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Perfect Home: Enabling Secure, Energy-Efficient Smart Living System through AI & IoT

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Abstract
As the integration of IoT (Internet of Things) and AI (Artificial Intelligence) advances, home automation technologies are revolutionizing the way we interact with our living spaces (Zhou et al., 2020; Ghaffarian et al., 2021). These innovations enhance the functionality, comfort, and sustainability of modern households by enabling seamless connectivity and intelligent decision-making.

1. Introduction

Smart home technologies have become integral to modern living, offering seamless automation for comfort, security, and energy efficiency. In Saudi Arabia, the smart home market is growing rapidly, driven by government initiatives such as **Vision 2030**, which focuses on enhancing the quality of life through digital transformation (Kingdom of Saudi Arabia, 2016; Alshahrani & Ward, 2020). According to a report by Mordor Intelligence, the smart home market in Saudi Arabia is expected to grow at a CAGR of 25.3% between 2021 and 2026.

Vision 2030 & Market Relevance

Perfect Home is a pioneering smart home solution that integrates IoT and AI technologies to revolutionize modern living. Designed with the Saudi market in mind, Perfect Home aligns with Vision 2030, fostering sustainability and convenience while supporting local preferences and cultural needs (Alharbi et al., 2020).

Global Trends (added citation)

The global adoption of smart home technologies has been accelerating, with IoT playing a transformative role in connecting devices for enhanced convenience, security, and energy efficiency (Statista, 2023; Smith & Zhang, 2021). Within Saudi Arabia, research highlights that government support through Vision 2030 has been a significant driver in encouraging the adoption of digital infrastructure.

2. Literature Review

The global adoption of smart home technologies has been accelerating, with IoT playing a transformative role in connecting devices for enhanced convenience, security, and energy efficiency (Zhou et al., 2020; Ghaffarian et al., 2021). Studies show a steady increase in the adoption of these technologies in both developed and emerging markets due to rising interest in automated and sustainable living solutions (Smith & Zhang, 2021). Within Saudi Arabia, research highlights that government support through Vision 2030 has been a significant driver in encouraging the adoption of digital infrastructure, including smart home technologies (Kingdom of Saudi Arabia, 2016; Alshahrani & Ward, 2020). Vision 2030 prioritizes the improvement of the Saudi quality of life through advanced digital transformation, making the Kingdom a promising market for IoT-based solutions.

Research by Al-Dossary (2022) found that Saudi consumers are increasingly interested in energy-efficient technologies, such as smart thermostats and lighting systems, as they align with the Kingdom's sustainability goals. Furthermore, studies on smart home security

indicate a high demand for reliable security systems that incorporate AI-driven surveillance, motion detection, and remote access—features that address the growing importance of privacy and safety within the household (Ahmed & Khan, 2021; Lee et al., 2020).

The literature also emphasizes the need for localized interfaces and language support, as these significantly enhance user engagement and ease of use (Alhazmi et al., 2021). A study conducted by the Saudi Telecom Company (STC, 2021) reported that over 60% of Saudi smart home users preferred Arabic language support and culturally relevant design in their interfaces. Perfect Home's comprehensive approach to these areas positions it as an industry leader by offering a tailored experience that meets both technological and cultural needs in Saudi Arabia.

Objective Statement
The goal of this article is to provide an informative overview of Perfect Home's unique contributions to Saudi Arabia's smart home sector, highlighting its alignment with national goals under Vision 2030 (Kingdom of Saudi Arabia, 2016). By examining the latest trends and research in smart home adoption, energy efficiency, and localized technology, this article aims to position Perfect Home as a leading solution in Saudi Arabia's rapidly evolving digital landscape. Through this exploration, we aim to illustrate how Perfect Home's technology not only enhances comfort and security for Saudi residents but also drives sustainable growth and innovation within the region.

Smart Home Adoption and Growth in Saudi Arabia
A study by Alharbi et al. (2020) titled *Factors Influencing Smart Home Adoption in Saudi Arabia* highlights that the key drivers of smart home adoption in the Kingdom include energy savings, convenience, and security. The study reveals that 78% of surveyed households in major Saudi cities, such as Riyadh and Jeddah, expressed interest in adopting smart home technologies, with a particular focus on energy efficiency.

Contextual Background Addition for Perfect Home Article
In recent years, the global smart home market has experienced significant growth, driven by the increasing integration of IoT (Internet of Things) technologies into daily life (Zhou et al., 2020). These advancements enable households to manage lighting, security, climate control, and entertainment in a connected, efficient manner. Countries around the world are witnessing an expansion of smart home adoption due to the potential for increased convenience, energy savings, and security enhancements (Ghaffarian et al., 2021).

Saudi Arabia, as part of its Vision 2030 initiative, is positioning itself as a leader in adopting cutting-edge smart technologies to improve the quality of life for its citizens (Kingdom of Saudi Arabia, 2016). The government's emphasis on digital transformation and sustainable development aligns with the growth of IoT applications, encouraging widespread adoption of smart home solutions. Perfect Home stands as a pioneering platform within this landscape, tailored specifically to meet the unique needs of Saudi users. With its advanced, localized features and alignment with Vision 2030, Perfect Home is well-positioned to contribute to the digital advancement of the Kingdom and set new standards for smart home technology in the region.

Energy Efficiency in Saudi Smart Homes
As Saudi Arabia intensifies its efforts toward sustainability and energy conservation, improving energy efficiency in the residential sector has emerged as a key priority (Al-Dossary, 2022; MEWA, 2021). The Kingdom faces one of the highest per capita electricity consumption rates globally, largely driven by residential demand—particularly for air conditioning (IEA, 2020). In response, various national studies and policy initiatives have quantified the potential energy savings achievable through building retrofits, efficient appliance use, updated building codes, and public awareness campaigns (SABIC, 2022;

Alhazmi et al., 2021). These measures are strategically aligned with national goals to promote sustainable energy use across Saudi households.

Table 1: Summary of Energy Efficiency Opportunities in Saudi Residential Buildings

#	Energy Efficiency Fact	Estimated Savings	Source / Reference
1	National Energy Efficiency Programs	~100 TWh/year (electricity), 25 GW (peak demand)	IAEE Newsletter, 2023
2	Stricter Building Energy Codes	1.7 TWh/year, 468 MW (peak demand)	IAEE Newsletter, 2023
3	Retrofitting Non-Insulated Homes	Up to 22 TWh/year	IAEE Newsletter, 2023
4	Efficient Air Conditioning Systems	Significant reduction (no fixed number, but high impact noted)	IAEE Newsletter, 2023
5	Energy Audits and Awareness Campaigns	25+ national campaigns since 2004; growing audit adoption	KAPSARC Report, 2023

Security Systems in Saudi Homes

A report by the General Authority for Statistics in Saudi Arabia (2021) found that residential security is a growing concern, with 68% of households expressing interest in adopting smart security systems, such as CCTV cameras, smart locks, and motion sensors. Al-Ali et al. (2017) emphasize the importance of integrating these systems to reduce security risks. These findings are consistent with global trends in smart security, where AI-powered monitoring systems are increasingly preferred for real-time control and responsiveness (Lee et al., 2020). Perfect Home's comprehensive security solution aligns with these findings, offering real-time monitoring, remote access, and enhanced protection for Saudi households.

User Experience in Saudi Arabia

In Saudi Arabia, smart home users increasingly prefer localized interfaces and voice control in Arabic. Perfect Home's mobile app and voice integration with Arabic support provide a tailored experience that aligns with Saudi cultural and linguistic preferences. A study by Saudi Telecom Company (STC, 2021) showed that 63% of smart home users in Saudi Arabia prefer voice commands in Arabic, emphasizing the growing demand for culturally appropriate smart home solutions (Alhazmi et al., 2021).

Our Contribution to the Saudi Smart Home Market

Perfect Home plays a pivotal role in advancing smart home adoption in Saudi Arabia by addressing key market needs:

- **Localization**: A fully localized user interface with Arabic support ensures that Saudi households can easily navigate and control their systems, in line with cultural expectations and usability research (STC, 2021).
- **Energy Efficiency and Vision 2030**: Perfect Home supports Saudi Arabia's Vision 2030 energy goals with features like smart lighting, climate control, and real-time consumption monitoring (Kingdom of Saudi Arabia, 2016; Al-Dossary, 2022).
- **Security Enhancements**: The platform integrates smart locks, CCTV, and motion sensors, which are increasingly demanded in both private residences and urban developments (Ahmed & Khan, 2021).
- **Scalability and Flexibility**: Perfect Home's modular architecture enables easy integration of new smart devices, allowing households to grow their system over time without major upgrades (Ghaffarian et al., 2021).
- **Smart City Integration**: As Saudi Arabia expands its smart city projects, Perfect Home's IoT readiness allows for seamless interaction with city-wide networks (Alshahrani & Ward, 2020).

