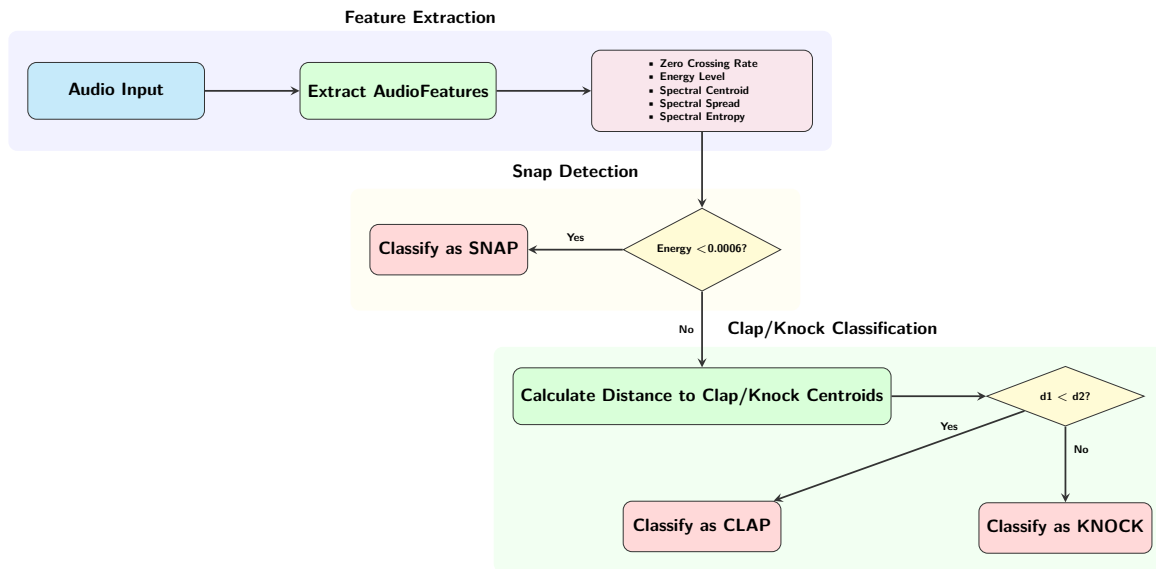


SOUND CLASSIFICATION ALGORITHM



HYBRID CLASSIFICATION APPROACH

Our system uses a hybrid approach combining rule-based and feature-based classification to distinguish between snap, clap, and knock sounds:

1. Impulse Duration Check (Noise Filtering)

- Calculates how long the loudest portion of sound lasts
- Rejects signals exceeding the `IMPULSE_DURATION` threshold
- Filters out noise, speech, and non-target sounds

2. Energy Threshold (Snap Detection)

- Evaluates total energy in the sound signal
- Snaps have distinctly lower energy than claps/knocks
- Quick classification based on `SNAP_ENERGY_THRESHOLD`

3. Feature-Based Classification (Clap/Knock)

- Extracts comprehensive feature vector from audio
- Compares against pre-calculated centroids using Euclidean distance
- Assigns label of closest matching centroid pattern

TECHNICAL DETAILS

Feature Extraction Process:

- **ZCR:** Captures frequency content and voice/unvoiced characteristics
- **Energy:** Quantifies overall intensity of the sound
- **Spectral Centroid:** Represents the "center of gravity" of the spectrum
- **Spectral Spread:** Measures bandwidth of the frequency distribution
- **Spectral Entropy:** Evaluates complexity of the spectral content

Centroid Calculation:

- Training data collected from multiple users
- Features extracted from labeled samples
- Centroid = mean of features for each class
- Distance measured as Euclidean distance in feature space

Advantages:

- Fast classification suitable for real-time gameplay
- Computationally efficient for embedded systems
- Robust against environmental noise variations
- Simple to train and implement in MATLAB