Indian Institute of Information Technology Allahabad

Home Connect

Group :- 6

IEC2022001 - Jaseel Muhammad

IEC2022024 - Harini Balaga

IEC2022065 - Vaishnavi Gunda

IEC2022102 - Abhinav Chaudhary

IEC2022107 - Esha Vangapandu

IFE2022001 - Arpit Kumar

IFE2022002 - Kavin Prakash

IFE2022017 - Mukesh Choudhary

IFE2022023 - Rohitashwa Mishra

IFE2022025 - Abhiram Nemani

Empathize: Understanding User Perspectives

Empathy Maps

Empathy maps capture the differences in user perspectives between traditional households and those transitioning to smart appliances:

1. **Say**
   - *Users in Traditional Homes*:
     "Our appliances work just fine; why do we need to change them?"
     "I don't have the time or knowledge to deal with complicated setups."
     "Switching between so many devices and apps seems frustrating."
   - *Users with Smart Appliances*:
     "Smart appliances are expensive and hard to integrate with existing setups."
     "The system doesn't justify the effort or cost right now."

2. **Think**
   - *Users in Traditional Homes*:
     - "Why fix something that's not broken?"
     - "Will smart appliances actually make life easier, or is it just hype?"
     - "I want convenience, but it shouldn't be this costly."
   - *Users with Smart Appliances*:
     - "Can I handle the learning curve of this technology?"
     - "What happens if devices from different brands don't work together?"

3. **Feel**
   - *Users in Traditional Homes*:
     - Comfortable with their familiar routines and appliances.
     - Hesitant or resistant to change due to cost and complexity fears.
   - *Users with Smart Appliances*:
     - Overwhelmed by fragmented ecosystems and compatibility issues.
     - Anxious about maintaining and operating the system effectively.

4. **Do**
   - *Users in Traditional Homes*:
     - Stick to reliable, familiar appliances.
     - Manually operate devices without automation.
   - *Users with Smart Appliances*:
     - Hesitate to invest fully in smart technology due to cost and perceived complexity.
     - Try to manage multiple apps and brands for basic automation.

Empathy maps highlight the contrasting user perspectives and help identify the unique pain points for transitioning households.

Journey Mapping: Visualizing User Experiences

Journey maps compare the experiences of traditional households with those adopting smart technology:

1. **User Actions & Touchpoints**
    - *Traditional Homes*:
        - Perform all tasks manually (e.g., switching lights, controlling fans, adjusting appliances).
        - Minimal exploration of automation or smart appliances.
    - *Homes with Smart Appliances*:
        - Research smart systems and consider cost-effectiveness.
        - Struggle with setup and learning to use devices.

2. **User Thoughts & Emotions at Each Stage**
    - *Traditional Homes*:
        - Thought: "I don’t need automation; I can manage my home fine."
        - Emotion: Contentment and skepticism about smart systems.
    - *Smart Appliance Users*:
        - Thought: "This technology seems promising but feels overly complicated."
        - Emotion: Frustration, especially during setup and integration.

3. **Pain Points and Moments of Delight**
    - *Traditional Homes*:
        - **Pain Points**: Manual effort for routine tasks; lack of convenience in adjusting appliances remotely.
        - **Moments of Delight**: Familiarity and ease of use without additional costs or complexities.
    - *Smart Appliance Users*:
        - **Pain Points**: High cost of upgrading, learning curve, and fragmented systems.
        - **Moments of Delight**: Automation of repetitive tasks; seamless control when the system works as expected.

4. **Opportunities for Improvement**
    - Simplify transitions for traditional homes by retrofitting appliances.
    - Lower costs to make smart technology accessible.
    - Create unified control systems that integrate multiple brands and devices.
    - Simplyfing the complex circuit into easier ones using parent-child circuits.

Persona: The Traditional Homeowner Exploring Smart Technology

1. Demographics

- **Name:** Rajesh Sharma
- **Age:** 42
- **Gender:** Male
- **Occupation:** Accountant
- **Location:** Suburban India
- **Family:** Married with two children (aged 10 and 14)
- **Tech Proficiency:** Moderate (uses a smartphone for basic functions but avoids advanced tech systems)

2. Goals and Motivations

- Simplify daily tasks, such as managing appliances remotely and saving energy.
- Improve convenience for his family while balancing affordability.
- Transition to a modern home environment without disrupting current routines.
- Reduce electricity bills through smart automation.

3. Pain Points and Challenges

- **High Costs:** Finds smart home solutions too expensive to justify the investment.
- **Setup Complexity:** Intimidated by the technical installation and integration processes.
- **Fragmented Ecosystems:** Concerned about needing multiple apps for different devices.
- **Learning Curve:** Worries that smart appliances might confuse or frustrate family members, especially his elderly parents.
- **Compatibility Issues:** Hesitant due to reports of devices from different brands not working seamlessly.

Purpose of the Persona
Rajesh represents a key user segment transitioning from traditional appliances to smart ones. His detailed profile helps the design team focus on creating affordable, user-friendly, and compatible solutions that address these common concerns, ensuring a smooth and satisfying user experience.

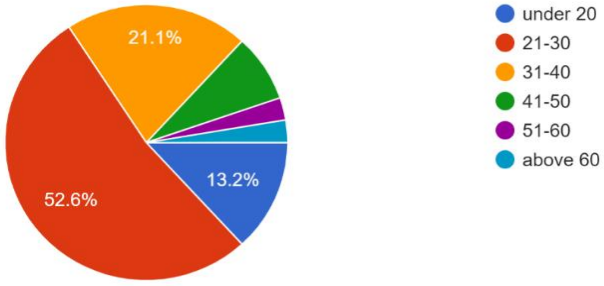
User Interviews: Gathering Direct Insights

Preparation: We Develop survey in form of interview. The result of survey are shown.

SURVEY REPORT

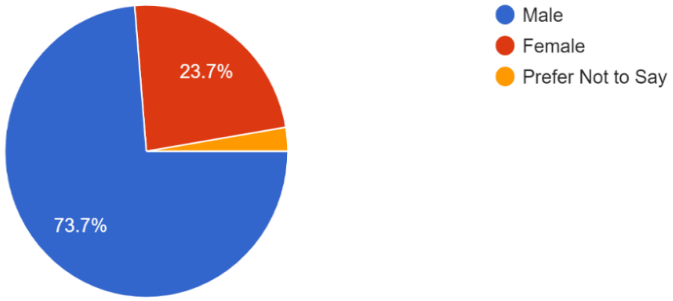
What is your age group

38 responses



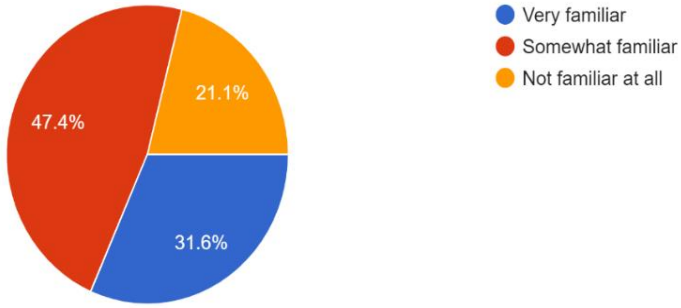
Gender

38 responses



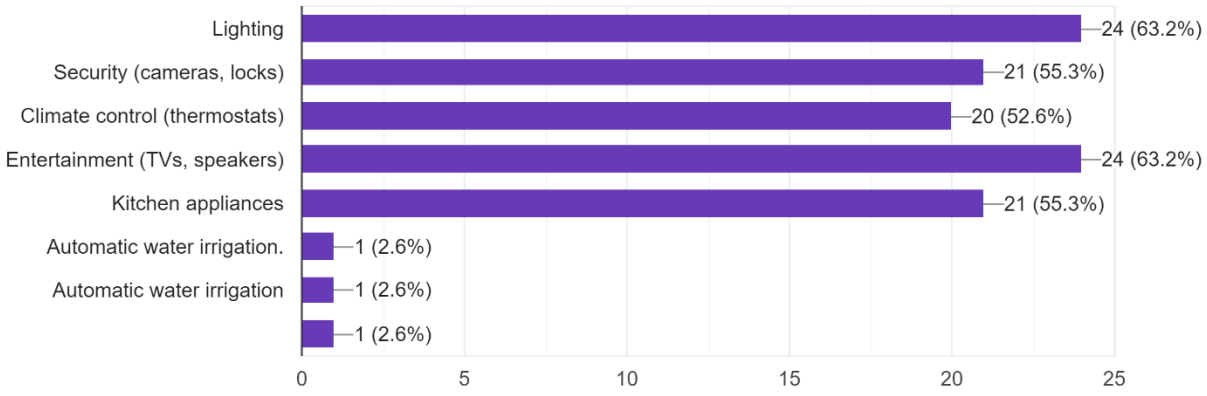
How familiar are you with smart appliances or smart home technology?