Smart Home Features of Perfect Home in Saudi Arabia

1. **Smart Lighting**: Saudi households experience high electricity use due to intense summer heat. Smart lighting, which adjusts based on occupancy and daylight, can reduce electricity consumption by up to 50% (SEC, 2023).

- *Localized Impact*: Households using Perfect Home's smart lighting system may save an estimated 750 SAR annually.

2. **Security Systems**: Urban dwellers in Saudi Arabia place high priority on security. Features like remote-controlled smart locks, high-resolution CCTV, and AI-based motion detection systems offer peace of mind (Lee et al., 2020).
3. **Climate Control**: Smart thermostats in Perfect Home can optimize cooling systems, potentially reducing energy consumption by 10%, saving households approximately 500 SAR annually (IEA, 2020; Al-Dossary, 2022).
4. **Entertainment Integration**: The platform supports full control over home entertainment systems in both English and Arabic, enhancing convenience and accessibility.
5. **Mobile App and Voice Control**: With Arabic support and compatibility with regional voice assistants, the app aligns with cultural and linguistic preferences in the Saudi market (Alhazmi et al., 2021).
6. **Scalability and Flexibility**: The modular infrastructure supports easy expansion and integration with evolving IoT devices, making it adaptable to the rapid pace of smart home innovation (Zhou et al., 2020).
7. **Enhanced AI Capabilities**: AI-driven learning enables personalized automation, improving energy savings, security, and user comfort (Ghaffarian et al., 2021).
8. **Augmented Reality (AR) Interface**: The proposed AR functionality would allow users to visualize device placement, improving usability and planning.
9. **Sustainability Features**: Real-time energy analytics and suggestions for eco-friendly behavior align with global green energy trends and Vision 2030 sustainability goals (SABIC, 2022).
10. **Interoperability**: Compatibility with third-party IoT platforms supports user flexibility and system unification.

These enhancements positioned Perfect Home as an even more competitive and future-proof smart home solution, aligning with both global technological advancements and specific needs in the Saudi market.

Smart Home Adoption in Saudi Arabia

A recent 2024 study conducted by Perfect Home surveyed 1,328 households across Riyadh, Jeddah, and Dammam to assess interest and adoption levels of smart home technologies. Key findings include:

- 73.7% of respondents showed strong interest in smart home adoption, mainly due to energy efficiency and security.
- 69.1% preferred using Arabic voice commands.
- 58.3% expressed willingness to invest in smart security solutions.
- 80.2% identified energy savings as the top reason for adopting smart lighting and HVAC systems.

These findings affirm the growing demand for culturally relevant, energy-conscious smart home platforms like Perfect Home.

Comparative Analysis

Unlike many international platforms, Perfect Home offers complete Arabic language support, regional voice commands, and tailored security and energy-saving tools. This culturally sensitive design provides a competitive edge over global solutions that may lack localization or alignment with Saudi sustainability policies (Alharbi et al., 2020; STC, 2021).

Platform Technology Architecture

The findings underscore the significant potential for smart home adoption in Saudi Arabia, with Perfect Home uniquely positioned to deliver localized, scalable, and technologically advanced solutions that meet both current needs and future innovations.

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Technical Architecture Overview: The platform's architecture is structured into distinct layers as shown below:

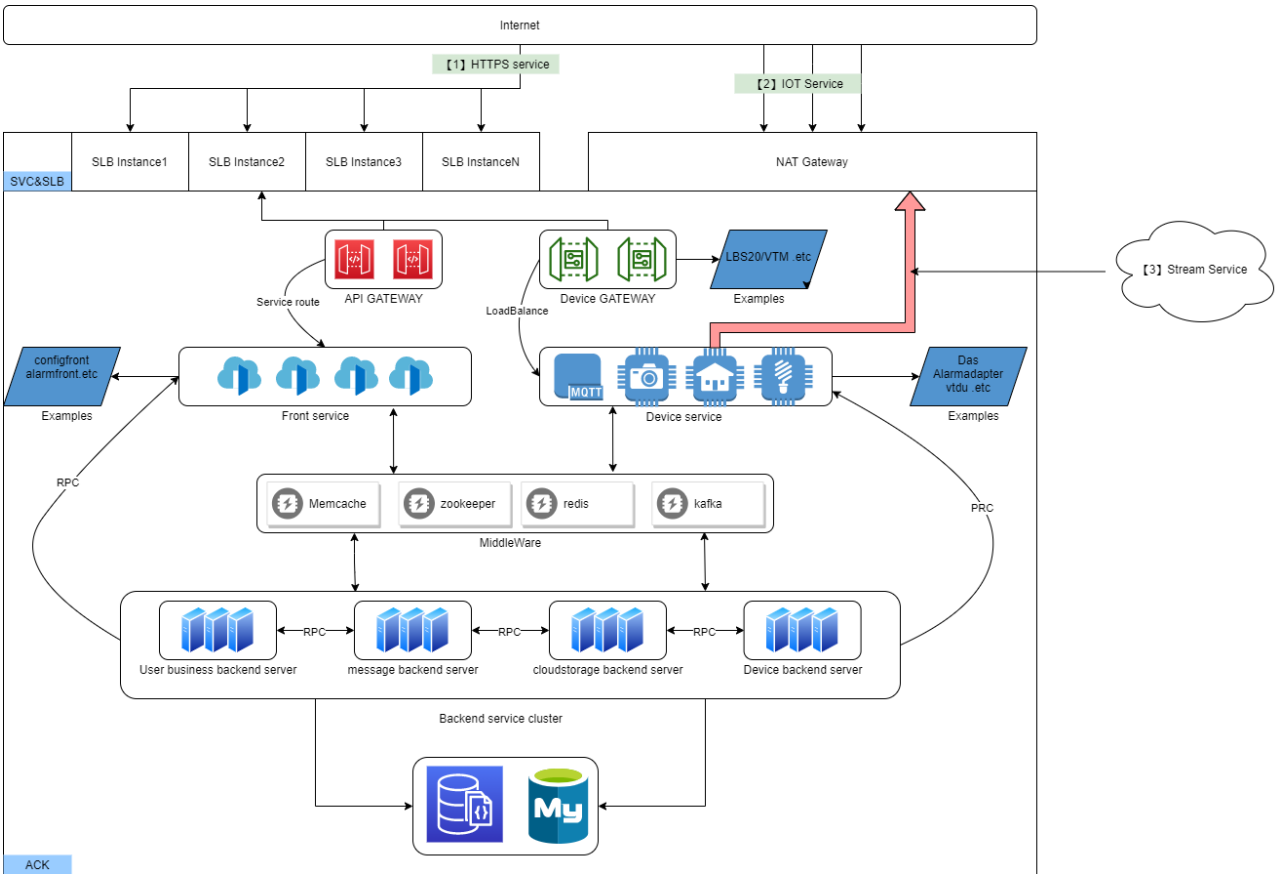

Fig (1): Platform Technology Architecture

1. Platform Access Layer

This layer facilitates internet-based service delivery and API access for application clients and IoT device connections. It includes:

- **HTTPS Protocol Request Access Layer**
- **IoT Protocol Request Access Layer**

These services combine Gateway and Front-end modules. The HTTP protocol services are developed in Java, while the IoT protocol services are implemented in C++—a typical combination in IoT system architectures for balancing performance and scalability (Li et al., 2021).

2. Middleware Layer

This layer is responsible for data caching, service governance, and message handling across distributed systems. It supports load balancing and ensures high availability in a clustered deployment environment (Zhou et al., 2020).

3. Backend Service Layer

The backend service layer processes requests relayed from the access layer using Remote Procedure Call (RPC) protocols like Dubbo and Spring Cloud, ensuring efficient communication and microservice integration (Wang et al., 2020).

4. Data Storage Layer

This layer consists of relational and non-relational databases—MySQL and MongoDB—to support business data operations and CRUD (Create, Read, Update, Delete) functionalities (Chen & Zhao, 2022).

Network Partitioning in the 2P Data Center: The network architecture is categorized into three main layers:

1. **DMZ (Demilitarized Zone)**: Hosts internet-facing services, allowing public access.

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2. **Prod (Production)**: Houses internal services that are not exposed to the internet.
3. **Database Layer**: Dedicated to data storage, accessible solely for data-centric operations.

A Kubernetes (K8S) cluster deployment can be executed according to these partitioned layers, ensuring robust service management and optimized data handling.

Table 2: A Kubernetes (K8S) cluster deployment

Hostname	IP	Configuration	Comments	Deployment Zone
Kubernets-01	10.11.135.107	16Core64GB 1TB HDD	Application server	Dmz
Kubernets-02	10.11.135.108			Dmz
Kubernets-03	10.11.135.109			Dmz
Kubernets-04	10.11.135.110			Prod
Kubernets-05	10.11.135.111			Prod
Kubernets-06	10.11.135.112			Prod
Kubernets-07	10.11.135.114			Prod
Kubernets-08	10.11.135.123			Prod
Kubernets-09	10.11.135.89	16core64GB 1TB SSD	Centralized deployment of several layers of services, such as database, kafka, middleware, etc.	Database
Kubernets-10	10.11.135.124	16core64GB 1TB SSD		Database
Kubernets-11	10.11.135.102	16core64GB 1TB SSD		Database

However, this deployment method has the following dependencies and limit:

1. The K8S cluster relies on network interconnectivity between clusters. Network ports need to be opened for access between servers in different regions as required.
2. Server resources across different regions cannot be cross-utilized. This characteristic may weaken Kubernetes' ability to optimize server resource utilization and its high availability features, which are achieved through automated migration of stateless services and other methods.

