# SMART HOME AUTOMATION SYSTEM

Objective:

To enhance energy efficiency through the implementation of analytics and recommendations, providing users with actionable insights to optimize device usage and contribute to a sustainable efficient smart home environment.

Database Schema:

The database comprises several interconnected tables to manage information related to users, rooms, devices, device events, settings, device setting values, firmware history, and power consumption history. Additionally, various views, stored procedures, and triggers have been implemented to facilitate data analysis and manipulation.

ER Diagram:
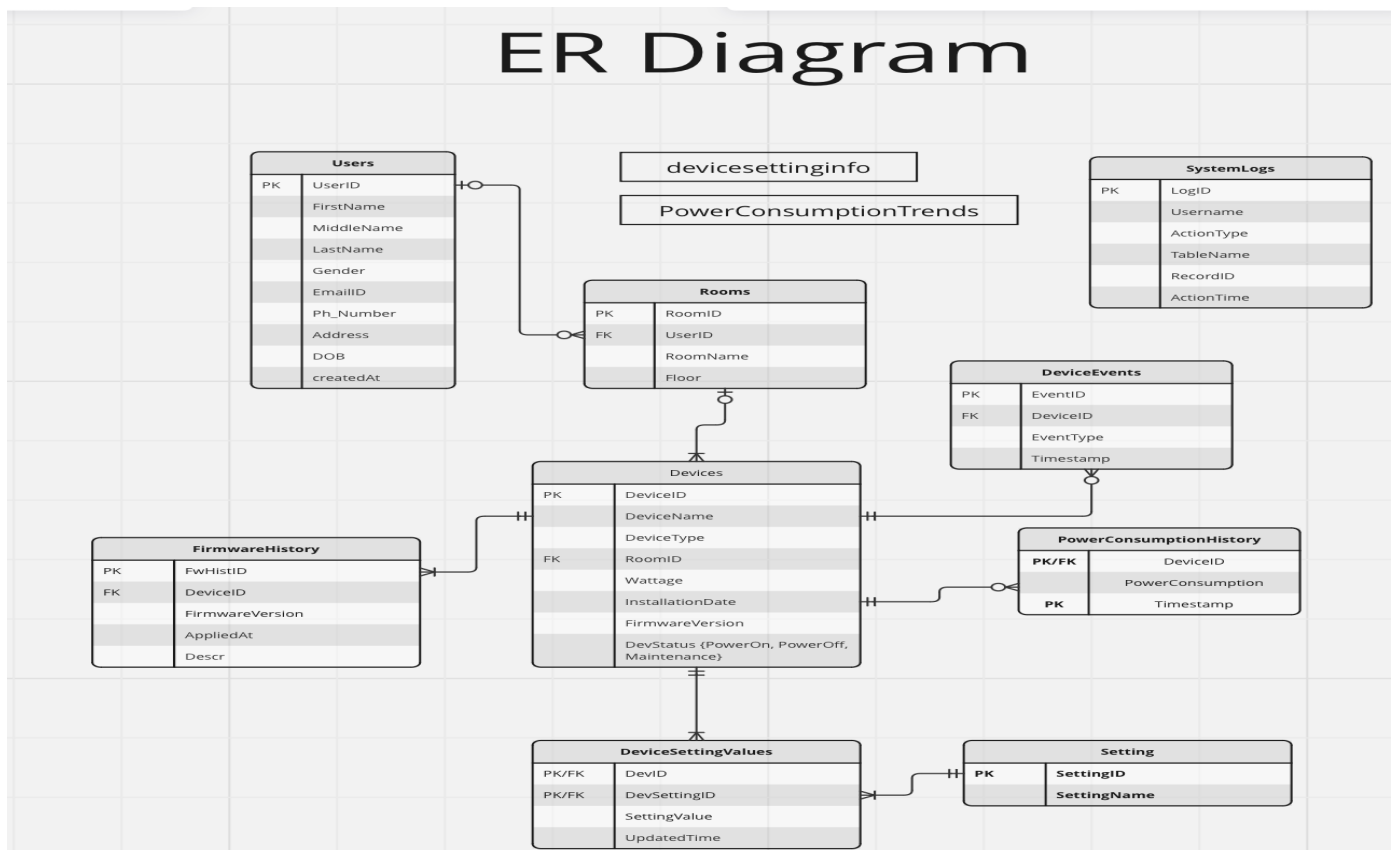
Tables Description:

