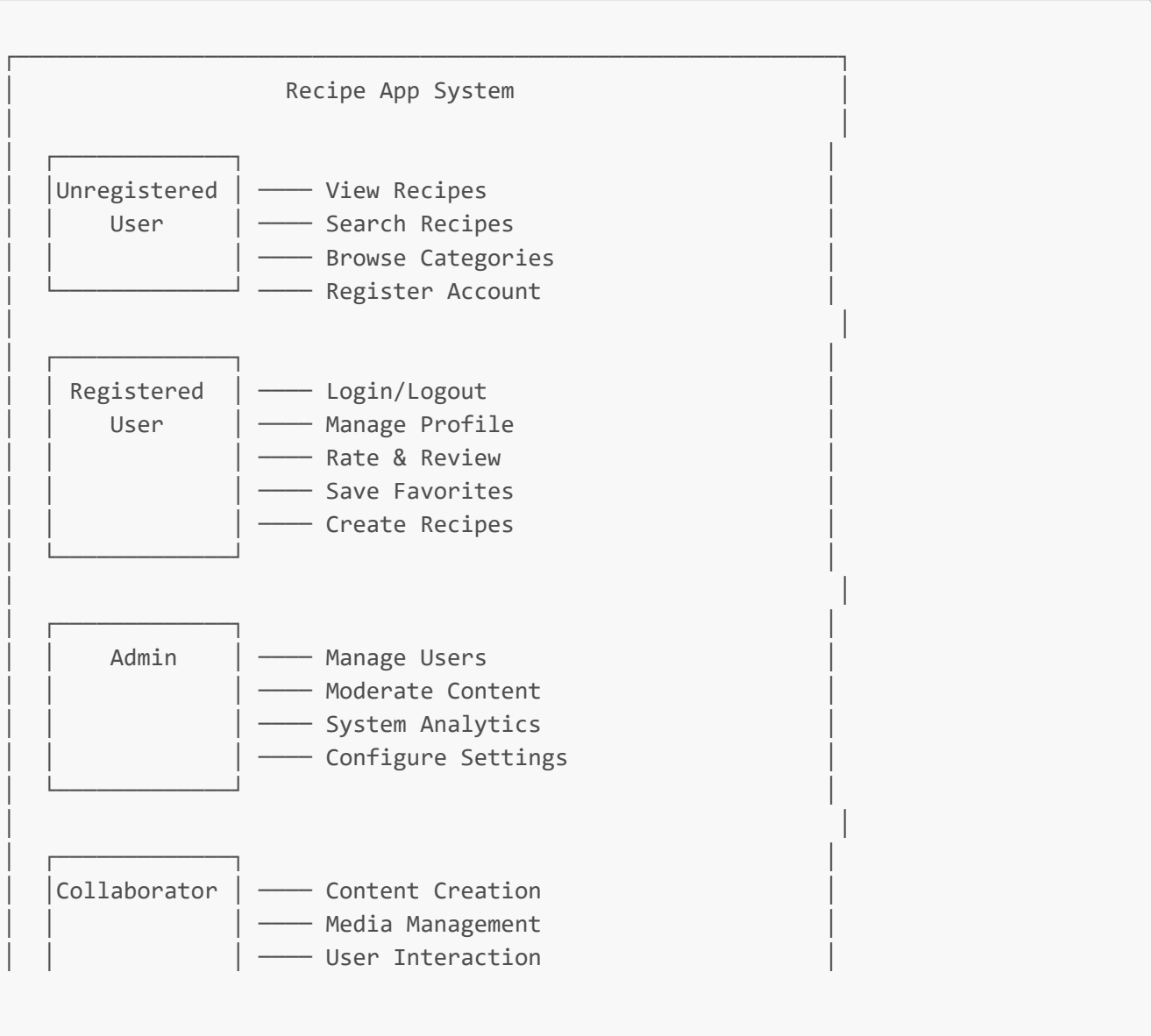
6.1.3 Admin

- All registered user functions
- Manage user accounts
- Moderate content
- Manage categories/cuisines
- View system analytics
- Configure system settings

6.1.4 Content Collaborator

- Add and edit recipes
- Upload media content
- Respond to user feedback
- View content statistics

6.2 Use Case Descriptions



```
│  └──────────────┘                                                  │
└────────────────────────────────────────────────────────────────────┘
```