38 responses



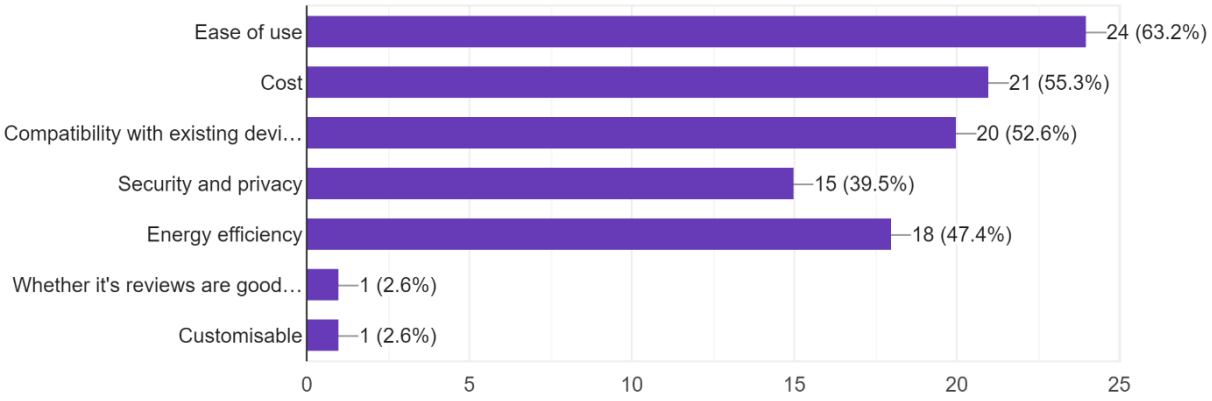
What areas of your home would you most like to integrate with smart appliances?

38 responses



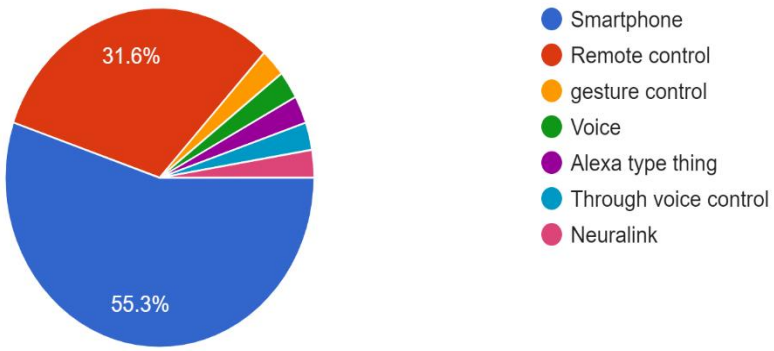
What are the most important features you look for in smart appliances?

38 responses



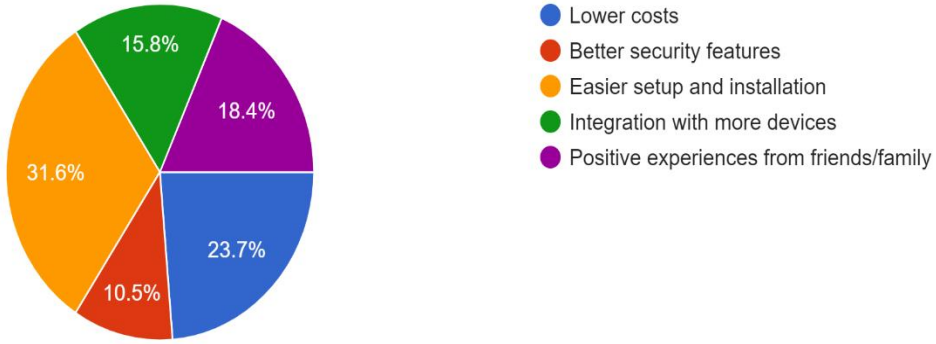
How do you prefer to control your smart appliances?

38 responses



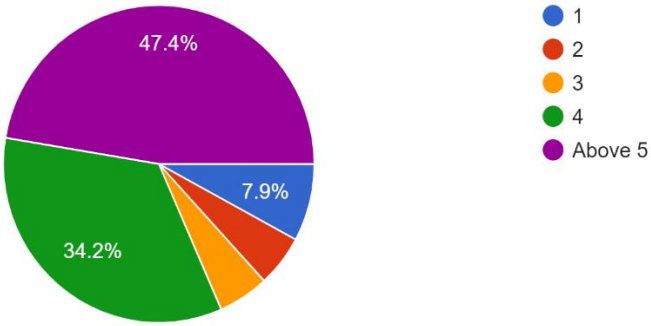
What would encourage you to invest in more smart appliances?

38 responses



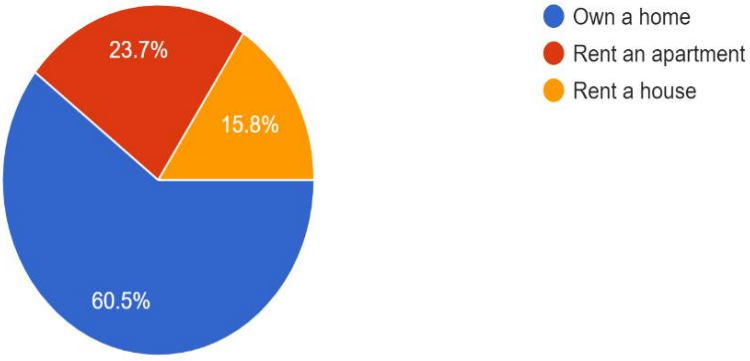
How many people live in your household?

38 responses



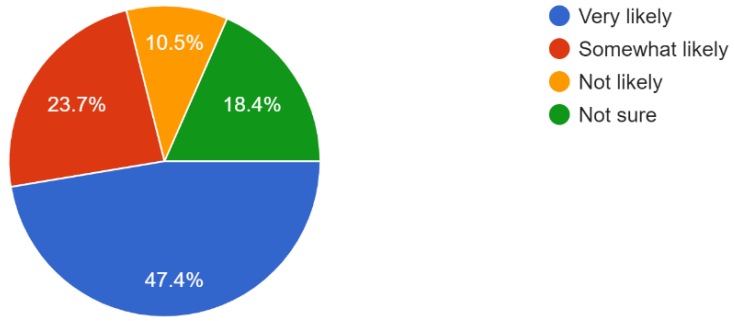
What is your living situation?

38 responses



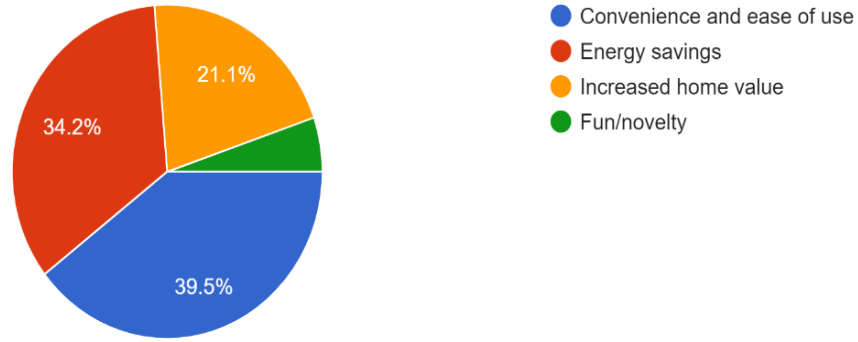
Would you consider switching to smart appliances if your current non-smart appliances could be converted into smart appliances at a comparable price?

