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10/15/2024

Team 5 Practicum Project Progress Report: Generate Three Projects and Choose One

Three initial project ideas:
#1. Anti Drone Device (Drone Swatter)
#2. Air Filter System
#3. Handheld Wordle Game (Handle)

Descriptions of each project idea:

Project #1 Name: Anti Drone Device (Drone Swatter)
Project #1 Description:
Drone Swatter is a drone detection and deterrence system that uses targeted radio frequency (RF) analysis to identify and disrupt nearby drones by detecting telemetry signals commonly used for drone communication within the 2.4 GHz and 5 GHz frequency bands. When a drone is detected within a specified proximity, an alert is generated with an option to jam the drone's control signal by broadcasting broadband white noise, temporarily disabling its operation by tampering with its pathfinding and connection.
Project #1 Concept of Operation:
Detection: The system remains idle while on and continuously scans for signals on 2.4 GHz and 5 GHz frequencies, typical of drone telemetry and control.
Telemetry Decoding: When a suspected drone signal is detected, the system attempts to decode its telemetry data to assess proximity and direction.
User Alert: If a drone is detected, the system alerts the user through an audible and visual signal.
Optional Jamming: With user initiation, the system transmits a controlled broadband noise signal to jam drone control, providing a secure perimeter around sensitive areas.
Project #1 Components:
Sensors
1) Software-Defined Radio (SDR):

HackRF One: Well-suited SDR, covering a wide frequency range (1 MHz to 6 GHz), including both 2.4 GHz and 5 GHz bands, and allowing full-duplex communication. It will be the primary device for capturing telemetry signals, decoding data, and initiating detection protocols.

2) Antennas:

Dual-Band Antenna (2.4 GHz and 5 GHz): A single dual-band antenna enhances signal detection for both frequency bands, simplifying the design while ensuring coverage.

Yagi Directional Antenna: This directional antenna is used for precise detection and tracking of the drone's approach direction, improving system responsiveness.

Controller

ESP32-S3 Microcontroller: The ESP32-S3 offers both Wi-Fi and Bluetooth capabilities, making it ideal for managing the SDR, performing initial signal processing, and controlling alert and jamming functions. It provides reliable data handling and control at a low cost, integrating well with the HackRF One and antennas.

Actuators

1) Broadband Noise Generator:

Mini-Circuits ZX93-2500+ Noise Source: This high-power noise source generates broadband white noise on the target bands (2.4 GHz and 5 GHz). Paired with the appropriate directional antennas, it provides efficient jamming capabilities when the user activates this mode.

2) Power Amplifier Module:

RF Power Amplifier (2.4 GHz and 5 GHz compatible): Boosts noise signal to ensure effective jamming within the desired radius, thus maintaining signal integrity during jamming.

3) User Alert System:

Buzzer: Emits audible alert when a drone is detected within range, ensuring prompt notification.

LED Indicator Panel: Provides a visual signal strength indication, giving the user an immediate sense of proximity and detection status.

Project #2 Name: Air Filter System

Project #2 Description:

The purpose of the air filter system is to identify problems with air quality and initiate a dual filtration process to enhance the surrounding environment. To monitor air contaminants and modify the filtration rate accordingly, it uses a collection of sensors. With the help of an ESP32 microcontroller, the system can be operated automatically or by the user over Wi-Fi in real-time monitoring. The system has an LCD screen that provides real-time feedback on system status and air quality levels. Air is filtered through two layers of cloth.

Project #2 Concept of Operation:

Detection: The system continuously monitors the air for pollutants such as dust, gasses, and humidity. It remains idle until pollutant levels rise above a certain threshold.

Sensor Readings: Once a pollutant is detected, ESP32 reads data from the sensors and evaluates the air quality levels. The system determines whether filtration needs to be activated or adjusted.

User Alert and Control: The system can alert the user via Wi-Fi notifications and display real-time air quality data on the LCD screen. The user can control the system manually or allow automatic filtration adjustment based on sensor data.

Filtration Control: The air is passed through two cloth filters, a coarse filter and a fine filter to remove larger particles and fine pollutants. The system dynamically adjusts the airflow using motor control relays based on the severity of contaminants. Filtration continues until safe air quality levels are restored.

Project #2 Components:

Sensors:

Air Quality Sensor (MQ-135): Detects various harmful gasses like CO_2, ammonia, and benzene.

Humidity and Temperature Sensor (DHT22): Monitors the air's humidity and temperature to adjust filtration speed and ensure optimal performance.

Controller:

ESP32 Microcontroller: Manages sensor data, processes air quality information, controls motor, provides Wi-Fi connectivity for remote monitoring, and communicates with the LCD screen.