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7. Sequence Diagrams

7.1 User Registration Sequence

```
sequenceDiagram
    participant U as User
    participant MA as Mobile App
    participant API as Backend API
    participant DB as Database
    participant ES as Email Service

    U->>MA: Enter registration details
    MA->>API: POST /api/SignUp
    API->>DB: Check email uniqueness
    DB-->>API: Email available
    API->>DB: Create user record
    API->>ES: Generate and send OTP
    ES-->>U: Email with OTP
    API-->>MA: Registration successful
    MA-->>U: OTP verification screen

    U->>MA: Enter OTP
    MA->>API: POST /api/VerifyOTP
    API->>DB: Validate OTP
    DB-->>API: OTP valid
    API->>DB: Update user status
    API-->>MA: Verification successful
    MA-->>U: Welcome screen
```

7.2 Recipe Creation Sequence

```
sequenceDiagram
    participant U as User
    participant MA as Mobile App
    participant API as Backend API
    participant FS as File Storage
    participant DB as Database

    U->>MA: Access create recipe
    MA->>API: GET /api/getCategories
    API->>DB: Fetch categories
    DB-->>API: Category list
    API-->>MA: Categories data
    MA-->>U: Recipe form with categories
```

```
    U->>MA: Fill recipe details + upload media
    MA->>FS: Upload images/videos
    FS-->>MA: File URLs
    MA->>API: POST /api/createRecipe
    API->>DB: Save recipe data
    DB-->>API: Recipe created
    API-->>MA: Success response
    MA-->>U: Recipe published confirmation
```

7.3 Recipe Search and View Sequence

```
sequenceDiagram
    participant U as User
    participant MA as Mobile App
    participant API as Backend API
    participant DB as Database
    participant Cache as Cache

    U->>MA: Enter search query
    MA->>API: POST /api/SearchRecipes
    API->>Cache: Check cached results
    Cache-->>API: Cache miss
    API->>DB: Search recipes
    DB-->>API: Recipe results
    API->>Cache: Store results
    API-->>MA: Recipe list
    MA-->>U: Display results

    U->>MA: Select recipe
    MA->>API: GET /api/getRecipe/{id}
    API->>DB: Fetch recipe details
    DB-->>API: Recipe data
    API-->>MA: Recipe details
    MA-->>U: Recipe view
```

7.4 Review and Rating Sequence

```
sequenceDiagram
    participant U as User
    participant MA as Mobile App
    participant API as Backend API
    participant DB as Database
    participant NS as Notification Service

    U->>MA: Rate recipe and write review
    MA->>API: POST /api/AddReview
    API->>DB: Check existing review
    DB-->>API: No previous review
    API->>DB: Save review
```

```
    API->>DB: Update recipe rating
    DB-->>API: Review saved
    API->>NS: Notify recipe owner
    API-->>MA: Review submitted
    MA-->>U: Thank you message
```

---

8. Entity Relationship Diagram

8.1 Database Schema Overview

```
erDiagram
    USERS {
        ObjectId _id PK
        String firstname
        String lastname
        String email UK
        String password
        String country_code
        String phone
        String avatar
        Number isOTPVerified
        Number is_active
        Date createdAt
        Date updatedAt
    }

    RECIPES {
        ObjectId _id PK
        String image
        String name
        ObjectId categoryId FK
        ObjectId cuisinesId FK
        Array ingredients
        String prepTime
        String cookTime
        String totalCookTime
        String servings
        String difficultyLevel
        Array gallery
        String video
        String overview
        String how_to_cook
        Date createdAt
        Date updatedAt
    }

    CATEGORIES {
        ObjectId _id PK
        String name
        Date createdAt
```

```
        Date updatedAt
    }

    CUISINES {
        ObjectId _id PK
        String name
        Date createdAt
        Date updatedAt
    }

    REVIEWS {
        ObjectId _id PK
        ObjectId userId FK
        ObjectId recipeId FK
        Number rating
        String comment
        Date createdAt
        Date updatedAt
    }

    FAVOURITE_RECIPES {
        ObjectId _id PK
        ObjectId userId FK
        ObjectId recipeId FK
        Date createdAt
        Date updatedAt
    }

    OTPS {
        ObjectId _id PK
        ObjectId userId FK
        String email
        Number otp
        Date createdAt
        Date updatedAt
    }

    INTRO {
        ObjectId _id PK
        String image
        String title
        String description
        Date createdAt
        Date updatedAt
    }

    ADS {
        ObjectId _id PK
        Number android_is_enable
        String android_app_ad_id
        String android_banner_ad_id
        Number ios_is_enable
        String ios_app_ad_id
        String ios_banner_ad_id
```

```
        Date createdAt
        Date updatedAt
    }

    FAQS {
        ObjectId _id PK
        String question
        String answer
        String status
        Date createdAt
        Date updatedAt
    }

    SETTINGS {
        ObjectId _id PK
        String privatePolicy
        String termsAndConditions
        Date createdAt
        Date updatedAt
    }

    USERS ||--o{ REVIEWS : "creates"
    USERS ||--o{ FAVOURITE_RECIPES : "has"
    USERS ||--o{ OTPS : "verified_by"
    RECIPES ||--o{ REVIEWS : "receives"
    RECIPES ||--o{ FAVOURITE_RECIPES : "liked_by"
    RECIPES }o--|| CATEGORIES : "belongs_to"
    RECIPES }o--|| CUISINES : "belongs_to"
```