38 responses

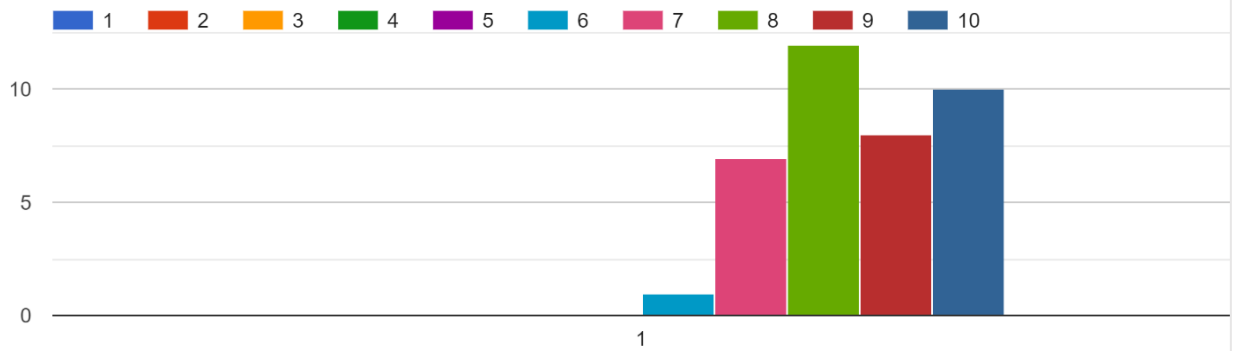


What would be the primary reason for you to adopt smart appliances in your home?

38 responses



On a scale of 1 to 10, rate our home connect idea



What would be your ideal smart appliance solution? Please describe any specific features or products you would like.

6 responses

If all control will be at single place it will be best.

electrical appliance

fully automated room

Any device for cylinder related issues

Security alarm in case of any error in device

Remote control

What challenges do you foresee with using smart appliances in your daily life?

16 responses

If there is some issue in converted smart appliaces would i be able to use it as non smart appliance till it is repaired.

cost effectiveness

effectiveness

malfunction of appliances

money saving

security and privacy

To make it budget for friendly

Compatibility issues

Limited number of devices

Making the component in a less cost

Providing in a nominal value

Connectivity issues

Money

Combining everything into a single product

Lag and accuracy

High costs

Define

Problem Statement:

As technology advances, there's a noticeable trend towards adopting modern smart appliances that allow for seamless control over various household functions. The idea is to make life more convenient by enabling control of devices and switches without interrupting your ongoing activities. However, the transition from traditional, non-smart appliances to smart ones has been relatively slow, and there are several key reasons for this:

1. High Costs: Smart appliances are pricey, creating a barrier for many consumers.
2. Setup Complexity: Non-smart homes often require costly upgrades for integration.
3. Cost-Benefit Gap: For many, the benefits don't justify the high expense.
4. Fragmented Ecosystems: Multiple apps are needed for different brands, disrupting ease of use.
5. Compatibility Issues: Limited interoperability between brands hinders a unified smart home experience.
6. Learning Curve: Operating smart devices can be difficult, especially for non-tech-savvy users.

Affinity Diagram: Organizing Insights from Empathy Phase

Step 1: Observations & Notes
Key observations and user statements were written on sticky notes based on empathy research, including user interviews, empathy maps, and journey maps.

Step 2: Grouping Similar Notes
Note were clustered into the following themes:

1. Cost Concerns

- "Smart appliances are too expensive for my budget."
- "The cost-benefit ratio doesn’t seem worth it."
- "I’d rather stick to traditional appliances unless the price drops significantly."

2. Setup Complexity

- "Setting up smart appliances seems very technical."
- "I don’t have the time to learn complex setups."
- "The installation process requires expensive upgrades to my home."

3. Fragmentation of Systems

- "Switching between multiple apps is annoying."
- "Different brands don’t work well together."
- "I want a unified system for managing all devices."

4. User Learning Curve

- "My parents can’t understand how to use these devices."
- "There’s too much to learn to make the system usable."
- "The manual isn’t clear enough for non-technical users."

5. Daily Convenience

- "I want to control appliances remotely to save time."
- "Automating repetitive tasks like switching lights would be great."
- "Managing energy efficiently is important to me."

Step 3: Creating Categories or Themes

Categories/Themes Identified:

1. **Affordability:** Highlighting cost-related barriers.
2. **Ease of Setup:** Focus on reducing complexity in installation.
3. **System Integration:** Need for interoperability and seamless experiences.
4. **Usability:** Simplifying user interfaces for non-tech-savvy users.
5. **Enhanced Convenience:** Desire for automation and time-saving features.

Step 4: Analyzing Relationships Between Groups

- *Affordability and Ease of Setup*: High costs often include installation expenses, creating dual barriers for adoption.
- *System Integration and Usability*: Unified systems that are easy to use would address both fragmentation and the learning curve.
- *Convenience and Usability*: Simplified user interfaces would make it easier for users to access automation and energy management features.

Insights from the Affinity Diagram

By clustering observations, the team can focus on these key areas to define the problem:

1. Reducing costs to make smart appliances more accessible.

2. Simplifying installation and setup processes.
3. Creating unified systems with seamless brand integration.
4. Designing intuitive interfaces for all user demographics.
5. Prioritizing automation features that enhance convenience and efficiency.

Point of View (POV) Statements: Articulating User Needs

Based on the initial problem statement and proposed solutions from your project PDF, here are the crafted POV statements:

1. **User:** A cost-conscious homeowner
    - **Need:** Needs affordable smart home solutions
    - **Because:** High costs of smart appliances create a financial barrier, making them inaccessible for many households.
2. **User:** A non-tech-savvy individual
    - **Need:** Needs an easy-to-use system for managing home appliances
    - **Because:** Complex setups and fragmented ecosystems make smart home technology intimidating and difficult to adopt.
3. **User:** A working professional
    - **Need:** Needs a way to control home appliances remotely and automate daily tasks
    - **Because:** They are often busy with work and household responsibilities, leaving little time for manual appliance management.
4. **User:** A family with mixed age groups (elderly and children)
    - **Need:** Needs smart appliances that are intuitive and safe for everyone to use
    - **Because:** Family members have varying levels of technical expertise and physical capabilities.
5. **User:** A tech-enthusiast homeowner
    - **Need:** Needs a unified smart home system that integrates devices from different brands
    - **Because:** Fragmented ecosystems require managing multiple apps, reducing overall convenience and user experience.

These POV statements provide a clear and user-centered direction for the design phase, ensuring solutions address real user needs identified in the emphasis stage. Let me know if you'd like further elaboration or visualization for your presentation!

Ideate

Brainstorming: Generating Ideas for Smart Home Appliance Transition

Using the brainstorming syntax and referring to the problem statement and solutions from the provided PDF, the following content is created:

1. Set the Stage

- **Environment:**
  A collaborative and relaxed environment was created to foster creativity. The brainstorming team included designers, engineers, and potential users to ensure diverse perspectives.
- **Ground Rules:**
  - Encourage all ideas, no matter how unconventional.
  - Avoid criticism or judgment during ideation.
  - Focus on addressing user pain points and aligning with the problem statement.

