Smart Pillow For snoring and sleep monitoring

Project Based Learning (PBL) Report
for the course
Internet Of Things- 20CS32001

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

By

G.Sadwika 22R11A05F3
K.Harshini 22R11A05F8
K.Srujani 22R11A05G0

Under the guidance of
E. Mahender

Department of Computer Science and Engineering
Accredited by NBA

Geethanjali College of Engineering and Technology
(UGC Autonomous)
(Affiliated to J.N.T.U.H, Approved by AICTE, New Delhi)
Cheeryal (V), Keesara (M), Medchal.Dist.-501 301.

MAY -2025

TABLE OF CONTENTS

INTRODUCTION

ABOUT THE PROJECT

Snoring during sleep is a widespread issue that can lead to disrupted sleep patterns, daytime fatigue, and even long-term health concerns. In severe cases, it can indicate sleep apnea, a condition requiring medical attention. The Smart Pillow for Snoring and Sleep Monitoring is a proactive solution developed using Internet of Things (IoT) principles to detect and gently correct snoring without disturbing the sleeper.

This system uses a sound sensor to detect snoring levels, and when detected beyond a certain threshold, it activates servo motors embedded within a pillow-like structure to shift the user's head gently. This subtle repositioning can help clear airway obstructions that cause snoring. Additionally, the system features a visual LED indicator and logs the snoring activity via serial output, providing a basic monitoring capability.

This PBL project aims to demonstrate how simple yet effective embedded systems combined with intelligent sensing can offer health-oriented automation. The smart pillow is designed to be compact, user-friendly, and cost-efficient, making it ideal for home-based deployment.

PROJECT OBJECTIVES AND OUTCOMES

Objectives:

- **Automated Snoring Detection:** Use a sound sensor to detect snoring patterns in real-time, automating the process of sleep monitoring without human intervention.

- **Automatic Intervention to Reduce Snoring:** When snoring is detected above a threshold, trigger servo motors to gently adjust the user's head position, encouraging a better breathing posture and minimizing snoring.

- **Real-Time Monitoring and Logging:** Collect and transmit real-time snore data via the serial monitor (or future cloud-based platforms) for medical analysis or sleep tracking.

- **Non-Invasive and Comfortable Solution:** Ensure user comfort through silent motor actions and minimal pillow movement, offering a non-disruptive and user-friendly sleep aid.

- **Intelligent Actuation Control:** Prevent repeated or unnecessary motor actions by using a motorsMoved flag, enabling energy efficiency and motor protection.

- **Safety and Low Power Consumption:** Design the system with safe voltage levels and controlled motor actuation, ensuring it's suitable for overnight use with minimal power consumption.

- **Affordable and Practical Sleep Aid:** Deliver a cost-effective snoring solution using ESP32 and commonly available components, making it accessible to a wide range of users with minimal maintenance needs.

Outcomes:

- **Improved Sleep Quality**

  Users experience better rest as the pillow automatically detects snoring and gently adjusts their head position to promote uninterrupted sleep.

- **Real-Time Snore Response**

  The system successfully identifies snoring through sound threshold detection and activates motors instantly, validating real-time actuation logic.

- **Increased User Comfort and Safety**

  Controlled and gentle motor movements ensure that the user's sleep is not disturbed, maintaining comfort and safety throughout the night.

- **Reliable Snore Monitoring**

  The analog sensor consistently detects snoring sounds, enabling trustworthy data collection and action triggering based on sound thresholds.

- **Reduction in Snoring Events**

  With timely motor interventions, the number of snoring episodes can be significantly reduced, contributing to better breathing patterns.

