Hamdard University
Department of Computing
Final Year Project

INTELLIGENT HOME ENERGY MANAGEMENT SYSTEM WITH POWER CONSUMPTION
FYP-021/FL24
Software Requirements Specifications

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Definition of Terms, Acronyms, and Abbreviations

[This section should provide the definitions of all terms, acronyms, and abbreviations required to interpret the terms used in the document properly.]

Term	Description

Table of Contents

1. Introduction

1.1 Purpose of Document

The purpose of this Software Requirement Specification (SRS) is to outline the functional, non-functional, and system requirements for the Intelligent Home Energy Management System (IHEMS). The system aims to assist homeowners in monitoring and optimizing their energy consumption to reduce electricity bills and improve efficiency.

1.2 Intended Audience

This document is intended for:

- Project stakeholders and sponsors

- Development team

- Quality assurance team

- End users of the system

1.3 Abbreviations

- IHEMS: Intelligent Home Energy Management System

- AI: Artificial Intelligence

- UI: User Interface

- IoT: Internet of Things

2. Overall System Description

2.1 Project Background

2.2 Problem Statement

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2.1 Project Background

The Intelligent Home Energy Management System integrates green energy monitoring and AI-driven analytics to help homeowners optimize energy consumption and reduce electricity bills.

2.2 Problem Statement

Homeowners struggle to manage energy usage effectively, leading to higher bills and grid strain. Existing systems lack real-time monitoring and proactive alerts.

2.3 Project Scope

The IHEMS project will involve the design and development of a smart energy management system that integrates devices and sensors to monitor and control energy usage. It will feature:

- Real-time energy monitoring.
- Alerts and recommendations for optimal energy use.
- Predictive analytics powered by AI to anticipate future consumption.
- A user-friendly mobile application for customization and monitoring.

This system will include research, design, implementation, testing, and documentation, with a functional prototype as a deliverable.

2.4 Not In Scope

- Integration with commercial energy providers
- Support for industrial energy management

2.5   Project Objectives

- **Energy Monitoring and Management:** Design a system to monitor household electricity usage and provide actionable recommendations to improve efficiency.

- **Smart Energy Management Alerts:** Notify users when energy consumption exceeds predefined thresholds and recommend corrective actions, including switching to alternative energy sources such as solar or generators.

- **Predictive Energy Analytics:** Leverage AI to predict future energy consumption based on historical usage patterns, weather data, and solar generation.

- **User-Friendly Interface:** Develop a customizable and intuitive interface for Android and iOS platforms.

2.6   Stake holders & Affected Groups

- Homeowners
- Development and QA teams
- Supervisors: Dr. Umer Farooq and Dr. Rashid Hussain

2.7   Operating Environment

- Hardware: IoT-enabled smart appliances, energy meters, and a central control hub.
- Software: Mobile app (iOS/Android), and web-based dashboard.
- Network: Wi-Fi communication.

2.8   System Constraints

- **Hardware:**
  - Sensors and devices like meters, solar panels, and microcontrollers will be used.
- **Software:**
  - A hybrid development methodology combining Agile and Waterfall will be employed.
  - The system shall be compatible with modern operating systems.

2.9   Assumptions & Dependencies

- Stable internet connectivity is assumed for system operation.
- Availability of solar panels or alternative energy sources in households.
- Historical energy data is required for AI-based predictions.

3 External Interface Requirements

3.1   Hardware Interfaces

- Sensors: Temperature, energy meters
- Controllers: Arduino, IoT devices
- Smart energy meters and IoT-enabled appliances with communication protocols (e.g., Zigbee, Wi-Fi).

3.2   Software Interfaces

- A responsive web and mobile application with dashboards, charts, and control panels.
- User-friendly navigation and interactive widgets for appliance control.
- Database: MS SQL
- Development tools: Visual Studio Code, Python, JavaScript, TensorFlow

3.3   Communications Interfaces

- Wi-Fi for device connectivity
- Cloud integration for data storage and analysis
- Secure communication via HTTPS and MQTT protocols.

4 System Functions / Functional Requirements

4.1   System Functions

• **Monitoring:**

%.1   The system shall monitor and log energy consumption in real-time.

%.2   It shall visualize energy usage through graphical representations.