2. Ideate

A rapid idea generation session was conducted to address key problems identified in the PDF:

- **Addressing High Costs:**
  - Modular upgrade kits to convert traditional appliances into smart ones at a lower cost.
  - Offer basic, budget-friendly smart devices with essential functionalities.
- **Simplifying Setup:**
  - Develop plug-and-play smart modules that integrate seamlessly with existing systems.
  - Provide installation tutorials using AR or app-based guidance.
- **Solving Fragmented Ecosystems:**
  - Build an all-in-one app that integrates appliances from multiple brands.
  - Use a universal smart home hub compatible with diverse devices.
- **Improving Usability:**
  - Develop voice-controlled systems with multilingual support for broader accessibility.
  - Design intuitive apps with simplified navigation for non-tech-savvy users.

3. Build on Ideas

- Combining ideas:

    - Merge modular upgrade kits with a plug-and-play setup to create a hassle-free upgrade process.
    - Integrate voice-controlled systems into the universal smart home hub for seamless operation.
- Expanding ideas:
    - Introduce subscription-based plans to reduce the upfront cost of smart devices.
    - Add real-time troubleshooting support in the all-in-one app for quick issue resolution.

4. Evaluate

The generated ideas were evaluated based on the following criteria:

- **Feasibility:** Can it be implemented using current technology and resources?
- **Cost-effectiveness:** Does it address affordability concerns?
- **User-friendliness:** Will non-tech-savvy users find it easy to adopt?
- **Impact:** Does it address multiple pain points effectively?

Top Ideas Selected for Development:

1. Modular upgrade kits with plug-and-play functionality.
2. A universal smart home hub with voice-controlled integration.
3. A budget-friendly subscription model for smart devices.
4. An all-in-one app for managing appliances from different brands.

SCAMPER: Examining the Smart Home Transition Problem

1. Substitute

- **Problem Area:** Expensive smart appliances and complex integration.
- **Substitution Idea:** Replace traditional high-cost smart appliances with modular upgrade kits to retrofit existing appliances, enabling smart functionality without a complete replacement.
- **Example:** Use ESP32-based plug-and-play modules instead of proprietary smart systems.

2. Combine

- **Problem Area:** Fragmented ecosystems requiring multiple apps for device control.
- **Combination Idea:** Merge a universal smart home hub with an all-in-one app that integrates multiple brands and allows centralized control.
- **Example:** Combine voice-control functionality with manual app controls in one interface for accessibility.

3. Adapt

- **Problem Area:** Non-tech-savvy users struggling with usability.
- **Adaptation Idea:** Adapt the existing interface with simplified modes (e.g., "Basic Mode" for beginners and "Advanced Mode" for tech-savvy users).
- **Example:** Use a visual, icon-based app design with drag-and-drop functionality to make device management intuitive for all users.

4. Modify/Magnify

- **Problem Area:** Lack of perceived value in smart appliances due to a weak cost-benefit ratio.
- **Modification Idea:** Enhance the appeal by adding features like energy tracking, which demonstrates savings over time, or real-time alerts for safety issues (e.g., gas leaks).
- **Example:** Magnify the use of existing sensors to also detect energy efficiency and notify users of high consumption.

5. Put to Another Use

- **Problem Area:** Single-purpose devices lack versatility.
- **Repurposing Idea:** Use smart home components like soil moisture sensors or gas detectors for broader applications.
- **Example:** Soil moisture sensors could also be used in industrial settings for environmental monitoring, and gas detectors could alert during kitchen or industrial leaks.

6. Eliminate

- **Problem Area:** High cost and complexity of system installation.
- **Elimination Idea:** Remove unnecessary steps in the setup process by creating plug-and-play devices that don't require advanced technical knowledge.
- **Example:** Eliminate the need for multiple wiring setups by using wireless connectivity for all devices.

7. Reverse/Rearrange

- **Problem Area:** Complicated device hierarchy in the parent-child controller model.
- **Reversal Idea:** Rearrange the hierarchy so that each "child" device can operate independently for critical functions, reducing reliance on the "parent" device during failures.
- **Example:** Design each child microcontroller to temporarily act as a parent when the central ESP32 is offline.

Mind Mapping: Exploring Connections for Home Connect

Here's a detailed representation of a mind map based on your **Home Connect** project from the PDF, structured with a central theme, branches, and sub-branches:

Central Theme:

"Transitioning to Smart Home Appliances"

Primary Branches and Sub-Branches:

1. User Challenges

- **High Costs**
  - Sub-branch: Limited affordability for middle-income families.
  - Sub-branch: High initial investment discourages users.
- **Setup Complexity**
  - Sub-branch: Non-tech-savvy users struggle with installation.
  - Sub-branch: Requires professional assistance for complex wiring.
- **Fragmented Ecosystems**
  - Sub-branch: Multiple apps for different brands.
  - Sub-branch: Lack of interoperability between devices.
- **Learning Curve**
  - Sub-branch: Complex interfaces intimidate users.
  - Sub-branch: Elderly and non-tech-savvy family members face difficulties.

2. Proposed Solutions

- **Cost-Effective Retrofits**
  - Sub-branch: Modular upgrade kits for traditional appliances.
  - Sub-branch: Subscription models to reduce upfront costs.
- **Simplified Installation**
  - Sub-branch: Plug-and-play devices.
  - Sub-branch: App-based setup guides.
- **Unified Ecosystem**
  - Sub-branch: All-in-one app for centralized control.
  - Sub-branch: Universal hub for managing devices from multiple brands.
- **User-Friendly Design**
  - Sub-branch: Intuitive interfaces with beginner and advanced modes.
  - Sub-branch: Voice-controlled systems for non-tech-savvy users.

3. Key Features

- **Automation**
  - Sub-branch: Threshold-based controls for temperature, humidity, and lighting.
  - Sub-branch: Customizable schedules for repetitive tasks.
- **Energy Management**
  - Sub-branch: Real-time energy tracking for appliances.
  - Sub-branch: Recommendations for reducing energy usage.
- **Safety Enhancements**
  - Sub-branch: Gas leak alerts with notifications and buzzer.

- Sub-branch: Vibration sensors for monitoring unusual activity.

4. Opportunities for Improvement

- **Scalability**
  - Sub-branch: Parent-child microcontroller system for distributed control.
  - Sub-branch: Independent operation of child nodes during parent node failures.
- **Personalization**
  - Sub-branch: Adaptive learning of user preferences over time.
  - Sub-branch: Multilingual support for voice commands.

Insights from Mind Mapping

1. **Connected Themes:** Cost, usability, and ecosystem integration are interconnected challenges that require combined solutions.
2. **Hidden Opportunities:** Expanding energy management and safety features can make smart appliances more appealing to users.
3. **User-Centered Innovation:** Personalized and adaptive systems can significantly enhance user experience, especially for diverse demographics.

Solution:

