SMART SENSOR FOR SPECTRUM OCCUPANCY DETECTION

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Abstract - Internet and communication play a significant role today. The primary can't use all the frequency they own. Effective communication is improved by identifying the vacant frequency and alerting the secondary user. A design to find the vacant frequency spectrum is presented in this study. The system recognizes the vacant frequency spectrum and alerts the secondary user to it. Spectrum sensing algorithm is based on Energy Detection Method. This theoretical approach finds the frequency spectrum that is not in use. It might lead to certain variations. We have created a system that includes a filter, an amplifier, a demodulator, and other components. LabView is used to implement this. The obtained curve is used as a practical value. The second user is informed via Arduino. This system effectively lowers costs. The design of this system allows for secondary users, such as bands with permits who are temporarily exploited in vacant spaces, to use it to its maximum efficiency and efficacy. Here, the curves derived from theoretical and real-world values are contrasted, and the outcome is shown.

***KeyWords*:** LavView, MatLab, Energy detection algorithm, Cognitive Radio, Spectrum sensing.

1.INTRODUCTION

For network providers, having a lightning-quick and dependable Internet connection is essential. Many of us utilise online services on a daily basis using our Internet-connected devices, such as our smart phones, PCs, smart TVs, and other products. Therefore, quick Internet access enables average customers to access a variety of services that are essential to our daily life. For the numerous Least Developed Countries (LDCs) and DCs, it is also a noteworthy development. Sadly, just 17.5% of people in LDCs and 41.3% of those in DCs currently have access to the Internet. The academic and commercial research communities are creating new broadband wireless technologies as a result. Wireless communication methods are often simpler and faster than conventional technologies. The radio spectrum resource, on the other hand, is fairly limited, and the traditional frequency allocation plan does not offer many chances for licenced users to be given access to a number of frequency bands. Unlicensed users frequently do not make the best use of the available resources, leaving open frequency bands. However, an open frequency range cannot be known to a secondary user. This is the impetus for the creation of a sensor that notifies a secondary user through Arduino when a frequency spectrum is free. This makes way for secondary users, including authorised bands that take advantage of vacant spaces for short periods of time.

The static spectrum allocation has produced many successful applications over the years, but it has also left little room for new services because practically all of the available frequency spectrum has been allotted to certain purposes. However, it has been demonstrated that the spectrum is actually underused, either in terms of time or space.Due to the issue of spectrum scarcity, researchers and operators are researching resource reuse strategies, introducing new frequency ranges, and making efficient use of the licenced spectrum. The radio frequencies allotted to the mobile industry and other industries for wireless communication are referred to as spectrum .Operators are pleading with national authorities to swiftly release enough inexpensive spectrum for mobile since the mobile industry has repeatedly shown its ability to produce economic value and social benefit. Mobile operators will be able to connect more users and provide quicker speeds thanks to additional frequencies, including both capacity and coverage bands.

It is suggested that new devices use the underutilized spectrum in an opportunistic manner, which is the core idea behind the cognitive radio (CR). Cognitive radio is a radio that is aware of the environment and can adapt the transmissions according to noise, interference, and channel variations. Awareness, cognition, and adaptation are three crucial properties of the cognitive radio system [8]. When a system is aware, it may measure and feel its surroundings, including whether the available spectrum is being used or not, the location of the radio source, the user profiles, and even the network's traffic and propagation characteristics. In fact, cognition demonstrates the capacity to process environmental data, which is essential for achieving the best system performance. The third idea is the use of SDR to let system parameters to be changed without altering the hardware of the system. These CR features show that the system is actually entirely dynamic, with its parameters, including frequency, transmit power, antenna layout, transmission protocol, modulation type, and more.

2.PROJECT OVERVIEW

The aim of this project is to create a spectrum sensing system that employs an energy detection algorithm to find unused frequency spectrum that primary users have left behind and to inform secondary users of that information. The system will be built to more effectively use the spectrum that is available and enhance overall communication capabilities.

Energy detection algorithm research and analysis: This will entail a thorough investigation of energy detection method and its applicability for the project. The algorithm's benefits and drawbacks will be assessed, and its effectiveness will be contrasted with that of alternative spectrum sensing methods.

A system that can accurately identify vacant frequency spectrum left by primary users will be built and developed based on the energy detection method that has been chosen. The system will be capable of handling various primary user kinds and spectrum situations, and it will be optimised for effective detection.To assess the performance of the constructed system, simulation tools like MATLAB will be used. In the simulation, blocks will be created to represent primary users transmitting signals in various frequency bands, and the energy detection technique will be utilised to find any unused spectrum that primary users have left behind.The simulation's outcomes will be evaluated against known unoccupied. To offer real-time data on available free spectrum, the spectrum sensing system will be integrated with secondary user devices like cognitive radios. Additionally, the system will be built to support dynamic spectrum access, allowing supplementary users to utilise the available spectrum for communication.System testing and evaluation: The system will be put to the test in a variety of settings to see how well it works at identifying unoccupied frequency spectrum and relaying that information to auxiliary users. The system will be judged on its precision, effectiveness, and capacity to manage various primary user types and spectrum situations.