Users: Contains user information.

```
[mysql> SELECT * FROM Users;
+--------+-----------+------------+----------+--------+--------------------------+------------+--------------+------------+---------------------+
| UserID | FirstName | MiddleName | LastName | Gender | EmailID                  | Ph_Number  | Address      | DOB        | CreatedAt           |
+--------+-----------+------------+----------+--------+--------------------------+------------+--------------+------------+---------------------+
|     32 | John      | A          | Doe      | Male   | john.doe@example.com     | 1234567890 | 123 Main St  | 1990-05-15 | 2023-12-11 19:47:14 |
|     33 | Jane      | B          | Smith    | Female | jane.smith@example.com   | 9876543210 | 456 Oak St   | 1985-08-22 | 2023-12-11 19:47:14 |
|     34 | Mike      | NULL       | Johnson  | Male   | mike.johnson@example.com | 5551234567 | 789 Pine St  | 1992-11-10 | 2023-12-11 19:47:14 |
|     35 | Alice     | C          | Brown    | Female | alice.brown@example.com  | 9998887777 | 101 Elm St   | 1988-03-28 | 2023-12-11 19:47:14 |
|     36 | Bob       | NULL       | Miller   | Male   | bob.miller@example.com   | 3334445555 | 202 Maple St | 1995-07-07 | 2023-12-11 19:47:14 |
|     37 | Revanth   | NULL       | Padala   | Male   | revanth@gamil.com        | 888-555-7775 | 29 Lambert St | 1998-11-17 | 2023-12-12 15:18:44 |
+--------+-----------+------------+----------+--------+--------------------------+------------+--------------+------------+---------------------+
```

Room: Contains room information.

```
[mysql> SELECT * FROM Rooms;
+--------+-------------+--------+-------+
| RoomID | RoomName    | UserID | Floor |
+--------+-------------+--------+-------+
|     15 | Living Room |     32 |     1 |
|     16 | Bedroom     |     33 |     2 |
|     17 | Kitchen     |     32 |     1 |
|     18 | Office      |     35 |     3 |
|     19 | Guest Room  |     36 |     2 |
+--------+-------------+--------+-------+
```

Devices: Contains device information, and the 'DevStatus' field denotes the status of the device.

```
[mysql> SELECT * FROM Devices;
+----------+-----------------+-----------------+--------+---------+---------------------+-----------------+-----------+
| DeviceID | DeviceName      | DeviceType      | RoomID | Wattage | InstallationDate    | FirmwareVersion | DevStatus |
+----------+-----------------+-----------------+--------+---------+---------------------+-----------------+-----------+
|        1 | Smart Light     | Light           |     19 |      60 | 2023-12-01 08:00:00 | 3.0.15          | PowerOff  |
|      201 | Smart Bulb      | Lighting        |     15 |      10 | 2023-12-03 00:48:22 | 3.1.16          | PowerOff  |
|      202 | Smart Thermostat | Climate Control |     17 |       5 | 2023-12-03 00:48:22 | 2.1.0           | PowerOff  |
|      203 | Smart TV        | Entertainment   |     18 |      80 | 2023-12-03 00:48:22 | 3.1             | PowerOn   |
|      204 | Smart Lock      | Security        |     16 |      25 | 2023-12-03 00:48:22 | 1.5             | PowerOff  |
|      205 | Smart Speaker   | Audio           |     15 |      30 | 2023-12-03 00:48:22 | 2.5             | PowerOff  |
|      206 | Smart AC        | Air Conditioner |     16 |      90 | 2023-12-13 15:49:14 | 4.0.0           | PowerOff  |
+----------+-----------------+-----------------+--------+---------+---------------------+-----------------+-----------+
```