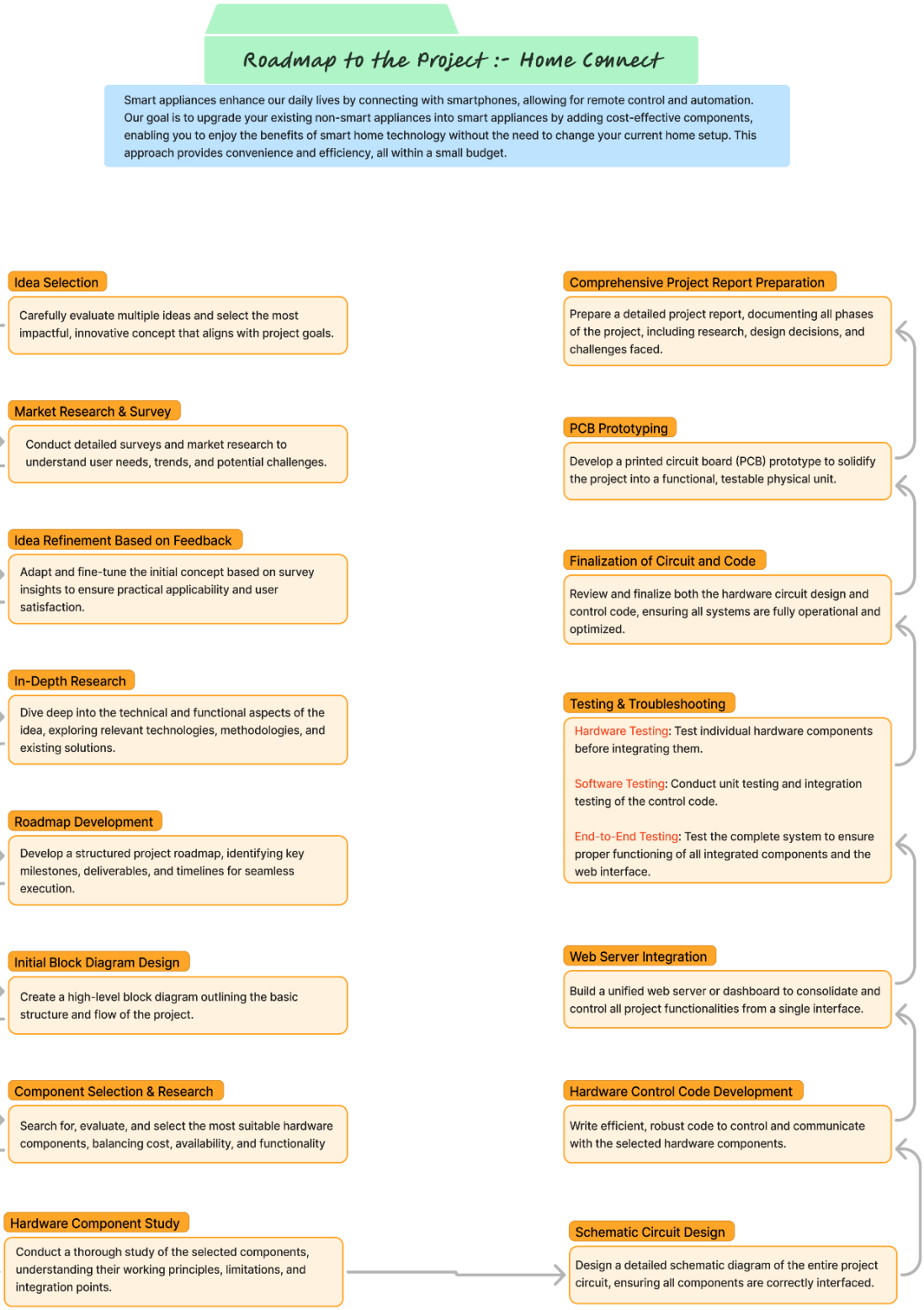
To make the transition from a traditional to smart environment practical and accessible, key hardware components serve as interfaces that convert standard appliances into smart devices. These components act as a bridge, allowing non-smart appliances to be managed through centralized control systems for automation and convenience.

A dedicated website provides centralized control over various processes, including switching lights on or off, regulating temperature and humidity, controlling a motor based on soil moisture levels, and more. This centralized approach offers a seamless way to manage multiple appliances.

The ESP32 microcontroller is used as the primary controller, handling inputs from sensors (such as moisture, light, temperature and humidity, and gas sensors) and controlling outputs (such as relays for lights, fans, motors, and alerts like a buzzer). The ESP32 is initially programmed and then connected to the website, which can be accessed via a unique IP address. This IP address enables real-time hosting across multiple devices simultaneously, providing flexible access and control.

We also added timers to show how much each components are working. We are implementing parent-child model. The team focuses on making smart home solutions affordable, centralized, and easy to use for diverse user groups, especially non-tech-savvy individuals.

Implementation Strategy:



Prototype

Key Features:

1. **Real-Time Updates:** Sensor values, like temperature, humidity, and light intensity, are updated in real-time, providing accurate and timely data for monitoring and control.
2. **Dual Control Options:** The system supports both manual and automatic control:
    - *Automatic Mode*: Set threshold values for each device, allowing automatic responses to changes in sensor readings.
    - *Manual Mode*: Use intuitive switches to control devices directly from the interface.
3. **Adjustable Thresholds:** Customize threshold values based on personal comfort or requirements, enabling precise automatic control.
4. **Real-Time Monitoring:** View up-to-the-minute data such as temperature, humidity, light intensity, heat index, and soil moisture, all from a single interface.
5. **Secure Access Control:** Each device can be assigned a unique ID and password, allowing restricted access if desired. This helps maintain privacy and control.
6. **Multi-User Access:** For shared environments, multiple users can connect to the device via Wi-Fi, offering centralized control from any authorized device.
7. **User-Friendly Website Interface:** The web interface is designed to be straightforward and easy to use, making smart home management accessible to everyone.
8. **Gas Leak Alerts:** In case of gas leakage, the system sends immediate alerts through the website, enhancing safety and providing peace of mind.
9. **Parent-child Relationship:** All components are connected in a well organized in a child microcontroller and child microcontroller are connected to parent microcontroller which takes final call.
10. **Timer:** It will count the time till what the components are turned on from the time of turning on the main supply.
11. **Laundering Notification:** It will sense vibrations from washing machines and turn it off and on when needed.
12. **Security Features:** Using LDR light sensors for detecting unusual movements.
13. **Weather Conditions:** Checking weather outside and maintain proportional temperature inside the house according.

This setup offers a practical and accessible path to smart home functionality, enabling centralized, efficient, and safe control over multiple home systems.

Hardware Components:

1. **ESP32 Microcontroller:** The main control unit, connecting all sensors and actuators for centralized automation. ESP-WROOM-32 ESP32. The ESP32 is integrated with Antenna switches, RF Balun, power amplifiers, low-noise amplifiers, filters, and management modules,

and the entire solution occupies the least area of PCB. 2.4 GHz Wi-Fi plus Bluetooth dual-mode chip, with TSMC Ultra-low power consumption 40nm technology, power dissipation performance, and RF performance is the best, safe and reliable, easy to extend to a variety of applications.

Features:
1. High performance-price ratio
2. Small volume, easily embedded to other product

2. **9 V battery:** Provides the necessary power to the 4-Channel Relay and other connected components. A **9V battery** is a compact, rectangular battery commonly used to power small electronic devices like remotes, smoke detectors, and sensors.

Known for its portability and reliable energy output, the 9V battery is widely used in low-power circuits and prototyping, especially for devices requiring consistent voltage over short durations.

3. **Methane Gas Sensor(MQ-9 Methane LPG Sensor Module):** Monitors gas levels to detect and alert for any gas leaks.

The sensitive material of the MQ-9 gas sensor is tin Oxide (SnO2), which with lower conductivity in clean air. When the target combustible gas exists, The sensor's conductivity is higher along with the gas concentration rising. Please use a simple electro circuit, Convert the change of conductivity to the corresponding output signal of gas concentration.MQ-5 gas sensor has a high sensitivity to Methane, Propane, and Butane, and could be used to detect both Methane and Propane. The sensor could be used to detect different combustible gas especially Methane, it is with low cost and suitable for different application.

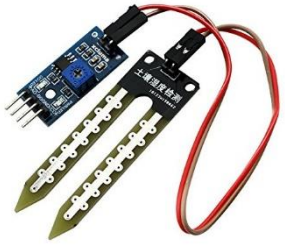
Features :

1. High sensitivity to LPG, natural gas, town gas.
2. Small sensitivity to alcohol, smoke.

4. **Temperature & Humidity Sensor(DHT11):** Measures ambient temperature and humidity for climate control. The DHT11 Humidity & Temperature Sensor Module is a basic, low-cost digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air and outputs a digital signal on the data pin (no analog input pins needed). Its very simple to use, and libraries and sample codes are available for Arduino and Raspberry Pi.

This DHT11 Humidity & Temperature Sensor Module makes is easy to connect to an Arduino or microcontroller as it includes the pull-up resistor required to use the sensor. Only three connections are required to be made to use the sensor– Vcc, Gnd, and Output. We have also included the cables required to connect the DHT11 to a microcontroller.

5. **Soil Moisture Sensor:** Tracks soil moisture levels, allowing automated watering for plants.