8.2 Relationship Descriptions

8.2.1 One-to-Many Relationships

- **Users** → **Reviews:** One user can create multiple reviews
- **Users** → **Favorites:** One user can have multiple favorite recipes
- **Recipes** → **Reviews:** One recipe can receive multiple reviews
- **Categories** → **Recipes:** One category can contain multiple recipes
- **Cuisines** → **Recipes:** One cuisine can contain multiple recipes

8.2.2 Many-to-Many Relationships

- **Users** ←→ **Recipes (via Favorites):** Users can favorite multiple recipes, recipes can be favorited by multiple users

8.2.3 One-to-One Relationships

- **Users** → **OTPs:** Each OTP verification is tied to one user session

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9. Database Design

9.1 Collection Specifications

9.1.1 Users Collection

```
{
  _id: ObjectId("..."),
  firstname: "John",
  lastname: "Doe",
  email: "john@example.com", // Unique index
  password: "hashed_password", // SHA256 double hash
  country_code: "+84",
  phone: "123456789",
  avatar: "profile_image_url",
  isOTPVerified: 1, // 0: not verified, 1: verified
  is_active: 1, // 0: inactive, 1: active
  createdAt: ISODate("2025-09-04T..."),
  updatedAt: ISODate("2025-09-04T...")
}
```

9.1.2 Recipes Collection

```
{
  _id: ObjectId("..."),
  image: "recipe_main_image.jpg",
  name: "Chicken Curry",
  categoryId: ObjectId("category_id"),
  cuisinesId: ObjectId("cuisine_id"),
  ingredients: [
    "500g chicken breast",
    "2 cups coconut milk",
    "1 onion diced"
  ],
  prepTime: "15 minutes",
  cookTime: "30 minutes",
  totalCookTime: "45 minutes",
  servings: "4 people",
  difficultyLevel: "Medium", // Easy, Medium, Hard
  gallery: ["img1.jpg", "img2.jpg"],
  video: "cooking_video.mp4",
  overview: "Delicious chicken curry recipe...",
  how_to_cook: "Step 1: Heat oil...",
  createdAt: ISODate("2025-09-04T..."),
  updatedAt: ISODate("2025-09-04T...")
}
```

9.2 Indexing Strategy

9.2.1 Primary Indexes

- **_id:** Automatic MongoDB ObjectId index
- **email (Users):** Unique index for authentication
- **name (Categories/Cuisines):** Text index for search

9.2.2 Compound Indexes

- **userId + recipeId (Reviews):** Prevent duplicate reviews
- **userId + recipeId (Favorites):** Prevent duplicate favorites
- **categoryId + cuisinesId (Recipes):** Optimize filtered searches

9.2.3 Text Indexes

- **Recipes:** Full text search on name, ingredients, overview
- **Categories/Cuisines:** Search by name

9.3 Data Validation Rules

9.3.1 User Validation

- Email format validation with regex
- Password minimum 8 characters
- Phone number format validation
- Required fields: firstname, lastname, email, password

9.3.2 Recipe Validation

- Required fields: image, name, overview, how_to_cook
- Difficulty level enum: ["Easy", "Medium", "Hard"]
- Positive integers for prep/cook time
- Valid ObjectId references for categoryId, cuisinesId

