4.2 TODO Design Process

This section documents the Low-Level Requirements (LLRs) derived from the system's high-level requirements.

1. Menu, Manual, Keyboard (REQ1–REQ3)

LLR1 – On system startup, the main MSH menu shall be displayed automatically without requiring any user input. (REQ1)
LLR2 – The main menu shall include at least the following options: Get Home Status, Add Device, Remove Device, Power On Device, Power Off Device, Change Mode, Change State, Manual, About, and Exit. (REQ1)
LLR3 – After completing any operation, the system shall redisplay the main menu to the user. (REQ1, REQ3)

LLR4 – The MSH shall provide a "Manual" option (key 8) that displays a page explaining how to use the menu options and system modes. (REQ2, REQ3)
LLR5 – The MSH shall provide an "About" option (key 9) that displays system and project information. (REQ2, REQ3)
LLR6 – After the Manual or About page is shown, the system shall return to the main menu when the user presses a key. (REQ1, REQ2, REQ3)

LLR7 – All menu navigation shall be controlled solely through keyboard input (numeric keys and/or character shortcuts such as L, C, T, D). (REQ3)
LLR8 – For any invalid key pressed in a menu, the system shall display an "invalid selection" message and keep the user in the same menu. (REQ3)
LLR9 – The system shall not proceed with any operation until a valid keyboard input is received. (REQ3)

2. Logging / Persistent Storage (REQ4)

LLR10 – At startup, the MSH shall create or open a persistent log file located in the application directory. (REQ4)
LLR11 – Each log entry shall include at least a timestamp, action type (e.g., "Add Light", "Change Mode"), and result (success/failure). (REQ4)
LLR12 – Log entries shall be appended to the log file without deleting or overwriting previous content. (REQ4)
LLR13 – The MSH shall log all critical operations, including device addition/removal, device power on/off, mode changes, state changes, alarms, and simulated calls to police or SMS notifications. (REQ4, REQ6, REQ7, REQ9, REQ11, REQ13)

3. Devices & Basic Infrastructure (REQ5, REQ8, REQ10)

LLR14 – The system shall support the following device types: Light, Camera, TV, and Smoke & Gas Detector as distinct device classes. (REQ5)
LLR15 – Each device instance shall have a unique identifier (ID) and name that are shown in status and device lists. (REQ5, REQ8)
LLR16 – Each device shall store its current power status (ON/OFF) and operational status (ACTIVE/INACTIVE or FAILED). (REQ5, REQ6, REQ9)

LLR17 – The "Add Device" menu (key 2) shall allow the user to select a device type using a character key: L for Light, C for Camera, T for TV, D for Detector. (REQ8, REQ3)
LLR18 – When adding devices, the system shall prompt the user for the quantity and create that many instances. (REQ8)
LLR19 – When configuring the first device in a group (e.g., Light 1 or Camera 1), the system shall ask whether the configuration should be copied to all remaining devices in that group. (REQ8, REQ10)
LLR20 – When copying configuration is confirmed, devices 2..N shall be created with the same configuration as the first one, and a message like "Light 1..10 added" or "Camera 1..4 added" shall be displayed. (REQ8, REQ10)

LLR21 – The system shall centralize default/static configuration parameters for each device type (e.g., default illumination, camera FPS, night vision flag) so they can be reused for future devices of that type. (REQ10)
LLR22 – When new devices are added, they shall inherit the current static configuration of their type unless overridden by user input. (REQ10, REQ8)

4. Power Control & Status (REQ6, REQ1)

LLR23 – The "Get Home Status" option (key 1) shall display the current system mode, state, and the on/off status of all devices. (REQ1, REQ5, REQ6)
LLR24 – The "Power On Device" menu (key 4) shall allow the user to select a device type and an ID and set its power status to ON. (REQ6, REQ3)
LLR25 – The "Power Off Device" menu (key 5) shall allow the user to select a device type and an ID and set its power status to OFF. (REQ6, REQ3)
LLR26 – Every power on/off operation shall generate a corresponding log entry specifying the device type, ID, and new power state. (REQ4, REQ6)

5. Add / Remove Devices (REQ8, REQ4)

LLR27 – The "Remove Device" menu (key 3) shall list all devices of the selected type and ask the user to provide an ID to remove. (REQ8, REQ3)
LLR28 – If the user enters an ID that does not exist for the selected device type, the system shall print an error message and leave the device list unchanged. (REQ8)
LLR29 – Removing a TV with a particular ID shall display a confirmation message such as "Samsung TV removed" or "LG TV removed". (REQ8)
LLR30 – Removing a Light with a particular ID shall display "Light <ID> removed" and the device shall no longer appear in status or subsequent power operations. (REQ8)
LLR31 – All add or remove operations shall be logged with device type, ID(s), and operation result. (REQ4, REQ8)