DeviceEvents: Contains device logs, and records events such as device turning ON/OFF, maintenance, firmware updates, and other updates.

```
[mysql> SELECT * FROM DeviceEvents;
+---------+----------+------------------------+---------------------+
| EventID | DeviceID | EventType              | Timestamp           |
+---------+----------+------------------------+---------------------+
|       1 |        1 | DeviceUpdated          | 2023-12-02 22:53:22 |
|       2 |        1 | DeviceStatusChanged    | 2023-12-02 23:05:07 |
|       3 |        1 | FirmwareUpdated        | 2023-12-03 00:19:30 |
|       4 |      202 | DeviceStatusChanged    | 2023-12-03 01:22:52 |
|       5 |      202 | FirmwareUpdated        | 2023-12-03 16:53:42 |
|       6 |      202 | PowerOn                | 2023-12-03 16:53:42 |
|       7 |      202 | PowerOff               | 2023-12-03 16:57:36 |
|       8 |      202 | PowerConsumptionChanged| 2023-12-03 17:01:11 |
|       9 |      202 | PowerOn                | 2023-12-03 17:04:42 |
|      10 |      202 | PowerOff               | 2023-12-03 21:32:22 |
|      11 |      202 | PowerOn                | 2023-12-03 21:44:47 |
|      12 |      202 | PowerOff               | 2023-12-03 22:46:56 |
|      13 |      201 | PowerOn                | 2023-12-04 13:23:21 |
|      14 |      203 | PowerOn                | 2023-12-04 19:06:22 |
|      15 |      201 | PowerOff               | 2023-12-13 13:46:29 |
|      26 |      205 | Maintenance            | 2023-12-13 14:34:21 |
|      27 |      205 | PowerOff               | 2023-12-13 14:34:59 |
|      28 |      205 | PowerOn                | 2023-12-13 14:36:04 |
|      29 |      205 | PowerOff               | 2023-12-13 14:36:32 |
|      30 |      205 | PowerOn                | 2023-12-13 14:37:07 |
|      31 |      205 | PowerOff               | 2023-12-13 14:49:07 |
|      32 |      201 | PowerOn                | 2023-12-14 22:11:16 |
|      33 |      201 | PowerOff               | 2023-12-15 16:08:00 |
|      34 |      201 | FirmwareUpdated        | 2023-12-15 16:10:54 |
+---------+----------+------------------------+---------------------+
```

Setting: Contains types of settings available for devices.

```
[mysql> SELECT * FROM Setting;
+-----------+----------------+
| SettingID | SettingName    |
+-----------+----------------+
|       101 | Brightness     |
|       102 | Temperature    |
|       103 | Volume         |
|       104 | Security Level |
|       105 | Power Mode     |
+-----------+----------------+
```

DeviceSettingValue: Contains information about the setting values for a device.

```
[mysql> SELECT * FROM DeviceSettingValues;
+-------+--------------+--------------+---------------------+
| DevID | DevSettingID | SettingValue | UpdatedTime         |
+-------+--------------+--------------+---------------------+
|     1 |          101 | 80           | 2023-12-11 20:51:19 |
|   201 |          101 | 60           | 2023-12-11 20:51:19 |
|   203 |          101 | 70           | 2023-12-11 20:51:19 |
|   203 |          103 | 55           | 2023-12-11 20:51:19 |
|   204 |          104 | 98           | 2023-12-11 20:51:19 |
+-------+--------------+--------------+---------------------+
```