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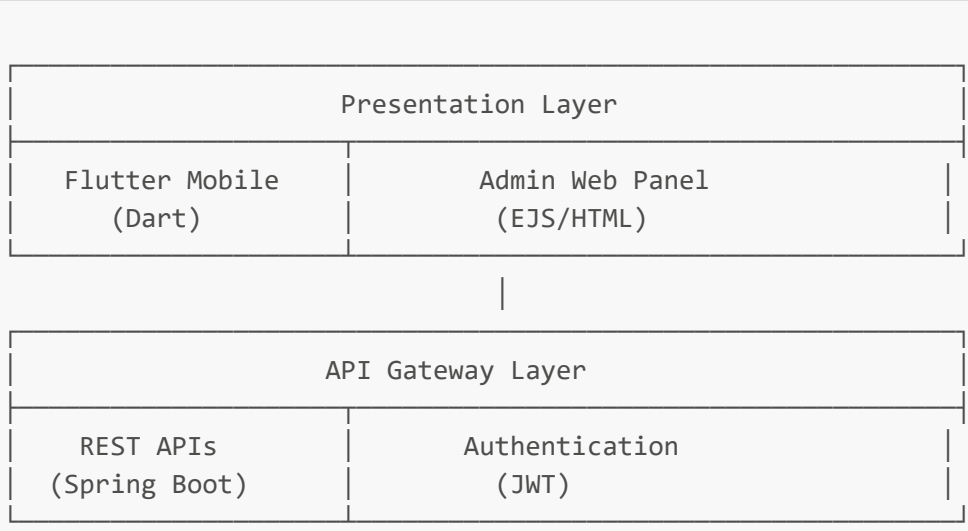
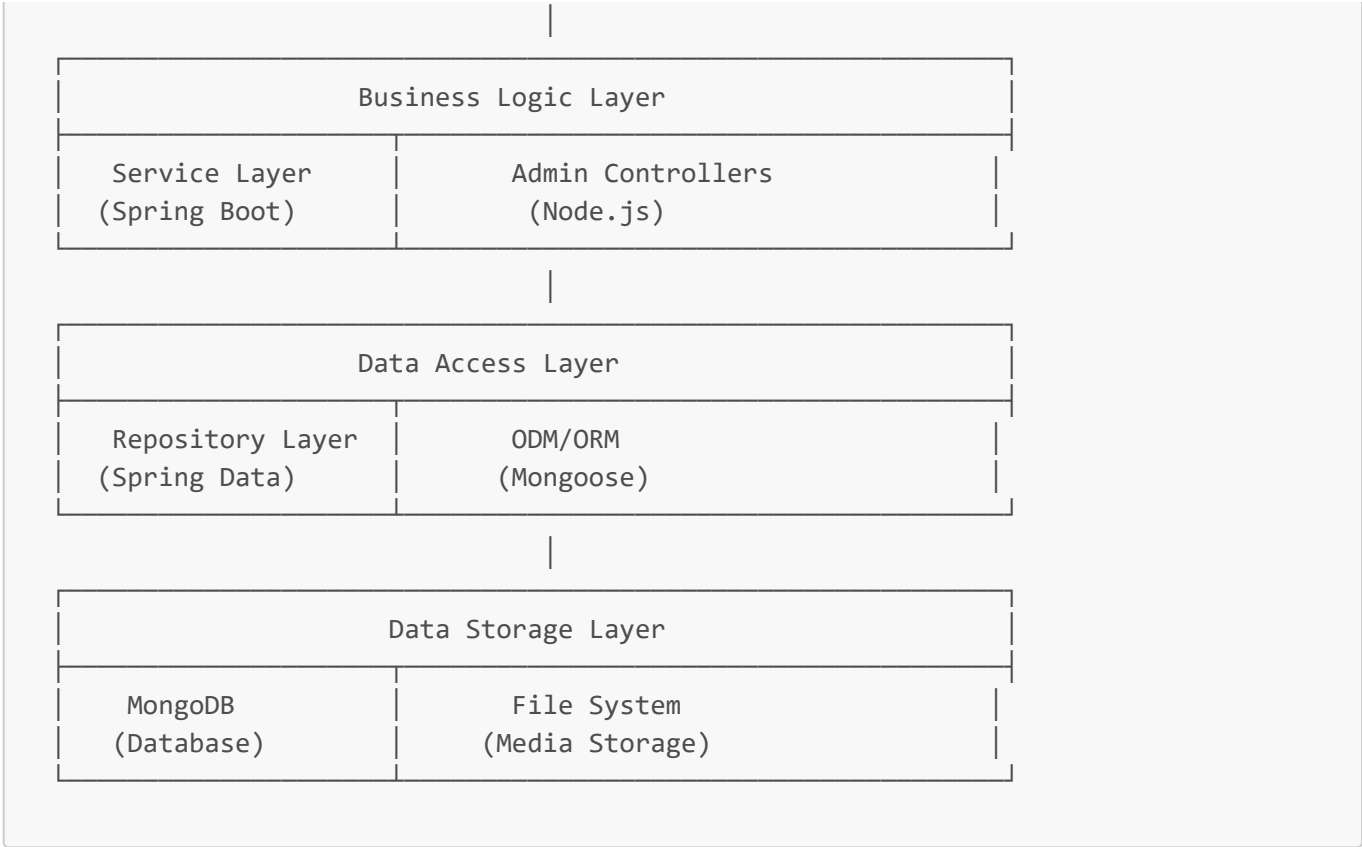
10. System Architecture

