PROJECT ABSTRACT

Sleep Quality Monitor with Snore Detection using ESP32

A bedside sleep monitor that detects snoring on-device: a MAX9814 microphone with AGC feeds an ESP32 running energy-plus-periodicity analysis at ~8 kHz; snore events are timestamped (DS3231) and logged as metadata-only CSV to microSD, with a morning sleep report on an OLED. Delivered built-to-order with working prototype, firmware, wiring docs, report, PPT and viva kit.

01. Title

Sleep Quality Monitor with Snore Detection using ESP32.

02. Introduction / Background

Snoring is the sleep complaint people most want measured — 'how bad is it, really?' — yet the answer is usually a partner's estimate. Phone apps exist but upload bedroom audio to the cloud. The embedded alternative processes everything on-device: a sensitive electret microphone with automatic gain control feeds an ESP32, which analyzes the audio stream for the loud, quasi-periodic bursts characteristic of snoring. Only event metadata (timestamp, duration, peak level) is stored — raw audio is processed in RAM and discarded, making privacy structural rather than promised. This project implements that real-time audio pipeline on a microcontroller with honest, non-medical framing.

03. Problem Statement

People want quantified insight into their snoring without cloud-uploaded bedroom audio or expensive sleep studies. Students need a build demonstrating real-time DSP on a microcontroller — sampling, short-time energy analysis, adaptive thresholding, periodicity checks — plus timestamped data logging and a privacy-first architecture, with clear limits distinguishing wellness estimation from medical diagnosis.

04. Objectives

- Sample microphone audio at ~8 kHz into a rolling RAM buffer on the ESP32.
- Detect snore-like bursts with short-time energy plus periodicity analysis in 100 ms frames.
- Adapt the detection threshold to room background noise so fans and AC do not flood the log.
- Timestamp every event with a DS3231 RTC and log metadata-only CSV to microSD (no audio stored).
- Render a morning report on OLED: total events, loudest episode, longest quiet stretch, 0–100 heuristic score.
- Provide one-button start/stop operation usable in the dark.

05. Proposed Methodology

Stage one builds the audio front end: MAX9814 gain staging and verification of clean capture at bedroom sound levels. Stage two implements the detection algorithm — frame energy computation, adaptive threshold with slow background tracking, burst-pattern validation for periodicity — tuned against recorded snore-like test signals. Stage three adds the logging layer

(CSV on microSD, RTC timestamps), the morning-report aggregator, and the single-button session control, followed by multi-night bench validation of the full pipeline.

06. System Architecture / Working

At bedtime a button press starts sampling; the ESP32 fills a rolling buffer at ~8 kHz. Firmware computes short-time energy per 100 ms frame and checks for the loud-burst-plus-periodicity signature of snoring against an adaptive threshold that tracks room background. Confirmed events open and close with timestamps, duration, and peak level written to the microSD CSV. A long press at wake-up ends the session and the firmware aggregates the night into the OLED morning report. Raw audio never leaves RAM.

07. Hardware / Software Requirements

- ESP32 development board
- MAX9814 microphone amplifier module with electret mic
- DS3231 RTC module; microSD card module
- 0.96-inch OLED display (I2C); pushbutton
- 5 V USB power supply
- Arduino IDE, C/C++ firmware

08. Expected Outcomes

A working bedside monitor that logs snore events night after night as spreadsheet-ready CSV and presents a morning summary — with privacy guaranteed by architecture. The student can explain sampling, energy-based event detection, adaptive thresholds, and why metadata-only logging is a design decision, not an afterthought.

09. Applications

- Personal wellness: quantifying snoring across lifestyle changes
- Pre-clinic screening data: structured logs to show a doctor
- Shared bedrooms: objective data instead of partner estimates

10. Future Scope

- Cough vs. snore classification with a tiny on-device model
- Multi-night trend charts on a companion phone dashboard
- Environmental sensing (room temperature/humidity) correlated with events