FirmwareHistory: Maintains firmware update history for all devices.

```
[mysql> SELECT * FROM FirmwareHistory;
+----------+----------+-----------------+---------------------+----------------------------------+
| FwHistID | DeviceID | FirmwareVersion | AppliedAt           | Descr                            |
+----------+----------+-----------------+---------------------+----------------------------------+
|        1 |        1 | 3.0.15          | 2023-12-03 00:19:30 | Firmware updated to 3.0.15       |
|        2 |      202 | 2.1.0           | 2023-12-03 16:53:42 | Firmware updated to 2.1.0        |
|        3 |      201 | 3.0.1           | 2023-12-04 07:09:45 | Devices Updated to latest version |
|        4 |      201 | 3.1.16          | 2023-12-15 16:10:54 | Firmware updated to 3.1.16       |
+----------+----------+-----------------+---------------------+----------------------------------+
```

PowerConsumptionHistory: Records the history of power consumption each time a device is turned ON.

```
[mysql> SELECT * FROM PowerConsumptionHistory;
+----------+------------------+---------------------+
| DeviceID | PowerConsumption | Timestamp           |
+----------+------------------+---------------------+
|      201 |             2.16 | 2023-12-13 13:46:29 |
|      201 |             0.18 | 2023-12-15 16:08:00 |
|      202 |             0.02 | 2023-12-01 20:33:20 |
|      202 |             0.01 | 2023-12-03 22:46:56 |
|      205 |             0.00 | 2023-12-13 14:36:32 |
|      205 |             0.01 | 2023-12-13 14:49:07 |
+----------+------------------+---------------------+
```

SystemLogs: Records all the actions performed by the database users.

```
[mysql> SELECT * FROM SystemLogs;
+-------+-----------------+------------+------------+----------+---------------------+
| LogID | Username        | ActionType | TableName  | RecordID | ActionTime          |
+-------+-----------------+------------+------------+----------+---------------------+
|    36 | Owner@localhost | INSERT     | Users      | 37       | 2023-12-12 15:18:44 |
|    37 | root@localhost  | UPDATE     | Devices    | 201      | 2023-12-13 13:46:29 |
|    38 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 13:48:42 |
|    39 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 13:49:30 |
|    40 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:13:19 |
|    41 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:13:43 |
|    42 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:14:22 |
|    43 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:17:45 |
|    44 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:19:50 |
|    45 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:20:14 |
|    46 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:21:34 |
|    47 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:27:00 |
|    48 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:34:21 |
|    49 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:34:59 |
|    50 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:36:04 |
|    51 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:36:32 |
|    52 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:37:07 |
|    53 | root@localhost  | UPDATE     | Devices    | 205      | 2023-12-13 14:49:07 |
|    54 | root@localhost  | INSERT     | Devices    | 206      | 2023-12-13 15:49:14 |
|    55 | root@localhost  | UPDATE     | Devices    | 201      | 2023-12-14 22:11:16 |
|    56 | Owner@localhost | UPDATE     | Devices    | 201      | 2023-12-15 16:08:00 |
|    57 | Owner@localhost | UPDATE     | Devices    | 201      | 2023-12-15 16:10:54 |
+-------+-----------------+------------+------------+----------+---------------------+
```

Views Descriptions:

1. **DeviceSettingInfo:** Provides a detailed view of settings for devices, including DeviceName, RoomName, SettingName, and SettingValue.

```
[mysql> SELECT * FROM DeviceSettingInfo;
+----------+----------------+-----------------+-------------+-----------+----------------+--------------+---------------------+
| DeviceID | DeviceName     | DeviceType      | RoomName    | SettingID | SettingName    | SettingValue | UpdatedTime         |
+----------+----------------+-----------------+-------------+-----------+----------------+--------------+---------------------+
|      201 | Smart Bulb     | Lighting        | Living Room |       101 | Brightness     | 60           | 2023-12-11 20:51:19 |
|      205 | Smart Speaker  | Audio           | Living Room |      NULL | NULL           | NULL         | NULL                |
|      204 | Smart Lock     | Security        | Bedroom     |       104 | Security Level | 98           | 2023-12-11 20:51:19 |
|      206 | Smart AC       | Air Conditioner | Bedroom     |      NULL | NULL           | NULL         | NULL                |
|      202 | Smart Thermostat | Climate Control | Kitchen   |      NULL | NULL           | NULL         | NULL                |
|      203 | Smart TV       | Entertainment   | Office      |       101 | Brightness     | 70           | 2023-12-11 20:51:19 |
|      203 | Smart TV       | Entertainment   | Office      |       103 | Volume         | 55           | 2023-12-11 20:51:19 |
|        1 | Smart Light    | Light           | Guest Room  |       101 | Brightness     | 80           | 2023-12-11 20:51:19 |
+----------+----------------+-----------------+-------------+-----------+----------------+--------------+---------------------+
```