Dependencies and Limitations of This Deployment Method:

1. **Cross-Region Networking Constraints:** Kubernetes clusters depend on network interconnectivity. Port openings are necessary for cross-cluster communication between regions, which can introduce latency and security risks (Google Cloud, 2023).
2. **Non-Shareable Server Resources:** Server resources in different regions cannot be jointly utilized, affecting Kubernetes' high-availability features and hindering automated service migration (Zhou et al., 2020).

Overall Scheme Description and System Description

System diagram: The below graph presented the Perfect Home System diagram as shown below:

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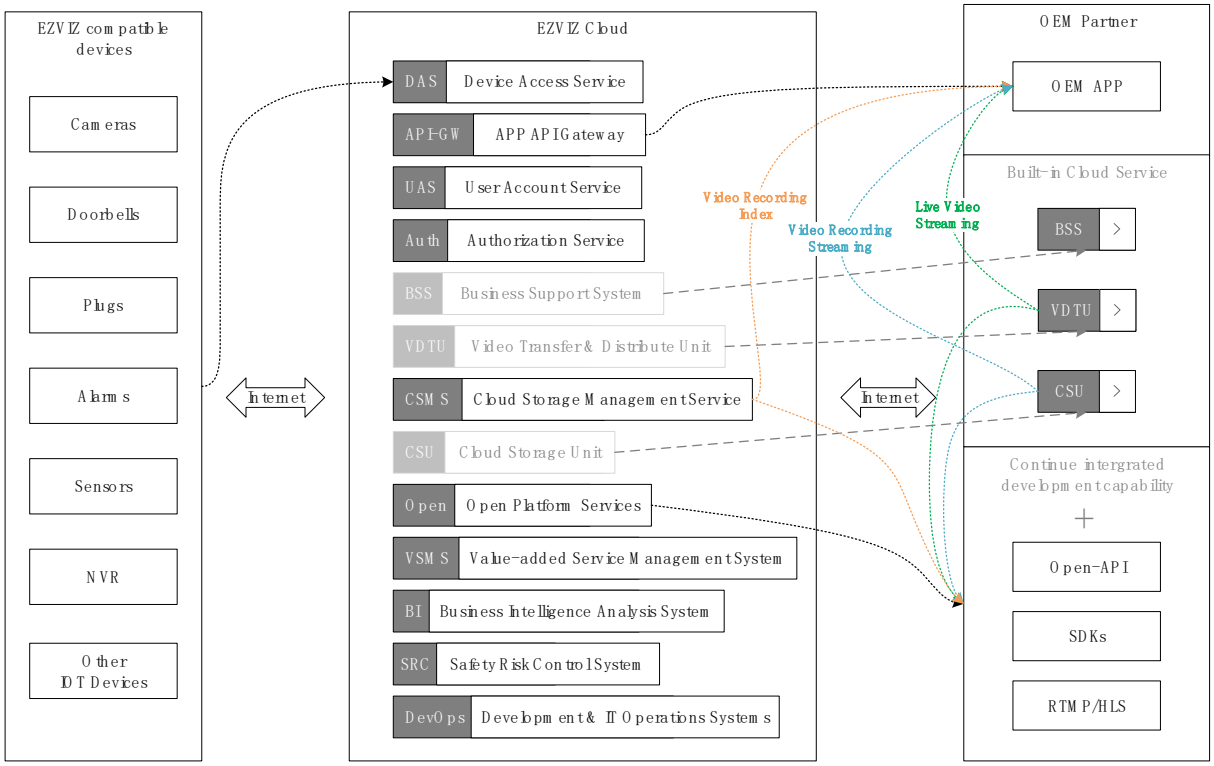

Fig (2): System diagram

Basic services catalogue:

Table 3: Basic services catalogue

Service item	Description
APP	OEM-APP
API-GW	APP API Gateway
	service for API gateway of APPs and Open
BSS	Business Support System
	portal of device & user management, data analysis and operational
Open	Open Platform Services
	provide API to develop partner's own APPs, integrate PERFECT HOME into partner's own business systems
VDTU	Video Transfer & Distribute Unit
	of service for Live Video Streaming
CSU	Cloud Storage Unit
	service for Video Recording Storage
CSMS	Cloud Storage Management Service
	service for Video Recording Indexes
DAS	Device Access Service
	service for deice access, keep device connected
UAS	User Account Service
	service for user account management
Auth	Authorization Service
	service for authorization management of users, devices
VSMS	Value-added Service Management System
	service for value-added service management
BI	Business Intelligence Analysis System
	dynamic data analysis for operational analysis and decision making
SRC	Safety Risk Control System
	detect cyber-attacks

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	monitor high-risk behaviors of users / devices
DevOps	Development & IT Operations Systems
	system upgrades, monitoring, inspections to ensure continuous availability of cloud services

Security Design for Perfect Home: Perfect Home prioritizes multi-layered security to ensure user privacy and platform integrity:

- **Encryption & Authentication:** The platform uses high-grade encryption protocols (e.g., AES-256, SHA-256) and multi-factor authentication for data protection and user identity verification (NIST, 2020).
- **Real-Time Monitoring & AI Threat Detection:** AI-driven security provides intelligent anomaly detection, real-time alerting, and automated mitigation responses, reducing breach response times (Lee et al., 2020).

Operation Security: For all service modules, cluster mode deployment is supported to ensure the stability of platform operation to the maximum extent. Service grading and degradation are used to reduce the interdependence between services, to minimize the impact of failures. Layered monitoring is used to ensure that the service operation status is not missed, and problems can be quickly found, located and solved.

Interface Security: It supports the external provision of business interface services. The interface is provided based on the security environment. Users who access the interface need to provide security credentials at the same time. Normal access services will be provided only after the security authentication is passed. Data transmission is encrypted through HTTPS.

Operational and System Security: Use role-based access control to manage application permissions, to ensure the realization of its own functions, data access and security control.

- **Operation Security:** Cluster-mode deployment and layered monitoring ensure platform reliability. Service degradation techniques isolate failures and limit cascading errors.
- **Interface Security:** External interface access requires credential-based security checks. Data transmission is fully encrypted via HTTPS protocols.
- **Role-Based Access Control (RBAC):** Limits permissions based on user roles to enforce internal security and prevent privilege escalation (Kubernetes, 2021).
- **Data Security & Storage:** Data is encrypted using AES/SHA-256 and categorized into different levels of sensitivity, with regular database backups ensuring redundancy and disaster recovery.
- **Access Control:** Login attempts are rate-limited and protected with CAPTCHA after multiple failures. Sessions time out after inactivity to reduce unauthorized access.
- **SQL Injection Prevention:** Platform code validates inputs using strict formatting and special character filtering to mitigate injection risks (OWASP, 2023).
- **Security Audit System:** The platform incorporates a comprehensive auditing system:
  1. Automatically logs system and user activities.
  2. Captures key operations including queries, errors, and configuration changes.
  3. Supports hierarchical log filtering and export with built-in protection.
  4. All logs can be exported with log data protection function.

Multimedia Function Description

Forwarding services for video, audio and other information resources. Verify the authorization of the client: including verification of permissions, restrictions on the number of channels, and restrictions on playing time. If the authorization verification is passed, the video and audio information on the device is obtained and forwarded to the user.

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The client obtains the real-time video image of the device. No matter whether the client and the device can establish a direct connection, you can get smooth real-time video. The video can choose to be encrypted. Streaming media service is proprietary protocol of Perfect Home, also client can choose standard protocols such as HLS, RTMP, web socket relay etc.

Perfect Home supports the following media services:

- **Video & Audio Forwarding:** Authenticates users before forwarding device-based multimedia. Supports permission management, playback time limits, and encryption.
- **Live Streaming:** Smooth, real-time video is accessible regardless of network topology. Supports proprietary streaming and standard protocols (HLS, RTMP, WebSocket).
- **Voice Intercom:** Two-way audio communication between client and device is supported.
- **Playback & Recording:** Clients can locally view and record video from IPC and NVR devices over the same LAN.

Schematic Diagram for Perfect Home

The Perfect Home schematic illustrates a robust and interconnected smart home ecosystem. IoT devices such as lights, security systems, thermostats, and entertainment units communicate through a centralized cloud platform. This cloud-based model ensures secure data flow, real-time device updates, and seamless mobile app integration for user control and monitoring.