- **Minimized False Activations**

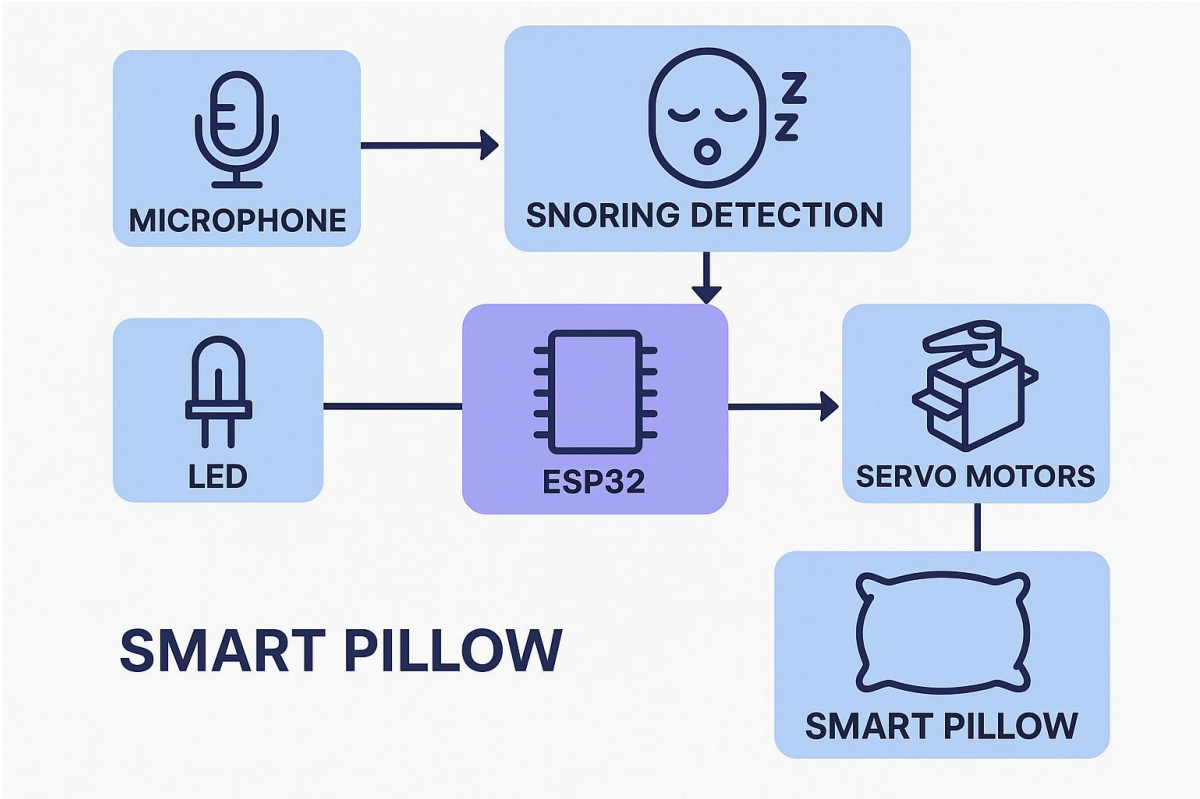
  Logic using a `motorsMoved` flag ensures that motors activate only when needed, preventing unnecessary movement and conserving power.

- **Foundation for Further Expansion**

  The working prototype lays the groundwork for future upgrades, such as data logging, cloud integration, or mobile alerts for caregivers or medical professionals.

SYSTEM DESIGN

SYSTEM ARCHITECTURE



The system architecture of the Smart Pillow consists of three main layers working together to detect and respond to snoring. At the hardware level, a sound sensor continuously monitors for snoring sounds. When snoring is detected based on a predefined threshold, the ESP32 microcontroller processes the signal and activates servo motors to gently adjust the pillow position, helping reduce snoring.

An LED provides real-time visual feedback, and the entire system operates independently without needing external servers or mobile apps. Optional data logging can store snoring event details for offline analysis. This standalone, sensor-driven design ensures the system is simple, responsive, and effective in improving sleep quality.

MODULES

1. Snoring Detection Module

Purpose: Detects snoring patterns in real-time using sensor input.

Key Features:

- Real-time analog sound detection using a microphone or sound sensor.
- Threshold-based triggering mechanism for snoring events.
- LED indicator for snoring detection confirmation.

2. Motor Control and Position Adjustment Module

Purpose: Gently adjusts pillow position to reduce snoring.

Key Features:

- Automatic activation of servo motors upon snore detection.
- Smooth sequential motion of the motors to change head posture.
- Reset and restore motion after snoring stops.

3. Sensor and Hardware Integration Module

Purpose: Manages interaction between sensors, motors, and ESP32.

Key Features:

- Integration of analog sound sensors for input.
- ESP32-based servo motor control and signal processing.
- Real-time interaction between hardware components.

4. Sleep Monitoring and Logging Module

Purpose: Records snoring data to analyze sleep quality.

Key Features:

- Logs timestamps of detected snoring events.
- Tracks frequency and duration of snoring episodes.
- Stores basic sleep behavior data locally (e.g., on SD card).

5. Notification and Alert Module

Purpose: Provides basic feedback to users or caretakers.

Key Features:

- LED or buzzer alerts during repeated snoring detection.
- Indication of system activity or potential malfunction.

6. Dashboard and Analytics Module (Local)

Purpose: Offers visual feedback through local displays.

Key Features:

- Displays count of snoring events via LCD/OLED screen.
- Summary of motor activations per night.
- Button-based navigation for reviewing previous sessions.

7. Support and Troubleshooting Module

Purpose: Assists users with operating and maintaining the device.

Key Features:

- Built-in error LED/blink patterns for diagnostics.
- Reset button and manual test functions.