2. **PowerConsumptionTrends:** Displays the total power consumption till date in a detailed view.

```
[mysql> SELECT * FROM PowerConsumptionTrends;
+--------+-------------+-----------------+-------------+----------------------+
| RoomID | RoomName    | DeviceName      | LastUpdated | TotalPowerConsumption |
+--------+-------------+-----------------+-------------+----------------------+
|     15 | Living Room | Smart Bulb      | 2023-12-15  |                 2.34 |
|     17 | Kitchen     | Smart Thermostat| 2023-12-03  |                 0.03 |
|     15 | Living Room | Smart Speaker   | 2023-12-13  |                 0.01 |
+--------+-------------+-----------------+-------------+----------------------+
```

Stored Procedures:

1. **CalculatePowerConsumption:**
   - Takes DeviceID, Start Date, and End Date as parameters.
   - Returns the total power consumption for the given period.

```sql
Delimiter //
CREATE DEFINER=`root`@`localhost` PROCEDURE `CalculatePowerConsumption`(IN DevID INT, IN startdate DATE, IN enddate DATE)
BEGIN
    SELECT d.DeviceID, d.DeviceName,
    SUM(PowerConsumption) AS TotalConsumption
    FROM PowerConsumptionHistory pch INNER JOIN Devices d
    ON d.DeviceID = pch.DeviceID
    WHERE pch.DeviceID = DevID AND Timestamp BETWEEN startdate AND enddate
    GROUP BY d.DeviceID, d.DeviceName;
END
//
Delimiter ;
```

2. **CalculateMaintenanceCount:**
   - Takes DeviceID, Start Date, and End Date as parameters.
   - Returns the number of times the device has undergone maintenance in the specified period.

```sql
Delimiter //
CREATE PROCEDURE CalculateMaintenanceCount(IN DevID INT, IN startdate DATE, IN enddate DATE)

BEGIN
    SELECT d.DeviceID, d.DeviceName,
    COUNT(de.EventType) AS `No.Of Maintenance`
    FROM DeviceEvents de INNER JOIN Devices d
    ON d.DeviceID = de.DeviceID
    WHERE de.EventType = 'Maintenance' AND
    de.DeviceID = DevID AND Timestamp BETWEEN startdate AND enddate
    GROUP BY d.DeviceID, d.DeviceName;
END
//
Delimiter ;
```

3. **CalculateFirmwareUpdates:**
   - Takes DeviceID, Start Date, and End Date as parameters.
   - Returns the number of times the device has been updated to the latest firmware in the specified period.

```
       Delimiter //
  ●    CREATE PROCEDURE CalculateFirmwareUpdates(IN DevID INT, IN startdate DATE, IN enddate DATE)

       BEGIN
           SELECT d.DeviceID, d.DeviceName,
               COUNT(fh.FirmwareVersion) AS `No.Of Times Updated`
               FROM FirmwareHistory fh INNER JOIN Devices d
               ON d.DeviceID = fh.DeviceID
               WHERE fh.DeviceID = DevID AND AppliedAt BETWEEN startdate AND enddate
               GROUP BY d.DeviceID, d.DeviceName;
           END
           //
       Delimiter ;
```

4. **Maintenance/PowerOff/PowerOn:**
   - Procedures to update the 'DevStatus' in the Devices table.