• **Alerts:**

%.1   Alerts shall be generated when consumption crosses 170, 180, and 190 units.

%.2   Notifications shall include actionable energy-saving recommendations.

• **Prediction:**

%.1   Predictive models shall forecast future energy consumption.

%.2   External data sources, such as weather, shall enhance predictions.

• **User Interface:**

%.1   The system shall provide a customizable and user-friendly interface.

%.2   The app shall support Android and iOS platforms.

Ref #	Functions	Category	Attribute	Details & Boundary Constraints
R1.1	Monitor real-time energy consumption	Evident	System Response Time	Updates within 2 seconds
R1.2	Provide energy optimization alerts	Evident	Alert Timeliness	Alerts issued within 1 second of threshold breach
R1.3	Predict future energy consumption	Hidden	AI Prediction Accuracy	90% accuracy based on historical and weather data
R1.4	Switch automatically between energy sources	Evident	System Adaptability	Switch occurs within 3 seconds of condition met
R1.5	Customize user preferences	Evident	User Interface Responsiveness	Settings updated within 1 second

System Attributes/ Nonfunctional Requirements

1. **Performance:**

   o The system shall handle real-time monitoring with low latency.
   o Predictive models shall respond within acceptable time limits.

2. **Reliability:**

   o Alerts must be delivered promptly and accurately.
   o The system shall be operational with minimal downtime.

3. **Usability:**

   o Interfaces shall adhere to accessibility standards.
   o The app shall require minimal user training.

4. **Scalability:**
   o The system shall support integration with additional smart devices.

Attribute	Details and Boundary Constraints	Category
Attribute	Details and Boundary Constraints	Category
Response Time	Updates must appear within 2 seconds of data collection	Optional
Concurrent User Load	Around 20 users can access the system simultaneously	Mandatory
Scalability	Supports integration with up to 50 smart devices	Mandatory
Data Encryption	All data must be encrypted using AES-256 standard	Mandatory
UI Responsiveness	UI changes should take no more than 1 second to reflect	Optional

4.2   Use Cases

4.2.1 List of Actors

- Homeowner

- System Admin

4.2.2 List of Use Cases

1. **User Registration and Login:**
   - Allow new users to register and existing users to log in.

2. **User Registration**
   - Enables new users to sign up by filling out required details.

3. **Select City and Meter Type:**
   - Allow users to specify their city and the type of meter (industrial or residential).

4. **Manage Tariff Settings:**
   - Configure tariffs by including base tariff, fuel adjustment price, and general sales tax.