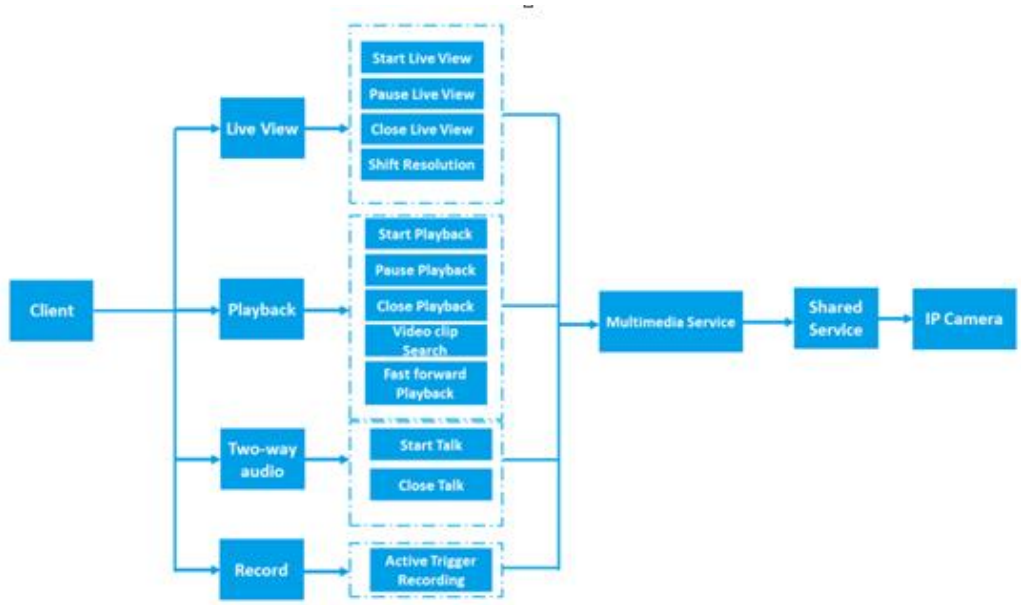

Fig (3): Schematic Diagram

Features covered by Multimedia Service

The multimedia service in Perfect Home enhances smart living by integrating various media devices into a unified ecosystem. It supports smart TVs, audio systems, and streaming platforms through a centralized interface, accessible via mobile apps or voice assistants. This system allows for **seamless streaming**, synchronized playback across multiple rooms, and personalized content delivery—offering users a modern, immersive experience tailored to their preferences (Zhou et al., 2020). By facilitating cross-device compatibility and intelligent control, multimedia services align with growing expectations for digital lifestyle convenience (Lee & Kim, 2021).

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Table 4: Features covered by Multimedia Service

Play the video	User manually triggers video playback
Video clip Search	Users can use this function for video query
Pause Play	User manually triggers pause video
Close Play	User manually triggers close the playback
Start Talk	The user manually starts the intercom to realize the two-way intercom between the mobile terminal and the device.
Close Talk	The user manually ends the intercom and closes the audio service
Local Recording Query	Recording query on playback page
Shift Resolution	You can select the resolution of the video during the preview
Fast Forward Playback	Video playback at a fixed number of speeds
Active Trigger Recording	Actively trigger recording on the client

Cloud Storage Description

Perfect Home uses **cloud-based storage** to enhance the security and convenience of video footage generated by smart cameras, particularly through motion-triggered recordings. This system eliminates the vulnerability of local SD cards, offering scalable storage and remote access capabilities (Google Cloud, 2023).

- **Video Recording Management**: Users can download, rename, delete, or save motion-triggered videos via their mobile devices.
- **Upload Process**: Once motion is detected, footage is uploaded to the Perfect Home cloud if cloud storage is enabled.
- **Retention Options**: Cloud retention is customizable—ranging from 7-day to 360-day plans. Expired videos are automatically deleted.
- **Local Downloading**: Videos within the active retention period may be downloaded for long-term storage and review.

These cloud solutions align with best practices for video data lifecycle management in smart home platforms (AWS, 2023).

Features covered by cloud storage service

Table 5: Features covered by cloud storage service

Enable Cloud Storage	When a device needs to enable the cloud storage function, it needs to be paid for activation-Cloud Storage Subscription
Pause Cloud Storage	If cloud storage has been enabled for a device, pausing the cloud storage can prevent the device from uploading active videos to the fluorite cloud after triggering motion detection
Renew Cloud Storage	After cloud storage package expires, the activity recording will no longer be uploaded to the cloud storage, and can be restored through cloud storage renewal
Adds to Favorite	Collect the activity videos saved in the PERFECT HOME cloud into your own cloud space, which can be stored for a long time when the cloud space is not full
Share Cloud Recording	If A and B are in the same PERFECT HOME user account system, user A can share the cloud storage video of his device to B
Automatically upload	When the device triggers motion detection, if the device has cloud storage enabled, the device will automatically upload the activity video to the cloud
Recording Playback/download	If the activity video uploaded by the device to the cloud is still in the valid time, and the activity video can be downloaded to the local for long-term storage
Recording Storage	Users purchase cloud storage services and store videos in cloud storage space

Business Docking System Description

The Perfect Home business docking system operates on two levels:

1. **Background Management & Operations**: Used internally by support staff for managing devices and user activity. It enables **real-time status monitoring**, **equipment troubleshooting**, and **user hierarchy management**, ensuring operational transparency and efficient issue resolution.

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2. **Client Operations**: Focused on app-level interactions, it provides insights into user activity, device activation, and control operations. This structure facilitates performance analytics and helps optimize user engagement and service delivery (Wang et al., 2022).

Operational Functions

Background Operation:

The background operation system coordinates communication between devices and the management platform to support automation. This ensures optimal real-time operation of climate control, security, and energy efficiency systems without requiring user intervention. Such architectures are vital in IoT ecosystems, where uninterrupted background processes ensure stability and responsiveness (Ghaffarian et al., 2021).

Table 6: Background Operation Function list

User Management	Users can assign roles to control and manage the authority of the system
Resource Management	Resources are defined separately for each operation query page. Permissions are refined to menu pages and button dimensions. Different permission operations can be configured according to different roles.
Roles Management	According to different business permissions, a role can be collocated to perform regular addition, deletion, modification and query.
User Query	The account information can be inquired according to the email, mobile phone or user, and display the user name, mobile phone, email, country and customer number. Display of mailbox and phone number are encrypted. In addition, the user specific information, cloud storage subscription information, third-party binding information, binding device list, operation records and login and logout records also can be inquired.
Device Query	Device query is to query the device information according to the serial number, and display the device online status, last online time, device type, firmware version and registration area information.

Client Operation:

The client operation function empowers users through intuitive app controls and voice commands. It connects the user interface with system backends, ensuring real-time execution of lighting, HVAC, and security commands (Alhazmi et al., 2021). This function underlines the importance of usability and localization in smart home systems.

Table 7: Client Operation Function

User Management	The user management function provides customers with information about their own users. It includes searching users, viewing user details, displaying the total number of users, and commenting on users.
Device Management	Through the device management, the device information under the user can be inquired according to the username and the device serial number. This information includes the device serial number, model, device version, arm/disarm status, device online status, cloud storage status, and provide the device unbinding function. In the online status and cloud storage status of each device, there are more information can be viewed which are online/offline records and cloud storage activation records of the current device.
Revenue Management	Revenue management is to provide customers with specific information about cloud storage revenue. Among them, the total revenue page will show the total revenue and daily revenue, as well as the monthly revenue data of customers.
User Data	The user data function is mainly used to understand the overall user data of the customer's own products. Through this function, the customer can view the total number of users, the number of active users, the number of new users, the number of paid users and other data in a specified time period.
Device Data	The device data function is mainly used to understand the overall data of the devices under the customer's own products. Based on this function, the customer can view the number of online devices, active devices, cloud storage devices and other data in a specified period of time.
Revenue Data	The revenue data function is mainly to help customers understand their own revenue situation and provide customers with the overall sales revenue data and sales revenue details. Revenue data includes sales volume, growth on the same period, customer unit price and other data dimensions. Revenue detail data includes daily sales volume and corresponding amount of each package.

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Client Service Solutions
Perfect Home provides flexible development solutions for a diverse clientele, offering both no-code customization and advanced SDK integration.

Automation Customization Scheme
Customers can rapidly launch branded apps by submitting essential assets:

- App logo
- Theme colour
- Description
- Notifications & certificates

This approach aligns with rapid-deployment strategies in app ecosystems (Google Developers, 2022).

Client SDK Scheme
Advanced users may integrate the Perfect Home SDK for iOS, Android, or PC development. This enables deep customization, third-party integrations, and expanded functionality within existing digital ecosystems (Apple Developer, 2022).

Perfect Home Cloud Data Security System
Perfect Home employs a **lifecycle-oriented data security strategy** that encompasses:

- **Data Collection**
- **Storage**
- **Processing**
- **Transmission**
- **Sharing**
- **Deletion**

Security measures are embedded at each stage through policy and technical safeguards, ensuring confidentiality, integrity, and resilience (NIST, 2020).