Triggers:

1. **trg_PowerConsumption:**
   - Triggered before updating the 'Devices' table when 'DevStatus' changes to 'PowerOff.'
   - Calculates power consumption based on the time since the last 'PowerOn' event and inserts the data into the 'PowerConsumptionHistory' table.

```
       DELIMITER //
  ●    CREATE TRIGGER `trg_PowerConsuptionCal`
       BEFORE UPDATE ON `Devices`
       FOR EACH ROW
       BEGIN
           -- Declare variables
           DECLARE lastPowerOnTimestamp DATETIME;
           DECLARE duration DECIMAL(10, 2);

           -- Check if the device status is changing to 'PowerOff'
           IF NEW.DevStatus = 'PowerOff' AND OLD.DevStatus != 'PowerOff' THEN
               -- Retrieve the timestamp of the last 'PowerOn' event for the device
               SELECT MAX(Timestamp) INTO lastPowerOnTimestamp
               FROM DeviceEvents
               WHERE DeviceID = NEW.DeviceID AND EventType = 'PowerOn';

               -- Check if there is a record of 'PowerOn'
               IF lastPowerOnTimestamp IS NOT NULL THEN
                   -- Calculate the duration between the last 'PowerOn' event and the current update
                   SET duration = TIMESTAMPDIFF(SECOND, lastPowerOnTimestamp, NOW()) / 3600.0;

                   -- Insert a record in the PowerConsumptionHistory table
                   INSERT INTO PowerConsumptionHistory (DeviceID, PowerConsumption, Timestamp)
                   VALUES (NEW.DeviceID, ((SELECT Wattage FROM Devices WHERE DeviceID = NEW.DeviceID) * duration / 1000.0), NOW());
               END IF;
           END IF;
       END;
       //
```

2. **trg_DeviceUpdate:**
   - Triggered after an update action is performed on the 'Devices' table.
   - Logs changes in the 'DeviceEvent' table.

```sql
DELIMITER //
CREATE TRIGGER trg_DeviceUpdated AFTER UPDATE ON Devices
FOR EACH ROW
BEGIN
    DECLARE dynamicEventType VARCHAR(50);
    -- Check if FirmwareVersion has changed
    IF NEW.FirmwareVersion != OLD.FirmwareVersion THEN
        SET dynamicEventType = 'FirmwareUpdated';
        INSERT INTO FirmwareHistory (DeviceID, FirmwareVersion, Descr, AppliedAt)
        VALUES (OLD.DeviceID, NEW.FirmwareVersion, CONCAT('Firmware updated to ', NEW.FirmwareVersion), NOW());

        INSERT INTO DeviceEvents (DeviceID, EventType, Timestamp)
        VALUES (OLD.DeviceID, dynamicEventType, NOW());
    END IF;
    -- Check if PowerConsumption has changed
    IF NEW.Wattage != OLD.Wattage THEN
        SET dynamicEventType = 'Wattage Changed';
        INSERT INTO DeviceEvents (DeviceID, EventType, Timestamp)
        VALUES (OLD.DeviceID, dynamicEventType, NOW());
    END IF;
    -- Check if DeviceStatus has changed
    IF NEW.DevStatus != OLD.DevStatus THEN
        SET dynamicEventType = NEW.DevStatus;
        INSERT INTO DeviceEvents (DeviceID, EventType, Timestamp)
        VALUES (OLD.DeviceID, dynamicEventType, NOW());
    END IF;
END //
```

Database User Access:

Owner (admin):

- Has full privileges, including insert, update, and delete on all tables except 'FirmwareHistory,' 'PowerConsumptionHistory,' and 'DeviceEvent.'

Conclusion:

This comprehensive database design ensures effective data management, tracking device events, power consumption analysis, and facilitates maintenance and firmware update tracking. The implemented views and stored procedures enhance the accessibility and usability of data for various analytical purposes. The triggers ensure real-time updates and logging of significant events in the database.