10.1 Architecture Overview





10.2 Component Descriptions

10.2.1 Presentation Layer

- **Flutter Mobile App:** Cross-platform mobile application providing user interface
- **Admin Web Panel:** Browser-based administrative interface for content management

10.2.2 API Gateway Layer

- **REST API Endpoints:** RESTful services for mobile app communication
- **Authentication Service:** JWT-based authentication and authorization

10.2.3 Business Logic Layer

- **Service Components:** Core business logic and data processing
- **Controller Layer:** Request handling and response formatting

10.2.4 Data Access Layer

- **Repository Pattern:** Abstraction layer for database operations
- **ORM/ODM:** Object mapping for database interactions

10.2.5 Data Storage Layer

- **MongoDB:** Primary database for application data
- **File System:** Storage for uploaded media files

10.3 Communication Patterns

10.3.1 Client-Server Communication

- **Protocol:** HTTPS for secure communication
- **Format:** JSON for data exchange
- **Authentication:** Bearer token in headers

10.3.2 Internal Communication

- **Database:** MongoDB connection pooling
- **File System:** Direct file system access
- **Email Service:** SMTP integration

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11. User Interface Design

11.1 Mobile App Interface

11.1.1 Authentication Screens

- **Login Screen:** Email/password input with OTP option
- **Registration Screen:** Multi-step form with validation
- **OTP Verification:** Numeric input with resend functionality
- **Password Reset:** Email input with OTP confirmation

11.1.2 Main Application Screens

- **Home Screen:** Featured recipes, categories, search bar
- **Recipe List:** Grid/list view with filtering options
- **Recipe Detail:** Full recipe with images, ingredients, steps
- **Profile Screen:** User information, favorites, settings

11.1.3 Interactive Features

- **Search Interface:** Real-time search with suggestions
- **Filter Panel:** Category, cuisine, difficulty filters
- **Rating Component:** Star rating with review text
- **Favorites:** Heart icon with animation

11.2 Admin Panel Interface

11.2.1 Dashboard

- **Analytics Cards:** User count, recipe count, reviews
- **Charts:** User growth, popular recipes, ratings distribution
- **Quick Actions:** Recent activities, pending approvals

11.2.2 Management Interfaces

- **User Management:** User list with search, edit, deactivate

- **Recipe Management:** Recipe CRUD with media upload
- **Category Management:** Category tree view with drag-drop
- **Settings Panel:** System configuration options

11.3 Design Principles

11.3.1 Mobile-First Design

- **Responsive Layout:** Adapts to different screen sizes
- **Touch-Friendly:** Adequate button sizes and spacing
- **Performance:** Optimized images and lazy loading

11.3.2 User Experience

- **Intuitive Navigation:** Clear menu structure
- **Consistent Design:** Unified color scheme and typography
- **Accessibility:** Screen reader support, color contrast

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12. Implementation

12.1 Development Phases

12.1.1 Phase 1: Foundation (Week 1-2)

- **Environment Setup:** Development tools installation
- **Database Design:** MongoDB schema creation
- **Basic Authentication:** User registration and login
- **Project Structure:** Repository setup and architecture

12.1.2 Phase 2: Core Features (Week 3-6)

- **Recipe Management:** CRUD operations
- **Category System:** Category and cuisine management
- **File Upload:** Image and video handling
- **Search Functionality:** Basic search implementation

12.1.3 Phase 3: Advanced Features (Week 7-10)

- **Review System:** Rating and commenting
- **Favorites:** User favorite recipes
- **Admin Panel:** Complete admin interface
- **Mobile App:** Flutter app development

12.1.4 Phase 4: Testing & Deployment (Week 11-12)

- **Unit Testing:** Component-level testing
- **Integration Testing:** API and database testing
- **User Acceptance Testing:** End-user testing

