College of Engineering
Department of Mechanical & Industrial Engineering

College of Engineering
School of Electrical Engineering & Computer Science

To Predict ▶ To Design ▶ To Perform

ME, ECE Capstone Design Programs

Team #56: Wi-Fi Routers with Intelligent Interference Detection and Avoidance

Garrett Hamilton, Brooklyn Isaac, Jamie Jewell, Landry Mathews, & Andrew Wendt

WiFind 2.0 is designed to be a smart Wi-Fi router system that can automatically switch its current operating channel to avoid congestion and improve the user's internet connection and performance.

Problem Description & Motivation

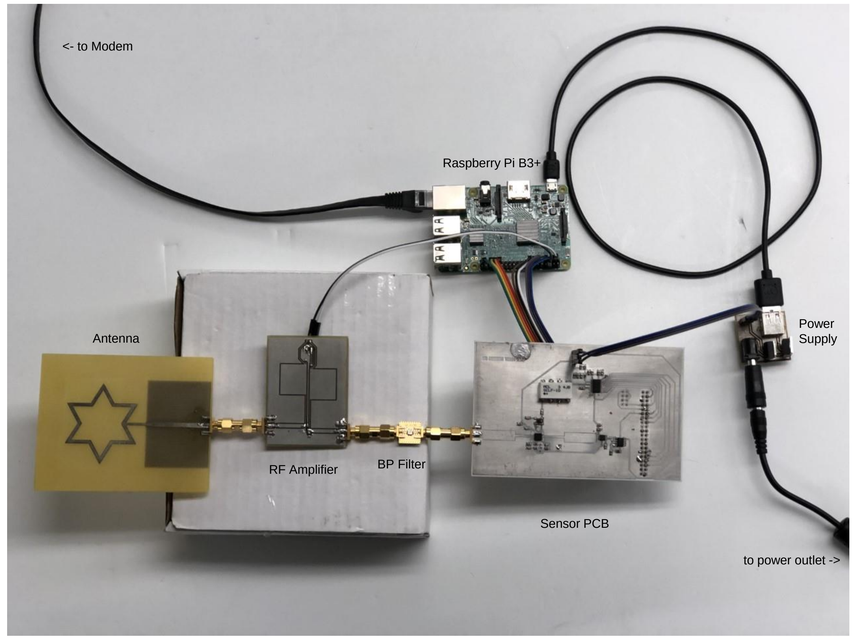
The number of devices operating in the Wi-Fi frequency range are increasing, while the allocated frequency range remains relatively stagnant. Currently, non-overlapping channels are being used to reduce congestion, but this is not feasible with a large number of networks operating in close proximity of each other. The goal is to design a smart Wi-Fi router that will dynamically change the channel it is operating on, to avoid congestion. This form of cognitive radio should increase the user's internet connection and performance.

Engineering Specifications

There are two qualitative requirement; a) design a custom radio frequency receiver system utilizing an analog to digital converter as a replacement for a software defined radio device b) prevent hysteresis. The quantitative requirements are listed in the table below.

Quantitative Engineering Requirements	Justification
Establish a power density threshold that is above or equal to 80% channel bandwidth	Users network performance decreases when more than 80% of the channel's bandwidth is being used.
Establish a packet error rate threshold that is above or equal to 5%	Users network performance begins to have a noticeable negative impact above 10% packet error rate.
Possess a "hopping time" that is no more than 10 seconds long	Reduces the length of interruption during the user's experience.
Have a final design cost that does not exceed $300	The average cost of an off-the-shelf router is around $150. The switching algorithms allows us to double the price. Therefore, the manufacturing cost should not exceed the retail cost.
Maintain dimensions that do not exceed 12" x 10" x 5"	Due to its hardware requirements, the smart router will be slightly larger than the average off-the-shelf router.
Follow IEEE 802.11 standards	This is the standard rules and regulations that must be followed regarding the 2.4-2.483 GHz frequency range.
Channels should not return to the channel it was previously on within 30 minutes from switching channels	It is not advantageous for users to switch channels back and forth between two channels to prevent channel flooding.

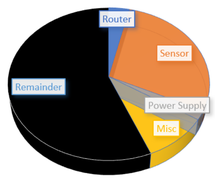
Wi-Find 2.0



Objectives

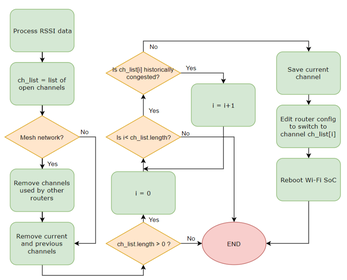
1. Create a fully autonomous smart Wi-Fi router that is able to detect network congestion through packet error rate (PER) and physical layer congestion through spectrum power density.
2. Implement custom radio frequency hardware to replace the functionality of the universal software radio peripheral used in the previous project.
3. The algorithms used for channel selection and switching should be optimized for reduce the time it takes to complete the algorithms.
4. Capable of communicating with multiple routers to contribute to the decision-making algorithms.
5. The connected system should have size and cost values that are similar to that of stand off-the-shelf routers.

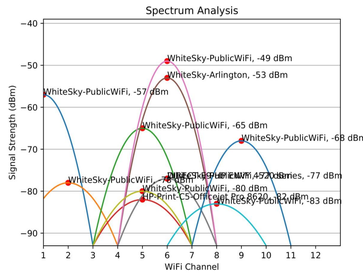
BUDGET BREAKDOWN



Testing

Tested Component	Result	Comments
Antenna	Pass	Center frequency at 2.4GHz, SWR of 1.1
Amplifier	Pass	Gain: 8 dB over entire passband
Bandpass Filter	Pass	Start frequency: 2.4 GHz, Stop frequency: 2.483 GHz
Mixer/Oscillator	Fail	No output was able to be detected from the mixer
Lowpass Filter	Pass	The Lowpass filter was able to pass a 1 MHz signal
Analog to Digital converter	Fail	During testing, the ADC was damaged and had a random changing voltage between 0.17 V and 1.5 V at the input.
Voltage Controller	Pass	The desired voltage was able to be controlled with PWM signals from the Raspberry Pi
Power Supply	Pass	Supplies 5V and 3.3V to desired outputs





A point system is used to determine which channels are congested. A score is assigned to each RSSI value in each channel. The higher the signal strength value, the higher the score it gets. The score is tallied up for each channel and the channels with the lowest scores are the least congested while higher scored channels are more congested.

September — Research

October — Concept Generation

November — Simulation and design change

January — Redesign

February — Manufacturing

March & April — Testing

Sponsor:Bascom Hunter

Advisers: John Scalzo & Shuangqing Wei