6. Modes (Normal, Evening, Party, Cinema) (REQ7)

LLR32 – The "Change Mode" menu (key 6) shall allow the user to choose among defined modes (e.g., Normal, Evening, Party, Cinema) using character keys such as N, E, P, C. (REQ7, REQ3)
LLR33 – When Party Mode is activated, the system shall set: Lights ON, Cameras ON, Smoke & Gas Detector ON, TV OFF, Music System ON. (REQ7, REQ6)
LLR34 – When Evening Mode is activated, the system shall set: Lights OFF, Cameras ON, Smoke & Gas Detector ON, TV OFF, Music System OFF. (REQ7, REQ6)
LLR35 – When any mode is changed, the system shall print a message such as "Mode changed to Party" or "Mode changed to Evening". (REQ7)
LLR36 – Each mode change shall be logged with the previous mode and the new mode. (REQ4, REQ7, REQ11)

7. States & State Navigation (REQ11, REQ12)

LLR37 – The MSH shall maintain an ordered list (history) of system states as they are activated (e.g., Normal, Sleep, High Performance). (REQ11)
LLR38 – The "Change State" menu (key 7) shall allow the user to switch to predefined states such as Normal, Sleep, High Performance using character keys (e.g., N, S, H). (REQ11, REQ3)
LLR39 – When changing to a new state, the current state shall be pushed into the state history before the new state is applied. (REQ11)

LLR40 – The "Previous State" option in the state menu shall restore the most recently stored state from the history and apply its configuration to devices. (REQ12, REQ11)
LLR41 – When state changes occur (including Previous), the system shall print messages like "State changed to Sleep" or "State changed to High Performance". (REQ11, REQ12)
LLR42 – State changes shall be logged with the old state, new state, and time of change. (REQ4, REQ11, REQ12)

8. Security, Camera & Smoke/Gas Events (REQ13, REQ14, REQ9, REQ5)

LLR43 – When the security system is active and a camera detects motion, the MSH shall immediately trigger the alarm for a duration of 5 seconds. (REQ13, REQ5)
LLR44 – In the same camera-motion event, the system shall power ON all configured Lights (except removed/failed ones, such as Light 6) for 5 seconds. (REQ13, REQ6, REQ9)
LLR45 – After the camera-motion alarm event starts, the system shall display the message "A call is placed to Police" and log this in the log file. (REQ13, REQ4)

LLR46 – When the Smoke & Gas Detector reports a high level of smoke, the system shall activate an alarm for 10 seconds. (REQ14, REQ5)
LLR47 – During the smoke alarm, the user shall be able to acknowledge the alarm by pressing any key, causing the alarm to stop before the full 10 seconds if pressed. (REQ14, REQ3)
LLR48 – All smoke/gas alarm events, including acknowledgment, shall be logged as part of the security record. (REQ4, REQ14)

9. Device Failure & Notification (REQ9, REQ4, REQ5)

LLR49 – Each device shall maintain a failure status flag that can be set when the device is detected as failed (e.g., Light 2 failure). (REQ9, REQ5)
LLR50 – The MSH shall provide a configuration option for selecting the notification method when a device fails (e.g., on-screen message, alarm, or SMS-like console message). (REQ9)
LLR51 – When Light 2 fails and notification type is SMS, the system shall display "A SMS is sent (Light 2 failure)" and mark Light 2 as INACTIVE. (REQ9)
LLR52 – All device failure events and related notifications shall be written into the log file with device type, ID, and notification method. (REQ4, REQ9)

10. Special Cases & Connectors (REQ8, REQ10)

LLR53 – After Light 2 fails and is removed, adding a new Light shall assign the next available ID (e.g., Light 11) and display "Light 11 added". (REQ8, REQ10)
LLR54 – The system shall allow Lights with different physical/connector types (e.g., "China's light" with different connector) to be added as independent device instances without affecting existing lights. (REQ5, REQ8, REQ10)
LLR55 – The system shall support powering ON the newly added Light (e.g., Light 11) using the Power On Device menu and display "Light 11 on". (REQ6, REQ8)

