PROJECT REPORT

AMAZING ACES

1. PROBLEM STATEMENT:

KNOB INTERFACE :

In modern households and offices, managing multiple appliances like lights and fans often requires physical interaction with multiple switches scattered across the premises. This can be particularly challenging for elderly individuals or people with mobility impairments who cannot easily access these switches.

Our goal is to develop a cost-effective, user-friendly **knob-based interface** that provides a centralized and accessible means of controlling non-smart domestic appliances (e.g., lights, fans) as well as compatible with smart devices.

While smart home solutions exist, they‘re often expensive and reliant on WiFi, hence in our prototype, we have focussed on connecting non smart devices particularly.

2. SCOPE OF THE PROBLEM:

The global population aged 65 and older is increasing rapidly, with projections estimating over 1.5 billion elderly people by 2050. Many individuals in this demographic experience physical limitations.

Limited mobility often leads to reduced independence and reliance on caregivers, which can affect the psychological well-being of elderly individuals and increase caregiving costs.

Moreover, millions of people worldwide live with mobility impairments, including wheelchair users, amputees, and individuals with chronic conditions such as arthritis. These challenges make everyday tasks a significant barrier.

2.1 INADEQUACY OF EXISTING SOLUTIONS:

Existing smart home solutions are often expensive, complex, and reliant on internet connectivity, making them inaccessible to low-income households. Additionally, these

systems often ignore the needs of elderly users who require simple and intuitive designs. a significant segment of the population is left underserved, with no practical or affordable solutions to address their basic needs.

3. CONCEPTS AND THEORIES:

3.1 WIRELESS ESP-NOW PROTOCOL:

ESP-NOW is a low-power wireless protocol introduced by Espressif Systems, specifically for direct peer-to-peer communication between ESP32 modules. It is optimized for fast, lightweight communication without the need for traditional Wi-Fi networking.

The transmitter module (rotary encoder) uses ESP-NOW to send control signals (rotation direction and button events) directly to the receiver module.

The receiver interprets these signals to toggle relays that control the connected appliances.

The use of ESP-NOW ensures a fast, reliable, and efficient wireless connection, making the system independent of existing network infrastructure.

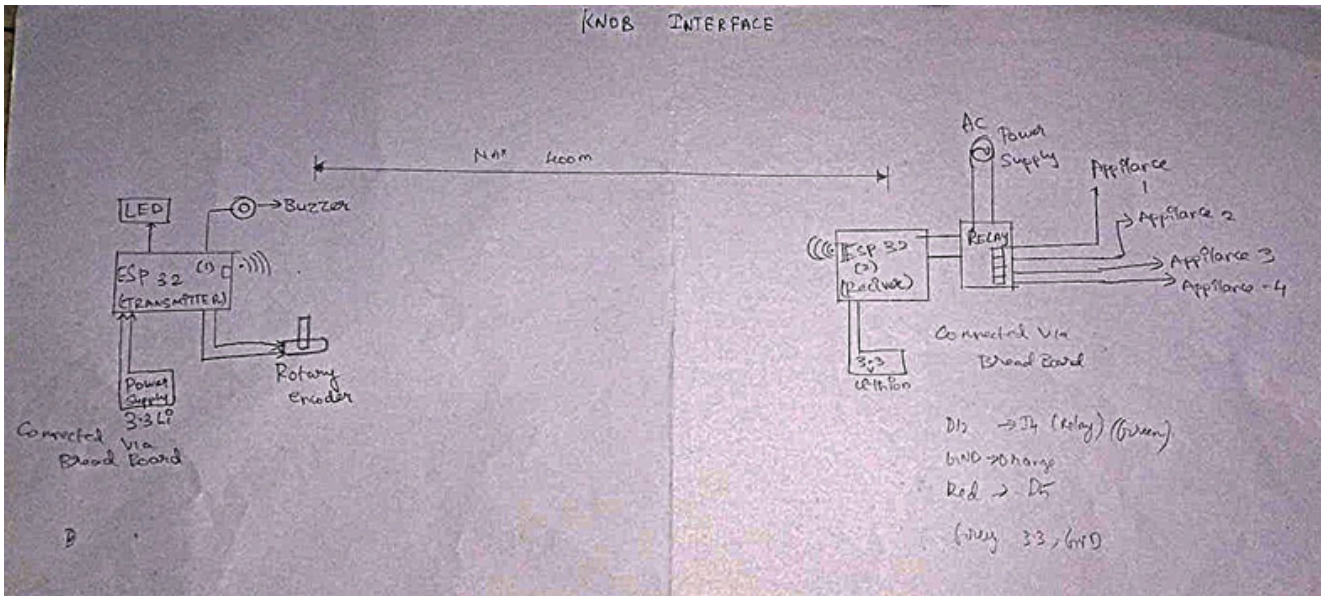
3.2 RELAY CONTROL PRINCIPLES:

A relay is an electromechanical switch used to control high-power circuits using a low-power signal, providing safe and efficient appliance control. The receiver module controls relays based on the data received from the transmitter.