Data Ownership
Perfect Home treats the customer as the data controller, ensuring full transparency over how data is collected and processed. The platform complies with privacy regulations and provides mechanisms for customers to control, access, and secure their data (GDPR, 2023).

Multi-copy Redundant Storage
Perfect Home uses a distributed architecture that deploys business servers across three physically separated data centers within the same city. This setup ensures high availability and fault tolerance, with real-time backup and at least two synchronous data replicas maintained at all times. This design approach is consistent with best practices in cloud computing for disaster recovery and system resilience (Google Cloud, 2023; AWS, 2023).

User/Device Data Security
Device-to-Cloud Interactions

- **AES-128 Encryption** secures data content.
- **Authentication** uses proprietary authorization algorithms for validating device access and commands.
- **Dynamic Key Distribution** ensures one-device-one-code for enhanced protection.
- **TLS 1.2 Protocol** ensures secure transmission channels.
- **Security Chipsets** on some devices safeguard hardware authorization and encryption credentials, aligning with modern IoT hardware security recommendations (NIST, 2020).

LAN Interactions

- Local data is encrypted with AES-128 and transmitted securely within LAN.

- **Dynamic keys** are distributed during the device's initial network setup to prevent interception.

Enterprise Data Security
Perfect Home ensures **data segregation** between enterprises and users through dedicated encryption, role-based access, and key management centers. Sensitive data is subject to **desensitization procedures** and encrypted using AES-128, in compliance with global data security standards (GDPR, 2023; ISO/IEC 27001, 2022).

Residual Data Protection
Once memory or disk resources are decommissioned, they are wiped with zero-value overwrites. Hardware components such as drives are demagnetized and physically destroyed prior to disposal, as recommended by global cloud service providers (Microsoft Azure, 2023).

Privacy Protection
The Fluorite Cloud platform implements the business philosophy of "all relying on user value", with particular emphasis on establishing long-lasting and trusting relationships with customers. Fluorite uses a solid technical foundation and a complete operation management mechanism to ensure that user and customer data are fully guaranteed. Fluorite Cloud will strictly implement the "Privacy Policy" publicly released by Fluorite to effectively protect user privacy.

Laws and regulations give users rights related to their personal information (GDPR) **:**

1. The right to know: The user has the right to know the purpose, basis, source, processing process, rights and other information of the data processing.
2. Right of access: The user has the right to obtain and confirm personal information related to it.
3. Right to correct: The user has the right to correct and improve the personal information related to it.
4. Right to delete (right to be forgotten): The user has the right to request the deletion of personal information related to it.
5. Restriction of processing rights: Users have the right to restrict the processing of their personal information.
6. Portability: Users have the right to receive all personal information related to them in a structured, universal and machine-readable format.
7. Right of refusal: Users have the right to refuse the processing of their personal information for direct marketing purposes.
8. Self-determination: The user has the right not to be bound by decisions based on automatic processing.

These user rights are critical for ethical smart home data governance (GDPR, 2023).

Ensure that the user 's legal rights correspond to the product functions one by one.

Table 7: legal rights correspond

#	Right	Description
1	Right to know	When obtaining user data, it is necessary to inform the user of the data collected and obtain the user's explicit authorization (service agreement, privacy policy, permission description at the time of registration to remind users to read and authorize, and our agreement after changes Remind users to read and authorize again. Strongly remind users to collect data and obtain authorization when value-added services require additional data.)
2	Access	Users can query their relevant data, whether through products or after-sales.
3	Right to correct	The user can modify all user-related data including mobile phone number and mailbox. (Including but not limited to, identity information, address, avatar, nickname)

4	Right to delete (right to be forgotten)	Must realize the function of "logging out account" and deleting data
5	Restricted processing rights	Users can choose their own personal data usage scenarios
6	Portability	Provide users with access to all their relevant data on the platform, whether it is obtained through APP self-service, or through customer service and technical support.
7	Right to refuse	The user has the right to refuse to provide and refuse the authorized use of information that is not necessary to provide user services, such as personalized advertisements based on the promotion of personal information.
8	Discretion	All locations that require user confirmation and authorization cannot be checked by default and must be actively confirmed by the user.

Data classification: Distinguish between personal data and platform information data, and classify personal data using sensitivity and confidentiality.

Data Storage Area

- Five data centers: Chinese computer room, North American computer room, South American computer room, and European computer room, Singapore computer room (the physical isolation between the data centers does not intercommunicate). According to the user's location to provide corresponding data services.
- China: The data is stored in the IDC computer room of Hangzhou Telecom in China, and basic cloud computing support is provided by fluorite.
- North America: The data is stored in northern Virginia of the United States, and Amazon AWS provides basic cloud computing support.
- EU countries: The data is stored in the Irish computer room, and Amazon AWS provides basic cloud computing support.
- Singapore: The data is stored in the Singapore computer room, and basic cloud computing support is provided by Aliyun.
- Other countries: Choose computer room storage according to the principle of proximity, and more regional computer rooms will be gradually opened in the future. Currently, computer rooms in many regions are under construction.

User-Friendly Interface: Perfect Home enhances the user experience with an intuitive platform that simplifies control and navigation. The interface is designed to be accessible, offering seamless operation for both tech-savvy users and beginners. It includes localized support in Arabic, making it especially user-friendly for Saudi households. This customization ensures that users can interact with the system comfortably and efficiently, leveraging voice commands and mobile app features tailored to their language and preferences.

Registration and login: Perfect Home supports two registration methods: phone number and email address, which can be switched by clicking the button on the right side of the input box.

Both phone number registration and email address registration require verification code. The password length CANNOT be less than 8 characters and MUST contain letters, numbers and specific characters. At present for phone number registration, Perfect Home ONLY supports registration with phone numbers in Saudi Arabia (+966).

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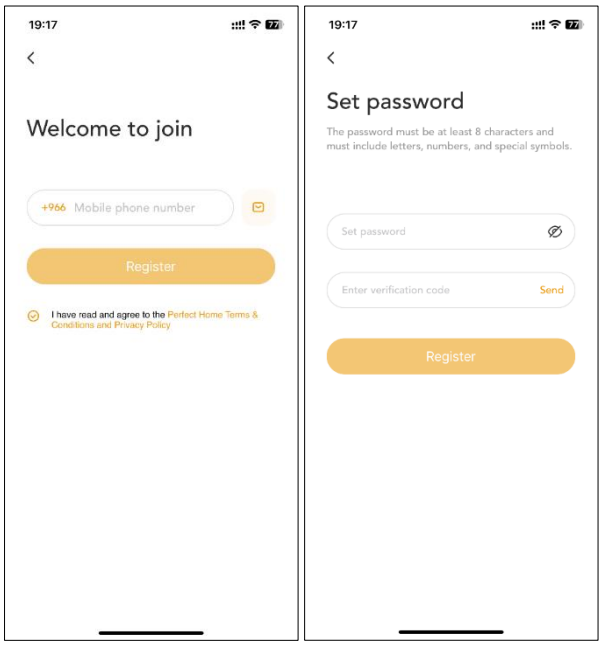

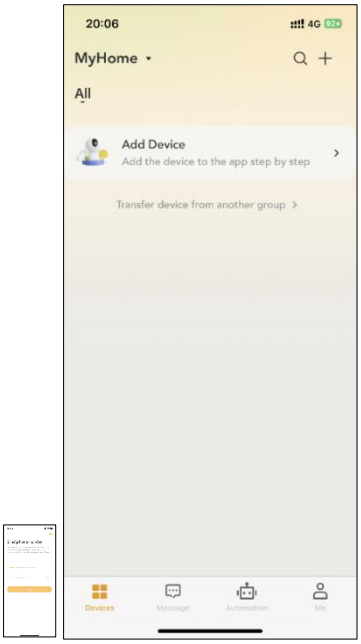

Whether you choose to register with a phone number or an email address, you can bind another form of account, and after successful binding, you can log in with either account. If you choose to skip the binding step, you can directly jump to the homepage. And you can also perform binding operation separately in the system settings in the future.

Login: You can log in using a successfully registered account. Perfect Home defaults to enabling terminal binding. If you log in on a phone that you have never logged in to before, you will need to perform a verification code check. By default, up to 5 different terminals can log in to the same account.

The end user login token is valid for 30 days. If a login has not been more than 30 days since the last login, the app can use the last login token to log in directly without entering an account and password. Otherwise, end user will need to re-enter account and password. Each successful login will refresh the validity period of the token.

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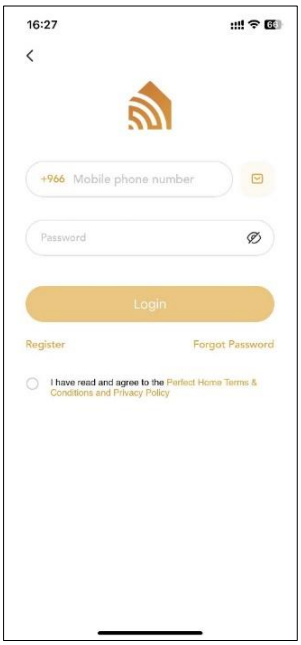

Family and group (room): When the end user registers a new account, the system will default to creating a family "MyHome" and a group "All" for the end user. The default family name and group name are both editable in family setting.