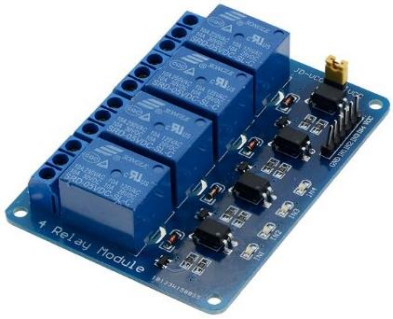


This Capacitive soil moisture sensor measures soil moisture levels by capacitive sensing rather than resistive sensing like other sensors on the market. It is made of corrosion-resistant material which gives it excellent service life. Insert it into the soil around your plants and impress your friends with real-time soil moisture data.

6. **Light Intensity Sensor (5mm LDR Sensor Photoresistor Photo Cell):** Detects light levels, enabling control of lighting based on ambient conditions. A photoresistor is a resistance made of a semiconductor material whose conductivity changes with the change of illuminance. This feature is used to make photoresistors of different shapes and light-receiving areas. Photoresistors are widely used in toys, lamps, cameras, and other industries

Feature:
1. Epoxy encapsulation
2. Good reliability
3. Small size
4. High sensitivity

7. **4-Channel 5V Relay Module:** Controls multiple appliances such as lights, fans, and the motor.



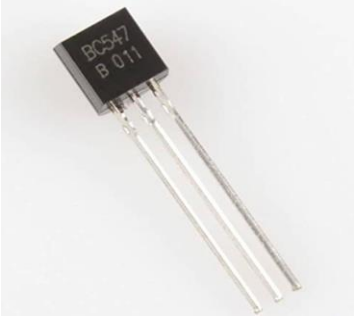
8. **Buzzer 5V-12mm-HYDZ-PCB Mountable:** Alerts users in case of emergencies, like gas leaks or other threshold breaches.

9. **Motor(Horizontal Submersible Pump):** Used for various automated functions, such as irrigation.

This DC 3-6 V Mini Micro Submersible Water Pump is a low-cost, small-size Submersible Pump Motor that can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA. Just connect the tube pipe to the motor outlet, submerge it in water, and power it.

10. **LED:** Provides visual indicators for system status and alerts.

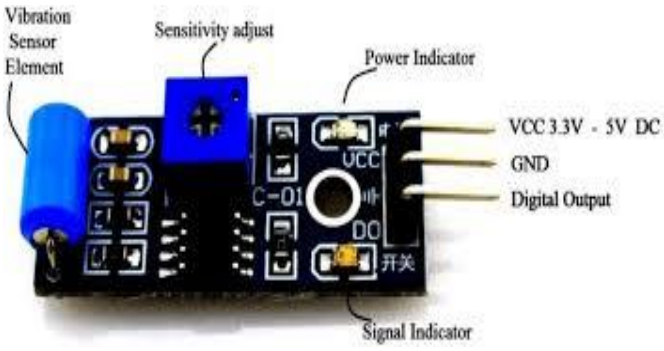
11. **BC547 NPN DIP Transistor:** The BC547 is a commonly used NPN bipolar junction transistor (BJT) available in a DIP (Dual Inline Package) configuration.



Here are some key features and specifications: The BC547 transistor is widely used due to its versatility, affordability, and ease of use in various electronic circuits, especially in hobbyist and educational projects.

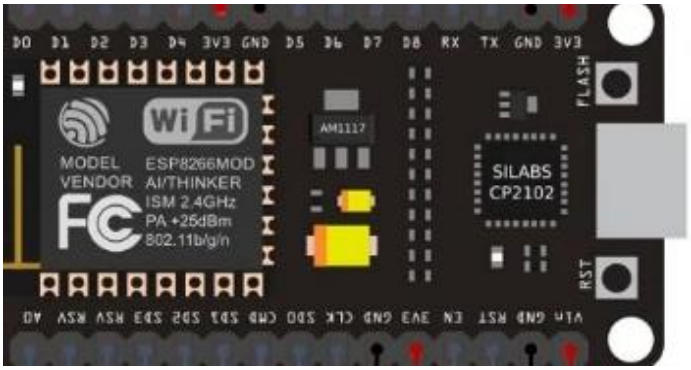
12. **1N4007 1W Diode:** 1N4007 1W Diode (Pack of 30) is a general-purpose silicon diode. AC adapter in a common household appliance is the most common application.

13. **Vibration Sensor:** For washing to detect it is on or off.



14. **330 Ohm 1WMetal Film Resistor:** We have 330 Ohm 1WMetal Film Resistor (Pack of 40) for through-hole applications. These WMFseries Metal Film Resistors are manufactured using the latest Magnetron Vacuum Sputtering System and are insulated with layers of lacquer ensuring a very stable resistive medium having a very low-temperature coefficient.

15. **ESP8266:** Child microcontroller for sensor reading from vibration sensors, LDR and extra switch for light/fan. Collect the sensor reading and send it to the parents. Parents reads the data and send the commands back to child.

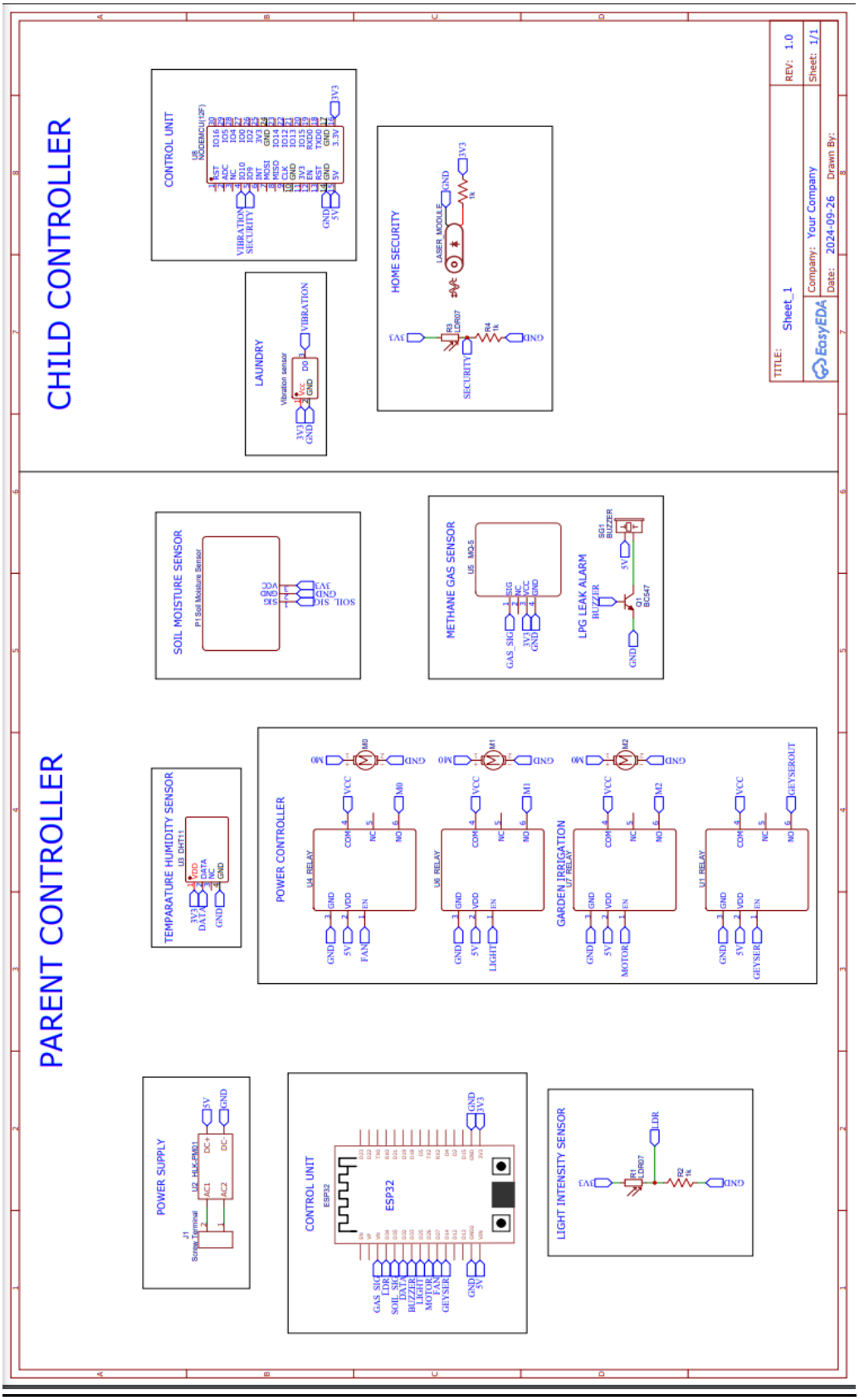


The ESP8266 module enables microcontrollers to connect to 2.4 GHz Wi-Fi, using IEEE 802.11 bgn. It can be used with ESP-AT firmware to provide Wi-Fi connectivity to external host MCUs, or it can be used as a self-sufficient MCU by running an RTOS-based SDK.