5. **Add Room Details:**
   - Allow users to specify the number of rooms and appliances in each room.
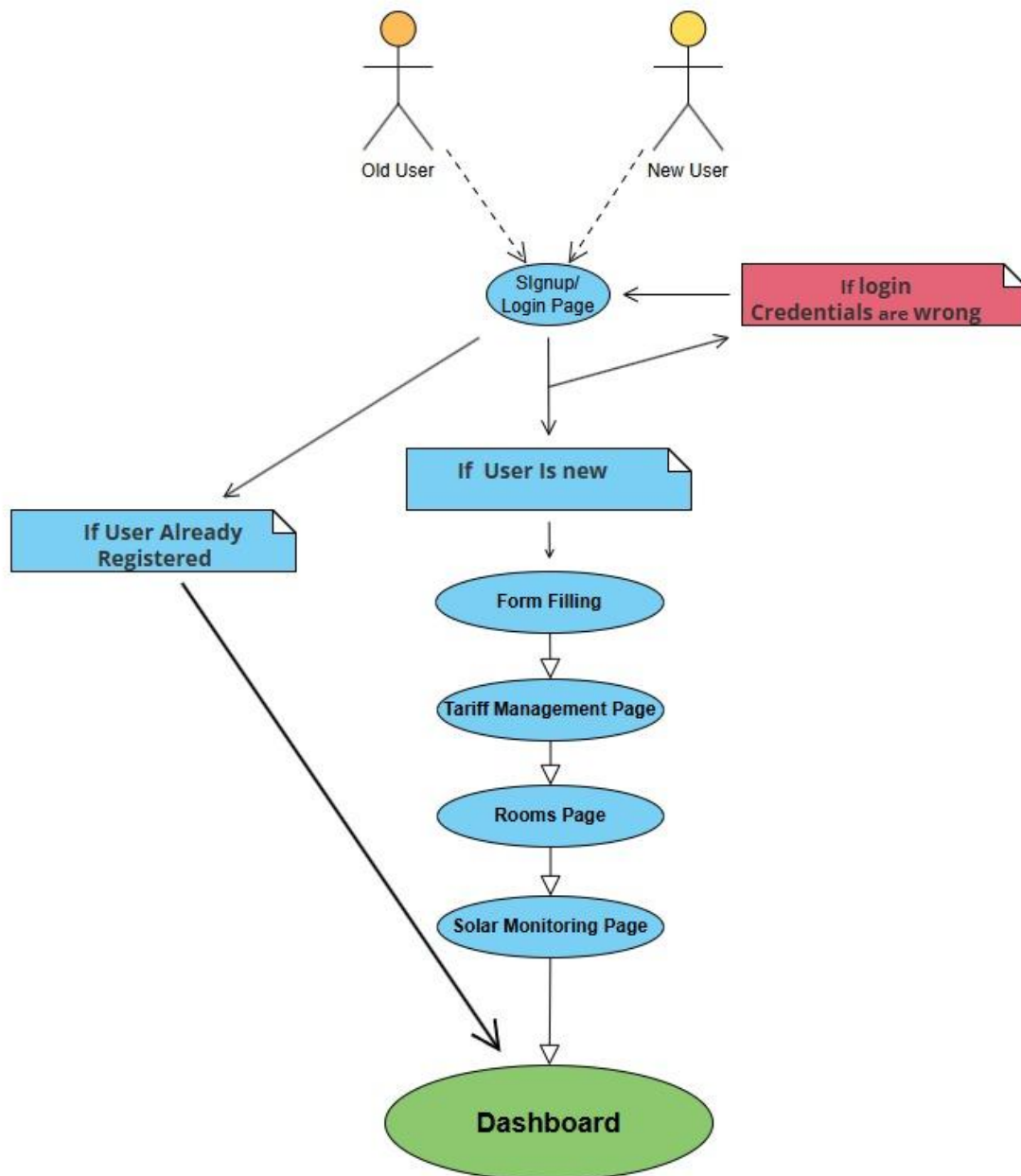
6. **Solar Energy Monitoring:**
   - Display live solar energy sensor readings and future generation predictions.

7. **View Dashboard:**
   - Provide a detailed overview of current energy usage, predictions for future consumption, and trends.
   - Displays an error message and prevents access when login credentials are invalid.

4.2.3 Use Case Diagram

4.2.4 Description of Use Cases

Use Case 1: User Login

Name	User Login
Actors	Old User, New User
Purpose	Allow users to access the system using valid credentials.
Description	Users enter their credentials on the login page. If valid, they are redirected to the dashboard. If invalid, they receive an error message prompting them to retry.
Cross References	Credential validation, Dashboard access.
Pre-Conditions	User must have an account.
Successful Post-Conditions	User is redirected to the dashboard.
Failure Post- Conditions	Error message is displayed, and the user remains on the login page.

Use Case 2: User Registration

Name	User Registration
Actors	New User
Purpose	Register new users into the system by gathering required information.
Description	New users provide their details via a form to create an account. This data is validated and stored in the database.
Cross References	Form Filling, Database update.
Pre-Conditions	User is not already registered.
Successful Post-Conditions	User is registered and proceeds to the next step (Tariff Management).
Failure Post- Conditions	Registration fails with an error message (e.g., invalid input or system error).

Use Case 3: Form Filling

Name	Form Filling
Actors	New User
Purpose	Collect necessary details from the user during registration.
Description	The system presents a form to the user to gather required details, such as personal information and preferences.
Cross References	User Registration, Database validation.
Pre-Conditions	User initiated the registration process.

Successful Post-Conditions	User details are saved, and the system redirects to the next step (Tariff Management).
Failure Post- Conditions	User is prompted to re-enter or correct invalid details.

Use Case 4: Tariff Management

Name	Tariff Management
Actors	Old User, New User
Purpose	Allow users to manage their energy tariff preferences.
Description	Users select or configure their preferred energy tariff plans.
Cross References	Dashboard, Solar Monitoring.
Pre-Conditions	User completed the form filling process.
Successful Post-Conditions	Tariff details are saved, and the system proceeds to the Rooms Page.
Failure Post- Conditions	Error message displayed; user retries tariff configuration.