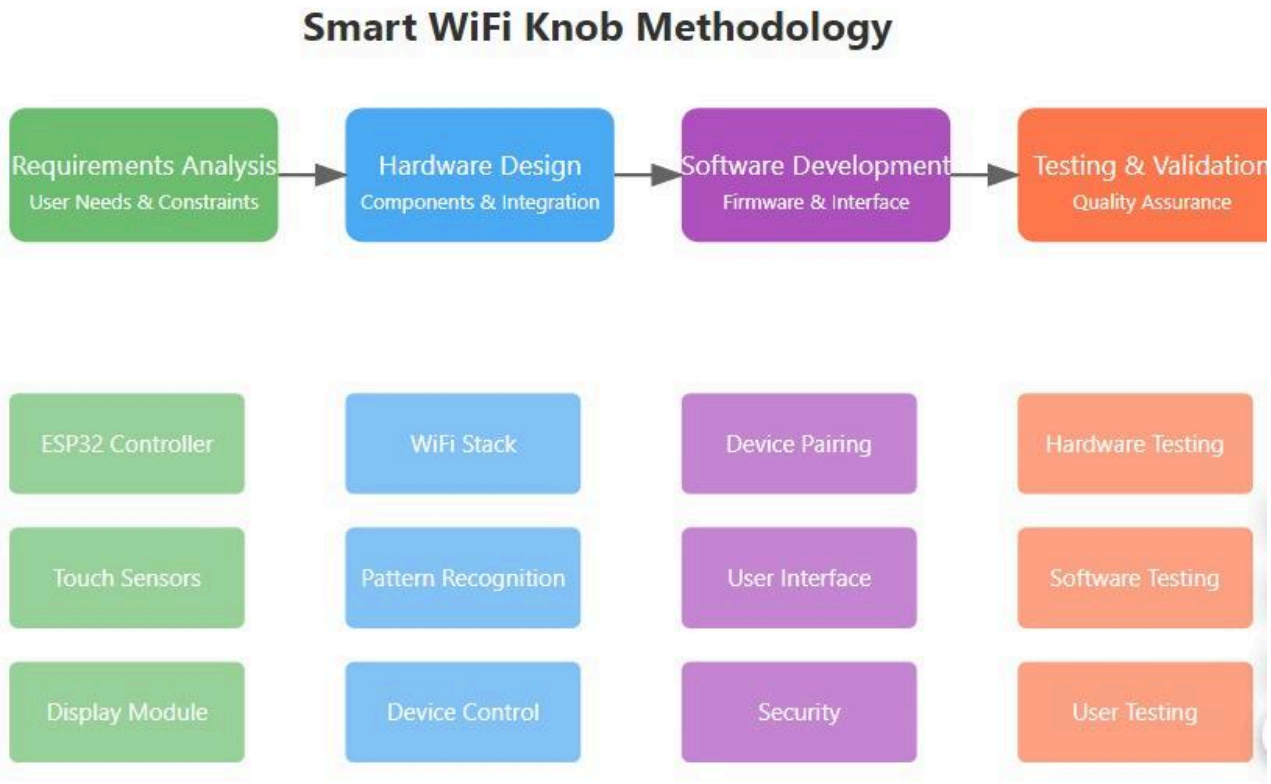
For example, in our prototype, rotating the encoder clockwise could activate a particular pin in transmitter, travelling to receiver, which controls the particular relay that control MODE 1 devices (blue LED light and bulb)