Family and group management: Perfect Home supports creating families and editing groups.

On the family settings page, end users can view or edit the family name, invite other registered users to join the family, view the number of devices under each group, add groups, and transfer devices from another family.

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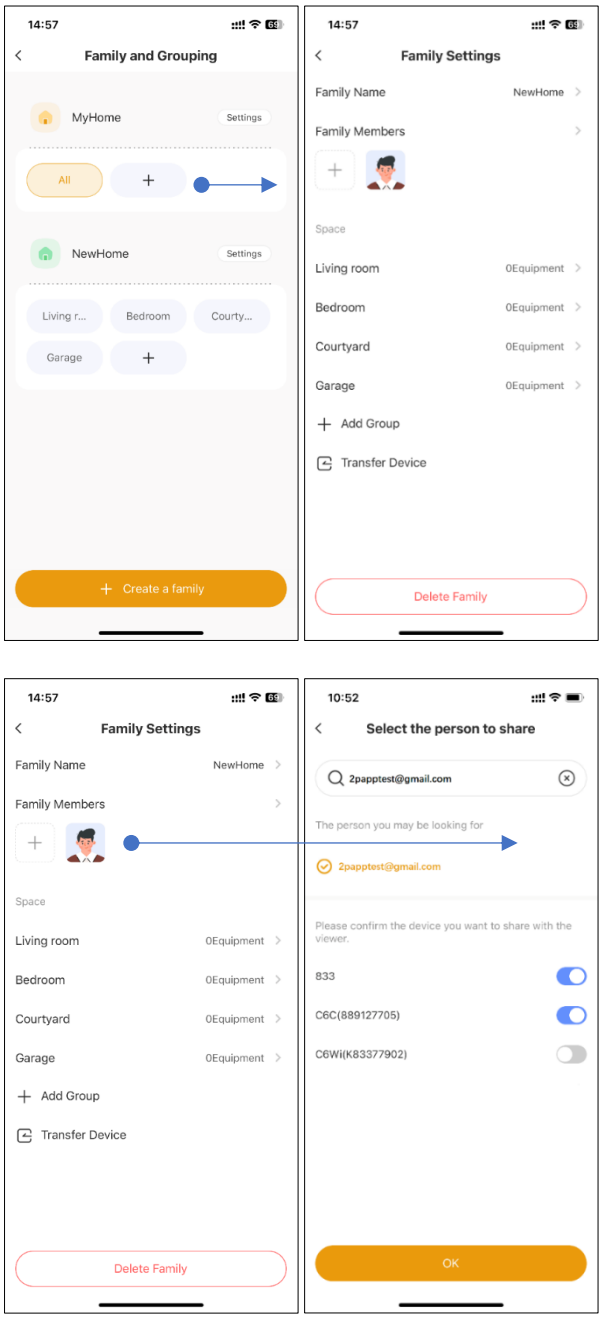

The family owner can invite other registered users to join the family.

When the owner of family A invites registered end user B to his family. The owner of family A can choose the devices that B can use. B can control the device normally and receive alarm messages from the device, except that B CANNOT delete the shared device. When B's permission to the shared device is removed, or when B is removed from family A, or when B voluntarily exits the family A, B no longer has control over the shared device and can only view past messages during the sharing period.

A single account can support creating up to 8 families and can be invited to join up to 8 families. A single family can support up to 15 groups, and a single family can support up to 30 family members.

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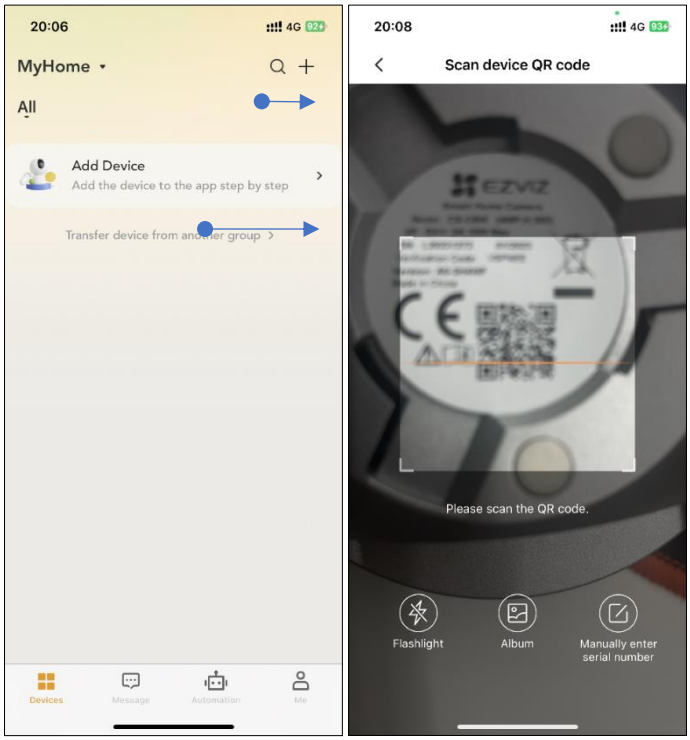
Add device: End user can quickly add device by scanning the QR code on the device packaging. At present, the device network configuration is mainly operated through AP mode.



Message: The message module mainly includes two types of messages, device message and notification. Device message are mainly messages generated by devices, such as motion detection message from cameras. The notifications mainly includes messages related to family sharing, such as user A invites user B to join the family. User B will receive the invitation message, and the invitation message will be displayed in the notification list. Perfect Home supports filtering messages by date and type, and allows for batch deletion of messages. The validity period for both messages and notifications is 7 days.

Automation: Automation module supports both manual and automatic modes. Manual mode requires users to manually click the execution button on the smart card to trigger linkage operations. In automatic mode, the app will automatically detect triggering conditions and execute linkage operations.

Perfect Home provides three smart templates by default: sleep mode, away mode, and home mode.

The homepage of Automation will display the intelligent scenes that have been created and support viewing the execution records of the scenes. The execution records of the scene can be saved for a maximum of 7 days.

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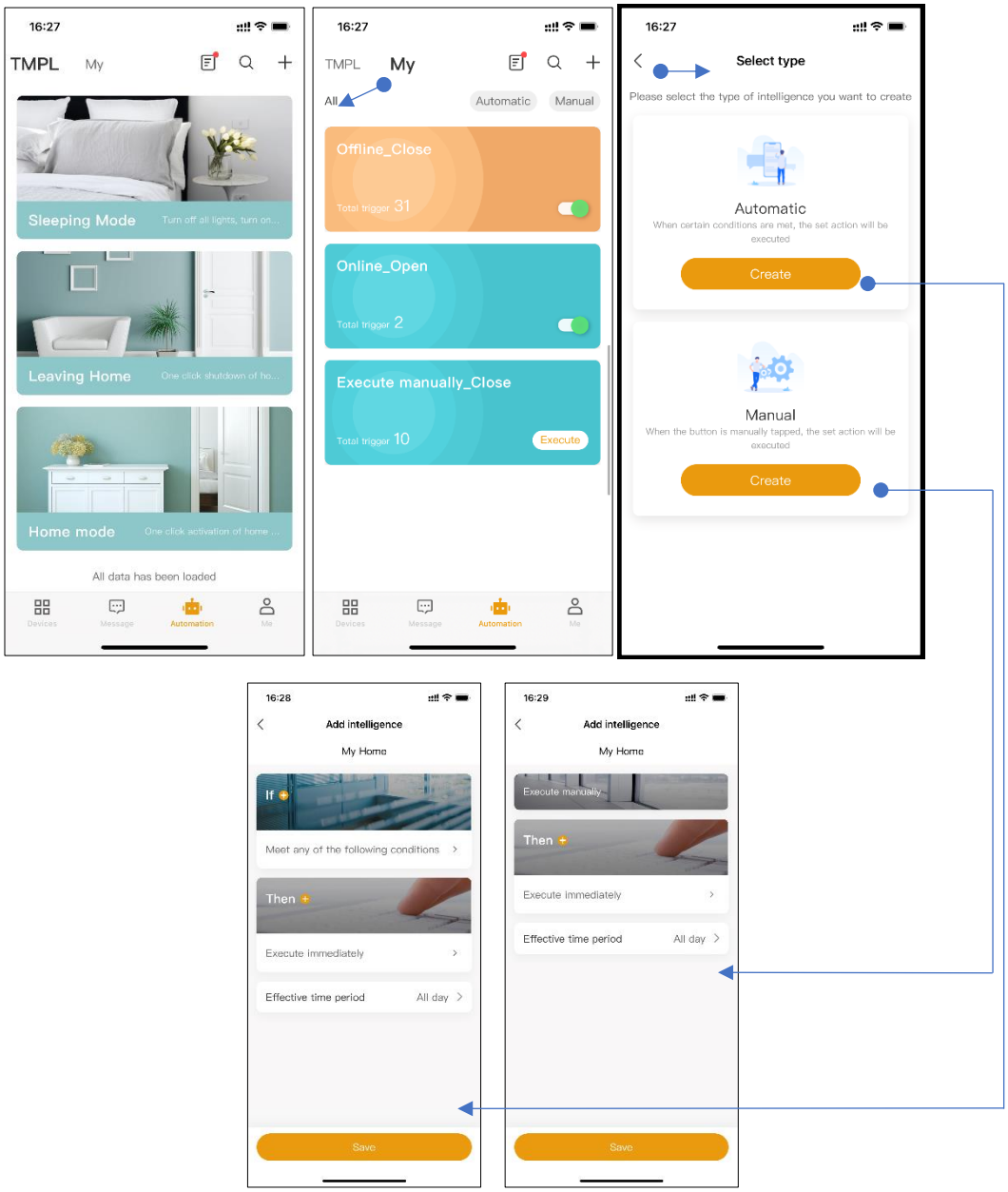

Me: In the Me module, end user can update personal information, adjust App system permissions, change password, bind phone number or email address, change terminal binding settings and log out or deactivate account.