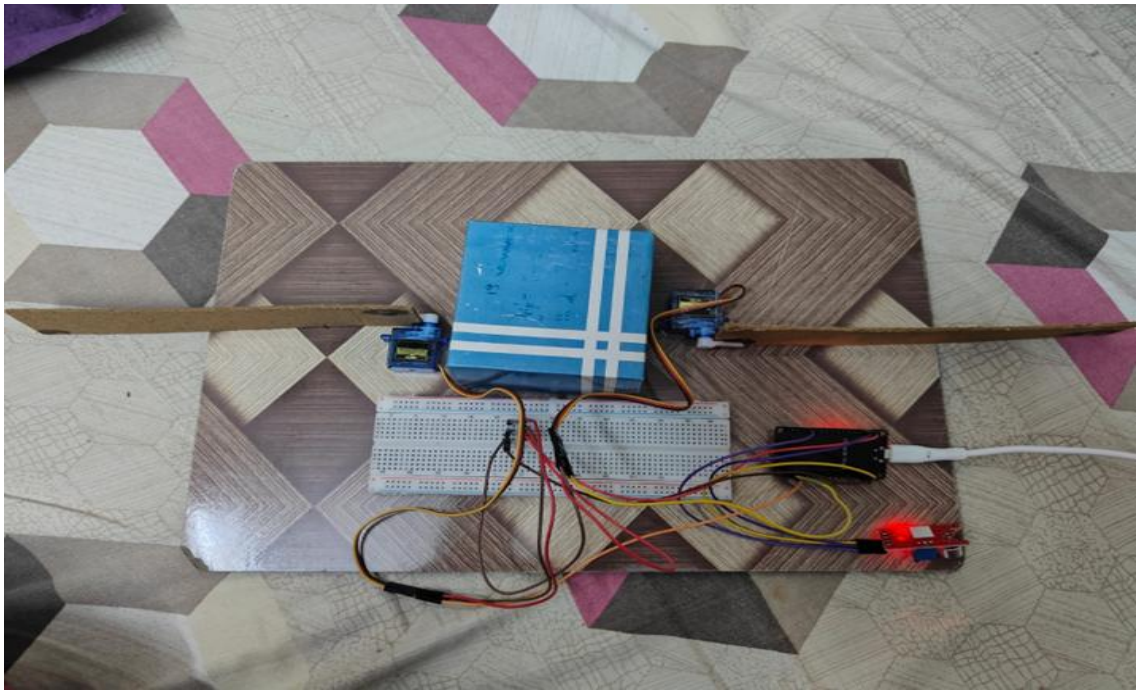
IMPLEMENTATION

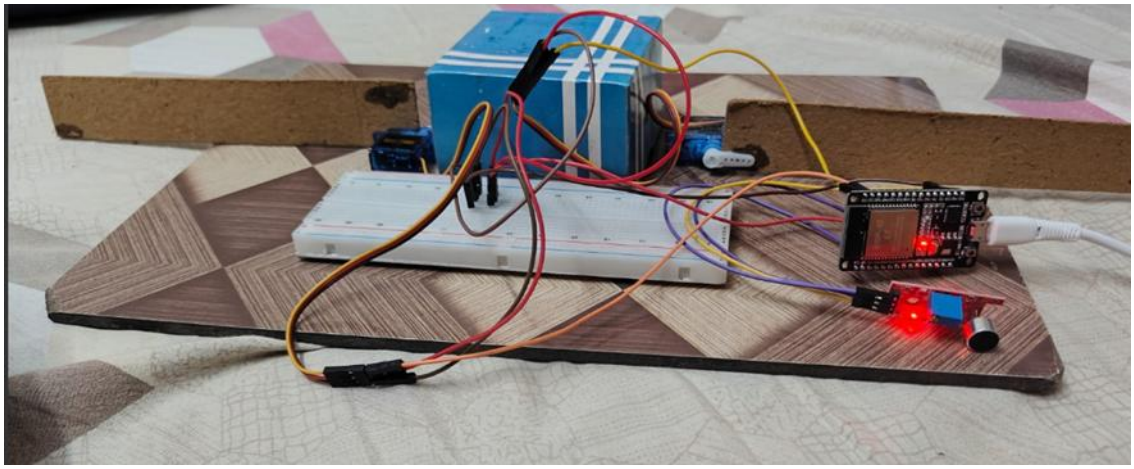
SAMPLE CODE

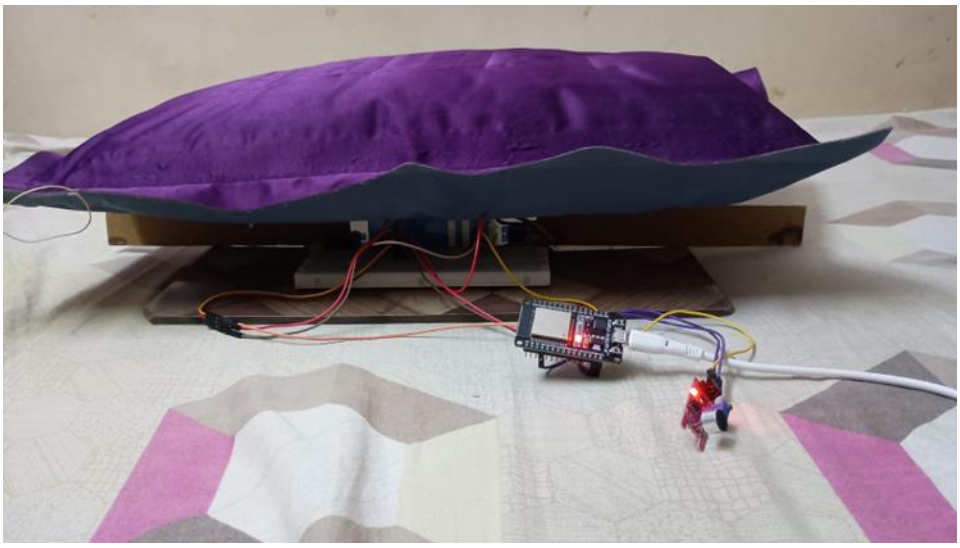
```
#include <ESP32Servo.h>

Servo motor1;
Servo motor2;

const int led = 2;          // LED pin
const int s = 34;           // Sensor pin (Analog input)
const int threshold = 2640;  // Threshold value for snoring sound detection
const int waitTime = 5000;   // Wait time in milliseconds (5 seconds)

// Flag to track if the motors have been moved
bool motorsMoved = false;

void setup() {
  // Start serial communication for debugging
  Serial.begin(9600);
  motor1.attach(23);        // Attach the first motor to pin 23
  motor2.attach(22);        // Attach the second motor to pin 22
  pinMode(led, OUTPUT);      // Set LED pin as output c
  pinMode(s, INPUT);        // Set sensor pin as input
}

void loop() {
  // Read the sensor value
  int ss = analogRead(s);

  // Print the sensor value to Serial Monitor for debugging
  Serial.println(ss);
```

```
  // Check if the sensor value exceeds the threshold (snoring detected)
  if (ss >= threshold && !motorsMoved) {
    digitalWrite(led, HIGH);   // Turn LED ON
    // First servo motor rotates to 90 degrees, then back to 0
    motor1.write(45);
    Serial.println("Motor 1 moved to 45 degrees.");
    delay(1000);              // Wait for 1 second
    motor1.write(0);
    Serial.println("Motor 1 returned to 0 degrees.");
    delay(1000);              // Wait for 1 second
    // Second servo motor rotates to 90 degrees, then back to 0
    motor2.write(45);
    Serial.println("Motor 2 moved to 45 degrees.");
    delay(1000);              // Wait for 1 second
    motor2.write(0);
    Serial.println("Motor 2 returned to 0 degrees.");
    delay(1000);              // Wait for 1 second
    // After both motors move, set the flag to indicate motors have been moved
    motorsMoved = true;
  }
  else if (ss < threshold && motorsMoved) {