- **Deployment:** Production environment setup

12.2 Technology Implementation

12.2.1 Backend Implementation

```
// Node.js API Controller Example
const SignUp = async (req, res) => {
    try {
        const { firstname, lastname, email, phone, password } = req.body;

        // Check existing user
        const existingUser = await userModel.findOne({ email });
        if (existingUser) {
            return res.status(400).json({
                status: false,
                message: "User already exists"
            });
        }

        // Hash password and create user
        const hashedPassword = sha256.x2(password);
        const newUser = new userModel({
            firstname, lastname, email, phone,
            password: hashedPassword
        });

        await newUser.save();

        // Generate and send OTP
        const otp = Math.floor(1000 + Math.random() * 9000);
        await sendOtpMail(email, otp);

        res.status(200).json({
            status: true,
            message: "Registration successful, OTP sent",
            userId: newUser._id
        });
    } catch (error) {
        res.status(500).json({
            status: false,
            message: "Internal server error"
        });
    }
};
```

12.2.2 Frontend Implementation

```
// Flutter API Service Example
class ApiService {
  static const String baseUrl = 'http://10.0.2.2:8190/api';

  static Future<Map<String, dynamic>> signUp(Map<String, dynamic> userData) async
{
    try {
      final response = await http.post(
        Uri.parse('$baseUrl/SignUp'),
        headers: {'Content-Type': 'application/json'},
        body: json.encode(userData),
      );

      return json.decode(response.body);
    } catch (e) {
      throw Exception('Failed to register user: $e');
    }
  }

  static Future<List<Recipe>> getAllRecipes() async {
    final response = await http.get(
      Uri.parse('$baseUrl/getAllRecipes'),
      headers: {'Authorization': 'Bearer ${await getToken()}'},
    );

    if (response.statusCode == 200) {
      final data = json.decode(response.body);
      return data['recipes'].map<Recipe>((json) =>
Recipe.fromJson(json)).toList();
    }
    throw Exception('Failed to load recipes');
  }
}
```

12.3 Code Organization

12.3.1 Backend Structure

```
backend/
├── controllers/          # Request handlers
├── models/              # Database schemas
├── routes/              # API route definitions
├── middleware/          # Authentication, validation
├── services/            # Business logic
├── config/              # Database, email configuration
└── utils/               # Helper functions
```

12.3.2 Frontend Structure

```
lib/
├── screens/              # UI screens
├── widgets/              # Reusable components
├── services/             # API communication
├── models/               # Data models
├── providers/            # State management
└── utils/                # Utilities and constants
```

---

13. Testing

13.1 Testing Strategy

13.1.1 Unit Testing

- **Backend:** Controller and service method testing
- **Frontend:** Widget and utility function testing
- **Database:** Model validation and query testing
- **Coverage:** Minimum 80% code coverage target

13.1.2 Integration Testing

- **API Testing:** Endpoint functionality and data flow
- **Database Integration:** CRUD operation verification
- **File Upload:** Media handling and storage testing
- **Email Service:** OTP delivery testing

13.1.3 System Testing

- **End-to-End:** Complete user workflow testing
- **Performance:** Load testing with concurrent users
- **Security:** Authentication and authorization testing
- **Compatibility:** Cross-platform and browser testing

13.2 Test Cases

13.2.1 Authentication Test Cases

```
// Test Case: User Registration
describe('User Registration', () => {
  test('Should register new user successfully', async () => {
    const userData = {
      firstname: 'John',
      lastname: 'Doe',
      email: 'john@test.com',
      phone: '123456789',
      password: 'password123'
    };
```

```
    const response = await request(app)
      .post('/api/SignUp')
      .send(userData)
      .expect(200);

    expect(response.body.status).toBe(true);
    expect(response.body.message).toContain('OTP sent');
  });

  test('Should reject duplicate email', async () => {
    // Test duplicate email registration
  });
});
```

13.2.2 Recipe Management Test Cases

```
// Test Case: Recipe Creation
describe('Recipe Management', () => {
  test('Should create recipe with valid data', async () => {
    const token = await getAuthToken();
    const recipeData = {
      name: 'Test Recipe',
      ingredients: ['ingredient1', 'ingredient2'],
      instructions: 'Test instructions'
    };

    const response = await request(app)
      .post('/api/createRecipe')
      .set('Authorization', `Bearer ${token}`)
      .send(recipeData)
      .expect(200);

    expect(response.body.status).toBe(true);
  });
});
```

13.3 Testing Tools

13.3.1 Backend Testing

- **Jest:** JavaScript testing framework
- **Supertest:** HTTP assertion library
- **MongoDB Memory Server:** In-memory database for testing
- **Postman:** Manual API testing