Use Case 5: Room Configuration

Name	Room Configuration
Actors	Old User, New User
Purpose	Enable users to configure their rooms for energy usage tracking.
Description	Users define the setup and preferences for energy management in individual rooms.
Cross References	Solar Monitoring, Dashboard.
Pre-Conditions	User completed the form filling process.
Successful Post-Conditions	Room configuration details are saved, and the system proceeds to the Solar Monitoring page.
Failure Post- Conditions	Error message displayed; user retries configuration.

Use Case 6: Solar Monitoring Setup

Name	Solar Monitoring Setup
Actors	Old User, New User
Purpose	Allow users to integrate and monitor solar energy usage.
Description	Users configure solar monitoring preferences and view solar energy statistics.
Cross References	Dashboard, Room Configuration.

Pre-Conditions	User completed room configuration.
Successful Post-Conditions	Solar monitoring preferences are saved, and the user is redirected to the dashboard.
Failure Post- Conditions	Error message displayed; user retries configuration.

Use Case 7: Dashboard Access

Name	Dashboard Access
Actors	Old User, New User
Purpose	Provide users with a central interface for managing energy systems.
Description	The dashboard displays energy statistics, solar monitoring, tariff details, and room configurations. Users can navigate to various sections from here.
Cross References	Login, Tariff Management, Solar Monitoring.
Pre-Conditions	User has successfully logged in or completed the registration process.
Successful Post-Conditions	User can view and manage system details via the dashboard.
Failure Post- Conditions	N/A (Dashboard is accessible only after meeting pre-conditions).

Typical Course Event:

Actor Action	System Response
The user enters login credentials.	The system validates the credentials.
The user clicks the "Login" button.	If valid, the system redirects the user to the dashboard. If invalid, an error message is displayed.

Actor Action	System Response
The user navigates to the "Signup" page.	The system displays a form for user details.
The user fills out the registration form.	The system validates the input data.
The user clicks the "Register" button.	If valid, the system creates a new account and redirects to the next step (Form Filling). If invalid, an error message is displayed.
The user fills out personal and required details.	The system validates the form data.
The user clicks the "Submit" button.	If valid, the system saves the details and proceeds to the Tariff Management page. If invalid, the system prompts the user to correct the errors.
The user selects or configures a tariff plan.	The system validates the selected plan.
The user clicks the "Save" button.	If valid, the system saves the preferences and redirects to the Rooms Page. If invalid, an error message is displayed.
The user configures rooms for energy usage tracking.	The system collects and validates the configuration data.

Actor Action	System Response
The user clicks the "Save" button.	If valid, the system saves the room configurations and redirects to the Solar Monitoring page. If invalid, an error message is displayed.
The user configures solar monitoring settings.	The system validates the settings and prepares the monitoring dashboard.
The user clicks the "Save" button.	If valid, the system saves the settings and redirects the user to the dashboard. If invalid, an error message is displayed.
The user logs in or completes registration.	The system displays the dashboard interface.
The user navigates through the dashboard.	The system provides access to energy statistics, tariff details, and solar monitoring configurations

5 Non - Functional Requirements

5.1   Performance Requirements

5.2   Safety Requirements

5.3   Security Requirements

5.4   Reliability Requirements

5.5   Usability Requirements

5.6   Supportability Requirements

5.7   User Documentation

5.1   Performance Requirements

- The system must process real-time data with a delay of less than 2 seconds.
- The system shall handle real-time monitoring with low latency.
- Predictive models shall respond within acceptable time limits.

5.2   Safety Requirements

- Ensure no data breaches or unauthorized access to user data.

5.3   Security Requirements

- Encrypt all sensitive data.

5.4   Reliability Requirements

- Alerts must be delivered promptly and accurately.
- The system shall be operational with minimal downtime.

5.5   Usability Requirements

- Interfaces shall adhere to accessibility standards.
- The app shall require minimal user training.

5.6   Supportability Requirements
- Ensure system updates can be deployed seamlessly.

5.7   User Documentation

- Comprehensive user manual and training materials.

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