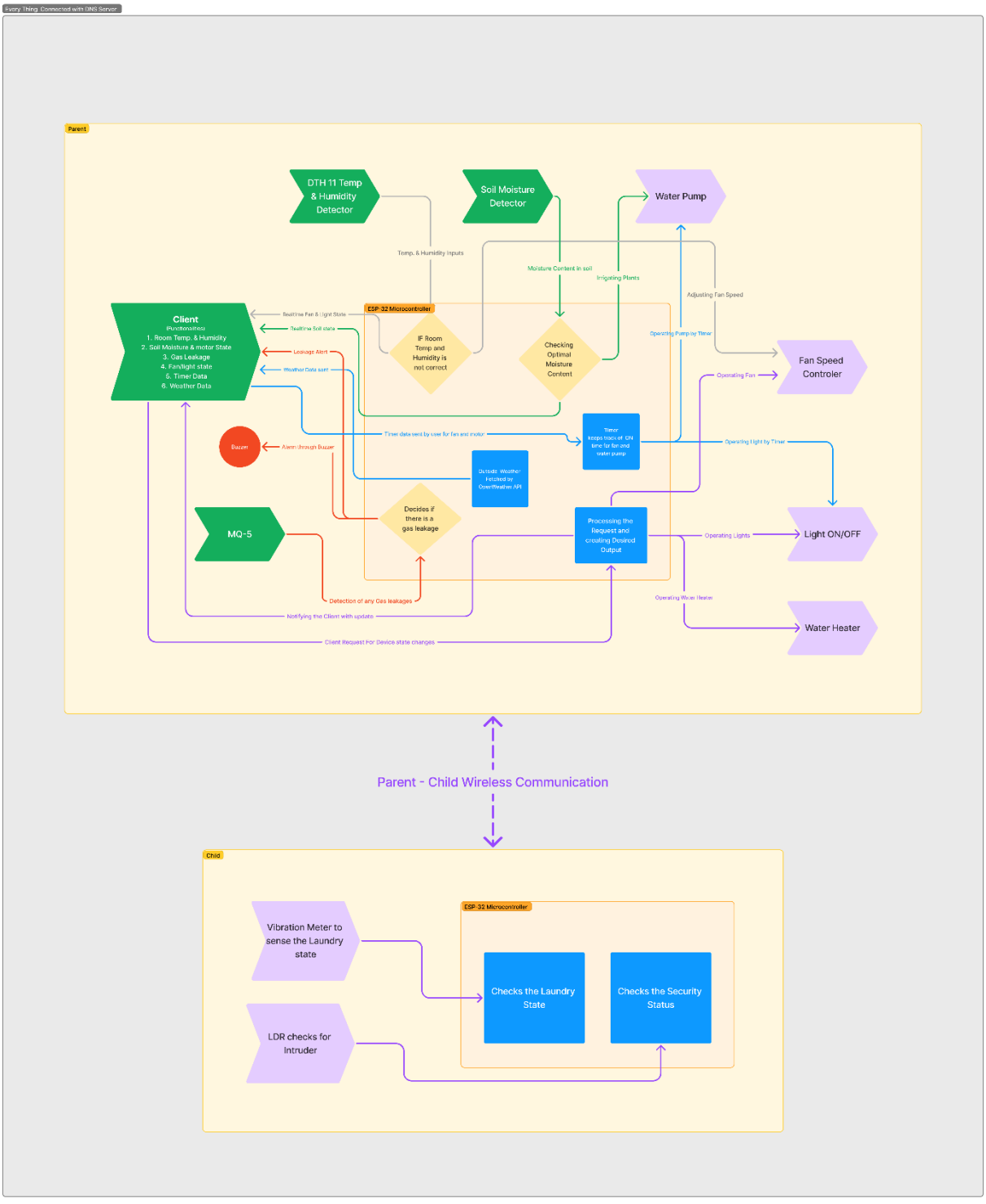
Software Components:

1. **Arduino IDE:** Used to program and upload code to the ESP32 microcontroller.
2. **VS Code:** Primary code editor for developing and managing the project's codebase.
3. **HTML, CSS, and JavaScript:** Build and style the web interface, enabling real-time control and monitoring of devices.
4. **C/C++ Language:** Core programming languages used in the Arduino IDE to control sensor readings, manage outputs, and handle logic for automated functions.

Circuit Design:



Block Diagram:



This block diagram represents the workflow and communication process for the Home Connect system, showcasing how sensors, controllers, and connected devices interact to enable smart automation. Below is a detailed explanation of each section and flow:

Top Layer (Parent Controller)

Client

The client acts as the user interface for monitoring and controlling devices.

- **Inputs and Outputs**:
  - Receives real-time sensor data, including:
    - Temperature and humidity.
    - Soil moisture levels.
    - Gas leakage alerts.
    - Appliance statuses (e.g., lights, fans, and heaters).
  - Displays weather data for user reference.
  - Allows users to:
    - Manually override settings.
    - Set thresholds for automatic responses.

ESP32 Microcontroller

Central to the system, it processes data from sensors and executes automation rules.

- **Primary Functions**:
  - Analyzes temperature, humidity, and soil moisture inputs to decide:
    - Fan speed for cooling.
    - Water pump activation for irrigation.
  - Integrates with the gas sensor (MQ-5) to detect and alert users about gas leaks.
  - Notifies the client in real-time about device state changes.

Sensors and Devices:

1. **DHT11 (Temperature & Humidity Detector)**:
   - Monitors room temperature and humidity.
   - Adjusts fan speed or triggers other devices based on preset thresholds.
2. **Soil Moisture Detector**:
   - Checks soil conditions to decide if irrigation is required.
   - Activates the water pump accordingly.
3. **MQ-5 Gas Sensor**:
   - Detects gas leaks and communicates this to the microcontroller for action.
   - Sends alerts to the client.

Outputs:

- **Fan Speed Controller**: Adjusts the fan's speed depending on room temperature and humidity.
- **Light ON/OFF**: Controls lights based on user input or timers.
- **Water Heater**: Activates when temperature conditions require heating.
- **Water Pump**: Operates to irrigate soil when moisture content is low.

Timers:

- Track durations for operations like irrigation or lighting.
- Ensure safety by setting maximum runtime limits.

Bottom Layer (Child Controllers)

This layer handles specific auxiliary tasks such as laundry monitoring and home security, operating as child nodes in the parent-child wireless communication model.

Inputs:

1. **Vibration Meter**:
    - Senses vibrations from washing machines to determine laundry status (active/inactive).
2. **LDR (Light Dependent Resistor)**:
    - Detects light changes to monitor security (e.g., intruder detection).

ESP32 Microcontroller (Child Node):

- Processes data from sensors and checks:
    - **Laundry Status**: Identifies if the washing machine is running or idle.
    - **Security Status**: Alerts the system of any unauthorized activity detected via the LDR.