13.3.2 Frontend Testing

- **Flutter Test:** Built-in testing framework

- **Mockito:** Mocking framework
- **Integration Test:** Widget interaction testing
- **Golden Tests:** UI regression testing

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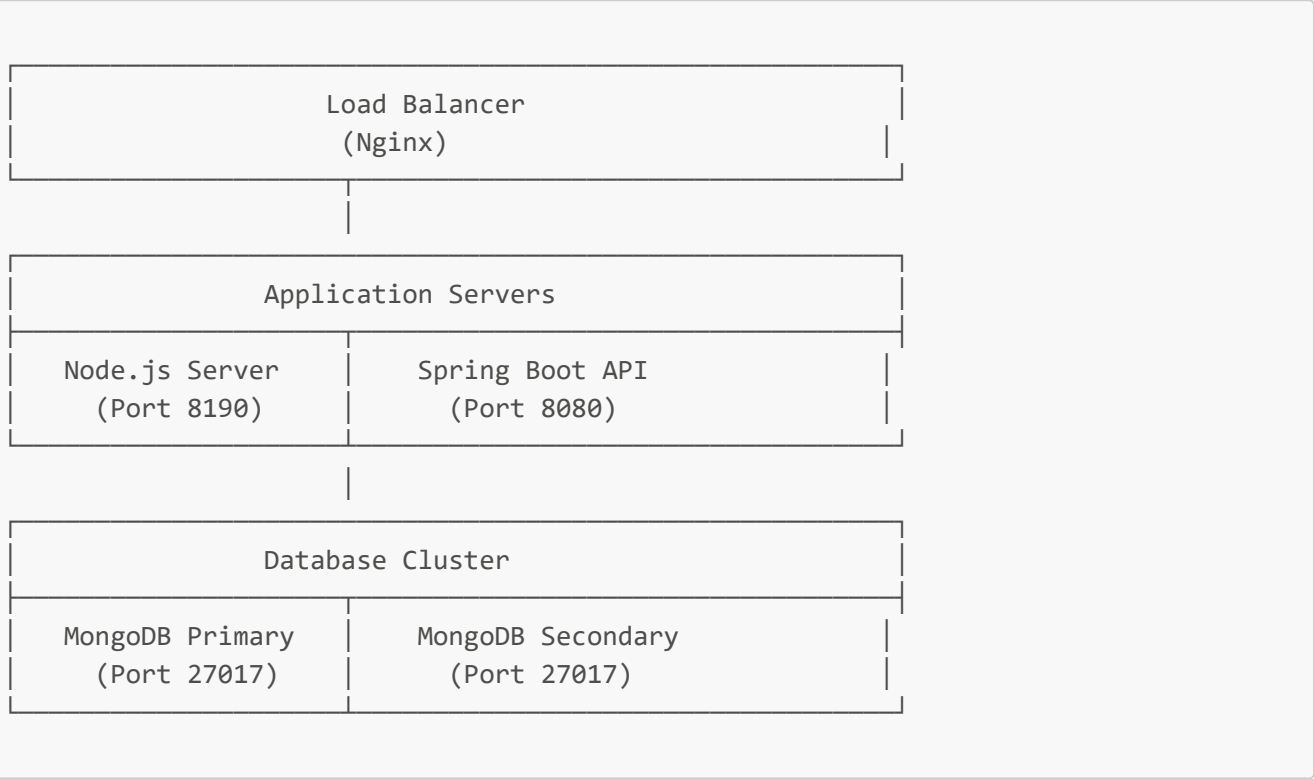
14. Deployment

14.1 Deployment Architecture

14.1.1 Production Environment



14.1.2 Deployment Strategies

- **Blue-Green Deployment:** Zero-downtime deployment
- **Rolling Updates:** Gradual service updates
- **Rollback Capability:** Quick reversion on issues
- **Health Checks:** Automated service monitoring

14.2 Environment Configuration

14.2.1 Production Environment Variables

```
# Node.js Application
NODE_ENV=production
PORT=8190
DB_URL=mongodb://prod-cluster:27017/recipe_db
JWT_SECRET=strong_production_secret
MAIL_HOST=smtp.gmail.com
MAIL_PORT=587
```

```
MAIL_USER=noreply@recipeapp.com
MAIL_PASS=app_specific_password

# Spring Boot Application
SPRING_PROFILES_ACTIVE=production
SERVER_PORT=8080
SPRING_DATA_MONGODB_URI=mongodb://prod-cluster:27017/recipe_db
SPRING_MAIL_USERNAME=noreply@recipeapp.com
SPRING_MAIL_PASSWORD=app_specific_password
```