Class Diagram

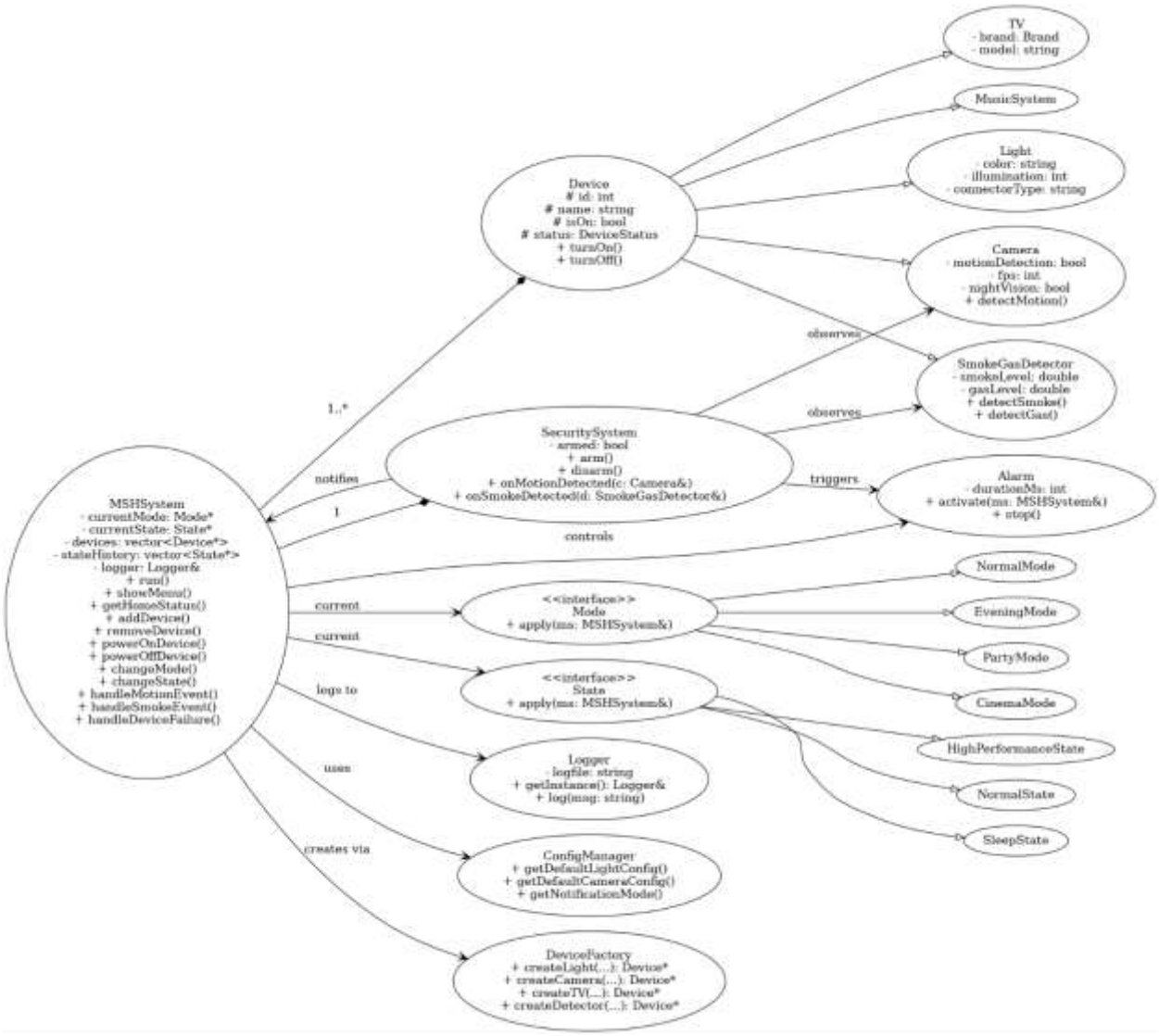
The following class diagram represents the overall design of the *My Sweet Home (MSH)* system. The diagram includes only the essential data members and key member functions, focusing mainly on the relationships between classes, as required. The system is structured around the main controller class `MSHSystem`, which coordinates all devices, modes, states, and security operations.

The `Device` class serves as an abstract base for all physical components in the home, including `Light`, `Camera`, `TV`, `SmokeGasDetector`, and `MusicSystem`. Each device shares common fields such as `id`, `name`, `isOn`, and `status`. Polymorphism is used to allow uniform handling of different device types.