The overall goal of this research is to create a system for efficiently detecting vacant frequency spectrum left by primary users and improves overall communication capabilities. By using energy detection algorithm and simulating the system, the performance of the system can be evaluated and compared to known unoccupied frequency spectrum.

3.PROBLEM STATEMENT

Primary users inefficient usage of frequency spectrum results in underutilization of the spectrum that is accessible. As a result, secondary users have less spectrum to use, which reduces their ability to communicate. The objective of this project is to create a reliable system for sensing unoccupied frequency spectrum left by primary users and relaying that information to secondary users so they can make better use of the spectrum that is already available and enhance communication capabilities.

4.EXISTING METHODOLOGY

Existing spectrum sensing techniques include the following:

1. Energy Detection: In this technique, the energy of the received signal is measured in order to determine whether a signal is there in a particular frequency band. To establish whether the frequency band is being used by a primary user or not, the energy detector compares the observed energy to a predetermined threshold.

2. Cyclostationary Feature Detection: This technique looks for the presence of a primary user by analysing the cyclostationary characteristics of a signal. The detector examines the signal at various time delays and frequency for cyclic correlations.

3. Matched Filter Detection: This technique looks for the presence of the principal user by matching a filter to their known signal. To assess whether or not the frequency band is occupied, the filter output is contrasted with a threshold.

4. Wavelet Transform: In this technique, the spectral components of a signal are analysed to determine whether a primary user is present. The presence of a principal user can be determined via the wavelet transform, which can also identify the spectral properties of the signal that are distinct from the noise.

5. Eigen value-Based Detection: This technique determines whether a primary user is present by analysing the eigen values of the signal that was received. The detector estimates the noise subspace and the signal subspace using the eigen values, signals enable more accurate frequency analysis of the vibration. The rearmost MEMS vibration detector offers a bandwidth of over 6 kHz which will be bandied latterly.

Existing method of spectrum sensing using any of the above spectrum sensing algorithm to detect the unoccupied frequency spectrum and it is connected to SDR and the result is obtained.

5.PROPOSED METHODOLOGY

The performance of the energy detection algorithm under actual circumstances is assessed by simulating the system with LabVIEW in order to compare it to practical simulation. The spectrum sensing system must first be designed in LabVIEW. In order to do this, the energy detecting algorithm must be chosen, and the required software building pieces must be developed. A graphical user interface (GUI) for user interaction and display of the simulation findings should also be incorporated into the system architecture. Simulate the Spectrum Sensing System: To identify the free frequency spectrum left by primary users, the spectrum sensing system can next be simulated in LabVIEW. The GUI may show the simulation results in real-time, indicating which frequency bands are occupied and

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which are vacant. Use LabVIEW to develop the energy detection technique and apply it to the simulated signals to find any unused frequency spectrum that the principal users have left behind. The simulation findings and the outcomes of the spectrum sensing system can be contrasted.To assess the system's accuracy, simulation data from the energy detection algorithm and the spectrum sensing system can be compared. Different performance indicators, including as detection probability, false alarm probability, and receiver operating characteristic (ROC) curves, can be used to make this comparison.The spectrum sensing system can be optimised for better performance based on the comparison's findings. To better manage various primary user types and spectrum situations, this may entail altering the detection threshold, the algorithm, or the software blocks. Implement the Optimised System: Finally, to further assess the precision and efficacy of the system, the optimised spectrum sensing system can be put into practise in a real-world setting and compared to the simulation findings.