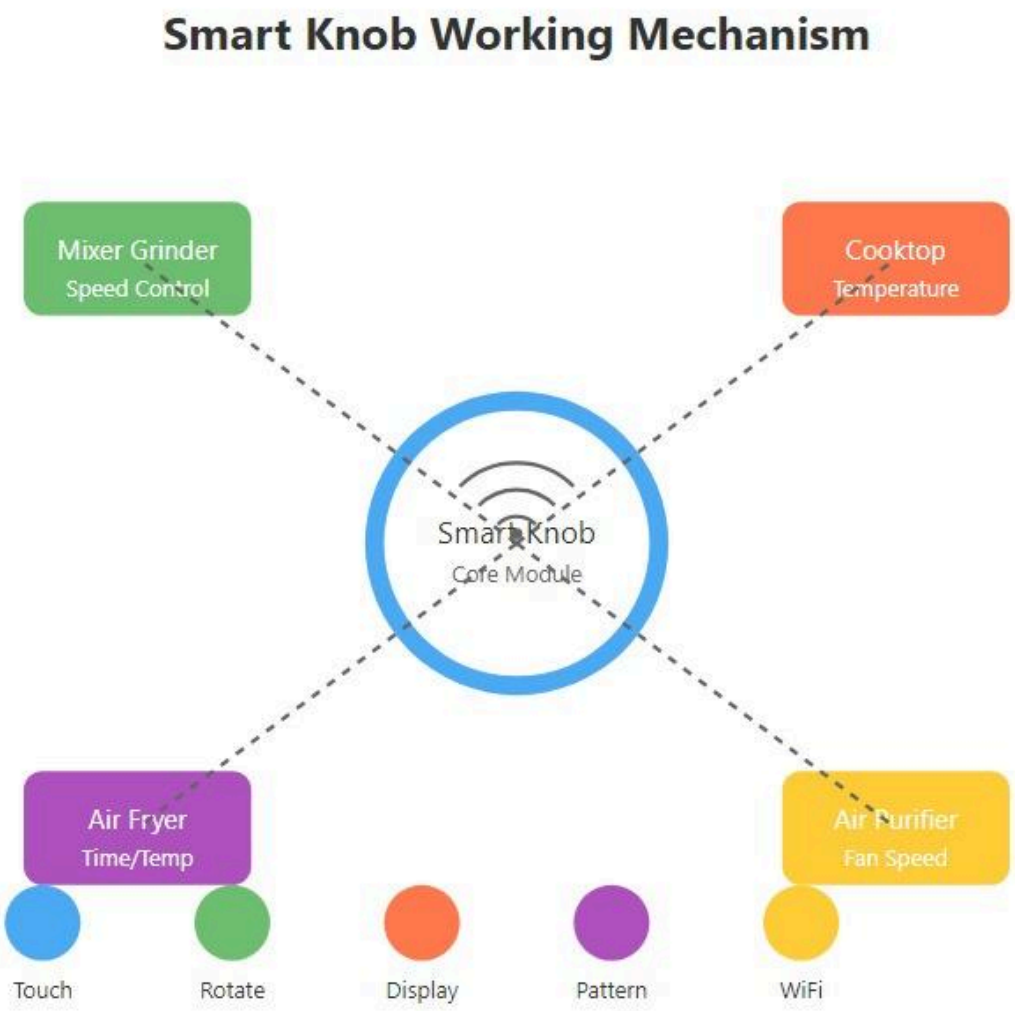
This mechanism ensures reliable, real-time control of appliances, providing flexibility to handle various devices with minimal complexity.

TECHNICAL SPECIFICATIONS (DIAGRAM)



4. FLOW OF OPERATIONS





1. User Input via Rotary Encoder (CW/CCW Rotation)

- Prototype:
    - Clockwise (CW) Rotation: Entering mode 1 (White LED and Bulb)
    - Counterclockwise (CCW) Rotation: Entering mode 2 (orange LED and pluggable blue bulb)
    - Feedback Mechanism: The buzzer provides an audible confirmation to the user that the input has been recognized for each turn of the encoder.
- Product (Expanded Functionality):
    - Different ranges within the rotation are mapped to control specific settings for different modes or appliances, ensuring a larger number of modes can be added.

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2. Transmission of Data Using ESP-NOW Protocol

- Functionality:

- The rotary encoder sends data about the direction of rotation (CW or CCW) and the current position to the transmitter.
- The transmitter sends this data wirelessly (Range: 400 m) to the receiver using the ESP-NOW protocol, ensuring low latency and efficient communication.

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3. Data Reception and Appliance Control

- Functionality:
  - The receiver module decodes the incoming data packet and determines the corresponding action based on the current mode and rotation direction.
  - The receiver then controls the particular relays for the particular mode, and subsequently the appliances.

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4. Button for Mode Switching and Additional Functions

· Product (Expanded Functionality):

  - The button can be used to switch off appliances, or to reset the encoder input data.

4.1 SAMPLE WORKFLOW (PROTOTYPE)

User Action: The user rotates the encoder clockwise (CW) to control lights in MODE 1

- Step 1: The rotary encoder sends the CW signal to the transmitter, the buzzer emitting sound to show rotation.
- Step 2: The transmitter wirelessly sends this data to the receiver.
- Step 3: The receiver decodes the data and adjusts the relay R1 controlling the specific lights, blue LED and white bulb.

5. VERIFICATION STEPS UNDERTAKEN FOR FEASIBILITY

5.1 HARDWARE TESTING:

Began by setting up a basic system using a rotary encoder and a single ESP module. The initial tests involved simple outputs such as a buzzer and an LED. This allowed us

to confirm the encoder's functionality and its ability to trigger changes in output based on rotation direction (Identifying issues with encoder readings)

Next, we integrated the ESP-NOW protocol to enable wireless communication between the transmitter and receiver. The receiver initially controlled a simple onboard LED to simulate appliance control, ensuring that the wireless data transmission between the devices was stable and reliable.