    digitalWrite(led, LOW);    // Turn LED OFF
    // Ensure both motors are at their original positions when snoring stops
    motor1.write(0);
    motor2.write(0);
    Serial.println("Snoring ended! Both motors returned to 0 degrees
    motorsMoved = false;       // Reset the flag
  }
  delay(100);  // Small delay to avoid excessive processing
}
```

SAMPLE OUTPUT







CONCLUSION

The Smart Pillow System presents an effective, automated, and user-centric solution for detecting snoring and enhancing sleep quality. By utilizing sound sensors and servo motors controlled through the ESP32 microcontroller, the system actively responds to snoring events in real-time. The intelligent actuation of servo motors gently adjusts the user's sleeping position, promoting uninterrupted sleep without manual intervention.

This system not only minimizes the effects of snoring but also provides a foundation for future integration with sleep analytics, mobile notifications, and cloud-based health monitoring. Designed with simplicity, responsiveness, and reliability in mind, the Smart Pillow fosters better rest, reduces sleep-related disturbances, and contributes to long-term well-being. Ultimately, it exemplifies the potential of IoT-based innovation in personal health and lifestyle improvement.

REFERENCES

1. **Servo Motor Control with ESP32:**

   https://randomnerdtutorials.com/esp32-servo-motor-web-server-arduino-ide/

   Covers how to control servo motors using the ESP32 with sample code and wiring diagrams.

2. **Analog Sound Sensor with ESP32:**

   https://lastminuteengineers.com/sound-sensor-arduino-tutorial/

   Explains how sound sensors work with microcontrollers, how to set thresholds, and how to interpret sensor values.

3. **Snoring Detection and Smart Sleep Aids Research:**

   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7147783/

   A scientific article discussing snoring detection methods, wearable devices, and their effectiveness in improving sleep.