14.2.2 Security Configuration

- **SSL/TLS:** HTTPS encryption for all endpoints
- **Firewall Rules:** Restricted port access
- **Database Security:** Authentication and encryption
- **Environment Isolation:** Separate staging and production

14.3 Monitoring and Maintenance

14.3.1 System Monitoring

- **Application Metrics:** Response time, error rates
- **Infrastructure Metrics:** CPU, memory, disk usage
- **Database Monitoring:** Query performance, connections
- **Log Aggregation:** Centralized logging system

14.3.2 Backup Strategy

- **Database Backups:** Daily automated backups
- **File System Backups:** Media file replication
- **Configuration Backups:** Environment variable storage
- **Disaster Recovery:** Multi-region backup storage

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15. Conclusion

15.1 Project Summary

The Recipe Application System successfully addresses the need for a comprehensive, mobile-first recipe sharing platform. The implementation combines modern technologies and best practices to deliver:

15.1.1 Key Achievements

- **Cross-Platform Mobile App:** Flutter-based application supporting iOS and Android
- **Robust Backend Architecture:** Dual backend system with Node.js and Spring Boot
- **Comprehensive Admin Panel:** Web-based administration with full content management
- **Scalable Database Design:** MongoDB with optimized schema and indexing
- **Security Implementation:** JWT authentication with OTP verification

15.1.2 Technical Highlights

- **Modern Technology Stack:** Latest versions of Flutter, Node.js, Spring Boot
- **RESTful API Design:** Well-structured endpoints with proper HTTP methods
- **Responsive UI/UX:** Mobile-optimized interface with intuitive navigation
- **Performance Optimization:** Caching, indexing, and efficient query design
- **Comprehensive Testing:** Unit, integration, and system testing coverage

15.2 Project Impact

15.2.1 User Benefits

- **Centralized Recipe Repository:** Single platform for discovering and sharing recipes
- **Interactive Cooking Experience:** Step-by-step guidance with multimedia support
- **Community Engagement:** Rating, reviewing, and social features
- **Personalized Experience:** Favorites, recommendations, and user profiles

15.2.2 Business Value

- **Scalable Architecture:** Ready for user growth and feature expansion
- **Monetization Ready:** Advertisement system and premium feature capability
- **Content Management:** Efficient admin tools for content curation
- **Analytics Integration:** User behavior tracking and insights

15.3 Future Enhancements

15.3.1 Short-term Improvements

- **Push Notifications:** Real-time updates for new recipes and interactions
- **Advanced Search:** AI-powered recipe recommendations
- **Social Features:** User following, recipe sharing, cooking groups
- **Offline Support:** Cached recipes for offline cooking

15.3.2 Long-term Vision

- **AI Integration:** Personalized meal planning and dietary recommendations
- **IoT Connectivity:** Smart kitchen appliance integration
- **Augmented Reality:** AR-guided cooking instructions
- **Marketplace Features:** Ingredient ordering and chef partnerships

15.4 Lessons Learned

15.4.1 Technical Insights

- **Microservices Approach:** Benefits of separating admin panel and API services
- **Database Design:** Importance of proper indexing for search performance
- **Mobile Development:** Flutter's efficiency for cross-platform development
- **Testing Strategy:** Value of comprehensive testing throughout development

15.4.2 Project Management

- **Agile Methodology:** Iterative development with regular feedback
- **Team Collaboration:** Effective communication and task distribution
- **Documentation:** Importance of maintaining comprehensive documentation
- **Quality Assurance:** Continuous testing and code review processes

15.5 Acknowledgments

We express our gratitude to all team members, advisors, and users who contributed to the successful completion of this project. Special thanks to:

- **Development Team:** For dedication and technical excellence
- **Testing Team:** For thorough quality assurance
- **UI/UX Designers:** For creating intuitive and attractive interfaces
- **Project Advisors:** For guidance and feedback throughout development

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Appendices

Appendix A: API Reference

[Detailed API documentation with all endpoints, parameters, and responses]

Appendix B: Database Schema

[Complete database schema with all collections and relationships]

Appendix C: User Manual

[Step-by-step user guide for mobile app and admin panel]

Appendix D: Installation Guide

[Detailed setup instructions for development and production environments]

Appendix E: Test Results

[Comprehensive testing results and performance benchmarks]

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This document represents the complete technical specification and implementation guide for the Recipe Application System developed by Group 4.