Actuators:

Fan Motor: Adjusts the airflow rate to filter out pollutants based on the sensor readings.

Relay Modules: Controls the activation and power levels of the filtration fan, allowing precise control over the filtering process.

Display Screen:

(16x2 or 20x4) LCD Display: Shows live air quality and pollutant levels, humidity, temperature, system status, and alerts. ESP32 refreshes data on this display continuously so that the user will have explicit visual feedback about air quality conditions.

Filtration Components:

Air Filter Cloth: First Layer: The first layer is the intake of air, which catches larger particles like dust, making it the front line of defense in the system.

Second Layer: It is at the air outlet and further strengthens the filtration by catching the finer particles to ensure only clean air is released.

Project #3 Name: Handheld Wordle Game (Handle)

Project #3 Description:

The Handheld Wordle Game would, in operation, take a word from the Wordle API and use it for a Wordle-style game built into a handheld gaming console. It brings a level of dimensionality to the phone game, and would enable us to add extra features to spice up Worlde itself. The game requires a built in screen, speakers, controllers/keyboard and a case. The system connects to the Wordle API either through Wi-Fi or through a phone Bluetooth connection and takes the daily Wordle word, which it then uses to play a word guessing game with the user.

Project #3 Concept of Operation:

Boot Up: Upon powering on the device, the handheld will prompt the user with the option to play today's Wordle game and to display their longest streak.

Getting Today's Wordle Word: After selecting to play a game, the ESP32 will use either Wi-Fi or bluetooth to connect to Wordle’s free API in order to grab a random five-letter word. The screen will then display five blank boxes.

Gameplay: Using the dials and keyboard, users will type a five-letter word and hit enter. The ESP32 will then compare that word against the daily word and use colored squares on the graphical display to communicate to the user which letters are incorrect, which letters are correct, and which letters are in the word but in the wrong spots.
Finishing the Game: Once the user guesses the word or runs out of chances, the game will end, and if the user was successful, the game will increase their win streak. If they fail, the streak will be reset instead.

Project #3 Components:

Sensors:

Push Button Switches: A switch network will be used to create a controller or keyboard interface that the user will utilize to interact with the game.
TE Connectivity / Alcoswitch: A Potentiometer dial such as the TE Alcoswitch can be implemented in order to work as a selection wheel or menu scroll wheel.

Controller:

ESP32-S3 Microcontroller: The ESP32-S3 offers options for Wi-Fi and Bluetooth, both possible ways to connect to the Wordle API in order to get the daily word. The ESP32-S3's flexibility and ease of programming will give us room to integrate both software and hardware features. Moreover, the non-volatile memory storage of the ESP32 will be beneficial in storing streaks and high scores.

Actuators:

Adafruit 1.9" 320x170 Color IPS TFT Display - ST7789: A colored screen is necessary for the functionality of a Wordle game, and the screen will show the number of remaining guesses, which letters are in the correct spots, and which letters are incorrect.
CVS-1508 Speakers: Add tactile sound feedback when a correct letter is selected, the word is guessed correctly, or the player loses the game.
28821 Coin Vibration Motor: A motor can be used to add a physical rumble feature to the game that, coupled with the sound, will provide a more exciting video-game experience for the user.

Power:

9V Battery Snaps & Contacts 9V PCB MOUNT: The 9 volt battery casing attached to the back of the device will power the screen, ESP32, and sensors. A rechargeable 9 volt battery should provide enough mA hours to power the handheld for up to 6 hours.
DC-to-DC Converter: Not all modules on the board will require the same amount of power. So, where necessary, an appropriate DC-to-DC converter will be selected to meet those power needs.

Figure 1. Project #1

Figure 2. Project #2

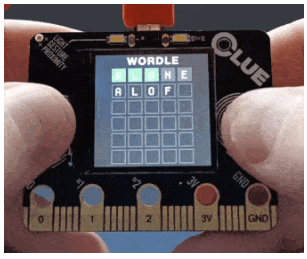

Figure 3. Project #3

Ultimately, the final project idea we have chosen to build is the Handheld Wordle Game. We passed on the Anti Drone Device project idea because it sounded too sophisticated and challenging to be completely implemented in the remaining seven weeks of the term, and it would require the availability of a drone which none of us have. We passed on the Air Filter System project idea because it did not sound challenging enough, as several members of the group already worked on similar projects, and a couple even designed and built air filter systems previously as part of the ECE 212 course. The Handheld Wordle Game is a new and unique project idea never designed by any team member, so it is an evenly fresh experience for us to implement using the disciplined design process taught in class and the available skills .

Finally, we came up with unique names: Handle for our project, Handle Builders for our team, and Handheld Wordle Game for our code repository.