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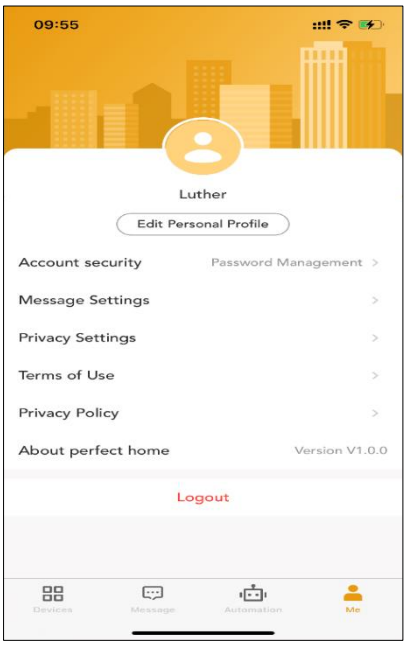
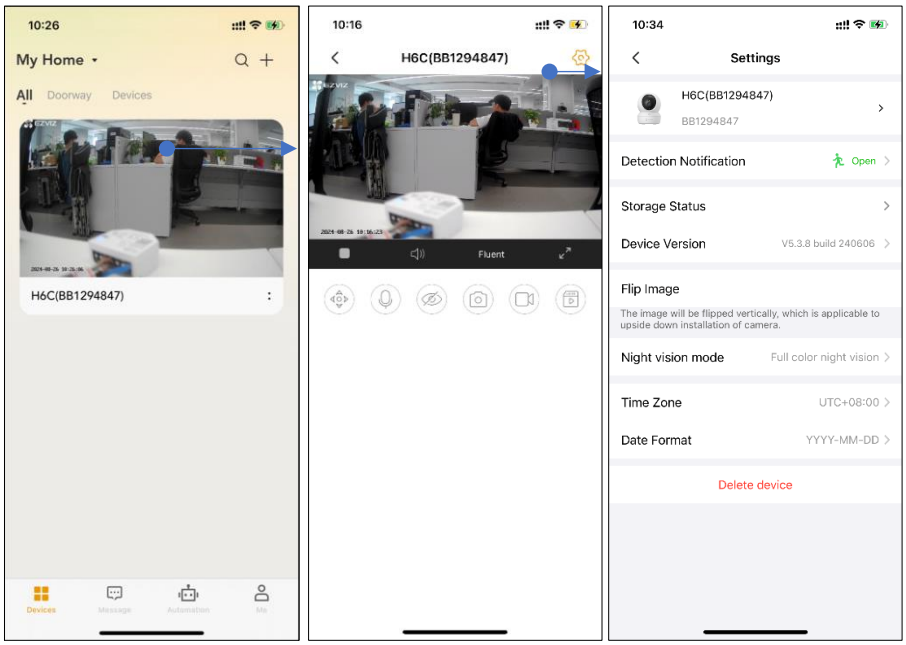


Camera Device Function Description: Users can enter the real-time preview page of the camera device by clicking on the device tag in the device list. Camera device will enable video encryption by default, and the first preview requires entering the device's verification code to complete the verification.



Function description:

Table 8: functions and Interaction Features.

	Function	Function description
	Start/Stop live view	View the real-time video stream of the camera
	Mute/Unmute	Turn on/off the sound in the video stream

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Fluent	Change resolution	Usually, camera has two types of video streams: fluent and high-definition
	Full screen	Make the current preview screen full screen.
	PTZ control	Pan/Tilt/Zoom control of the camera
	Two-way voice talk	Initiate real-time intercom operation with camera.
	Privacy mode switch	Turn on/off the privacy mode of the camera. In privacy mode, the camera lens will be obscured. This feature depends on camera capability.
	Take screen shot	Take a screenshot of the current preview screen. The screenshot will be saved in the phone album.
	Start/Stop video recording	Start/Stop video recording. The recorded video will be saved in the phone album.
	SD card video playback	View video files stored on the device's SD card.

For scenarios involving heavy data transmission, such as live view and SD card video playback functions, cameras supporting both P2P and Relay transmission methods. In P2P mode, the device will directly transmit the streaming data to the mobile app without the need for relay services for forwarding. When the P2P link fails to establish, the camera will first push the data stream to the Relay service, which will then forward it to the mobile app. Perfect Home camera supports up to 4 streams of data (including preview and SD card video playback) simultaneously, and up to 1 intercom simultaneously.

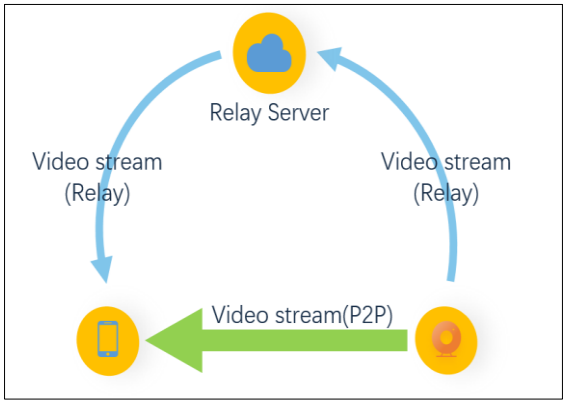

Fig (4): Video Streaming Flow for Camera and Mobile Device

If multiple apps simultaneously initiate live view, SD card video playback, and intercom operations on a camera, the app will receive an error message returned by the camera when it exceeds the camera's streaming capacity limit.

WIFI Relay (T35W, T35WM, T36WM)

Taking the Perfect Home functions, as an example here. T36WM relay supports dual channel mode and independent control by channel. Perfect Home supports viewing basic

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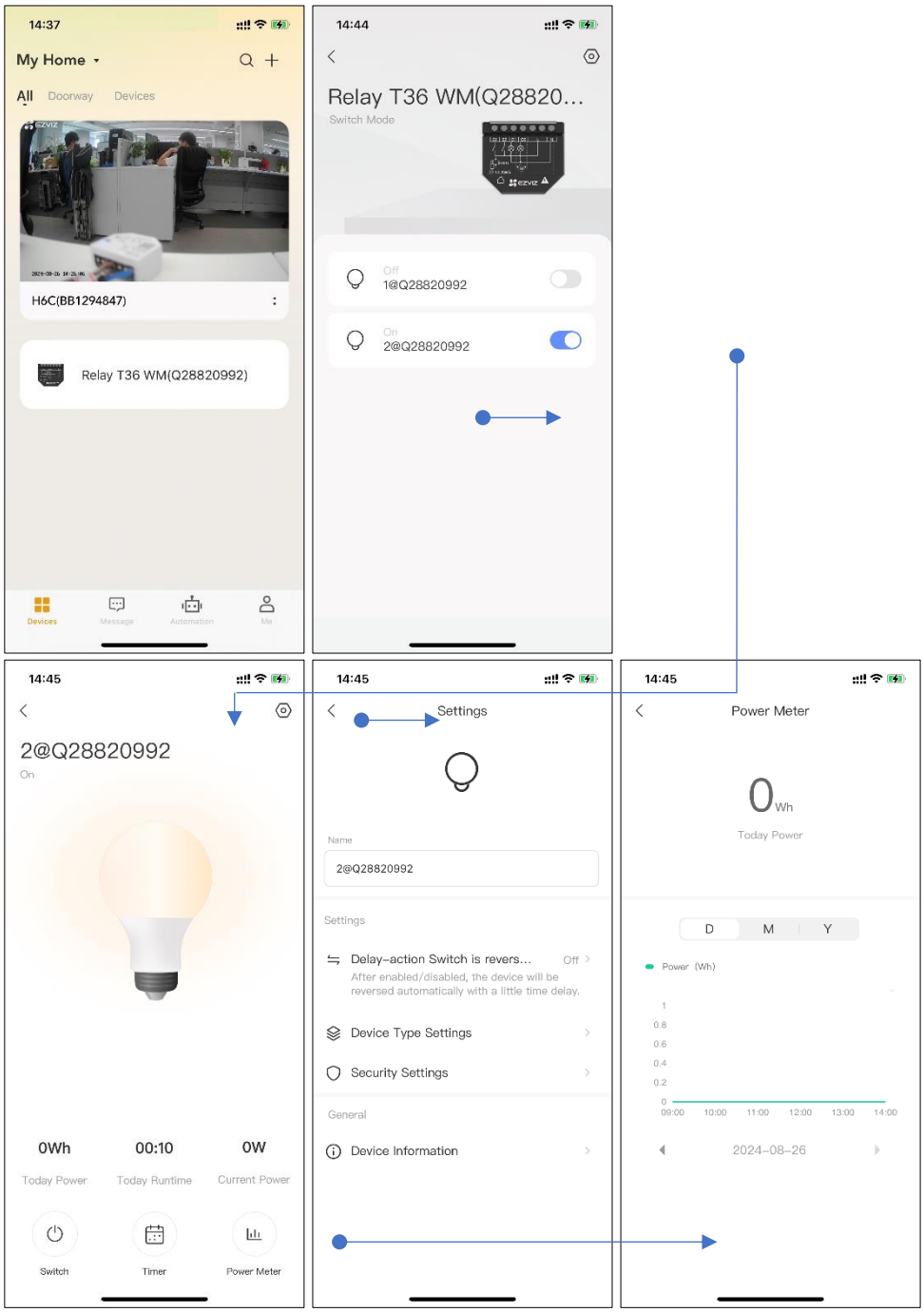
information of channels, setting switch modes for channels, view the operation records of the channel, and setting voltage, current, and power alarms for channels. On the channel details page, it supports on/off control of channels, setting time schedules, and viewing power consumption.

