Experiment 8

Aim-Simulation of spectrum sensing using energy detection method in cognitive radio.

Software-Octave

Theory-

In Cognitive Radio (CR), the secondary user (unlicensed user) needs to detect whether the primary user (licensed user) is active or inactive on a certain frequency band before transmitting. One common method of spectrum sensing is energy detection, where the secondary user detects the presence of a signal based on the energy of the received signal.

Steps Involved:

Generate Primary User (PU) signal: If the primary user is active, generate a signal. Otherwise, the signal is zero.

Noise: Simulate an environment with noise (e.g., Gaussian noise).

Energy Calculation: Calculate the energy of the received signal.

Threshold Comparison: Compare the energy to a threshold to decide whether the PU is present or not.

Simulation Parameters:

N: Number of samples.

SNR: Signal-to-noise ratio.

H0 : Hypothesis that no primary user is active (only noise).

H1 : Hypothesis that the primary user is active (signal + noise).

Threshold: A value above which the received signal is considered to be coming from an active PU.

Parameters:

N: Number of samples taken to estimate the signal's energy.

SNR_dB: The signal-to-noise ratio in dB. It determines the strength of the PU signal relative to the noise.

threshold: A pre-defined energy value. If the calculated energy exceeds this threshold, the CR user assumes that the PU is active.

Primary User Signal:

If the primary user is active, a random Gaussian signal with a power corresponding to the specified SNR is generated.

If the primary user is inactive, the signal is set to zero (i.e., there is no transmission from the PU).

Noise:

Gaussian noise with zero mean and unit variance is added to the received signal to simulate a noisy channel.

Energy Detection:

The energy of the received signal is calculated as the sum of the squared magnitudes of the signal samples, divided by the number of samples. This gives the average energy of the signal.

The calculated energy is then compared to the threshold to decide whether the primary user is active or not.

Decision Making:

If the energy is above the threshold, it is assumed that the primary user is active, and the channel is occupied.

If the energy is below the threshold, the channel is assumed to be free, and the cognitive radio can transmit.

Visualization:

The received signal is plotted to visualize the signal's amplitude over time. This can help in understanding how the signal and noise interact.

Conclusion:-

Code In Octave(Don't write Code in writeup)

```
% Parameters
N = 1000;           % Number of samples for the signal
SNR_dB = -10;       % Signal-to-Noise Ratio in dB
threshold = 1.5;    % Detection threshold
PU_active = true;   % Primary User active or not (1 = active, 0 = inactive)

% Generate primary user's signal if PU is active
if PU_active
  PU_signal = sqrt(10^(SNR_dB/10)) * randn(1, N); % Scaled random signal
else
  PU_signal = zeros(1, N);                % No signal if PU is inactive
end

% Add Gaussian noise to simulate the noisy environment
noise = randn(1, N);  % Noise with mean 0 and variance 1

% Received signal (signal + noise if PU is active, otherwise only noise)
received_signal = PU_signal + noise;

% Energy Detection: Calculate the energy of the received signal
energy = sum(abs(received_signal).^2) / N;

% Threshold Comparison: Decide if PU is active based on energy
if energy > threshold
  disp('Channel is occupied by Primary User (PU)');
else
  disp('Channel is free, Cognitive Radio can transmit');
```

```
end

% Plotting the received signal for visualization
figure;
plot(received_signal);
title('Received Signal');
xlabel('Sample Index');
ylabel('Amplitude');
grid on;
```