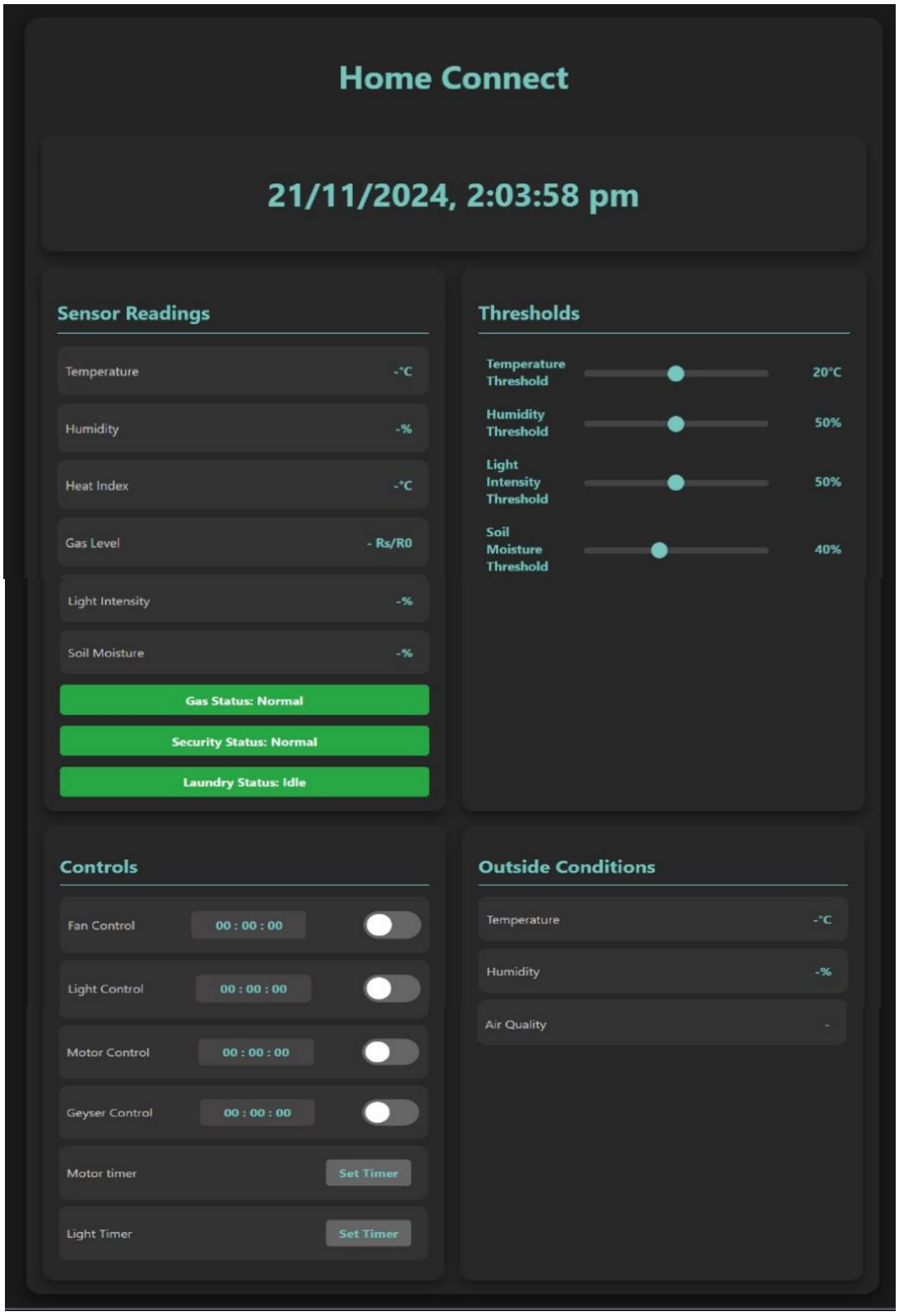
Communication:

- **Parent-Child Wireless Communication**:
    - The child ESP32 sends updates (e.g., security and laundry states) to the parent ESP32 for centralized decision-making and client notification.

Overall Workflow

1. Sensors continuously monitor environmental conditions (e.g., temperature, moisture, gas levels, light).
2. Data flows to the parent ESP32, which:
    - Processes the inputs.
    - Executes automation rules.
    - Sends updates to the client interface.
3. Child controllers handle specialized tasks (e.g., laundry monitoring, security) and communicate their results to the parent controller via wireless protocols.
4. Users interact with the client interface to monitor statuses or manually control devices.

Website Image:



Test

Working: Step-by-Step Guide to Set Up and Use the Smart Control System

Step 1: Load the Program onto the ESP32 Microcontroller

- Open the Arduino IDE and upload the program to the ESP32. This code will manage sensor readings, control logic, and network connectivity.

Step 2: Access the Website through a Unique IP Address

- After programming, use the unique IP address generated by the ESP32 to access the control website.
- The website can be hosted on a device whose ID and password is provided in program.
- To control multiple devices simultaneously, connect each device to the device's Wi-Fi and use the IP address to access centralized control.

Step 3: Set Up Your Desired Thresholds

- Configure the website's threshold settings to customize automatic responses for temperature, humidity, light intensity, and soil moisture levels.

Step 4: Monitor and Respond to Changes in Real-Time

- **Automatic Control:** As parameters change, automatic responses are triggered based on the conditions and thresholds you set:
  - **Gas Alert**: If the flammable gas level exceeds the safe limit, the *Gas Status* indicator changes to "Not Normal" (in red) and the buzzer sounds an alert.
  - **Temperature Control**: When temperature exceeds the threshold, the fan automatically turns on to cool the environment.
  - **Humidity Control**: If humidity surpasses the threshold, the fan is activated for air circulation.
  - **Lighting Control**: If light intensity exceeds the set threshold, the system automatically switches off the light.
  - **Irrigation Control**: When soil moisture drops below the threshold, the motor starts watering until the desired moisture level is reached.
  - **Heat Index**: Calculates the maximum safe temperature based on current temperature and humidity, adjusting as conditions change.

- **Manual Controls**: Use the website to manually manage device functions:
  - Turn the fan on/off.
  - Control the motor's operation.
  - Switch the lights on/off.

Step 5: Maintain Real-Time Updates and Automation

- ❖ Keep the connection active for real-time updates and for the system to automatically perform necessary functions based on the monitored parameters.

This setup allows seamless, centralized control of devices, providing both automatic and manual options for a fully responsive smart environment.

Challenges Faced:

1. **Voltage Compatibility for Components:**

- ➢ To ensure all components operate seamlessly, we selected parts with compatible voltage levels from the store.

2. **Data Synchronization Issue:**

- ➢ Initially, updates made on the website did not reflect correctly in the program, leading to operational failures. We resolved this by replacing byte-format data with JSON format, enabling more reliable and structured data transmission.

3. **Website Layout Enhancement:**

- ➢ The original website required excessive scrolling, making it challenging to view all functionalities at once and leading to wasted space. To improve user experience, we redesigned the website for a more compact, interactive layout that displays essential information efficiently.

4. **Replacement of Light Intensity Sensor:**

- ➢ The initial light intensity sensor was damaged, so we replaced it with a new one to restore functionality.

5. **PCB Fabrication for Component Management:**

- ➢ With multiple components involved, managing connections became cumbersome. We addressed this by fabricating key connections on a PCB, allowing components to easily connect via the board. This improved organization and ease of handling.

6. **Power Supply Issue**

- ➢ The Hi-Link HLK-5M05, which we initially considered as our primary power source, poses a safety risk due to its direct use of a 220V AC input to convert to 5V DC. Working directly with a 220V AC supply presents safety concerns.

Conclusion:

We successfully designed a functional prototype of the "Home Connect" system, achieving all intended features seamlessly. This system automates various tasks, simplifying daily routines and enhancing home safety. Home Connect efficiently handles essential functions that often require manual effort, such as watering plants and monitoring for hazards like gas leaks. Additionally, it streamlines routine operations, allowing users to control appliances like lights and fans without interrupting their workflow. This prototype demonstrates the potential of smart home automation to improve convenience, safety, and energy efficiency in everyday life.