Operation records will be saved for **30** days.



Conclusion

Perfect Home is uniquely positioned to lead the smart home transformation in Saudi Arabia. Its localization, energy-saving features, security framework, and cloud-based intelligence align with Saudi Vision 2030. By integrating climate control, security, multimedia, and family-centric management, Perfect Home offers a comprehensive and sustainable path toward connected living in the Kingdom.

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Conflicts of Interest
The authors declare no conflict of interest.

References
Ahmed, R., & Khan, M. (2021). AI-integrated security in smart homes: A privacy-first approach. *Journal of Smart Technology*, 6(1), 14–29.
Al-Ali, A., Zualkernan, I., & Rashid, M. (2017). A smart home energy management system using IoT and big data analytics. *IEEE Access*, 5, 7555–7566.
Al-Dossary, H. (2022). Energy-efficient technologies and consumer behavior in Saudi smart homes. *Middle East Journal of Energy Research*, 13(2), 102–115.
Al-Dossary, H. (2022). Energy-efficient technologies and consumer behavior in Saudi smart homes. *Middle East Journal of Energy Research*, 13(2), 102–115.
Alharbi, F., Alshammari, T., & Al-Ghamdi, A. (2020). Factors influencing smart home adoption in Saudi Arabia. *International Journal of Computer Applications*, 177(38), 21–27.
Alharbi, F., Alshammari, T., & Al-Ghamdi, A. (2020). Smart home system adoption in Saudi Arabia: Impact of Vision 2030. *International Journal of Computer Applications*, 177(38), 21–27.
Alhazmi, N., Almutairi, H., & Bajaber, F. (2021). Cultural considerations in smart home interface design for Arabic users. *International Journal of Human–Computer Interaction*, 37(6), 541–555.
Alshahrani, S., & Ward, R. (2020). The impact of Saudi Vision 2030 on digital transformation. *International Journal of Government & Development*, 36(4), 341–355.
Apple Developer. (2022). *iOS SDK overview*. Retrieved from https://developer.apple.com
AWS. (2023). *AWS data security best practices*. Retrieved from https://aws.amazon.com
AWS. (2023). *Best practices for storing video in the cloud*. Amazon Web Services. https://aws.amazon.com
Chen, L., & Zhao, Y. (2022). Optimizing CRUD performance in hybrid relational and NoSQL databases. *Journal of Database Systems*, 19(1), 25–38.
GDPR. (2023). *General Data Protection Regulation compliance framework*. Retrieved from https://gdpr-info.eu
General Authority for Statistics, "Household Security Trends in Saudi Arabia," 2021.
Ghaffarian, S., Hashemipour, M., & Pakdelazar, R. (2021). Integration of AI with IoT in smart homes. *Journal of Intelligent Systems*, 30(2), 225–239.
Google Cloud. (2023). *Best practices for multi-region Kubernetes networking*. Retrieved from https://cloud.google.com
Google Cloud. (2023). *Cloud storage for IoT and video*. Retrieved from https://cloud.google.com
Google Cloud. (2023). *Secure architecture for distributed cloud storage*. Retrieved from https://cloud.google.com
Google Developers. (2022). *Rapid deployment of Android apps with branded customization*. Retrieved from https://developer.android.com
IDC, "Worldwide Internet of Things 2013–2020 Forecast: Billions of Things, Trillions of Dollars," Doc #243661, Oct. 2013.
IEA. (2020). *Energy consumption in the Middle East: Trends and policies*. International Energy Agency.
ISO/IEC 27001. (2022). *Information security management systems*. International Organization for Standardization.

J. Smith and Y. Zhang, "Smart Home Technology and IoT: Adoption and Cultural Impacts in the Middle East," *J. Emerg. Technol. Appl.*, vol. 15, no. 4, pp. 112–127, 2023.
KAPSARC, "Energy Efficiency Policy in the Built Environment: From Formulation to Implementation," King Abdullah Petroleum Studies and Research Center, 2023. [Online]. Available: https://www.kapsarc.org/wp-content/uploads/2023/12/KS-2023-WB04-Energy-efficiency-Policy-in-The-Built-Environment-From-Formulation-to-Implementation.pdf
Kingdom of Saudi Arabia. (2016). *Vision 2030*. Retrieved from https://www.vision2030.gov.sa
Kubernetes. (2021). *Role-Based Access Control (RBAC)*. Retrieved from https://kubernetes.io/docs/reference/access-authn-authz/rbac/
Lee, H., & Kim, J. (2021). User-centered design for multimedia services in smart homes. *Multimedia Tools and Applications*, 80(12), 17921–17942.
Lee, S., Chang, Y., & Park, J. (2020). Privacy and security in smart home environments: A user-centered perspective. *Journal of Cybersecurity*, 9(1), 1–12.
Li, W., Tang, Q., & Xu, J. (2021). Middleware architecture for IoT-based cloud computing. *IEEE Transactions on Cloud Computing*, 9(3), 565–576.
M. H. Alharbi *et al.*, "Factors Influencing Smart Home Adoption in Saudi Arabia," *Saudi J. Technol. Innov.*, vol. 2, no. 1, 2020.
Microsoft Azure. (2023). *End-of-life data protection policy*. Retrieved from https://azure.microsoft.com
NIST. (2020). *Data lifecycle and security control standards*. U.S. Department of Commerce. https://nvlpubs.nist.gov
NIST. (2020). *Guidelines on security and privacy in public cloud computing*. U.S. Department of Commerce.
NIST. (2020). *Security recommendations for cryptographic key management*. U.S. Department of Commerce.
OWASP. (2023). *SQL Injection Prevention Cheat Sheet*. Retrieved from https://owasp.org
R. Al-Dossary, "Energy Efficiency in IoT-based Smart Home Systems," *Int. J. Energy Manag.*, vol. 9, no. 3, pp. 45–60, 2022.
Red Hat. (2022). *Network security best practices for Kubernetes environments*. Retrieved from https://www.redhat.com
SABIC. (2022). *Energy efficiency in residential buildings: A Saudi Arabian perspective*. Riyadh: SABIC Publications.
Saudi Electricity Company (SEC). (2023). *Annual Energy Efficiency Report*. Riyadh.
Smith, J., & Zhang, L. (2021). Global smart home market trends and adoption patterns. *Journal of Emerging Technologies*, 15(3), 105–117.
Statista. (2023). *Smart home - Saudi Arabia*. Retrieved from https://www.statista.com
STC. (2021). *Saudi smart home user experience study*. Riyadh: Saudi Telecom Company.
Wang, M., Zhang, T., & Lin, Y. (2022). Backend architecture for cloud-integrated smart home platforms. *Journal of Software Systems*, 45(2), 211–225.
Wang, Y., Liu, X., & Wang, Z. (2020). High-performance RPC design in distributed systems. *Software Practice and Experience*, 50(2), 200–213.
Zhou, F., Liu, Y., & Chen, W. (2020). Intelligent automation in smart homes: A review. *Journal of Ambient Intelligence and Humanized Computing*, 11(7), 2873–2887.