The system was further tested by integrating relays to control higher-power appliances. We connected the receiver-relay setup to an AC power supply and controlled actual light bulbs. This step validated the system's ability to manage household appliances that require more power than simple LEDs

2. WIRELESS PROTOCOL TESTING:

Tested communication range and latency by moving the transmitter and receiver further apart and monitoring the response time. The range, in theory, is 400 metres.

Tested the system in environments with walls and other obstacles to simulate real-world conditions.

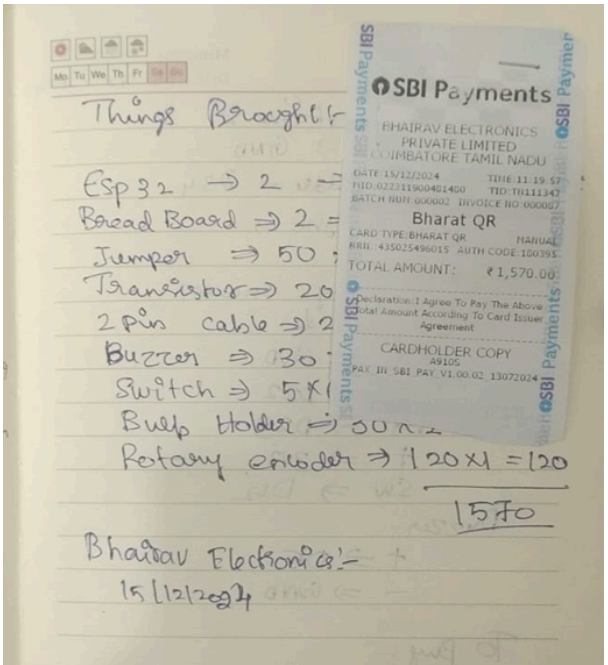
3. USER EXPERIENCE TESTING:

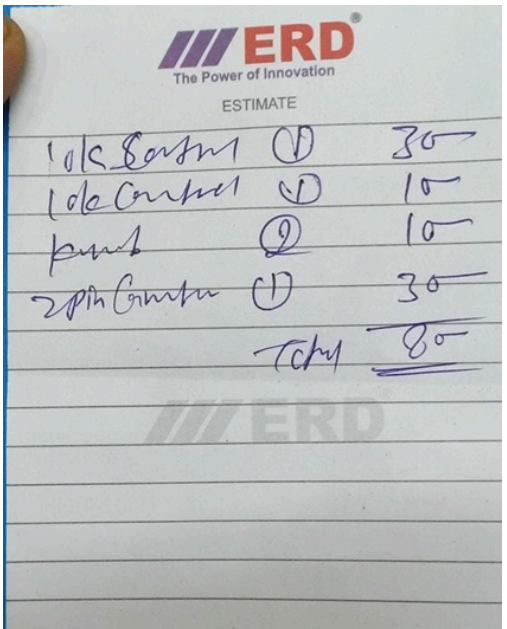
Tested the buzzer feedback mechanism to ensure it provided clear, audible signals upon each rotation or button press.

The system was deemed intuitive and user-friendly for controlling appliances from a seated position, such as a wheelchair.

6. FINANCIAL DETAILS:

The bills are attached below, total costing up to approx. ₹2,000 ± ₹200





6.1 COST ANALYSIS:

1. ELECTRONICS:

S.NO	COMPONENTS	COST
1	ESP 32 x 2	480 x 2 = 960
2	Bread Boards x 2	80 x 2 = 160
3	Jumper wires	50 x 3 = 150
4	Rotary encoder	120 x 1 = 120
5	Switch x 6	5 x 6 = 30
6	Buzzer	30 x 1 = 30
7	2 pin Cable	20 x 1 = 20
8	Transistor	20 x 2 = 40
9	Relays x 2	90 x 2 = 180
10	Bulbs + LEDS	Approx. 200

2. MISCELLANEOUS (AESTHETICS) : Chart paper; Cardboard box and other contingencies – approx. 150

7. UNIQUENESS OVER EXISTING SOLUTIONS:

1. The system is designed to control non-smart appliances, such as basic lights and fans, without requiring them to be "smart" devices.
2. The system can easily scale to control multiple appliances by adding more relays or adjusting the encoder’s functionality, without requiring significant hardware changes or upgrades. It offers flexible modes and range control for different appliances.
3. The rotary encoder in our model provides a simple, hands-on interface that does not require the precise touch control of a touchscreen, making it easier for users with dexterity or vision challenges.

4. Our model is designed to be compact and lightweight, making it easy to integrate into a wheelchair or carry around, offering a convenient and accessible solution for elderly individuals or those with limited mobility