Modes and states are modeled using the Strategy/State design pattern. The `Mode` interface has concrete implementations such as `NormalMode`, `EveningMode`, `PartyMode`, and `CinemaMode`, each applying its own configuration to the system. Similarly, the `State` interface includes `NormalState`, `SleepState`, and `HighPerformanceState`, with the system maintaining a history of previously applied states.

The `SecuritySystem` observes both the `Camera` and `SmokeGasDetector` and triggers alarms, light behavior, or police notifications when motion or smoke is detected. The `Alarm` class is responsible for timed alarm activation.

Infrastructure components include `Logger` and `ConfigManager`, both implemented using the Singleton pattern, and `DeviceFactory`, which handles creation of all device objects.



Class diagram of the My Sweet Home (MSH) system showing main modules and relationships

- Uses **basic data members** (id, name, status, config fields, etc.)
- Uses **basic member functions** (turnOn, turnOff, apply, detectSmoke, log, etc.)
- Shows the **relationships very clearly**:
    - `MSHSystem` aggregates `Device`
    - `MSHSystem` uses `Mode`, `State`, `SecuritySystem`, `Logger`, `ConfigManager`, `DeviceFactory`, `Alarm`

- `Device` is a base class of `Light`, `Camera`, `TV`, `SmokeGasDetector`, `MusicSystem`
- `Mode` and `State` are interfaces with concrete subclasses
- `SecuritySystem` observes `Camera` and `SmokeGasDetector` and notifies `MSHSystem`, triggers `Alarm`

Developer	Assigned Components (Classes / Modules / Concepts)	Design Patterns / Concepts Used
MAHMOUD JALLOH	`MSHSystem` (main controller), menu handling, main loop, integration of all subsystems	**Facade** (system entry point), Controller, basic menu flow
ABDULBARI ABDULGHANI AHMED LEFTESI	`Device` base class, `Light`, `Camera`, `TV`, `SmokeGasDetector`, `MusicSystem`, `DeviceStatus` enum	**Inheritance & Polymorphism**, possible **Template Method** for shared on/off behaviour
BASHIR ABDULWAHED BASHIR TAYANI	`Mode` interface, `NormalMode`, `EveningMode`, `PartyMode`, `CinemaMode`, mode-change logic inside `MSHSystem::changeMode()`	**Strategy / State Pattern** for system modes
OMAR ABDELSALAM MAHROUS ABDELMOTLEB	`State` interface, `NormalState`, `SleepState`, `HighPerformanceState`, `stateHistory` management (previous / next behaviour)	**State Pattern** for system performance states
ABDULRAUF ABDULHAMİD ALSAYD ALSIAD	`SecuritySystem`, motion detection logic, smoke detection logic, event handling between devices → security → system	**Observer-style** interaction, event-driven logic
AHMED ESSALEM	`Alarm` system (5s/10s alarms), alarm activation/stop logic, connection to lights and notifications	Timer/Command-like behaviour, collaboration with SecuritySystem
MOHAMED ASHRAF RAMADAN MOHAMED	`Logger` (Singleton), `ConfigManager` (Singleton), `DeviceFactory`, failure notification logic (SMS/message/alarm), configuration inheritance	**Singleton**, **Factory Method**, cross-cutting infrastructure

In our design, developer responsibilities are distributed according to major subsystems within the MSH architecture. **Mahmoud Jalloh** is responsible for the main controller (`MSHSystem`), including the menu structure and overall system navigation. **Abdulbari Abdulghani Ahmed Leftesi** implements the device abstraction and all concrete device types—such as Light, Camera, TV, Smoke & Gas Detector, and Music System—ensuring proper use of inheritance and polymorphic behaviour.

Bashir Abdulwahed Bashir Tayani focuses on the system modes, implementing the `Mode` interface and its concrete variants using the Strategy/State design pattern. **Omar Abdelsalam Mahrous Abdelmotleb** develops the system performance states and manages the state history mechanism, enabling transitions such as Sleep, Normal, and High Performance.

The most complex subsystem is handled jointly by **Abdulrauf Abdulhamid Alsayd Alsiad** and **Ahmed Essalem**, who together implement the security system, motion and smoke event handling, alarm integration, and failure notifications. Finally, **Mohamed Ashraf Ramadan Mohamed** is responsible for building the shared infrastructure components, including the `Logger` (Singleton), `ConfigManager` (Singleton), and `DeviceFactory` (Factory Method

1. The Group Info

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