6. BLOCK DIAGRAM

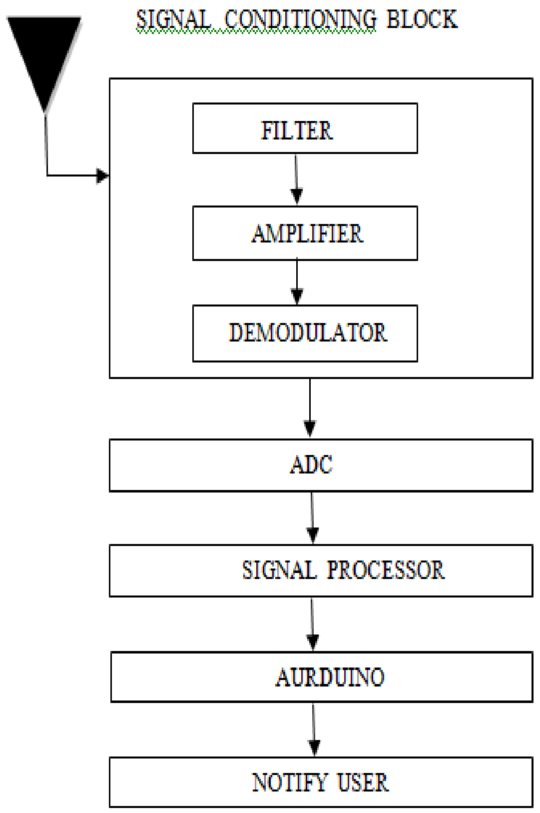

Fig 1 Block Diagram

7. BLOCK DIAGRAM DESCRIPTION

Incoming signal is received through antenna. The signal received from antenna is conditioned by signal conditioning block, This block contains filter, low noise amplifier and demodulator. Low pass filter is used here. It filters the incoming signal to reduce its bandwidth and choose the desired channel. Filtered signal is amplified by low noise amplifier. A demodulator receives an amplified signal from low pass amplifier and extracts the phase and quadrature components. These signals are then sampled and quantized by an analog-to-digital converter by adding their in phase and quadrature components at the input. Signal samples are processed to confirm that a primary user is present in the frequency range being analyzed. The sensor controller receives the results and passes them on to the user who requested them through the output interface. Here, the controller is an Arduino. It is informed to the user by connecting via the internet.

8. SOFTWARES USED

Software's used in this project are as follows

1) LabView
2) Matlab

9. RESULTS AND DISCUSSION

a) MatLab Results

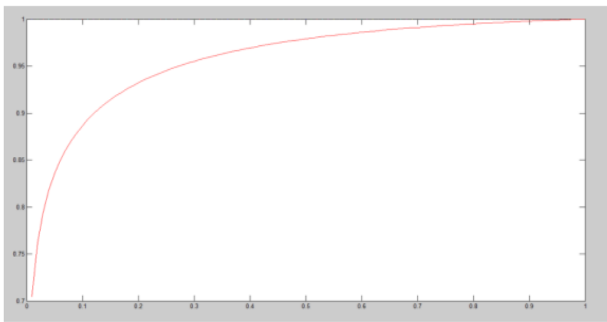

Fig 1 Matlab Results

The graph where pf as input and pd as output is obtained. In the graph if the value decrease beyond the threshold value there will be absence of primary user.

It is reported the relation between imposed Pfa, that is a function of the threshold estimated on a vacant channel, and the worst case obtained Pfa during test phase. In perfect estimation case, such relation should approach the bisector line (y = x). the characterization of the algorithm has been reported in terms of receiver operating characteristic (ROC) curves, describing the relation between the imposed Pfa and the obtained Pd.

b)LabView

Above mentioned blocks (mentioned in figure 1) are simulated in LabView and the result is obtained. The LabView simulated results are more accurate compared to theoretical results.

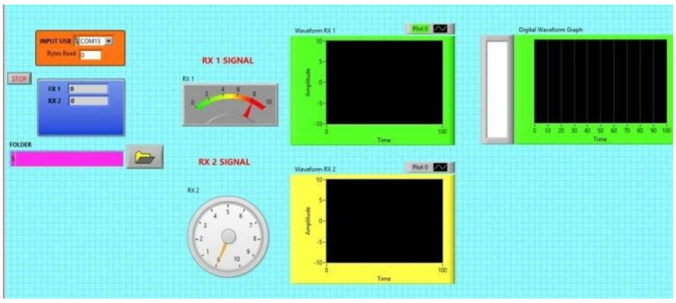

Fig 3 Labview Simulation

10. SCOPE OF THE PROJECT

- The LabView block will be connected to a transceiver and used as a smart sensor to determine the frequency spectrum that is not in use.
- The Spectrum Sensing Database will also be made aware of the outcome.
- Also The system is employed to identify any malicious users.

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11.CONCLUSIONS

The sensor designed detects the spectrum occupancy level in cognitive radio networks. It is used to detect the availability of unoccupied frequency channels in cognitive radio networks. This sensor is used to execute the spectrum sensing tasks and publish the sensing results on spectrum sharing database. A standalone sensor has been introduced for the DSA framework's monitoring of spectrum occupancy. The adopted device has mostly been described before being put to use in TVWSs for spectrum sensing tasks. occupancy outcomes have undergone analysis under a variety of SNR situations and a typical signal operating in TV broadcast bandwidths. Additionally, an analysis to assess its performance under potential channelization misalignments conditions has been completed

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